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# Betting against beta ☆

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ABSTRACT

We present a model with leverage and margin constraints that vary across investors and time. We find evidence consistent with each of the model's five central predictions: (1) Because constrained investors bid up high-beta assets, high beta is associated with low alpha, as we find empirically for US equities, 20 international equity markets, Treasury bonds, corporate bonds, and futures. (2) A betting against beta (BAB) factor, which is long leveraged low-beta assets and short high-beta assets, produces significant positive risk-adjusted returns. (3) When funding constraints tighten, the return of the BAB factor is low. (4) Increased funding liquidity risk compresses betas toward one. (5) More constrained investors hold riskier assets.



## 1. Introduction

A basic premise of the capital asset pricing model (CAPM) is that all agents invest in the portfolio with the highest expected excess return per unit of risk (Sharpe ratio) and leverage or de-leverage this portfolio to suit their risk preferences. However, many investors, such as individuals, pension funds, and mutual funds, are constrained in the leverage that they can take, and they therefore overweight risky securities instead of using

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leverage. For instance, many mutual fund families offer balanced funds in which the "normal" fund may invest around 40% in long-term bonds and 60% in stocks, whereas the "aggressive" fund invests 10% in bonds and 90% in stocks. If the "normal" fund is efficient, then an investor could leverage it and achieve a better trade-off between risk and expected return than the aggressive portfolio with a large tilt toward stocks. The demand for exchange-traded funds (ETFs) with embedded leverage provides further evidence that many investors cannot use leverage directly.

This behavior of tilting toward high-beta assets suggests that risky high-beta assets require lower risk-adjusted returns than low-beta assets, which require leverage. Indeed, the security market line for US stocks is too flat relative to the CAPM (Black, Jensen, and Scholes, 1972) and is better explained by the CAPM with restricted borrowing than the standard CAPM [see Black (1972, 1993), Brennan (1971), and Mehrling (2005) for an excellent historical perspective].

Several questions arise: How can an unconstrained arbitrageur exploit this effect, i.e., how do you bet against beta? What is the magnitude of this anomaly relative to the size, value, and momentum effects? Is betting against beta rewarded in other countries and asset classes? How does the return premium vary over time and in the cross section? Who bets against beta?

We address these questions by considering a dynamic model of leverage constraints and by presenting consistent empirical evidence from 20 international stock markets, Treasury bond markets, credit markets, and futures markets.

Our model features several types of agents. Some agents cannot use leverage and, therefore, overweight high-beta assets, causing those assets to offer lower returns. Other agents can use leverage but face margin constraints. Unconstrained agents underweight (or short-sell) high-beta assets and buy low-beta assets that they lever up. The model implies a flatter security market line (as in Black (1972)), where the slope depends on the tightness (i.e., Lagrange multiplier) of the funding constraints on average across agents (Proposition 1).

One way to illustrate the asset pricing effect of the funding friction is to consider the returns on market-neutral betting against beta (BAB) factors. A BAB factor is a portfolio that holds low-beta assets, leveraged to a beta of one, and that shorts high-beta assets, de-leveraged to a beta of one. For instance, the BAB factor for US stocks achieves a zero beta by holding $1.4 of low-beta stocks and shortselling $0.7 of high-beta stocks, with offsetting positions in the risk-free asset to make it self-financing.[1] Our model predicts that BAB factors have a positive average return and that the return is increasing in the ex ante tightness of constraints and in the spread in betas between high- and low-beta securities (Proposition 2).

When the leveraged agents hit their margin constraint, they must de-leverage. Therefore, the model predicts that, during times of tightening funding liquidity constraints, the BAB factor realizes negative returns as its expected future return rises (Proposition 3). Furthermore, the model predicts that the betas of securities in the cross section are compressed toward one when funding liquidity risk is high (Proposition 4). Finally, the model implies that more-constrained investors overweight high-beta assets in their portfolios and less-constrained investors overweight low-beta assets and possibly apply leverage (Proposition 5).

Our model thus extends the Black (1972) insight by considering a broader set of constraints and deriving the dynamic time series and cross-sectional properties arising from the equilibrium interaction between agents with different constraints.

We find consistent evidence for each of the model's central predictions. To test Proposition 1, we first consider portfolios sorted by beta within each asset class. We find that alphas and Sharpe ratios are almost monotonically declining in beta in each asset class. This finding provides broad evidence that the relative flatness of the security market line is not isolated to the US stock market but that it is a pervasive global phenomenon. Hence, this pattern of required returns is likely driven by a common economic cause, and our funding constraint model provides one such unified explanation.

To test Proposition 2, we construct BAB factors within the US stock market and within each of the 19 other developed MSCI stock markets. The US BAB factor realizes a Sharpe ratio of 0.78 between 1926 and March 2012. To put this BAB factor return in perspective, note that its Sharpe ratio is about twice that of the value effect and 40% higher than that of momentum over the same time period. The BAB factor has highly significant risk-adjusted returns, accounting for its realized exposure to market, value, size, momentum, and liquidity factors (i.e., significant one-, three-, four-, and five-factor alphas), and it realizes a significant positive return in each of the four 20-year subperiods between 1926 and 2012.

We find similar results in our sample of international equities. Combining stocks in each of the non-US countries produces a BAB factor with returns about as strong as the US BAB factor.

We show that BAB returns are consistent across countries, time, within deciles sorted by size, and within deciles sorted by idiosyncratic risk and are robust to a number of specifications. These consistent results suggest that coincidence or data mining are unlikely explanations. However, if leverage constraints are the underlying drivers as in our model, then the effect should also exist in other markets.

Hence, we examine BAB factors in other major asset classes. For US Treasuries, the BAB factor is a portfolio that holds leveraged low-beta (i.e., short-maturity) bonds and shortsells de-leveraged high-beta (i.e., long-term) bonds. This portfolio produces highly significant risk-adjusted returns with a Sharpe ratio of 0.81. This profitability of shortselling long-term bonds could seem to contradict the well-known "term premium" in fixed income markets. There is no paradox, however. The term premium means

[1] While we consider a variety of BAB factors within a number of markets, one notable example is the zero-covariance portfolio introduced by Black (1972) and studied for US stocks by Black, Jensen, and Scholes (1972), Kandel (1984), Shanken (1985), Polk, Thompson, and Vuolteenaho (2006), and others.