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Beta, value, and growth: Do dichotomous risk-preferences explain stock returns?☆

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ABSTRACT

I propose a Capital Asset Pricing Model in which investor demand exhibits a speculative component. In equilibrium, investors' optimal trade-off between diversification and speculation generates predictable patterns for stocks with extreme book-to-market ratios. Using data on U.S. stocks, I find evidence consistent with the model predictions. I show that the value premium varies with investors' propensity to speculate, and therefore includes a substantial behavioral component. Overall, the findings shed new light on the role of dichotomous risk-preferences in asset pricing.

1. Introduction

A large body of experimental evidence shows that individuals simultaneously exhibit both risk-averse and risk-seeking behavior (see, e.g., Shoemaker, 1982, Camerer, 1995, and Starmer, 2000, for excellent surveys). Using two decades of U.S. households' stockholdings data from the Survey of Consumer Finances, Polkovnichenko (2005) is the first to find non-experimental evidence for this type of preferences. American households hold well-diversified portfolios through various types of mutual funds, but at the same time also hold undiversified portfolios made up of very few stocks. Interestingly, they seem to be aware of the higher risk of underdiversification. They choose it in an attempt to get ahead by hoping to capture large, although unlikely, gains.[1] In a recent study, Dimmock et al. (2021) find similar results using data from a RAND American Life Panel survey.

In this paper, I explore the potential role of dichotomous risk-preferences in asset pricing. I propose a Capital Asset Pricing Model (Sharpe, 1964; Lintner, 1965; Black, 1972) in which investor demand exhibits a speculative component. In equilibrium, investors' optimal trade-off between diversification and speculation generates predictable patterns for stocks with extreme book-to-market ratios.[2] Using monthly data on U.S. stocks from 1926 through 2017, I find evidence consistent with the model predictions. I show that simple trading strategies on value and growth stocks yield positive and robust abnormal returns, both in portfolio analysis and in Fama–MacBeth regressions with firm characteristics. The results suggest that mispricing accounts for up to 44% of the value premium. Interestingly, this magnitude is close to the mispricing component of asset pricing anomalies reported by McLean and Pontiff (2016).

The central prediction of the model is that abnormal returns on value and growth stocks should vary with agents' propensity

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[1] In particular, the median fraction of speculative investments ranges from 15% to 33% of total financial assets across different wealth cohorts, which suggests that this type of investment is also non-negligible in size.

[2] Stocks with high and low book-to-market ratios are commonly referred to as "value" and "growth" stocks, respectively, and their difference in returns is known as the "value premium".

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to speculate. Baker and Wurgler (2006, 2007) show that such propensity is more pronounced when investors exhibit some form of sentiment.[3] The cross-sectional mispricing of the book-to-market ratio should then be stronger for stocks characterized by a high sentiment beta (Glushkov, 2005; Baker et al., 2012). The empirical evidence lends support to this prediction, as sentiment betas explain away abnormal returns on extreme book-to-market stocks. While previous literature finds no significant relation between market-wide investor sentiment and the value premium (Baker and Wurgler, 2006, 2007; Stambaugh et al., 2012), I show that the relation is actually quite strong when measuring investor sentiment at the stock level.

The model also predicts that the diversification component of stock demand increases during good economic times, whereas the speculative component decreases. Abnormal returns on value and growth stocks should then be concentrated around economic downturns, when speculative demand is large. Consistent with this prediction, I find that an increase in the cyclical component of industrial production or personal income is associated with a substantial decrease in abnormal returns on extreme book-to-market stocks. Previous studies show that the risk-based explanation of the value premium implies a negative correlation with the business cycle (see, e.g., Lakonishok et al., 1994; Petkova and Zhang, 2005). I find that the mispricing component of the value premium follows a similar countercyclical pattern.

In their pioneering theoretical work, Shefrin and Statman (2000) find that a dichotomous attitude towards risk should create underdiversification. Polkovnichenko (2005) and Dimmock et al. (2021) provide empirical evidence for this prediction, and suggest that further efforts are needed to integrate such risk-preferences in portfolio theory and asset pricing. To the best of my knowledge, the present work is the first to implement this point by deriving specific theoretical implications for stock prices. The findings provide support to the intuition that dichotomous preferences in portfolio formation should ultimately affect stock returns, thus making this framework a promising avenue for future asset pricing research.

In the theoretical analysis, I consider a two-period economy in which the representative agent maximizes utility over consumption under borrowing constraints. To consume in the second period, the agent can invest in a risk-free security and two risky assets. In addition to the canonical diversification motive, the agent also invests in speculation. This specification incorporates the fact that risk-seeking behavior is present in all individuals to some extent (see, e.g., Friedman and Savage, 1948; Kahneman and Tversky, 1979; Lopes, 1987; Polkovnichenko, 2005), in an attempt to get a shot at riches (Shefrin and Statman, 2000). Specifically, gains may be coded in separate mental accounts (Thaler, 1980, 1985, 1999), depending on the aspiration of the subject (Shefrin and Statman, 2000; Das et al., 2010).

In equilibrium, the agent forms a separate portfolio for each of the two investment motives. In doing so, the expected utility of earning \$1 from diversification is set equal to that of earning \$1 from speculation, which avoids instances of extreme risk-taking known as the plungers issue (Hirshleifer, 1966). At the optimum, the diversification portfolio is mean–variance efficient and includes both risky assets. The speculative portfolio instead includes only one of the assets, as the agent's utility from speculation is convex and leads to a corner solution. While this result differs from standard portfolio analysis, it is qualitatively consistent with real-world investment behavior.[4]

The choice as to which asset to pick for speculation depends on its payoff function. Since utility in the speculative domain increases with both the first and second moment of an asset's payoff, a sufficient condition for an asset to be picked for speculation is that its payoff function exhibits a higher mean and volatility than the other asset. In turn, the asset picked for speculation trades at a lower book-to-market ratio if the agent's propensity to speculate is large enough. A sufficient condition for the latter relation to hold is that the returns on the speculative asset are no more volatile than those on the other asset.[5]

The presence of speculative demand affects the security market line both theoretically and empirically. On the theoretical side, the agent reduces current consumption to invest in speculation, which increases the risk-free rate. The security market line then tilts to the right with respect to the case with standard risk-averse preferences. Empirically, the presence of speculative demand depresses the returns on the market portfolio. The empirical security market line then lies below its theoretical counterpart, underestimating the risk premium that the agent requires in the diversification domain.

This creates a number of predictable patterns for value and growth stocks. Since value stocks only enter the diversification portfolio, they should yield positive abnormal returns due to the (empirically) flatter security market line. On the other hand, growth stocks yield negative abnormal returns due to the presence of speculative demand. The effect should be comparatively weaker, however, because growth stocks also enter the diversification portfolio, which partly offsets their overpricing. Overall, the mispricing of value and growth stocks increases with investors' propensity to speculate.

I also find that investments in the diversification portfolio increase with wealth, whereas speculative investments follow the opposite pattern. The intuition is that a poorer agent seeks an overall riskier financial position in an attempt to increase future consumption. The economic mechanism is similar to Kahneman and Tversky's (1979) loss aversion, with the important difference that the agent has preferences over consumption levels rather than changes with respect to a reference point. This feature of investor demand implies that the mispricing of value and growth stocks is countercyclical.

In the second part of the paper, I take these predictions to the data. As a preliminary exercise, I verify whether growth stocks meet the model's two sufficient conditions to be selected and priced as speculative assets. To this end, I analyze the payoff function and return volatility of companies with extreme book-to-market ratios. First, I find that growth stocks exhibit superior but also more volatile operating performance with respect to value stocks, which makes them comparatively more attractive as speculative investments. Second, I find that growth stocks exhibit less volatile returns than value stocks, which makes their lower book-to-market ratio consistent with the presence of speculative demand. Therefore, the identification of growth stocks as speculative investments appears to be a good fit.[6]

To test the model predictions, I analyze abnormal returns on value and growth stocks. In the first group of tests, I perform a portfolio analysis. I primarily define value and growth stocks as portfolios of U.S. stocks from the NYSE, AMEX, and NASDAQ, formed on the ratio between book value and market value of equity, calculated at the end of each June using NYSE breakpoints.

3 Note that this category includes both individual and institutional investors (Barber and Odean, 2002; Hong and Kostovetsky, 2012; DeVault et al., 2019).

4 For example, American households simultaneously invest in diversification through the market portfolio, and speculation through a subset of stocks (Polkovnichenko, 2005; Dimmock et al., 2021).

5 The intuition behind this result is that the volatility of returns decreases nonlinearly with the price level. However, this is not a necessary condition (see the Appendix for details).

6 This point is also consistent with previous literature (see, e.g., Conrad et al., 2014). It is important to stress, however, that diversification and speculation are not mutually-exclusive investment motives. As the model suggests, growth stocks are also part of the efficient portfolio.

In particular, I consider the top and bottom 30%, 20%, and 10%. For robustness, I also include portfolios formed on cashflow-to-price and earnings-to-price (Lakonishok et al., 1994; Fama and French, 1996). All portfolio data is from Kenneth French's website. The sample period is from July 1926 to December 2017 for the book-to-market portfolios, and from July 1951 to December 2017 for the cashflow-to-price and earnings-to-price portfolios.

For each of these portfolios, I construct the dependent variable as equal-weighted returns. The reason for this choice is twofold. First, value-weighting makes the definition of value and growth stocks almost identical to the two legs of the book-to-market factor (HML), which makes the estimates uninterpretable. Equal-weighting then allows for the inclusion of HML as an explanatory variable, which is important because it should capture the systematic risk associated with the book-to-market ratio (see, e.g., Fama and French, 1993; Davis et al., 2000). Second, value-weighting tends to obscure relevant mispricing patterns, which typically affects stocks of smaller size (Baker and Wurgler, 2006).

Following previous literature, I start the analysis with the Fama and French (1993) three-factor model (see, e.g., Daniel and Titman, 1997; Davis et al., 2000). The results lend support to the theoretical predictions. Abnormal returns are positive and significant for value stocks, negative and significant for growth stocks, and therefore positive and significant for the value-minus-growth portfolio. Also, the mispricing of growth stocks is indeed weaker (in absolute value) than that of value stocks. Specifically, I find abnormal returns equal to 0.23% per month for stocks with the top 30% book-to-market ratios, increasing to 0.27% for the top 20%, and 0.28% for the top 10%. For stocks with the lowest book-to-market ratios, these estimates are −0.13%, −0.18%, and −0.23%, respectively. The results are analogous for the cashflow-to-price and the earnings-to-price portfolios.[7]

One concern is that factor models may not entirely capture systematic risk, as firm characteristics may affect stock returns in their own right. To address this issue, I estimate Fama–MacBeth regressions from Edmans (2011) using CRSP-Compustat data, and introduce a dummy variable that takes on value one for the bottom 30% price-to-book stocks, defined as above, and zero otherwise. To effectively compare the top and the bottom 30% of the price-to-book distribution, I leave out the stocks that lie in the middle 40%. In this setup, the coefficient of the dummy variable can be interpreted as abnormal returns (Gompers et al., 2003; Mueller et al., 2017). Reassuringly, the results are similar to those from the time series analysis.

The main model prediction is that abnormal returns on value and growth stocks should vary with agents' propensity to speculate. To identify the latter, I acknowledge that investors engage in speculative investments when they exhibit high sentiment (Baker and Wurgler, 2006, 2007). Given the cross-sectional nature of speculative demand (Stambaugh et al., 2012), I measure the propensity to speculate at the stock level using investor sentiment betas (Glushkov, 2005; Baker et al., 2012). Consistent with the theoretical arguments, I find that sentiment betas explain away the relative mispricing of value and growth stocks. The results are robust to a number of alternative explanations, such as neglected HML risk (Daniel and Titman, 1997), biases in expectations (Lakonishok et al., 1994), and preferences for idiosyncratic volatility (Bali and Cakici, 2008), penny stocks (Bhootra, 2011), or stocks with a high market beta (Frazzini and Pedersen, 2014).

In the last group of tests, I analyze how the mispricing component of the value premium varies over the business cycle. Consistent with the theoretical predictions, I find that a one-standard-deviation increase in the cyclical component of the monthly industrial production index, estimated through the Hodrick and Prescott (1997) filter, is followed by a 0.41% decrease in abnormal returns on the value-minus-growth portfolio, constructed using top and bottom 30% book-to-market stocks, respectively. For the 20% and the 10% thresholds, the coefficient increases in magnitude (and significance) to 0.43% and 0.60%, respectively. The estimates are similar for the other price-to-book portfolios, and when repeating the analysis with real disposable personal income.

The paper makes several contributions to the literature. First, the findings speak to the literature on the value premium. The positive relation between the book-to-market ratio and stock returns is a well-known empirical regularity in stock markets around the world.[8] The findings presented in this paper support the view that the value premium includes a mispricing component (see, e.g., Chen et al., 2008), offering new insights on the underlying mechanism. While previous studies suggest the presence of biases in expectations (see, e.g., Lakonishok et al. (1994) for an excellent review), I find that the mispricing of the value premium is related to investors' propensity to speculate. The results then support the idea that speculative behavior does not necessarily reflect errors in judgment (Polkovnichenko, 2005).

More generally, the paper contributes to a growing literature on speculative demand. Barberis and Huang (2008) develop an asset pricing model based on Tversky and Kahneman's (1992) cumulative prospect theory, in which investors overweight extreme gain and loss outcomes. In equilibrium, most investors hold the market portfolio whereas a few prefer some lottery-like assets with a skewed return distribution. The setup I propose differs from theirs in that it does not require biased probability estimates, a preference over higher orders of the return distribution, or a reference point. The results also differ in terms of portfolio formation, as the representative agent in this paper simultaneously engages in both diversification and speculation. Other research explores an approach in which investors derive direct utility from speculative activities, such as trading (Luo et al., 2019), or gambling (Conlisk, 1993). In this paper, speculation emerges from risk preferences alone, thus incorporating recent empirical evidence on investor behavior (Polkovnichenko, 2005; Dimmock et al., 2021).

The paper proceeds as follows. Section 2 presents the model. Section 3 introduces the data. Section 4 discusses the empirical results. Section 5 concludes.

2. Model

In the theoretical framework, I consider a two-period economy in which the representative agent maximizes utility over consumption under borrowing constraints. To consume in the second period, the agent can invest in a risk-free bond and two risky assets.[9] The two assets, denoted by A and B, yield an expected payoff of $\bar{v}_i$ with a standard deviation of σ_i, for $i = A, B$. Both assets are available in unit supply. Agents exhibit unbiased expectations and there is no asymmetric information.

7 I also find similar estimates in simple CAPM regressions, which is a less rich specification but also more consistent with the predictions of the model, and in the five-factor models from Pástor and Stambaugh (2003) or Fama and French (2015).

8 For empirical evidence in the U.S., see, e.g., Stattman (1980), Rosenberg et al. (1985), and Fama and French (1992). For foreign countries, see, e.g., Chan et al. (1991), Capaul et al. (1993), and Fama and French (1998).

9 The presence of only two risky assets is for simplicity and without loss of generality.

In addition to the canonical diversification motive, agents also invest in speculation.[10] This setup incorporates the fact that risk-seeking behavior is present in all individuals to some extent, and gains may be coded in separate mental accounts depending on the aspiration of the subject.[11] Following previous literature, I define utility over such accounts as additively separable (see, e.g., Lopes, 1987; Shefrin and Statman, 2000; Barberis et al., 2001; Barberis and Huang, 2008).

The agent solves:

$$\max_{\left\{c_0, \tilde{c}_1, \tilde{c}_1^s\right\}} U = u(c_0) + \frac{1}{1+\delta} E\left(u(\tilde{c}_1) + u_s(\tilde{c}_1^s)\right), \tag{1}$$

where c_0 is current consumption, $\tilde{c}_1$ and $\tilde{c}_1^s$ represent future consumption coming from the proceeds of the investments in diversification and speculation, respectively, and δ is the subjective discount rate. The agent then codes future payoffs into two separate mental accounts, over which preferences are concave ($u''(c_1) < 0$) and convex ($u_s''(c_1^s) \geq 0$), respectively. In either investment, the agent cannot take leveraged positions.[12]

Under these preferences, the optimal investment is as follows (see Appendix A.1). Indifference curves are upward-sloping and convex in the diversification domain, whereas they are downward-sloping and concave in the speculative domain. The agent is then risk-averse over diversification and risk-seeking over speculation. This implies that the agent chooses a combination of both assets for the diversification portfolio, but only picks one asset for the speculative portfolio.

The choice of which of the two assets to pick for speculation depends on their payoff functions. Since utility in the speculative domain increases with both the first and second moment of an asset's payoff distribution, a sufficient condition for an asset to be picked for speculation is that its payoff function exhibits a higher mean and volatility than those of the other asset. For exposition purposes and without loss of generality, I assume that the agent picks asset B for the speculative portfolio.

Then the constraints for the maximization problem are as follows:

$$c_0 = w_0 - b - x_A - x_B - x_B^s, \tag{2}$$

$$\tilde{c}_1 = b(1+r_f) + x_A(1+\tilde{r}_A) + x_B(1+\tilde{r}_B), \tag{3}$$

$$\tilde{c}_1^s = x_B^s(1+\tilde{r}_B), \tag{4}$$

where w_0 is the agent's wealth endowment (akin to sure income from Phelps, 1962), b is the investment in the riskless bond, x_A is the total investment in asset A, x_B and x_B^s are the investments in asset B driven by the diversification and the speculative motive, respectively, r_f is the risk-free rate, $\tilde{r}_A$ is the return on asset A, and $\tilde{r}_B$ is the return on asset B. Note that total demand for asset B is then $x_B + x_B^s$.

The first-order conditions yield (see Appendix A.2):

Proposition 1. *At the optimum, the representative agent equals the expected utility of earning \$1 from diversification to that of earning \$1 from speculation:*

$$E\left(u'(\tilde{c}_1)\right) = E\left(u_s'(\tilde{c}_1^s)\right), \tag{5}$$

which rules out corner solutions in the allocation of wealth across the two domains. This implies that even if the speculative asset defaults in the second period, the agent may still consume the proceeds from the diversification portfolio (generated by the other asset).

The first-order conditions also imply that if utility is convex enough in the speculative domain, the agent is willing to pay a higher price per unit of expected payoff for asset B than they are for asset A. That is:

Proposition 2. *In equilibrium, the asset picked for speculation exhibits a lower book-to-market ratio if the agent's propensity to speculate is large enough.*

A sufficient condition for this relation to hold is that the returns on the speculative asset (i.e., asset B) are no more volatile than those on the other asset (i.e., asset A). This is due to the fact that the volatility of returns decreases nonlinearly with the price level (see Appendix A.3 for details).

The presence of speculative demand affects the security market line in two ways. Compared with a model with standard risk-averse preferences, the security market line tilts to the right. The reason is that the agent reduces current consumption to invest in speculation, which increases the risk-free rate. From an empirical standpoint, the presence of speculative demand depresses the returns on the market portfolio. The empirical security market line then lies below its theoretical counterpart, underestimating the risk premium that the agent requires for diversification. This implies (see Appendix A.4 for details):

Proposition 3. *The canonical security market line underestimates (overestimates) returns on the asset with a high (low) book-to-market ratio. The mispricing is stronger for the asset with high book-to-market, and increases with the agent's propensity to speculate.*

The magnitude of the mispricing is asymmetric across the two assets because the speculative one also enters the diversification portfolio, which partly offsets the overpricing brought about by speculative demand. The agent's propensity to speculate, on the other hand, is captured by the coefficient of absolute risk-seeking, which represents the counterpart to the coefficient of absolute risk-aversion from the diversification domain.

Finally, the first-order conditions also imply:

Proposition 4. *The diversification component of stock demand increases with the agent's wealth, whereas the speculative component decreases.*

The intuition is that a poorer agent increases the overall risk of their financial position by shifting from diversification to speculation, in an attempt to increase future consumption (see Appendix A.5 for details). An important implication of this behavior is that the mispricing of the two assets, which is driven by speculative demand, is countercyclical.

At face value, this behavior is similar to that of an investor with prospect preferences who would exhibit risk aversion in the positive-return range and risk-seeking behavior in the negative-return range. However, there are two subtle but important differences here. First, the representative agent from this model does not exhibit a reference point. Second, and related, the agent exhibits a preference over levels of wealth rather than changes.

[10] The results that follow would be similar in a setup where only a fraction of investors exhibit dichotomous preferences, as long as speculative demand is large or unpredictable enough for arbitrageurs (De et al., 1990), or processing information is costly (Hirshleifer and Teoh, 2003).

[11] For example, Lopes (1987) shows that the human emotions of fear and hope generate desires for both security and potential within the same individual. Shefrin and Statman (2000) build on this insight and propose a behavioral portfolio theory that incorporates mental accounting into asset pricing, assuming that individuals have a wealth aspiration level and a minimum acceptable probability for achieving that aspiration. Similarly, Das et al. (2010) integrate behavioral and mean–variance portfolio theory in a mental accounting framework, in which risk is defined as the probability of failing to reach the threshold level in each mental account.

[12] Therefore, there are no bankruptcy concerns.

As a result, risk-seeking behavior is moderated by the mere level of wealth instead of changes with respect to a pre-specified reference point.[13]

2.1. Testable implications

In the empirical work that follows, I test three specific hypotheses that are implied by the propositions above. From Propositions 2 and 3, I derive:

Hypothesis 1. Value stocks exhibit positive abnormal returns in standard asset pricing models, whereas growth stocks exhibit negative abnormal returns. The former effect should be of stronger magnitude than the latter.

Hypothesis 2. Abnormal returns on value and growth stocks should increase with investors' propensity to speculate.

Hypothesis 1 represents an important empirical test for two reasons. First, it provides a specific rationale behind the mispricing of value and growth stocks, with guidance as to which effect should be stronger. Second, while the value premium is well-known and seems to reflect compensation for risk, it is unclear whether it also includes a mispricing component (see, e.g., Davis et al., 2000). On the other hand, Hypothesis 2 builds on the model prediction that greater risk-seeking behavior amplifies the relative mispricing of value and growth stocks.

From Proposition 4, I derive:

Hypothesis 3. The mispricing component of the value premium is countercyclical.

The economic mechanism underlying Hypothesis 3 is that the optimal investments in diversification and speculation vary with the level of wealth. When agents are poorer, they move money away from diversification and reallocate it towards speculation. To the degree that speculative demand generates mispricing for value and growth stocks, then the mispricing component of their return differential should be more pronounced during bad economic times when speculative demand is large.

In the empirical analysis below, I take these predictions to the data.

3. Data

I define value and growth stocks in three alternative ways. In the primary specification, I consider the ratio between book value and market value of equity, calculated at the end of each June using NYSE breakpoints of top/bottom 30%, 20%, and 10%. The book value of equity used in June of year t is the book equity for the last fiscal year end in $t-1$. The market value of equity is price times shares outstanding at the end of December of $t-1$. In addition, I also consider the cashflow-to-price and earnings-to-price ratios. The cashflow used in June of year t is total earnings before extraordinary items, plus equity's share of depreciation, plus deferred taxes (if available) for the last fiscal year end in $t-1$. The earnings used in June of year t are total earnings before extraordinary items for the last fiscal year end in $t-1$.

Table 1 reports the summary statistics of monthly excess returns on equal-weighted portfolios of stocks with extreme book-to-market ratios. The sample period is from July 1926 to December 2017 for the book-to-market portfolios, and from July 1951 to December 2017 for the other price-to-book measures, for an overall number of 1,098 and 798 monthly observations, respectively. To estimate excess returns, I use the one-month Treasury bill rate. All portfolio data is from Kenneth French's website, and constructed using the universe of U.S. stocks from the NYSE, AMEX, and NASDAQ.

Table 1
Summary statistics: Returns on book-to-market portfolios.

Panel A. 30% threshold					
	Mean	SD	P25	Median	P75
Low30-Rf	0.62	6.78	−2.85	0.98	4.16
Mid40-Rf	1.02	6.94	−2.23	1.23	4.13
High30-Rf	1.45	8.65	−2.26	1.25	4.55
High30-Low30	0.83	4.62	−1.16	0.42	2.26
Panel B. 20% threshold					
	Mean	SD	P25	Median	P75
Q1-Rf	0.56	6.91	−3.02	1.00	4.20
Q2-Rf	0.86	6.67	−2.41	1.22	4.27
Q3-Rf	0.99	6.91	−2.23	1.14	4.08
Q4-Rf	1.17	7.39	−2.15	1.27	4.11
Q5-Rf	1.56	9.24	−2.24	1.24	4.75
Q5-Q1	1.00	5.49	−1.28	0.52	2.69
Panel C. 10% threshold					
	Mean	SD	P25	Median	P75
D1-Rf	0.49	7.13	−3.25	0.82	4.33
D2-Rf	0.68	6.66	−2.78	1.11	4.25
D3-Rf	0.78	6.50	−2.45	1.08	4.31
D4-Rf	0.94	6.94	−2.46	1.20	4.32
D5-Rf	0.97	6.88	−2.32	1.09	4.21
D6-Rf	1.01	7.00	−2.19	1.22	4.12
D7-Rf	1.15	7.23	−2.06	1.20	4.17
D8-Rf	1.20	7.65	−2.20	1.24	4.13
D9-Rf	1.43	8.51	−2.10	1.28	4.62
D10-Rf	1.68	10.30	−2.57	1.14	4.85
D10-D1	1.19	6.95	−1.71	0.53	3.15

Summary statistics for the returns on equal-weighted portfolios of U.S. stocks from the NYSE, AMEX, and NASDAQ, formed on the ratio between book value and market value of equity, calculated at the end of each June using NYSE breakpoints (bottom 30%, middle 40%, and top 30% in Panel A, quintiles in Panel B, and deciles in Panel C). The book value of equity used in June of year t is the book equity for the last fiscal year end in $t-1$. The market value of equity is price times shares outstanding at the end of December of $t-1$. The summary statistics are mean, standard deviation, and the 25th, 50th, and 75th percentiles of the distribution. Returns are monthly and expressed in percentage points. Excess returns are calculated by subtracting the risk-free rate (Rf), defined as the one-month Treasury bill rate. The data is from Kenneth French's website. The sample period is from July 1926 to December 2017.

For the 30% breakpoint (Panel A), the average monthly return is 1.45% for value stocks, 1.02% for the middle 40% stocks, and 0.62% for growth stocks. The value premium is then 0.83% per month, and highly significant (t-stat 5.96). For the 20% breakpoint (Panel B), the average return increases monotonically from 0.56% in the bottom quintile to 1.56% in the top quintile, which yields a highly significant value premium of 1.00% (t-stat 6.03). For the 10% breakpoint (Panel C), the average return again increases monotonically from 0.49% in the bottom decile to 1.68% in the top decile, and the 1.19% difference in returns is highly significant (t-stat 5.66). I find an analogous pattern for the average returns on the cashflow-to-price and earnings-to-price portfolios (unreported).

In the theoretical analysis, I find that a sufficient condition for the speculative asset to trade at a lower book-to-market ratio is that it exhibits an equal or lower volatility of returns than the other asset. Growth stocks seem to meet this criterion, as their return volatility is substantially lower than that of value stocks. For the 30% book-to-market threshold, growth stocks exhibit a standard deviation of returns of 6.78%, whereas the standard deviation of returns is 8.65% for value stocks. For the 20% threshold, the estimates are 6.91% and 9.24%, respectively. For the 10% threshold, they are 7.13% and 10.30%, respectively.

[13] This is an important advantage especially when testing the model's predictions, as the empirical identification of a reference point is not required.

Table 2
Summary statistics: Firm characteristics.

Panel A. Full sample					
	Mean	SD	P25	Median	P75
Total assets ($m)	8,583	71,034	112	458	2,185
Market cap ($m)	4,701	20,383	80	395	1,853
EBITDA ($m)	703	2,943	16	66	293
EBIT ($m)	495	2,169	11	46	203
ROA	0.15	0.08	0.10	0.14	0.19
Dividend yield	0.04	4.43	0.00	0.01	0.03
Trading volume (mln shares)	104,797	494,499	1,392	7,588	48,904
Book-to-market	0.97	65.59	0.35	0.57	0.88
Cashflow-to-price	0.29	13.50	0.10	0.16	0.28
Earnings-to-price	0.10	3.89	0.04	0.06	0.10
Panel B. Top 30% book-to-market					
	Mean	SD	P25	Median	P75
Total assets ($m)	12,775	111,569	87	314	1,734
Market cap ($m)	2,333	11,852	35	131	715
EBITDA ($m)	570	2,678	10	34	167
EBIT ($m)	364	1,834	6	22	106
ROA	0.12	0.05	0.08	0.11	0.15
Dividend yield	0.07	4.79	0.00	0.02	0.04
Trading volume (mln shares)	54,472	260,055	609	2,719	17,883
Book-to-market	2.31	133.82	0.76	1.01	1.43
Cashflow-to-price	0.58	22.35	0.16	0.26	0.41
Earnings-to-price	0.18	6.88	0.05	0.08	0.12
Panel C. Bottom 30% book-to-market					
	Mean	SD	P25	Median	P75
Total assets ($m)	5,524	25,066	138	567	2,507
Market cap ($m)	8,014	29,280	205	876	3,910
EBITDA ($m)	857	3,106	26	105	445
EBIT ($m)	651	2,413	20	79	336
ROA	0.20	0.09	0.14	0.19	0.24
Dividend yield	0.01	0.02	0.00	0.01	0.02
Trading volume (mln shares)	168,743	676,426	3,223	18,727	102,890
Book-to-market	0.35	0.23	0.20	0.30	0.43
Cashflow-to-price	0.14	0.12	0.07	0.10	0.16
Earnings-to-price	0.06	0.04	0.04	0.05	0.07

Summary statistics for firm-level accounting and market data in the sample. Panel A includes the full sample, Panel B the top 30% book-to-market firms, and Panel C the bottom 30%. The book-to-market ratio is the ratio between the book value and market value of equity, calculated at the end of each June using NYSE breakpoints. The book value of equity used in June of year t is the book equity for the last fiscal year end in $t-1$. The market value of equity is price times shares outstanding at the end of December of $t-1$. The variables include total assets; market capitalization, calculated at the end of the calendar year; EBITDA; EBIT; return on assets (ROA), calculated as EBIT over total assets; the dividend yield, defined as the ratio between dividends per share and the stock price; trading volume; the book-to-market ratio, defined as above; the cashflow-to-price ratio, where cashflow is defined as total earnings before extraordinary items, plus equity's share of depreciation, plus deferred taxes (if available) in June of year t; and the earnings-to-price ratio, where earnings are defined as total earnings before extraordinary items in June of year t. The summary statistics are mean, standard deviation, and the 25th, 50th, and 75th percentiles of the distribution. The data is from CRSP-Compustat. Observations are annual, and the sample period is from 1960 to 2017.

Table 2 reports the summary statistics for firm-level accounting and market data from CRSP-Compustat, with a breakdown into top and bottom 30% book-to-market companies. The model predicts that a sufficient condition for an asset to be picked for speculation is that its payoff function exhibits a higher mean and variance with respect to the other asset. Growth stocks seem to tick both boxes. Low book-to-market firms exhibit better operating performance than high book-to-market firms on a number of dimensions, such as EBITDA (0.9 v. 0.6 billion), EBIT (0.7 v. 0.4 billion), and return on assets (0.20 v. 0.12), and also exhibit a higher standard deviation for all three measures.

Other metrics also lend support to the identification of growth stocks as potential speculative investments. For example, growth firms pay less dividends than value firms, as attested by a lower dividend yield (0.01 v. 0.07), which makes them harder to evaluate and thus more attractive to speculative demand (see, e.g., Baker and Wurgler, 2006). Correspondingly, growth stocks are characterized by a much higher trading volume (168.7 v. 54.4 billion shares). Among other dimensions of interest, growth firms exhibit higher market capitalization than value firms (8.0 v. 2.3 billion), but lower total assets (5.5 v. 12.7 billion). Finally, growth firms also exhibit a lower ratio between cashflow and price (0.14 v. 0.58), and between earnings and price (0.06 v. 0.18).

4. Empirical results

The empirical analysis proceeds as follows. First, I estimate abnormal returns on value and growth stocks. Second, I analyze their relation with investors' propensity to speculate. Finally, I analyze the pattern of abnormal returns on value and growth stocks over the business cycle.

4.1. Abnormal returns

Factor models

Hypothesis 1 states that standard asset pricing tests underestimate the returns on value stocks, and overestimate the returns on growth stocks. To test this conjecture, I first estimate abnormal returns on value and growth stocks using the Fama and French (1993) three-factor model:

$$R_{i,t} = \alpha_i + \beta_i MKT_t + s_i SMB_t + h_i HML_t + \epsilon_{i,t}, \tag{6}$$

where $R_{i,t}$ represents equal-weighted excess returns on value stocks ($i = v$) or growth stocks ($i = g$), and the value-minus-growth portfolio ($i = p$), defined as an arbitrage portfolio with a long position in value stocks and a short position in growth stocks, and the regressors are the factor-mimicking portfolios for market (MKT), size (SMB), and book-to-market (HML).[14] The factor loadings β_i, s_i, and h_i are time-invariant, and determine the risk premium on portfolio returns.[15] Standard errors are robust to heteroskedasticity and autocorrelation. Hypothesis 1 implies $\alpha_v > 0$, $\alpha_g < 0$, $|\alpha_v| > |\alpha_g|$, and $\alpha_p > 0$.

The reason for the choice of equal-weighting in the portfolio construction is twofold. First, the returns on value-weighted price-to-book portfolios exhibit extremely high correlation with the book-to-market factor (which is also value-weighted), thus making the regression estimates uninterpretable. Using equal-weighted returns then allows for the inclusion of book-to-market portfolios on the left-hand side of the equation, while keeping the book-to-market factor from Fama and French (1993) as a regressor. This is of crucial importance because the latter constitutes a measure of systematic risk (see, e.g., Fama and French, 2004; Liew and Vassalou, 2000), and therefore should be part of the risk premium. Second, value-weighting tends to obscure relevant mispricing patterns, giving too little weight to stocks with greater noise trader demand (Baker and Wurgler, 2006).[16]

Table 3 presents the estimates for the book-to-market portfolios. In Panel A, I consider the 30% breakpoint. The empirical

[14] The book-to-market factor is constructed as the average value-weighted return on two value portfolios minus the average return on two growth portfolios. Value and growth are respectively defined as stocks with top and bottom 30% book-to-market ratios. Each of these two categories is further divided into stocks that exhibit above- and below-median market cap, for a sum total of four portfolios. See Fama and French (1993) for further details.

[15] From an empirical standpoint, the advantage of using an unconditional model is to avoid the hurdle of identifying the relevant state variables for the representative investor (Merton, 1973), which can make the pricing error of models with time-varying betas even more severe than that of models with constant betas (Ghysels, 1998).

[16] Other asset pricing studies also use equal weighting to estimate abnormal returns (see, e.g., Cooper et al., 2001; Hong and Kacperczyk, 2009; Edmans, 2011). Another advantage of this approach is that it makes the results from portfolio analyses directly comparable with those from panel regressions of returns (which I estimate below), as the latter equally weight all observations (Edmans, 2011).

Table 3
Abnormal returns on book-to-market portfolios.

Panel A. 30% threshold										
	a	b	s	h	t(a)	t(b)	t(s)	t(h)	Obs.	$\bar{R}^2$
Low30-Rf	−0.13	1.07	0.67	−0.25	−2.51	55.65	10.42	−8.43	1,098	0.93
Mid40-Rf	0.08	1.01	0.71	0.32	2.03	42.85	16.12	7.97	1,098	0.97
High30-Rf	0.23	1.01	1.06	0.86	4.38	59.84	19.45	16.71	1,098	0.96
High30-Low30	0.36	−0.06	0.39	1.11	5.52	−2.82	3.54	21.79	1,098	0.80
Panel B. 20% threshold										
	a	b	s	h	t(a)	t(b)	t(s)	t(h)	Obs.	$\bar{R}^2$
Q1-Rf	−0.18	1.09	0.67	−0.32	−2.87	48.69	8.87	−9.11	1,098	0.92
Q2-Rf	0.03	1.02	0.67	0.04	0.68	64.52	13.92	1.22	1,098	0.95
Q3-Rf	0.06	1.00	0.68	0.33	1.40	44.35	15.21	8.38	1,098	0.96
Q4-Rf	0.14	0.98	0.81	0.57	3.38	43.74	13.45	10.59	1,098	0.96
Q5-Rf	0.27	1.03	1.16	0.97	3.74	55.84	19.07	16.01	1,098	0.94
Q5-Q1	0.44	−0.07	0.49	1.29	5.19	−3.01	4.08	22.08	1,098	0.78
Panel C. 10% threshold										
	a	b	s	h	t(a)	t(b)	t(s)	t(h)	Obs.	$\bar{R}^2$
D1-Rf	−0.23	1.11	0.69	−0.41	−3.11	41.44	8.14	−8.52	1,098	0.90
D2-Rf	−0.07	1.06	0.63	−0.19	−1.34	55.10	10.60	−7.01	1,098	0.93
D3-Rf	0.00	1.00	0.65	−0.05	0.08	60.84	12.61	−1.60	1,098	0.94
D4-Rf	0.06	1.04	0.68	0.14	1.25	38.95	13.43	3.02	1,098	0.94
D5-Rf	0.06	1.01	0.68	0.28	1.20	52.90	13.19	7.53	1,098	0.95
D6-Rf	0.06	1.00	0.69	0.38	1.31	35.89	17.17	9.08	1,098	0.95
D7-Rf	0.15	0.97	0.78	0.49	3.17	40.85	14.83	10.98	1,098	0.95
D8-Rf	0.13	0.98	0.84	0.64	2.85	44.53	11.85	9.73	1,098	0.95
D9-Rf	0.24	1.03	0.98	0.80	4.69	36.01	13.98	9.87	1,098	0.95
D10-Rf	0.28	1.02	1.34	1.14	2.47	35.21	13.96	11.24	1,098	0.88
D10-D1	0.52	−0.09	0.64	1.55	3.91	−3.09	4.55	15.31	1,098	0.72

Fama–French three-factor model regressions of the excess returns on equal-weighted portfolios of U.S. stocks from the NYSE, AMEX, and NASDAQ, formed on the ratio between book value and market value of equity, calculated at the end of each June using NYSE breakpoints (bottom 30%, middle 40%, and top 30% in Panel A, quintiles in Panel B, and deciles in Panel C). The book value of equity used in June of year t is the book equity for the last fiscal year end in $t-1$. The market value of equity is price times shares outstanding at the end of December of $t-1$. Returns are monthly and expressed in percentage points. Excess returns are calculated by subtracting the risk-free rate (Rf), defined as the one-month Treasury bill rate. The data is from Kenneth French's website. The sample period is from July 1926 to December 2017. The t-statistics are robust to heteroskedasticity and autocorrelation.

Table 4
Abnormal returns on alternative price-to-book portfolios.

Panel A. Cashflow-to-price										
	a	b	s	h	t(a)	t(b)	t(s)	t(h)	Obs.	$\bar{R}^2$
Low30-Rf	−0.10	1.04	0.75	0.01	−1.75	59.02	8.76	0.09	798	0.94
High30-Rf	0.29	0.97	0.77	0.58	6.37	53.60	12.06	10.49	798	0.93
High30-Low30	0.39	−0.06	0.02	0.57	7.52	−4.32	0.89	22.49	798	0.60
Q1-Rf	−0.14	1.06	0.80	−0.07	−2.46	47.90	9.63	−1.19	798	0.93
Q5-Rf	0.30	1.00	0.82	0.62	6.22	45.35	12.17	11.75	798	0.91
Q5-Q1	0.45	−0.07	0.03	0.69	7.49	−3.79	1.07	23.15	798	0.59
D1-Rf	−0.18	1.10	0.85	−0.16	−2.86	47.29	11.62	−3.04	798	0.91
D10-Rf	0.33	1.01	0.88	0.65	4.75	43.14	12.28	11.62	798	0.89
D10-D1	0.51	−0.08	0.03	0.81	6.07	−2.46	0.71	14.79	798	0.54
Panel B. Earnings-to-price										
	a	b	s	h	t(a)	t(b)	t(s)	t(h)	Obs.	$\bar{R}^2$
Low30-Rf	−0.07	1.05	0.78	0.00	−1.23	56.26	9.82	−0.04	798	0.94
High30-Rf	0.27	0.95	0.73	0.59	4.98	48.01	11.41	10.52	798	0.93
High30-Low30	0.35	−0.10	−0.05	0.59	4.89	−4.10	−1.35	21.83	798	0.64
Q1-Rf	−0.11	1.07	0.83	−0.05	−1.58	48.73	10.69	−0.88	798	0.93
Q5-Rf	0.30	0.97	0.78	0.60	5.00	50.34	11.58	10.75	798	0.92
Q5-Q1	0.40	−0.10	−0.05	0.66	5.09	−4.13	−1.46	20.20	798	0.61
D1-Rf	−0.18	1.10	0.91	−0.10	−2.28	35.62	11.78	−1.87	798	0.91
D10-Rf	0.30	1.00	0.88	0.62	4.74	54.36	12.23	11.19	798	0.90
D10-D1	0.48	−0.10	−0.03	0.72	5.05	−3.00	−0.80	16.91	798	0.53

Fama–French three-factor model regressions of the excess returns on equal-weighted portfolios of U.S. stocks from the NYSE, AMEX, and NASDAQ, formed at the end of each June on the ratio between cashflow and market equity (Panel A) and the ratio between earnings and market equity (Panel B). The cashflow used in June of year t is total earnings before extraordinary items, plus equity's share of depreciation, plus deferred taxes (if available) for the last fiscal year end in $t-1$. The earnings used in June of year t are total earnings before extraordinary items for the last fiscal year end in $t-1$. Market equity is price times shares outstanding at the end of December of $t-1$. The portfolios are formed using NYSE breakpoints (top v. bottom 30%, quintiles 5 v. 1, and deciles 10 v. 1). Returns are monthly and expressed in percentage points. Excess returns are calculated by subtracting the risk-free rate (Rf), defined as the one-month Treasury bill rate. The data is from Kenneth French's website. The sample period is from July 1951 to December 2017. The t-statistics are robust to heteroskedasticity and autocorrelation.

pattern is consistent with the model predictions. I find that value stocks yield positive and significant monthly abnormal returns of 0.23% (t-stat 4.38), whereas growth stocks yield negative and significant monthly abnormal returns of −0.13% (t-stat −2.51). The mispricing is then present for both value and growth stocks, and is indeed weaker for the latter (by 10 bps) as predicted by the model. As a result, the value-minus-growth portfolio exhibits a positive and significant alpha of 0.36% (t-stat 5.52).

Among the slope coefficients, the market beta of the value-minus-growth portfolio is negative and significant (−0.06, t-stat −2.82). Growth stocks then seem to be more sensitive to systematic fluctuations of the stock market than value stocks, despite earning lower returns. This is in line with the findings from Fama and French (2006), and more generally with the high-beta low-return anomaly (see, e.g., Frazzini and Pedersen, 2014; Hong and Sraer, 2016), a point to which I return in the cross-sectional analyses below.

Both value and growth stocks have positive and significant loadings on the size factor (t-stats 19.45 and 10.42, respectively). As expected, value stocks load positively on the book-to-market factor (t-stat 16.71), while growth stocks negatively (t-stat −8.43). The adjusted R-squared is above 90% for value and growth stocks, and 80% for the value-minus-growth portfolios, which indicates that the models fit the data well.

In Panel B, I consider the 20% breakpoint. The results follow a similar pattern, and slightly increase in magnitude. I find that monthly abnormal returns are equal to 0.27% for value stocks (t-stat 3.74), −0.18% for growth stocks (t-stat −2.87), and 0.44% for the value-minus-growth portfolio (t-stat 5.19). In particular, alpha increases monotonically from the bottom to the top quintile, even though it is only significant for quintiles 1, 4, and 5. Again, the mispricing is asymmetric across value and growth stocks. It is weaker for the latter, also in terms of statistical significance.

In Panel C, I consider the 10% breakpoint. The coefficients further increase in magnitude. Value stocks yield monthly abnormal returns of 0.28% (t-stat 2.47), growth stocks −0.23% (t-stat −3.11), and the value-minus-growth portfolio 0.52% (t-stat 3.91). Alpha increases monotonically from the bottom to the top decile, and exhibits again an asymmetric pattern (only significant for deciles 1 and 7–10).

It is interesting to compare the magnitude of abnormal returns on value and growth stocks to that of simple average returns. In the sample period, the average monthly return on the value-minus-growth portfolio is 0.83% for the 30% breakpoint, 1.00% for the 20% breakpoint, and 1.19% for the 10% breakpoint (see Table 1). Abnormal returns on these portfolios, on the other hand, are respectively 0.36%, 0.44%, and 0.52% (see Table 3). Therefore, mispricing accounts for approximately up to 44% of the value premium.

This finding is nontrivial. For example, Davis et al. (2000) refute Daniel and Titman's (1997) claims on the mispricing of value and growth stocks on the grounds that it seems confined to a specific portfolio formation and a limited time period. Conversely, the findings presented in this section suggest that such mispricing is much more pervasive. In the analysis that follows, I also shed light on the channel that generates the mispricing of extreme book-to-market stocks.

For robustness, I repeat the analysis for the alternative price-to-book measures. The results are in Table 4. In Panel A, I consider the cashflow-to-price portfolios. For the 30% breakpoint, I find that monthly abnormal returns are equal to a highly significant 0.29% for value stocks (t-stat 6.37), a marginally significant −0.10% for growth stocks (t-stat −1.75), and a highly significant 0.39% for the value-minus-growth portfolio (t-stat 7.52). The mispricing of growth stocks is then again weaker. The coefficients again increase in magnitude when considering higher thresholds, and exhibit a similar pattern for the earnings-to-price portfolios in Panel B.

Table 5
Abnormal returns on book-to-market portfolios: CAPM regressions.

Panel A. 30% threshold						
	a	b	t(a)	t(b)	Obs.	$\bar{R}^2$
Low30-Rf	−0.15	1.16	−1.32	24.44	1,098	0.83
Mid40-Rf	0.23	1.19	1.97	18.73	1,098	0.84
High30-Rf	0.55	1.35	3.21	11.15	1,098	0.69
High30-Low30	0.70	0.19	5.35	1.20	1,098	0.05
Panel B. 20% threshold						
	a	b	t(a)	t(b)	Obs.	$\bar{R}^2$
Q1-Rf	−0.22	1.17	−1.78	21.35	1,098	0.82
Q2-Rf	0.09	1.16	0.96	43.30	1,098	0.86
Q3-Rf	0.21	1.19	1.83	18.86	1,098	0.84
Q4-Rf	0.37	1.22	2.65	12.60	1,098	0.78
Q5-Rf	0.63	1.40	3.30	10.81	1,098	0.65
Q5-Q1	0.85	0.23	5.42	1.32	1,098	0.05
Panel C. 10% threshold						
	a	b	t(a)	t(b)	Obs.	$\bar{R}^2$
D1-Rf	−0.29	1.18	−2.20	17.48	1,098	0.78
D2-Rf	−0.08	1.14	−0.70	28.70	1,098	0.84
D3-Rf	0.04	1.12	0.40	35.63	1,098	0.85
D4-Rf	0.15	1.20	1.58	27.10	1,098	0.85
D5-Rf	0.19	1.18	1.76	21.49	1,098	0.84
D6-Rf	0.22	1.19	1.83	16.64	1,098	0.83
D7-Rf	0.35	1.20	2.58	13.68	1,098	0.78
D8-Rf	0.38	1.24	2.64	11.66	1,098	0.75
D9-Rf	0.54	1.34	3.21	10.30	1,098	0.71
D10-Rf	0.71	1.46	3.19	10.95	1,098	0.57
D10-D1	1.00	0.28	4.99	1.48	1,098	0.04

CAPM regressions of the excess returns on equal-weighted portfolios of U.S. stocks from the NYSE, AMEX, and NASDAQ, formed on the ratio between book value and market value of equity, calculated at the end of each June using NYSE breakpoints (bottom 30%, middle 40%, and top 30% in Panel A, quintiles in Panel B, and deciles in Panel C). The book value of equity used in June of year t is the book equity for the last fiscal year end in $t-1$. The market value of equity is price times shares outstanding at the end of December of $t-1$. Returns are monthly and expressed in percentage points. Excess returns are calculated by subtracting the risk-free rate (Rf), defined as the one-month Treasury bill rate. The data is from Kenneth French's website. The sample period is from July 1926 to December 2017. The t-statistics are robust to heteroskedasticity and autocorrelation.

Alternative factor models

As elegantly put in Fama and French (2004), the size and book-to-market factors correlate with unidentified state variables that constitute systematic risk other than market beta. Fama and French (1993, 1996) propose these factors to enhance the CAPM equation in the spirit of the intertemporal CAPM from Merton (1973), in an attempt to identify all relevant state variables. Attesting to this interpretation, the size and book-to-market factors reflect covariation with fundamentals like earnings and sales (Fama and French, 1995), the state of the economy (Liew and Vassalou, 2000), and investment opportunities (Petkova, 2006).

Since then, the CAPM has been replaced by the three-factor model as a baseline specification in most empirical asset pricing research. Despite its empirical drawbacks, however, the security market line is conceptually closer to the theoretical model I propose. Also, the correlation between the returns on the book-to-market portfolios and the book-to-market factor may potentially bias the results. To address these concerns, I re-estimate the test equation using the market factor as the only regressor.

The results are in Table 5. Reassuringly, I find that abnormal returns are similar to those from the three-factor model. Interestingly, only extreme growth stocks exhibit significant overpricing in this specification (i.e., bottom 10% threshold). This lends again support to the model prediction that the demand for growth

Table 6
Abnormal returns on book-to-market portfolios: Sample breakdown.

Panel A. July 1926–March 1972										
	a	b	s	h	t(a)	t(b)	t(s)	t(h)	Obs.	$\bar{R}^2$
Low30-Rf	−0.07	1.06	0.49	−0.19	−1.85	55.43	7.18	−5.46	549	0.97
High30-Rf	0.26	1.01	1.14	0.94	2.67	57.40	23.04	27.87	549	0.98
High30-Low30	0.33	−0.05	0.65	1.13	3.96	−1.85	6.33	29.42	549	0.90
Q1-Rf	−0.09	1.08	0.47	−0.25	−1.83	54.32	6.05	−6.07	549	0.97
Q5-Rf	0.32	1.00	1.28	1.09	2.41	37.80	24.77	20.53	549	0.97
Q5-Q1	0.40	−0.08	0.81	1.34	3.77	−2.22	8.67	22.59	549	0.88
D1-Rf	−0.08	1.09	0.47	−0.31	−1.07	44.89	4.94	−5.94	549	0.95
D10-Rf	0.34	0.94	1.50	1.34	1.70	18.89	11.45	9.23	549	0.92
D10-D1	0.41	−0.15	1.03	1.65	2.10	−2.78	7.17	10.29	549	0.80
Panel B. April 1972–December 2017										
	a	b	s	h	t(a)	t(b)	t(s)	t(h)	Obs.	$\bar{R}^2$
Low30-Rf	−0.23	1.10	0.87	−0.18	−2.74	39.57	11.04	−2.84	549	0.91
High30-Rf	0.31	0.92	0.91	0.62	4.12	40.41	13.48	12.17	549	0.89
High30-Low30	0.54	−0.17	0.04	0.79	5.28	−4.81	0.93	19.39	549	0.72
Q1-Rf	−0.30	1.12	0.88	−0.27	−3.18	37.26	11.06	−3.98	549	0.90
Q5-Rf	0.36	0.93	0.96	0.65	4.22	34.80	13.26	11.71	549	0.86
Q5-Q1	0.65	−0.19	0.08	0.92	5.64	−4.70	1.36	18.13	549	0.70
D1-Rf	−0.41	1.14	0.92	−0.38	−3.78	25.99	13.44	−5.23	549	0.88
D10-Rf	0.40	0.96	1.05	0.71	3.92	24.81	12.36	10.12	549	0.80
D10-D1	0.81	−0.18	0.13	1.10	5.92	−4.52	1.82	15.44	549	0.66
Panel C. January 1994–December 2017										
	a	b	s	h	t(a)	t(b)	t(s)	t(h)	Obs.	$\bar{R}^2$
Low30-Rf	−0.26	1.17	0.76	−0.24	−2.16	24.89	8.73	−3.48	288	0.88
High30-Rf	0.36	0.92	0.76	0.55	2.53	25.58	21.83	14.11	288	0.85
High30-Low30	0.62	−0.25	0.00	0.78	4.03	−5.36	0.03	17.86	288	0.73
Q1-Rf	−0.36	1.20	0.78	−0.33	−2.81	23.38	8.59	−4.37	288	0.86
Q5-Rf	0.42	0.93	0.79	0.56	2.64	23.27	15.55	8.69	288	0.81
Q5-Q1	0.78	−0.28	0.01	0.89	4.65	−5.21	0.17	18.48	288	0.72
D1-Rf	−0.48	1.24	0.83	−0.45	−3.73	19.98	10.90	−4.71	288	0.85
D10-Rf	0.45	0.99	0.86	0.60	2.22	16.72	14.17	6.64	288	0.74
D10-D1	0.92	−0.26	0.03	1.06	4.84	−3.73	0.38	15.60	288	0.66

Fama–French three-factor model regressions of the excess returns on equal-weighted portfolios of U.S. stocks from the NYSE, AMEX, and NASDAQ, formed on the ratio between book value and market value of equity, calculated at the end of each June using NYSE breakpoints (top v. bottom 30%, quintiles 5 v. 1, and deciles 10 v. 1). The book value of equity used in June of year t is the book equity for the last fiscal year end in $t-1$. The market value of equity is price times shares outstanding at the end of December of $t-1$. Returns are monthly and expressed in percentage points. Excess returns are calculated by subtracting the risk-free rate (Rf), defined as the one-month Treasury bill rate. The data is from Kenneth French's website. The sample period is from July 1926 to March 1972 in Panel A, from April 1972 to December 2017 in Panel B, and from January 1994 to December 2017 in Panel C. The t-statistics are robust to heteroskedasticity and autocorrelation.

stocks exhibits both a diversification and a speculative component, and the latter prevails only for the most speculative type of growth stocks.

On the other hand, the three-factor model may actually include too few factors. For instance, Carhart (1997) augments the model to four factors, to include momentum. Pástor and Stambaugh (2003) build on this framework and add liquidity as a fifth factor. In a recent paper, Fama and French (2015) augment the three-factor model themselves by introducing an investment and a profitability factor. In unreported tests, I find similar results with these alternative factor models.

Sample breakdown

One concern raised in previous literature is that the pricing error of value and growth stocks may be specific to a particular time period. For example, Daniel and Titman (1997) show that some trading strategies on stocks with extreme book-to-market measures yield positive abnormal returns. Davis et al. (2000), however, object that the pricing error is only confined to a limited subsample, namely, from July 1973 to December 1993, for a total of 20.5 years.

To address this issue, I re-estimate the test equation in two subsamples of equal length. The results are in Table 6. Panel A presents the estimates from the first subsample, running from July 1926 to March 1972. For the 30% breakpoint, I find that monthly abnormal returns are equal to 0.26% for value stocks (t-stat 2.67), −0.07% for growth stocks, even though marginally significant (t-stat −1.85), and 0.33% for the value-minus-growth portfolio (t-stat 3.96). The results are similar, in both magnitude and significance, for the 20% and the 10% breakpoints.

Panel B presents the estimates from the second subsample, which covers the period from April 1972 to December 2017. The results become remarkably stronger, especially for growth stocks. For the 30% breakpoint, I find that monthly abnormal returns are equal to 0.31% for value stocks (t-stat 4.12), −0.23% for growth stocks (t-stat −2.74), and 0.54% for the value-minus-growth portfolio (t-stat 5.28). The coefficients increase even further, in both magnitude and significance, for the other breakpoints.

Even though the results are robust to the sample breakdown, the asymmetry in the estimates deserves further attention. One possible explanation for this pattern is that the second subsample includes the online trading era. Recent research shows that the pursuit of speculative investment strategies has increased since online stock trading became available.[17] It seems plausible, then,

17 Barber and Odean (2002) find that active young traders who invest in small growth stocks with high market risk are more likely to switch to online trading. After going online, however, their performances worsen significantly as a result

that speculative demand may have a larger impact on stock prices in the second subsample, making the mispricing of extreme book-to-market stocks more pronounced.

To test this conjecture, I restrict the analysis to the period from January 1994 to December 2017. This subsample not only captures the online trading era, but also complements the sample period considered in Daniel and Titman (1997). The results are in Table 6, Panel C. Consistent with the online trading argument, the results become even stronger with respect to the baseline estimates from Table 2. Monthly abnormal returns on the value-minus-growth portfolio increase to 0.62% for the 30% breakpoint (t-stat 4.03), 0.78% for the 20% breakpoint (t-stat 4.65), and 0.92% for the 10% breakpoint (t-stat 4.84).

Fama–MacBeth regressions

Another concern is that factor models may not entirely capture systematic risk, as firm characteristics may affect stock returns in their own right. To address this issue, I test Hypothesis 1 through the following Fama–MacBeth regressions from Edmans (2011):

$$R_{it} = \beta_1 D_{it-1} + \gamma' Z_{it} + \epsilon_{it}, \tag{7}$$

where R_{it} is the excess return on stock i in month t, D_{it-1} is a dummy variable that takes on value one if the beginning-of-year price-to-book ratio is among the bottom 30% of the sample distribution, and Z_{it} is a vector of firm characteristics that include firm size, defined as the log of market capitalization at the end of month $t-2$; the log of the book-to-market ratio, calculated each July and held constant through the following June; the ratio of dividends in the previous fiscal year to market value at calendar year-end, calculated each July and held constant through the following June; cumulative returns over months $t-3$ through $t-2$, months $t-6$ through $t-4$, and months $t-12$ through $t-7$; the log of the dollar volume of trading in the stock in month $t-2$; the log of the stock price at the end of month $t-2$.[18] All the data is retrieved from CRSP-Compustat. To effectively compare the top with the bottom price-to-book stocks, I leave out the stocks that lie in the middle 40% of the price-to-book distribution (see, e.g., Mueller et al., 2017). The coefficient of the dummy variable can be interpreted as abnormal returns (Gompers et al., 2003; Mueller et al., 2017). Hypothesis 1 implies $\beta_1 > 0$.

The results are in Table 7, columns (1), (3), and (5).[19] I find that coefficient of the dummy variable is positive and significant in all specifications. Stocks with a top 30% book-to-market ratio earn higher monthly abnormal returns than stocks with a bottom 30% book-to-market ratio (0.50%, t-stat 4.04). The results are similar for cashflow-to-price (0.42%, t-stat 4.57), and earnings-to-price (0.21%, t-stat 2.69).

Overall, the empirical evidence is in line with Hypothesis 1. The presence of such robust mispricing is also consistent with the idea that arbitrage activity is rather limited in stocks with extreme price-to-book ratios, due to the high costs of arbitrage (Ali et al., 2003), and binding short-sales constraints (Nagel, 2005).[20]

of more frequent and even more speculative trading. Bogan (2008) shows that since the advent of the Internet ever more people open accounts with brokers and engage in some sort of stock picking. As a result, both the amount of trading and the participation rate in the stock market have significantly increased.

18 This test equation was originally proposed by the pioneering work of Brennan et al. (1998).

19 The table reports the time-series averages of the coefficients, estimated through cross-sectional regressions for each month of the sample.

20 It is interesting to note that in addition to growth stocks, negative abnormal returns also characterize other assets that are commonly thought of as speculative, such as over-the-counter stocks (Ang et al., 2013), and lotteries and bets (see, e.g., (Sauer, 1998)).

4.2. Propensity to speculate

Hypothesis 2 states that abnormal returns on value and growth stocks should increase with investors' propensity to speculate. To identify the latter, I consider stock-level sentiment betas (Glushkov, 2005; Baker et al., 2012). For each stock, I estimate a five-year rolling regression of excess returns on the market, size, and book-to-market factors, and Baker and Wurgler's (2007) monthly investor sentiment index, orthogonalized to a number of macroeconomic indicators, and available from Jeffrey Wurgler's website, and define the stock's sentiment beta as the standardized coefficient of the index, expressed in absolute value (Glushkov, 2005). A high sentiment-beta identifies stocks traded by investors that are more prone to sentiment, and therefore speculation (Baker and Wurgler, 2006, 2007).

To test Hypothesis 2, I re-estimate the Fama–MacBeth regressions by introducing an interaction term between the price-to-book dummy and the sentiment beta. The results are in Table 7, columns (2), (4), and (6). Consistent with the theoretical predictions, the coefficient of the interaction term is positive and significant, and explains away the coefficient of the standalone dummy. For stocks that exhibit a one-standard-deviation sentiment beta, the difference in monthly abnormal returns between stocks with a top and a bottom 30% book-to-market ratio increases by 0.82% (t-stat 3.44). The magnitudes are similar for the other price-to-book measures. The results then suggest that the mispricing of the book-to-market ratio is confined to stocks held by investors who exhibit a high propensity to speculate.

In additional tests, I address a number of potential alternative explanations for these results. For example, research shows that investors exhibit a preference for stocks with lottery-like characteristics (Kumar, 2009), such as stocks with high idiosyncratic volatility (Bali and Cakici, 2008), or penny stocks (Bhootra, 2011). High-sentiment-beta stocks may then partly overlap with these stock categories.

To shed light on this issue, I propose a horse race with these alternative measures. In the spirit of Ang et al. (2006), I define idiosyncratic volatility as the standard deviation of the residuals from the regressions of individual stock returns on the three-factor model. To avoid any overlap with investor sentiment, I augment the model with the investor sentiment index. Since stock returns and idiosyncratic volatility both represent functions of stock prices, they might be spuriously correlated (see, e.g., (Brennan et al., 1998)). Therefore, I introduce a dummy variable that takes on value one if a stock exhibits above-median idiosyncratic volatility in a given month, and zero otherwise.

The results are in Table 8, column (1). Consistent with previous research, I find that the coefficient of idiosyncratic volatility as a standalone variable is negative and significant. However, the coefficient of its interaction term with the book-to-market dummy is close to zero in both magnitude and significance. Conversely, the coefficient of the interaction term between sentiment beta and the book-to-market dummy is still positive and highly significant (0.76%, t-stat 3.11). The results are similar when replacing the idiosyncratic volatility dummy with its continuous counterpart (unreported).

Next, I introduce a dummy variable that takes on value one if stocks trade at a price below \$5, which represents the conventional threshold to identify penny stocks. Such stocks represent 5.6% of all stocks in the sample. The results are in Table 8, column (2). I find that the coefficient of the penny-stock dummy is largely outside of the rejection region, both as a standalone variable and as an interaction term with the book-to-market dummy. The main coefficient of interest, on the other hand, remains largely unaffected (0.82%, t-stat 3.45). Overall, then, the results seem unlikely to be driven by stocks with lottery-like features.

Table 7
Abnormal returns on price-to-book portfolios: Fama–MacBeth regressions.

Dep. Variable: $R_i - R_f$	Book-to-market		Cashflow-to-price		Earnings-to-price	
	(1)	(2)	(3)	(4)	(5)	(6)
Dummy	0.0050*** (4.04)	0.0012 (0.71)	0.0042*** (4.57)	0.0026 (1.60)	0.0021*** (2.69)	0.0011 (0.83)
Dummy ×Sentiment beta		0.0082*** (3.44)		0.0053** (2.00)		0.0046** (2.00)
Sentiment beta		−0.0087*** (−3.00)		−0.0076*** (−2.75)		−0.0079*** (−2.72)
Book-to-market (−1)	0.0056 (1.48)	0.0017 (1.61)	0.0055*** (4.21)	0.0035*** (4.04)	0.0063*** (5.54)	0.0057*** (6.50)
Dividend yield (−1)	0.0891 (1.05)	−0.0248* (−1.67)	−0.0035 (−0.10)	−0.0382** (−2.26)	0.0013 (0.06)	−0.0352** (−2.19)
CumRet (−2,-3)	−0.0108 (−1.05)	−0.0190*** (−7.90)	−0.0082* (−1.95)	−0.0182*** (−7.28)	−0.0085** (−2.55)	−0.0160*** (−6.61)
CumRet (−4,-6)	−0.0235 (−1.57)	−0.0150*** (−7.29)	−0.0110*** (−3.82)	−0.0143*** (−7.10)	−0.0027 (−0.68)	−0.0131*** (−6.16)
CumRet (−7,-12)	−0.0013 (−0.41)	0.0007 (0.48)	0.0014 (0.77)	0.0000 (0.03)	−0.0000 (−0.01)	0.0012 (0.76)
Size (−2)	0.0049*** (3.90)	0.0037*** (5.84)	0.0036*** (5.67)	0.0036*** (6.22)	0.0029*** (4.11)	0.0036*** (6.23)
Price (−2)	−0.0136*** (−11.81)	−0.0134*** (−14.01)	−0.0126*** (−12.61)	−0.0130*** (−13.85)	−0.0121*** (−11.56)	−0.0128*** (−13.88)
Volume (−2)	−0.0029*** (−3.62)	−0.0021*** (−4.16)	−0.0023*** (−3.73)	−0.0020*** (−4.23)	−0.0014** (−2.01)	−0.0022*** (−4.73)
Observations	364,774	361,106	401,921	397,912	384,849	380,955
R-squared	0.0912	0.0922	0.1090	0.0942	0.1065	0.0913

Fama–MacBeth regressions of monthly excess stock returns on a dummy variable that takes on value one if the stock has a top 30% book-to-market, cashflow-to-price, or earnings-to-price ratio at the beginning of the year, and a vector of firm-level controls from Brennan et al. (1998), including: the log of the book-to-market ratio (calculated each July and held constant through the following June), the ratio of dividends in the previous fiscal year to market value at calendar year-end (calculated each July and held constant through the following June), the log of cumulative returns over months $t-3$ through $t-2$, months $t-6$ through $t-4$, and months $t-12$ through $t-7$, size (defined as the log of market capitalization at the end of month $t-2$), the log of the dollar volume of trading in the stock in month $t-2$, and the log of the stock price at the end of month $t-2$. In columns (2), (4), and (6), the regressions include the stock's investor sentiment beta, and an interaction term between the sentiment beta and the price-to-book dummy. Sentiment betas are calculated separately for each stock in the sample over a 5-year moving window through regressions on the market, size, and book-to-market factors, and Baker and Wurgler's (2007) monthly investor sentiment index, orthogonalized to business cycle indicators. The data includes the universe of U.S. stocks from CRSP-Compustat. Excess returns are calculated by subtracting the risk-free rate, defined as the one-month Treasury bill rate from Ibbotson Associates. The book value of equity used in June of year t is the book equity for the last fiscal year end in $t-1$. The cashflow used in June of year t is total earnings before extraordinary items, plus equity's share of depreciation, plus deferred taxes (if available) for the last fiscal year end in $t-1$. The earnings used in June of year t are total earnings before extraordinary items for the last fiscal year end in $t-1$. Market equity is price times shares outstanding at the end of December of $t-1$. All specifications exclude stocks whose price-to-book ratios lie in the middle 40% of the distribution. The sample is from January 1960 to December 2017. The numbers in parentheses are heteroskedasticity- and autocorrelation-robust t-statistics.

*$p < 0.10$.
**$p < 0.05$.
***$p < 0.01$.

Since growth stocks exhibit a significantly higher market beta than value stocks, the mispricing of the value premium might be related to the market-beta anomaly, i.e., the tendency of high-market-beta stocks to become overpriced and yield lower subsequent returns (Frazzini and Pedersen, 2014). To address this issue, I introduce stock-level market betas in the analysis. Akin to Hong and Kacperczyk (2009), I estimate them through regressions of excess returns on each stock on the market, size, and book-to-market factors over a five-year rolling window.

The results are in Table 8, column (3). Consistent with the market-beta anomaly, I find that the coefficient of market beta is negative, although outside of the rejection region. The coefficient of the interaction term between market beta and the book-to-market dummy, on the other hand, is close to zero. The coefficient of the interaction term between sentiment beta and the book-to-market dummy is again largely unaffected (0.81%, t-stat 3.37).

Daniel and Titman (1997) propose a decomposition of the value premium into a mispricing component, captured by the book-to-market ratio as a simple characteristic, and a risk component, captured by the stock-level HML beta. Since the empirical model so far includes the former but not the latter, it might be this omission that drives part of the results. To address this concern, I repeat the analysis by including HML betas, estimated in the same way as market betas. The results are in Table 8, column (4). Reassuringly, the main coefficient of interest is again unchanged (0.82%, t-stat 3.43).

Finally, Cohen et al. (2003) propose a decomposition of the market-wide value premium into an expected return and an expected profitability component, respectively defined as the difference in the average book-to-market ratio and return on equity between value and growth stocks. The former measure, also known as the value spread, is especially important because it captures expectations of future returns on HML. Therefore, I use it to test whether the results are indeed related to risk preferences, or simply reflect biases in expected returns (see, e.g., Lakonishok et al., 1994).

Table 8
Abnormal returns on price-to-book portfolios: Fama–MacBeth regressions with sentiment betas.

Dep. Variable: $R_i - R_f$	(1) iVol	(2) Penny	(3) MKT beta	(4) HML beta	(5) VS beta	(6) PS beta
Dummy B/M	0.0027	0.0008	0.0021	0.0007	0.0017	0.0001
	(1.58)	(0.50)	(1.31)	(0.44)	(1.02)	(0.03)
Dummy B/M ×Sentiment beta	0.0076***	0.0082***	0.0081***	0.0082***	0.0085***	0.0092***
	(3.11)	(3.45)	(3.37)	(3.43)	(3.51)	(3.83)
Dummy B/M ×Characteristic	−0.0002	−0.0032	0.0007	−0.0000	0.0025	−0.0014
	(−0.17)	(−0.86)	(0.77)	(−0.02)	(1.30)	(−1.07)
Sentiment beta	−0.0085**	−0.0088***	−0.0085***	−0.0084***	−0.0072**	−0.0092***
	(−2.53)	(−3.01)	(−2.88)	(−2.90)	(−2.50)	(−3.12)
Characteristic	−0.0018**	−0.0018	−0.0021	−0.0012	0.0048	−0.0002
	(−2.53)	(−0.54)	(−1.40)	(−0.69)	(1.39)	(−0.08)
Book-to-market (−1)	0.0012	0.0021**	0.0011	0.0016	0.0010	0.0014
	(1.14)	(1.97)	(1.00)	(1.53)	(1.01)	(1.35)
Dividend yield (−1)	−0.0248*	−0.0305**	−0.0310**	−0.0163	−0.0273*	−0.0243
	(−1.65)	(−2.05)	(−2.12)	(−1.14)	(−1.82)	(−1.63)
CumRet (−2,-3)	−0.0189***	−0.0184***	−0.0184***	−0.0199***	−0.0236***	−0.0221***
	(−7.83)	(−7.64)	(−7.65)	(−7.76)	(−8.72)	(−8.60)
CumRet (−4,-6)	−0.0157***	−0.0146***	−0.0152***	−0.0138***	−0.0148***	−0.0139***
	(−7.54)	(−7.13)	(−7.57)	(−6.36)	(−6.32)	(−6.35)
CumRet (−7,-12)	−0.0005	0.0010	0.0014	0.0015	0.0019	0.0034**
	(−0.31)	(0.68)	(0.95)	(1.02)	(1.22)	(2.21)
Size (−2)	0.0036***	0.0038***	0.0031***	0.0034***	0.0034***	0.0034***
	(5.97)	(5.97)	(5.25)	(5.51)	(5.51)	(5.50)
Price (−2)	−0.0135***	−0.0139***	−0.0125***	−0.0125***	−0.0125***	−0.0128***
	(−14.33)	(−14.35)	(−13.19)	(−13.75)	(−13.40)	(−13.84)
Volume (−2)	−0.0022***	−0.0022***	−0.0018***	−0.0021***	−0.0022***	−0.0020***
	(−4.38)	(−4.18)	(−3.82)	(−4.21)	(−4.26)	(−3.92)
Observations	355,193	361,106	361,106	361,106	360,808	360,808
R-squared	0.0952	0.0979	0.1226	0.1224	0.1175	0.1168

Fama–MacBeth regressions of monthly excess stock returns on a dummy variable that takes on value one if the stock has a top 30% book-to-market, cashflow-to-price, or earnings-to-price ratio at the beginning of the year, the stock's investor sentiment beta, an interaction term between the sentiment beta and the price-to-book dummy, a stock characteristic, an interaction term between the characteristic and the price-to-book dummy, and a vector of firm-level controls from Brennan et al. (1998), including: the log of the book-to-market ratio (calculated each July and held constant through the following June), the ratio of dividends in the previous fiscal year to market value at calendar year-end (calculated each July and held constant through the following June), the log of cumulative returns over months $t-3$ through $t-2$, months $t-6$ through $t-4$, and months $t-12$ through $t-7$, size (defined as the log of market capitalization at the end of month $t-2$), the log of the dollar volume of trading in the stock in month $t-2$, and the log of the stock price at the end of month $t-2$. Sentiment betas are calculated separately for each stock in the sample over a 5-year moving window through regressions on the market, size, and book-to-market factors, and Baker and Wurgler's (2007) monthly investor sentiment index, orthogonalized to business cycle indicators. The characteristics are idiosyncratic volatility in column (1), a dummy variable for penny stocks in column (2), market beta in column (3), HML beta in column (4), value-spread beta in column (5), and profitability-spread beta in column (6). The data includes the universe of U.S. stocks from CRSP-Compustat. Excess returns are calculated by subtracting the risk-free rate, defined as the one-month Treasury bill rate. The book value of equity used in June of year t is the book equity for the last fiscal year end in $t-1$. The cashflow used in June of year t is total earnings before extraordinary items, plus equity's share of depreciation, plus deferred taxes (if available) for the last fiscal year end in $t-1$. The earnings used in June of year t are total earnings before extraordinary items for the last fiscal year end in $t-1$. Market equity is price times shares outstanding at the end of December of $t-1$. All specifications exclude stocks whose price-to-book ratios lie in the middle 40% of the distribution. The sample is from January 1960 to December 2017. The numbers in parentheses are heteroskedasticity- and autocorrelation-robust t-statistics.
$^{*}p < 0.10$.
$^{**}p < 0.05$.
$^{***}p < 0.01$.

The value spread is a pure time-series variable. To include it in the analysis, I create a stock-level version of it by estimating individual value-spread betas for each stock in the sample. A high value-spread beta then indicates a high sensitivity of individual stock returns to the market-wide value spread. The results are in Table 8, column (5). I find that the coefficient of the value-spread beta, either as a standalone variable or as an interaction term with the book-to-market dummy, is not significant. On the other hand, the coefficient of interest remains again positive and highly significant (0.85%, t-stat, 3.51). In column (6), I find similar results when replacing the value spread with the profitability spread (0.92%, t-stat 3.83).

Overall, then, these additional results indicate that the mispricing of the value premium seems unrelated to preferences for lottery or high-beta stocks, neglected HML risk, or biases in expectations. Rather, the results seem to reflect investors' propensity to speculate.

4.3. Abnormal returns over the business cycle

Hypothesis 3 states that the mispricing component of the value premium is countercyclical. To test this conjecture, I study the relation between abnormal returns on value and growth stocks and aggregate monthly income, alternatively defined as the industrial production index or real disposable personal income from the Bureau of Economic Analysis. The sample starts in January 1972 for the former, and January 1959 for the latter. Following the model's guidance, I consider income in levels, and therefore separate the cyclical component from the trend component of the series using the Hodrick and Prescott (1997) filter.[21]

Despite stationarity, the high autocorrelation of the filtered series generates endogeneity concerns. Therefore, I estimate the following two-stage least squares regression:

$$R_{i,t} = \alpha_i + \delta_i w_{t-1} + \beta_i MKT_t + s_i SMB_t + h_i HML_t + \epsilon_{i,t}, \quad (8)$$

where $R_{i,t}$ represents equal-weighted excess returns on value stocks ($i = v$), growth stocks ($i = g$), the value-minus-growth portfolio ($i = p$); w_{t-1} is the beginning-of-period level of income, instrumented by its lag from the previous quarter; and the other regressors are again the market, size, and book-to-market factors. Standard errors are robust to heteroskedasticity and autocorrelation. Hypothesis 3 implies $\delta_p < 0$, i.e., a reduction in the return differential between value and growth stocks not accounted for by the risk premium (as captured by the three factor loadings).

Table 9 presents the estimates for the book-to-market portfolios and the industrial production index. In Panel A, I consider the 30% breakpoint. I find that a one-standard-deviation increase in the cyclical component of the industrial production index is followed by a 0.36% decrease in monthly abnormal returns on value stocks (t-stat −2.24), whereas the coefficient is close to zero in both magnitude and significance for growth stocks (0.05%, t-stat 0.26). These two effects result into a 0.41% decrease in monthly abnormal returns on the value-minus-growth portfolio (t-stat −3.17).

The results for the 20% breakpoint, in Panel B, show a similar empirical pattern. The coefficient monotonically increases in both magnitude (in absolute value) and significance across quintiles. I find that a one-standard-deviation increase in the cyclical component of the industrial production index has a near-zero effect on the return on growth stocks, whereas it is followed by a decrease in monthly abnormal returns on value stocks of up to −0.41% in quintile 5 (t-stat −2.11). The results are analogous for the 10% breakpoint, in Panel C.

These results lend support to the model predictions in two ways. First, the part of the value premium that is not explained by factor loadings (and therefore represents mispricing) indeed decreases during good economic times, as predicted by Hypothesis 3. Second, the effect is mostly driven by value stocks. This is consistent with the theoretical prediction that growth stocks enter both the diversification and the speculative portfolio, so the variations in these two types of demand tend to cancel out. As a result, the mispricing of growth stocks varies little with the business cycle.

Table 10 presents the estimates for the book-to-market portfolios and real disposable personal income. For the 30% breakpoint, I find that a one-standard-deviation increase in the cyclical component of real disposable personal income is followed by a 0.36% decrease in monthly abnormal returns on value stocks (t-stat −2.46). The effect is not significant and close to zero for growth stocks (−0.10%, t-stat −0.92), whereas it is negative and highly significant for the value-minus-growth portfolio (0.27%, t-stat −1.97). The results are similar for the other breakpoints. Interestingly, both the pattern and the magnitude of the coefficients are comparable across the two tables.

In Table 11, I introduce the alternative price-to-book measures. In Panel A, I consider the cashflow-to-price portfolios. For the 30% breakpoint, I find that a one-standard-deviation increase in the cyclical component of the industrial production index is followed by a 0.22% decrease in monthly abnormal returns on value stocks (t-stat −2.08), whereas the effect is close to zero and not significant for growth stocks (0.02%, t-stat 0.14). For the value-minus-growth portfolio, the effect is negative and highly significant (0.23%, t-stat −2.57). The coefficients are comparable for the 20% breakpoint, while weaker (in statistical significance) for the 10% breakpoint. The estimates are similar for the earnings-to-price portfolios, in Panel B.

The findings lend support to Hypothesis 3, and also shed new light on the countercyclicality of the value premium. Lakonishok et al. (1994) find that high book-to-market stocks outperform low book-to-market stocks during extreme down markets, and tend to do slightly better also during recessions. Chen et al. (2008) find that the expected value premium tends to increase during economic downturns, but this correlation is too large to be explained by rational pricing alone. My results suggest that the countercyclicality of the value premium partly reflects variation in mispricing.

Table 9
Returns on book-to-market portfolios and the industrial production index.

	a	$\delta \times \sigma$	t(a)	t(δ)	Obs.	$\bar{R}^2$
Panel A. 30% breakpoint						
Low30-Rf	−0.23	0.05	−2.68	0.26	548	0.91
Mid40-Rf	0.12	−0.14	2.26	−1.16	548	0.94
High30-Rf	0.32	−0.36	5.36	−2.24	548	0.90
High30-Low30	0.55	−0.41	5.87	−3.17	548	0.72
Panel B. 20% breakpoint						
Q1-Rf	−0.30	0.02	−3.20	0.09	548	0.89
Q2-Rf	0.01	0.04	0.07	0.24	548	0.93
Q3-Rf	0.09	−0.18	1.53	−1.37	548	0.93
Q4-Rf	0.21	−0.19	3.90	−1.90	548	0.94
Q5-Rf	0.37	−0.41	5.41	−2.11	548	0.87
Q5-Q1	0.67	−0.43	6.35	−3.19	548	0.71
Panel C. 10% breakpoint						
D1-Rf	−0.41	0.06	−3.85	0.27	548	0.88
D2-Rf	−0.09	−0.03	−1.08	−0.13	548	0.90
D3-Rf	−0.01	0.15	−0.17	0.89	548	0.92
D4-Rf	0.03	−0.08	0.44	−0.48	548	0.91
D5-Rf	0.08	−0.19	1.18	−1.39	548	0.91
D6-Rf	0.10	−0.16	2.29	−1.51	548	0.93
D7-Rf	0.24	−0.15	3.87	−1.26	548	0.93
D8-Rf	0.19	−0.22	3.28	−2.30	548	0.93
D9-Rf	0.30	−0.31	4.82	−2.34	548	0.91
D10-Rf	0.42	−0.54	4.52	−1.95	548	0.81
D10-D1	0.83	−0.60	6.49	−3.43	548	0.67

Regressions of the excess returns on equal-weighted portfolios of U.S. stocks from the NYSE, AMEX, and NASDAQ, formed on the ratio between book value and market value of equity, calculated at the end of each June using NYSE breakpoints (bottom 30%, middle 40%, and top 30% in Panel A, quintiles in Panel B, and deciles in Panel C), on the cyclical component of the monthly industrial production index, estimated through the Hodrick and Prescott (1997) filter, and instrumented by its value from the previous quarter through a two-stage IV regression due to endogeneity concerns. All regressions include the market, size, and book-to-market factors from Fama and French (1993) as controls. The book value of equity used in June of year t is the book equity for the last fiscal year end in $t-1$. The market value of equity is price times shares outstanding at the end of December of $t-1$. The coefficient of the industrial production index (δ) is multiplied by the standard deviation of the index (σ). Returns are monthly and expressed in percentage points. Excess returns are calculated by subtracting the risk-free rate (Rf), defined as the one-month Treasury bill rate. Financial data is from Kenneth French's website, whereas the industrial production index is from the Bureau of Economic Analysis. The sample period is from January 1972 to December 2017. The t-statistics are robust to heteroskedasticity and autocorrelation.

[21] I also check whether the filtered series are stationary through the following unit root tests: Elliott et al.'s (1996) Dickey–Fuller GLS test, which has better small sample properties than the augmented Dickey–Fuller test; and Phillips and Perron's (1988) test, which is robust to unspecified autocorrelation and heteroskedasticity in the disturbance term of the test equation. In all tests, I find that the null hypothesis of a unit root is rejected at the 1% level.

Table 10
Returns on book-to-market portfolios and real disposable personal income.

	a	$\delta \times \sigma$	t(a)	t(δ)	Obs.	$\bar{R}^2$
Panel A. 30% breakpoint						
Low30-Rf	−0.20	−0.10	−2.91	−0.92	704	0.92
Mid40-Rf	0.09	−0.20	1.94	−2.33	704	0.94
High30-Rf	0.29	−0.36	5.34	−2.46	704	0.91
High30-Low30	0.49	−0.27	6.11	−1.97	704	0.71
Panel B. 20% breakpoint						
	a	$\delta \times \sigma$	t(a)	t(δ)	Obs.	$\bar{R}^2$
Q1-Rf	−0.26	−0.10	−3.33	−0.82	704	0.91
Q2-Rf	0.00	−0.16	−0.01	−1.73	704	0.93
Q3-Rf	0.06	−0.22	1.32	−2.27	704	0.94
Q4-Rf	0.20	−0.20	4.14	−2.40	704	0.95
Q5-Rf	0.33	−0.41	5.20	−2.38	704	0.88
Q5-Q1	0.59	−0.31	6.36	−1.96	704	0.70
Panel C. 10% breakpoint						
	a	$\delta \times \sigma$	t(a)	t(δ)	Obs.	$\bar{R}^2$
D1-Rf	−0.35	−0.01	−3.78	−0.07	704	0.89
D2-Rf	−0.10	−0.22	−1.43	−1.82	704	0.91
D3-Rf	−0.01	−0.10	−0.25	−1.07	704	0.93
D4-Rf	0.02	−0.21	0.31	−1.96	704	0.92
D5-Rf	0.05	−0.27	0.78	−2.93	704	0.92
D6-Rf	0.08	−0.17	1.83	−1.56	704	0.94
D7-Rf	0.21	−0.14	3.85	−1.85	704	0.93
D8-Rf	0.19	−0.25	3.80	−2.37	704	0.94
D9-Rf	0.30	−0.29	5.39	−2.26	704	0.92
D10-Rf	0.34	−0.51	3.95	−2.24	704	0.83
D10-D1	0.69	−0.50	5.85	−2.17	704	0.65

Regressions of the excess returns on equal-weighted portfolios of U.S. stocks from the NYSE, AMEX, and NASDAQ, formed on the ratio between book value and market value of equity, calculated at the end of each June using NYSE breakpoints (bottom 30%, middle 40%, and top 30% in Panel A, quintiles in Panel B, and deciles in Panel C), on the cyclical component of the monthly real disposable personal income, estimated through the Hodrick and Prescott (1997) filter, and instrumented by its value from the previous quarter through a two-stage IV regression due to endogeneity concerns. All regressions include the market, size, and book-to-market factors from Fama and French (1993) as controls. The book value of equity used in June of year t is the book equity for the last fiscal year end in $t-1$. The market value of equity is price times shares outstanding at the end of December of $t-1$. The coefficient of real disposable personal income (δ) is multiplied by the standard deviation of the series (σ). Returns are monthly and expressed in percentage points. Excess returns are calculated by subtracting the risk-free rate (Rf), defined as the one-month Treasury bill rate. Financial data is from Kenneth French's website, whereas real disposable personal income is from the Bureau of Economic Analysis. The sample period is from January 1959 to December 2017. The t-statistics are robust to heteroskedasticity and autocorrelation.

Table 11
Returns on alternative price-to-book portfolios and the industrial production index.

	a	$\delta \times \sigma$	t(a)	t(δ)	Obs.	$\bar{R}^2$
Panel A. Cashflow-to-price						
Low30-Rf	−0.09	0.02	−1.17	0.14	548	0.93
High30-Rf	0.27	−0.22	5.11	−2.08	548	0.92
High30-Low30	0.36	−0.23	5.47	−2.57	548	0.61
Q1-Rf	−0.16	0.05	−2.00	0.40	548	0.92
Q5-Rf	0.29	−0.24	4.85	−1.79	548	0.90
Q5-Q1	0.45	−0.29	5.82	−2.65	548	0.60
D1-Rf	−0.21	0.06	−2.47	0.41	548	0.91
D10-Rf	0.30	−0.15	3.50	−1.01	548	0.87
D10-D1	0.52	−0.21	5.04	−1.47	548	0.55
Panel B. Earnings-to-price						
	a	$\delta \times \sigma$	t(a)	t(δ)	Obs.	$\bar{R}^2$
Low30-Rf	−0.05	0.02	−0.62	0.20	548	0.93
High30-Rf	0.24	−0.18	3.78	−2.10	548	0.93
High30-Low30	0.29	−0.20	3.88	−2.11	548	0.67
Q1-Rf	−0.09	0.03	−1.06	0.25	548	0.93
Q5-Rf	0.25	−0.19	3.76	−1.97	548	0.92
Q5-Q1	0.34	−0.22	3.62	−2.07	548	0.64
D1-Rf	−0.18	0.06	−2.02	0.45	548	0.91
D10-Rf	0.24	−0.13	3.09	−1.06	548	0.90
D10-D1	0.42	−0.19	3.86	−1.62	548	0.56

Regressions of the excess returns on equal-weighted portfolios of U.S. stocks from the NYSE, AMEX, and NASDAQ, formed at the end of each June on the ratio between cashflow and market equity (Panel A) and the ratio between earnings and market equity (Panel B), on the cyclical component of the monthly industrial production index, estimated through the Hodrick and Prescott (1997) filter, and instrumented by its value from the previous quarter through a two-stage IV regression due to endogeneity concerns. All regressions include the market, size, and book-to-market factors from Fama and French (1993) as controls. The cashflow used in June of year t is total earnings before extraordinary items, plus equity's share of depreciation, plus deferred taxes (if available) for the last fiscal year end in $t-1$. The earnings used in June of year t are total earnings before extraordinary items for the last fiscal year end in $t-1$. Market equity is price times shares outstanding at the end of December of $t-1$. The portfolios are formed using NYSE breakpoints (top v. bottom 30%, quintiles 5 v. 1, and deciles 10 v. 1). The coefficient of the industrial production index (δ) is multiplied by the standard deviation of the index (σ). Returns are monthly and expressed in percentage points. Excess returns are calculated by subtracting the risk-free rate (Rf), defined as the one-month Treasury bill rate. The data is from Kenneth French's website. Financial data is from Kenneth French's website, whereas the industrial production index is from the Bureau of Economic Analysis. The sample period is from January 1972 to December 2017. The t-statistics are robust to heteroskedasticity and autocorrelation.

5. Conclusion

Building on the evidence that individuals simultaneously possess both risk-averse and risk-loving traits, I propose a Capital Asset Pricing Model in which investor demand exhibits a speculative component. Consistent with the theoretical predictions, I find that standard empirical tests underestimate returns on value stocks, and to a lesser extent overestimate returns on growth stocks. As a result, a value-minus-growth investment strategy exhibits positive and robust abnormal returns in both portfolio and stock-level analyses.

In keeping with the mechanism highlighted in the model, I also show that abnormal returns on extreme price-to-book stocks increase with investors' propensity to speculate. The mispricing of value and growth stocks is entirely explained away by a stock's sentiment beta. While previous literature on investor sentiment finds no significant relation with the value premium, I show that the relation is actually quite strong when considering stock-level sentiment instead of its market-wide counterpart. This result lends support to the model prediction that the value premium is related to speculative demand.

Previous studies find a negative correlation between the value premium and the business cycle. In this paper, I show that this effect largely reflects countercyclical variation in mispricing and is mostly driven by value stocks. Abnormal returns on growth stocks are less sensitive to economic fluctuations, which lends support to the idea that these stocks are picked by investors for both diversification and speculation purposes. When the economy improves, the diversification component of stock demand increases whereas the speculative component decreases. Among growth stocks, these two effects cancel out.

To the best of my knowledge, this is the first paper that studies the relation between dichotomous risk-preferences and stock returns. The results suggest that this is a promising framework to study the risk-return relation in financial markets.

Appendix

A.1. Risk-return relation and optimal investment

To analyze how the risk-return relation affects optimal investment in the two domains, consider the portfolios as given. Let $c_0 = w_0 - np - n_s p_s$ be current consumption, where n and n_s are the number of shares purchased in the diversification and speculative portfolios, respectively, which trade at prices p and p_s. Let $\tilde{c}_1 = n\tilde{v}$ and $\tilde{c}_1^s = n_s\tilde{v}_s$ be future consumption from diversification and speculation, respectively, where $\tilde{v}$ and $\tilde{v}_s$ are the payoffs per share from each portfolio.

Consider a generic indifference curve corresponding to utility level u_0:

$$u(c_0) + \frac{1}{1+\delta}E\left(u(\tilde{c}_1) + u_s(\tilde{c}_1^s)\right) = u_0, \tag{A.1}$$

and differentiate it with respect to n:

$$-u'(c_0)p + \frac{1}{1+\delta}E(u'\left(\tilde{c}_1\right)\tilde{v}) = 0. \tag{A.2}$$

Using the definition of covariance, and solving out for the expected payoff:

$$\bar{v} = v_f - \frac{cov(u'\left(\tilde{c}_1\right), \tilde{v})}{E(u'(\tilde{c}_1))}, \tag{A.3}$$

where $\bar{v} \equiv E(\tilde{v})$, and v_f is the payoff from the risk-free asset:

$$v_f \equiv \frac{p(1+\delta)u'(c_0)}{E(u'(\tilde{c}_1))}. \tag{A.4}$$

Using a first-order Taylor expansion of marginal utility around $\bar{c}_1$:

$$u'\left(\tilde{c}_1\right) \approx u'\left(\bar{c}_1\right) + u''\left(\bar{c}_1\right)\left(\tilde{c}_1 - \bar{c}_1\right), \tag{A.5}$$

we can rearrange as:

$$\bar{v} \approx v_f + \gamma cov(\tilde{c}_1, \tilde{v}) \equiv v_f + \gamma n\sigma^2, \tag{A.6}$$

where $\sigma^2 \equiv var(\tilde{v})$, and γ is Arrow–Pratt's coefficient of absolute risk aversion (Pratt, 1964; Arrow, 1971):

$$\gamma \equiv -\frac{u''\left(\bar{c}_1\right)}{u'\left(\bar{c}_1\right)}. \tag{A.7}$$

The risk-return relation for diversification is then as follows:

$$\frac{d\bar{v}}{d\sigma} = 2n\gamma\sigma > 0, \tag{A.8}$$

$$\frac{d^2\bar{v}}{d\sigma^2} = 2n\gamma > 0, \tag{A.9}$$

which implies that the indifference curves over payoffs are upward-sloping and convex in the diversification domain. In an economy with two risky assets, this type of preference implies that the agent will choose a convex combination of them as long as they are not perfectly correlated.

Next, differentiate a generic indifference curve with respect to n_s:

$$-u'(c_0)p_s + \frac{1}{1+\delta}E(u_s'\left(\tilde{c}_1^s\right)\tilde{v}_s) = 0. \tag{A.10}$$

Using the definition of covariance, and solving out for the expected payoff:

$$\bar{v}_s = v_f^s - \frac{cov(u_s'\left(\tilde{c}_1^s\right), \tilde{v}_s)}{E(u_s'(\tilde{c}_1^s))}, \tag{A.11}$$

where $\bar{v}_s \equiv E(\tilde{v}_s)$, and v_f^s is the payoff from the risk-free asset:

$$v_f^s \equiv \frac{p_s(1+\delta)u'(c_0)}{E(u_s'(\tilde{c}_1^s))}. \tag{A.12}$$

Using a first-order Taylor expansion of marginal utility around $\bar{c}_1^s$:

$$u_s'\left(\tilde{c}_1^s\right) \approx u_s'\left(\bar{c}_1^s\right) + u_s''\left(\bar{c}_1^s\right)\left(\tilde{c}_1^s - \bar{c}_1^s\right), \tag{A.13}$$

we can rearrange as:

$$\bar{v}_s \approx v_f^s - \gamma_s cov(\tilde{c}_1^s, \tilde{v}_s) \equiv v_f^s - \gamma_s n_s \sigma_s^2, \tag{A.14}$$

where $\sigma_s^2 \equiv var(\tilde{v}_s)$, and γ_s is the coefficient of absolute risk-seeking:

$$\gamma_s \equiv \frac{u_s''\left(\bar{c}_1^s\right)}{u_s'\left(\bar{c}_1^s\right)}. \tag{A.15}$$

The risk-return relation for speculation is then as follows:

$$\frac{d\bar{v}_s}{d\sigma_s} = -2n_s\gamma_s\sigma_s < 0, \tag{A.16}$$

$$\frac{d^2\bar{v}_s}{d\sigma_s^2} = -2n_s\gamma_s < 0, \tag{A.17}$$

which implies that the indifference curves over payoffs are downward-sloping and concave in the speculation domain. In an economy with two risky assets, this type of preference implies that the agent will choose a corner solution rather than a combination of the two assets. A sufficient condition for an asset to be picked for speculation is that the first two moments of its payoff function are higher than those of the other asset.[22]

A.2. First-order conditions

In the diversification domain, the first-order condition with respect to asset i (with $i = A, B$) yields:

$$u'(c_0) = \frac{1}{1+\delta}E(u'\left(\tilde{c}_1\right)\left(1+\tilde{r}_i\right)), \tag{A.18}$$

which can be rearranged as:

$$E\left(1+\tilde{r}_i\right) = \frac{u'(c_0)}{E(u'\left(\tilde{c}_1\right))}(1+\delta) - \frac{cov(u'\left(\tilde{c}_1\right), \tilde{r}_i)}{E(u'(\tilde{c}_1))}. \tag{A.19}$$

For the riskless asset, the first-order condition yields:

$$1 + r_f = \frac{u'(c_0)}{E(u'\left(\tilde{c}_1\right))}(1+\delta). \tag{A.20}$$

Using the Taylor expansion introduced above, and combining the two equations:

$$E\left(\tilde{r}_i\right) - r_f = \gamma cov(\tilde{c}_1, \tilde{r}_i). \tag{A.21}$$

In the speculation domain, the first-order condition (for asset B) yields:

$$u'(c_0) = \frac{1}{1+\delta}E(u_s'\left(\tilde{c}_1^s\right)\left(1+\tilde{r}_B\right)), \tag{A.22}$$

which can be rearranged as:

$$E\left(1+\tilde{r}_B\right) = \frac{u'(c_0)}{E(u_s'\left(\tilde{c}_1^s\right))}(1+\delta) - \frac{cov(u_s'\left(\tilde{c}_1^s\right), \tilde{r}_B)}{E(u_s'(\tilde{c}_1^s))}. \tag{A.23}$$

[22] The intuition is that a higher expected payoff and a higher volatility are both desirable features in the speculative domain, so an asset that exhibits these characteristics dominates the other asset.

The time value of money has to be the same across the two domains:

$$1 + r_f = \frac{u'(c_0)}{E(u'_s(\tilde{c}^s_1))}(1+\delta) = \frac{u'(c_0)}{E(u'(\tilde{c}_1))}(1+\delta), \tag{A.24}$$

which implies Proposition 1. Using the Taylor expansion introduced above, and combining the two equations:

$$E(\tilde{r}_B) - r_f = -\gamma_s cov(\tilde{c}^s_1, \tilde{r}_B). \tag{A.25}$$

Since the demand for asset B includes both a diversification and a speculative component, the overall risk-premium on asset B is a weighted average of the risk premia in the two domains:

$$\pi_B = x_B \gamma cov(\tilde{c}_1, \tilde{r}_B) - x^s_B \gamma_s cov(\tilde{c}^s_1, \tilde{r}_B), \tag{A.26}$$

where $x_B + x^s_B = 1$ in equilibrium (due to unit supply). For stock A, on the other hand, the risk premium is simply:

$$\pi_A = \gamma cov(\tilde{c}_1, \tilde{r}_A). \tag{A.27}$$

A.3. Book-to-market ratio

In equilibrium, the asset picked for speculation (B) has a lower book-to-market ratio (per share) if:

$$\frac{\bar{v}_B}{P_B} < \frac{\bar{v}_A}{P_A}. \tag{A.28}$$

Using the definition of returns, the inequality implies that asset B requires an overall lower risk premium, i.e., $\pi_B < \pi_A$, or equivalently:

$$x_B \gamma cov(\tilde{c}_1, \tilde{r}_B) - x^s_B \gamma_s cov(\tilde{c}^s_1, \tilde{r}_B) < \gamma cov(\tilde{c}_1, \tilde{r}_A). \tag{A.29}$$

Developing further, and using the fact that $x_A = 1$ in equilibrium, the condition is met if the risk-seeking coefficient γ_s clears threshold γ_0:

$$\gamma_s > \frac{\gamma}{(x^s_B)^2}\left(x^2_B - \frac{var(\tilde{r}_A)}{var(\tilde{r}_B)}\right) \equiv \gamma_0, \tag{A.30}$$

which implies Proposition 2. Since $\gamma_s > 0$ and $x_B \in (0, 1)$, a sufficient condition for the inequality to hold is that $var(\tilde{r}_A) \geq var(\tilde{r}_B)$.

A.4. Security market line

In the diversification domain, agents choose the optimal combination of the two risky assets by identifying the tangency portfolio on the capital market line. The demand for the tangency portfolio is:

$$x_T = x_A + x_B, \tag{A.31}$$

whereas the returns on the tangency portfolio are:

$$\tilde{r}_T = \frac{1}{x_T}(x_A \tilde{r}_A + x_B \tilde{r}_B). \tag{A.32}$$

The pricing equation for a generic asset i also holds for the tangency portfolio itself:

$$E(\tilde{r}_T) - r_f = \gamma cov(\tilde{c}_1, \tilde{r}_T). \tag{A.33}$$

Replacing in the equation for asset i yields the security market line:

$$E(\tilde{r}_i) - r_f = \frac{cov(\tilde{r}_i, \tilde{r}_T)}{var(\tilde{r}_T)}(E(\tilde{r}_T) - r_f) \equiv \beta_i(E(\tilde{r}_T) - r_f). \tag{A.34}$$

Note that this equation determines the risk premium for all assets in a world with standard risk-averse preferences. In an economy with dichotomous risk-preferences, instead, it only determines the risk premium that agents require for diversification. Also, the security market line is flatter in the latter setup. The reason is that the agent reduces current consumption to invest in speculation, which increases the risk-free rate.

The presence of speculative demand also makes the empirical security market line flatter. To see why, note that the returns on the tangency portfolio from the diversification domain are:

$$\tilde{r}_T = \frac{x_A}{x_A + x_B}\tilde{r}_A + \frac{x_B}{x_A + x_B}\tilde{r}_B. \tag{A.35}$$

In the empirical analysis, however, it is not possible to disentangle the two types of demand for asset B. Then both end up in the empirical market portfolio:

$$\hat{r}_T = \frac{x_A}{x_A + x_B + x^S_B}\tilde{r}_A + \frac{x_B}{x_A + x_B + x^S_B}\tilde{r}_B + \frac{x^S_B}{x_A + x_B + x^S_B}\tilde{r}^S_B, \tag{A.36}$$

which implies $E(\tilde{r}_T) > E(\hat{r}_T)$. As a result, the true (and unobservable) security market line lies above its empirical counterpart.

The returns on asset A can then be expressed as the sum of the (biased) empirical estimate of the risk premium plus a pricing error:

$$E(\tilde{r}_A) - r_f = \beta_A(E(\tilde{r}_T) - r_f) \equiv \alpha_A + \hat{\beta}_A(E(\hat{r}_T) - r_f), \tag{A.37}$$

where $\alpha_A > 0$. Therefore, the security market line underestimates the risk premium required for diversification. This implies underpricing for asset A. Similarly, the returns on asset B can be expressed as:

$$E(\tilde{r}_B) - r_f = \beta_B(E(\tilde{r}_T) - r_f) \equiv \alpha_B + \hat{\beta}_B(E(\hat{r}_T) - r_f), \tag{A.38}$$

where $\alpha_B < 0$ if the speculative component of the risk premium dominates (see Eq. (A.26)). Put together, these two points imply Proposition 3.

A.5. Optimal stock demand and income

In the diversification domain, the derivative of the first-order condition for the investment in asset i with respect to the agent's wealth is:

$$\underbrace{-u(c_0)\left(\frac{dc_0}{dw_0}\right)}_{>0} + \underbrace{\frac{1}{1+\delta}E\left(u(\tilde{c}_1)\left(1+\tilde{r}_i\right)\right)}_{<0}\frac{dx_i}{dw_0} = 0. \tag{A.39}$$

In the speculation domain, the derivative of the first-order condition for the investment in asset B with respect to the agent's wealth is:

$$\underbrace{-u(c_0)\left(\frac{dc_0}{dw_0}\right)}_{>0} + \underbrace{\frac{1}{1+\delta}E\left(u_s(\tilde{c}^s_1)\left(1+\tilde{r}_B\right)\right)}_{>0}\frac{dx^s_B}{dw_0} = 0. \tag{A.40}$$

The two equations imply $\frac{dx_i}{dw_0} > 0$ for $i = A, B$, and $\frac{dx^s_B}{dw_0} < 0$. In turn, this implies Proposition 4.

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