The Unlevered Capital Asset Pricing Model

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Leverage is the predominant source of time variation in betas and the usual approaches to deal with this variation may not fully eliminate pricing errors. Using an unlevered CAPM, we show that unlevered betas explain the cross-sectional variation in average unlevered returns of 7,563 U.S. firms and a variety of test portfolios, between 1952-2014. The model is an improvement of the traditional implementation of the CAPM and the Fama and French (1993) three-factor model. The robustness of the results, the theoretical underpinnings, and the circumstantial evidence of previous literature, advocate for the use of unlevered returns in asset pricing tests.

Keywords*:* Asset Pricing, Leverage Effect, Unlevered Beta, CAPM, Cross-section of Stock Returns. **JEL**: G10, G12

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I. Introduction

This article reconsiders a central question in tests of asset pricing theories, namely, whether variation in the regression coefficients of time-series regressions of market portfolio returns on stock returns, known as betas, can explain the cross-sectional variation in average stock returns, as implied by the capital asset pricing model (CAPM). Most scholars agree that the CAPM is conceptually sound, but there is also substantial consensus that it is an empirical failure. We argue instead that the CAPM has failed empirically because of the potential large time variation in betas due to changes in firms' leverage ratios. Moreover, the usual approaches to deal with time-varying betas, for example estimating a conditional CAPM, are not adequate to eliminate large pricing errors. Instead, we offer a straightforward alternative method. We deal with the leverage effect first by unlevering the returns, and then calculate so-called "unlevered betas" based on an unconditional, unlevered CAPM. We show that unlevered betas are able to explain cross-sectional variation in average unlevered returns. While the economic mechanism of a leverage effect is not new and our approach is simple, the method is powerful in overcoming many econometric issues and the results are robust.

Current asset pricing literature considers the CAPM to be, at best, conditionally correct and acknowledges that betas, expected returns, volatility, and so forth are likely to vary over time. In addition, the intertemporal CAPM (ICAPM) highlights that a market portfolio need not be mean-variance efficient if investors hedge against state variable risk. In any case, several considerations render the classic, unconditional tests of the CAPM (Black, Jensen, and Scholes, 1972; or Fama and MacBeth, 1973) more or less useless, and most empirical asset pricing literature proposes unconditional multi-factor models in response.[1]

[1] Although some recent asset pricing studies test consumption-based theories (e.g., Santos and Veronesi, 2006; Avramov, Cederburg, and Hore, 2014; Ferson, Nallareddy, and Xie, 2012; Savov, 2011; Jagannathan and Wang, 2007), many empirical papers try to identify additional risk factors, using either the Fama and French (1993) three-factor model or the CAPM as a baseline model. Such additional risk factors are often momentum based (Carhart, 1997; Moskowitz, Ooi, and Pedersen,

These multi-factor studies commonly confront the long-short strategies based on portfolio sorts using an additional risk factor with a few baseline models and thereby seek to investigate whether the strategies generate significant alphas. Alternatively, they conduct Fama-MacBeth two-step regressions to show that the additional factor is a priced risk factor. Although some studies are explicit on the theory they test, in many cases, it remains unclear whether the approach is motivated by arbitrage pricing theory (APT), the ICAPM, or some other theory. The sole focus seems to be on empirical performance. General agreement indicates that multi-factor models are an appropriate way to deal with time-varying parameters of a theoretical stochastic discount factor model, whereas the exact motivation for a particular specification is not always deemed relevant. Yet, as recently pointed out by Harvey et al. (2013), the vast number of attempts to explain the cross-section of expected returns using a multi-factor approach has resulted in extensive data mining. They also question the economic or statistical sense of using conventional significance criteria for a newly discovered factor, especially when there is little theory to motivate such a factor.

We recognize that moments of stock returns and/or the stochastic discount factor are likely time-varying, but we argue that the lion's share of variation in expected returns, betas, and volatility is caused by the so-called leverage effect. We recommend addressing this leverage effect *first*, before estimating an asset pricing model, which is precisely the aim of our method.

The leverage effect has attracted considerable interest in literature on stock return volatility (e.g., Schwert, 1989; Nelson, 1991), but its implications have not received as much attention in empirical asset pricing literature (recent exceptions are Choi, 2015; Obreja, 2013; and Lally, 2004). It is commonly argued that because the leverage effect is

2012), volatility based (Boguth and Kuehn, 2013; Xing, Zhang, and Zhao, 2010; Fu, 2009; Adrian, and Rosenberg, 2008; Yan, 2011, Xing, 2008), liquidity based (Chordia, Huh, and Subrahmanyam, 2009; Acharya and Pederson, 2005; Sadka, 2010), geographically based (Kim, Pantzalis, and Park, 2012; Garcia and Norli, 2012), or based on higher moments such as skewness (Chang, Christoffersen, and Jacobs, 2013; Conrad, Dittmar, and Ghysels, 2013; Bali, Cakici, and Whitelaw, 2011; Kapadia, 2011; Boyer, Mitton, and Vorkink, 2010). Some examples of other factors include innovation (Cohen, Diether, and Malloy, 2013), insider trading (Cohen, Malloy, and Pomorski , 2012), the probability of information-based trading (Burlacu, Fontaine, Jimenez-Garces, and Seasholes, 2012; Easley, Hvidkjaer, and O'Hara, 2010), and profitability (Novy-Marx, 2013; Fama and French, 2006).

nothing else than time-varying betas, a correctly specified asset pricing model that holds unconditionally should be able to price any asset – also those assets subject to a leverage effect.

Even if the CAPM is not the correct unconditional model, some scholars have argued that the CAPM can, in principle, hold conditionally. Some tests of the conditional CAPM rely on "agnostic" procedures, that is, the time-varying parameters are estimated using return data only. For example, Lewellen and Nagel (2006) adopt rolling window regressions to estimate time-varying betas and time-varying risk premia. A conditional CAPM of this sort may seem suited to capture time variation in betas due to leverage. However, studies using such approaches are not conclusive. For example, Lewellen and Nagel (2006) and Ang and Kristensen (2012) reject the conditional CAPM, however, Ang and Chen (2007), and Adrian and Franzoni (2009) do not reject the conditional CAPM. The discussion of whether or not the conditional CAPM holds seems to center around value portfolios, for which the pricing errors are found to be largest.

In this context, Ang and Chen (2007) point out that while the bias in alphas of unconditional models indeed should be small, the sample variance of rolling-window betas is biased and underestimates the true time variance in betas when time-varying betas are very persistent. They also claim that in this case the true distributions of unconditional alphas can be rather disperse and that it is not unusual to observe a large alpha in small samples. This large dispersion may explain why there are large alphas in the post-1963 U.S. sample but not in the pre-1963 sample associated with book-to-market portfolio sorts. Indeed, we confirm that the leverage ratios, and by implication the associated betas, are highly persistent, especially for value portfolios.

A more structural way to deal with time-varying betas due to leverage is to obtain betas using the leverage ratio as an instrument. However, such a specification does not take into account the effect leverage has on volatility. While this approach may also remove the bias in the pricing error, adopting a constant volatility model can also lead to incorrect inference on the significance of the pricing errors. More generally, Boguth et al. (2011) warn for additional biases due to overconditioning of the CAPM, and Harvey (2001) points out that the estimates of betas are very sensitive to the choice of instruments.

Instead of conditioning betas on leverage ratios, we propose to simply unlever the returns first, as this takes care of both the variation in betas and volatility due to leverage. Our believe is that the dynamic nature of leverage ratios unnecessarily obfuscates the underlying asset returns; it potentially inflates return volatility substantially and generates time-varying betas, risk premia, and volatility, that are highly persistent. We appreciate the point of Boguth et al. (2011) on the potential bias due to overconditioning, and the point of Harvey (2001) on the sensitivity of the estimates of betas to the choice of instruments. However, we feel that the transformation of levered to unlevered returns is more in the spirit of rewriting an identity, in contrast to using conditioning variables as a proxy for some economic phenomenon; e.g. dividend-price ratios to condition for the equity premium. Of course, there are measurement issues related to leverage ratios, however, in practice an investor is in principle able to obtain the same unlevered returns that we construct in this study. Time-varying betas due to leverage are in this sense much more tangible compared to, for example, estimates of time-varying risk premia based on dividend-price ratios.

We test the implications of our unlevered CAPM for both a cross-section of 7,563 listed U.S. firms and a variety of sets of portfolios for the period 1952-2014. We compare the performance of our model against that of the traditional implementation of the CAPM and the Fama and French (1993) three-factor model. We use the Gibbons, Ross, and Shanken (1989) statistic to test whether the pricing errors of the models are jointly significantly different from zero, and we adopt the Fama-MacBeth (1973) two-step procedure to test if the unlevered betas are a priced risk factor. Our model performs quite well in comparison with the benchmark models; perhaps even more important, the results are remarkably robust. Both the traditional implementation of the CAPM and Fama and French (1993) three-factor model exhibit rather erratic behavior in terms of cross-sectional fit, whereas our unlevered CAPM yields stable estimates, with cross-sectional R^2s that are consistently large independent of the particular sorting choice of the test portfolios. Our results are in line with Choi (2015), who focuses on the dynamic behavior of betas and the relation between leverage and the value effect using a carefully constructed dataset of unlevered returns for the U.S. between 1982-2007. He finds that unlevered betas are indeed much more stable over time compared to levered betas, and that leverage can largely account for the value effect.

In the next section, we derive the main equation describing the relation between unlevered betas and stock returns. Then in Section III we introduce our methodology and specify how we test the model. After we describe our data and present the results, we conclude in Section VI.

II. The Model

There are N risky (real) assets, and asset i trades against price $P_i(t)$ at time t. We refer to the dollar amount invested in asset i at time t as the capital stock, $K_i(t) = P_i(t)n_i(t)$, where $n_i(t)$ is the amount invested in asset i.

ASSUMPTION 1: *The dynamic path of the return on capital of asset i, $\frac{dP_i(t)}{P_i(t)}$, is represented by a diffusion of the form:*

$$\frac{dP_i(t)}{P_i(t)} = \mu_i(\cdot)dt + \sigma_i(\cdot)dz_i(t),$$

where $\mu_i(\cdot)$ and $\sigma_i(\cdot)$ may depend on state variables at time t. Furthermore, $z_i(t)$ is a standard Brownian motion, and correlations between the Brownian motions are given by $\rho_{ij}(t)dt = dz_i(t)dz_j(t), \forall i, j$, with $1 \leq \rho_{ij}(t) \leq 1, \forall i, t \neq j$, and $\rho_{ii}(t) = 1 \forall i, t$.

We define the *market portfolio* of risky assets at time t as the portfolio of real capital stocks, so it is a vector $\mathbf{K}(t)$, defined as $\mathbf{K}(t)' = (K_1(t), \ldots, K_i(t), \ldots, K_N(t))$. We define the portfolio weights $w_i(t)$ as $w_i(t) = \frac{K_i(t)}{\iota'\mathbf{K}}$, where ι is a vector of ones. We also adopt an assumption that is central to the capital asset pricing model (CAPM).

ASSUMPTION 2: *The market portfolio, $\mathbf{K}(t)$, is an instantaneous mean-variance efficient portfolio.*

This assumption allows for non linear production functions, but it implies a linear investment technology, so that capital is perfectly fungible. Furthermore, it means there are no market frictions and that investors do not hedge against state variable risk.

The relevant implication of assuming mean-variance efficiency is that the diffusion terms of the return on the market portfolio are proportional to the diffusion terms of a stochastic discount factor. Therefore, correlations with the market portfolio should be proportional to expected returns. To be precise, under mean-variance efficiency of the market portfolio, the implied stochastic discount factor, $\Lambda(t)$, is characterized by:

$$\frac{d\Lambda(t)}{\Lambda(t)} = -r(t)dt - \lambda(t)\sum_i w_i(t)\sigma_i(\cdot)dz_i(t), \tag{1}$$

where $r(t)$ is the (implied) risk free rate, and $\lambda(t) > 0$ reflects the price of risk.

We introduce (short-term) firm-level debt, $D_i(t)$, and firm-level equity, $E_i(t)$, which are the only two methods of financing real assets we consider, such that $K_i(t) = D_i(t) + E_i(t)$. It then follows that:

$$\frac{dK_i(t)}{K_i(t)} = \frac{dD_i(t)}{D_i(t)}\frac{D_i(t)}{K_i(t)} + \frac{dE_i(t)}{E_i(t)}\frac{E_i(t)}{K_i(t)}. \tag{2}$$

We define $P_i^E(t)$ and $P_i^D(t)$ as the price of equity and debt, respectively, for firm i at time t, and $s_i(t)$ and $m_i(t)$ as the amount of shares and debt, respectively. We can decompose the changes in the capital stock, total debt, and total equity into price changes and quantity changes, then include the (potential) cash-flow interest payments and dividend payments, $d_i(t)$, in the decomposition:

$$\underbrace{\frac{dP_i(t)}{P_i(t)}}_{\text{Productive capital gains}} + \underbrace{\frac{dn_i(t)}{n_i(t)}\left(1+\frac{dP(i)}{P_i(t)}\right)}_{\text{Investments/divestments in real capital}} \tag{3}$$
$$= \left[\underbrace{\frac{dP_i^D(t)}{P_i^D(t)} + r(t)dt}_{\text{Return on debt}} - \underbrace{r(t)dt}_{\text{Interest payments}} + \underbrace{\frac{dm_i(t)}{m_i(t)}\left(1+\frac{dP_i^D(t)}{P_i^D(t)}\right)}_{\text{Debt issuances/repurchases}}\right]\frac{D_i(t)}{K_i(t)}$$
$$+ \left[\underbrace{\frac{dP_i^E(t)+d_i(t)dt}{P_i^E(t)}}_{\text{Return on equity}} - \underbrace{\frac{d_i(t)dt}{P_i^E(t)}}_{\text{Dividend payments}} + \underbrace{\frac{ds_i(t)}{s_i(t)}\left(1+\frac{dP^E(i)}{P_i^E(t)}\right)}_{\text{Equity issuances/repurchases}}\right]\frac{E_i(t)}{K_i(t)}.$$

Cancelling the investments/divestments in real capital against net cash flows (net value of interest payments, debt issuances/ repurchases, dividend payments, and equity issuances/ repurchases) simplifies Equation (3) to:

$$\mu_i(\cdot)dt + \sigma_i(\cdot)dz_i(t) = r(t)\frac{D_i(t)}{K_i(t)}dt + \frac{E_i(t)}{K_i(t)}\left(\frac{dP_i^E(t)+d_i(t)dt}{P_i^E(t)}\right), \tag{4}$$

where we assume for simplicity that interest is always paid, conforming to the short-term rate $r(t)$, and (short-term) debt is risk free, $dP_i^D(t) = 0$. In practice, corporate debt is not risk-free and equity holders have limited liability, which will generally imply a non-linear relation between the underlying value of the firm and its equity value when the firm is highly leveraged (see e.g. Choi, 2015). However, we focus on differences in the cross-section of average returns and expect that our linear approximation is able to sufficiently capture these differences. We define $\mu_i^E(\cdot)$ and $\sigma_i^E(\cdot)$ as the drift and diffusion terms of $\frac{dP^E(i)+d_i(t)}{P_i^E(t)}$, where $d_i(t)$ are the dividends of firm i. If we take Equation (4) and subtract the risk-free rate, we have:

$$(5)\qquad (\mu_i(\cdot) - r(t))dt + \sigma_i(\cdot)dz_i(t) = \frac{E_i(t)}{K_i(t)}\left((\mu_i^E(\cdot) - r(t))dt + \sigma_i^E(\cdot)dz_i(t)\right).$$

This equations relates the excess returns on real capital (left-hand side) to the unlevered excess returns on equity, using the leverage ratio of the firm (right-hand side).

Since the diffusion term of the left-hand side of Equation (4) should be equal to the diffusion term of the right-hand side, we can find the diffusion term of the price changes in equity:

$$\sigma_i^E(\cdot) = \frac{K_i(t)}{E_i(t)}\sigma_i(\cdot).$$

Using the stochastic discount factor, we then can find the expected return on equity, using a continous time pricing equation (Cochrane, 2001):

$$(6)\qquad \mu_i^E(\cdot)dt = r(t)dt - E_t\left[\frac{d\Lambda(t)}{\Lambda(t)}\frac{dP_i^E(t)}{P_i^E(t)}\right].$$

Evaluating this equation gives us the excess return process, $dR_i^e(t) \equiv \frac{dP_i^E(t)}{P_i^E(t)} + \frac{d_i(t)}{P_i^E(t)} - r(t)dt$, for the equity of firm i:

$$(7)\qquad dR_i^e(t) = \frac{K_i(t)}{E_i(t)}\lambda(t)\sigma_{\mathbf{K}}^2(\cdot)\beta_i(t)dt + \frac{K_i(t)}{E_i(t)}\sigma_i(\cdot)dz_i(t),$$

where $\sigma_{\mathbf{K}}^2(\cdot)$ is the conditional variance of the market portfolio, and define the conditional *unlevered beta* of firm i as $\beta_i(t) = \left(\sum_j w_j(t)\rho_{ij}(t)\sigma_i(\cdot)\sigma_j(\cdot)\right)/\sigma_{\mathbf{K}}^2(\cdot)$.

Equation (7) is a conditional version of the CAPM that reveals that time variation in the expected excess returns can arise as a result of four separate sources of time variation, namely: i) variation in the leverage of the firm $\frac{K_i(t)}{E_i(t)}$, ii) variation in the price of risk $\lambda(t)$, iii) changes in the variance of the market portfolio $\sigma_{\mathbf{K}}^2(\cdot)$, or iv) variation in unlevered betas $\beta_i(t)$. In turn, time variation in stock return volatility can arise from two sources of time variation: $i)$ variation in the leverage of the firm $\frac{K_i(t)}{E_i(t)}$, or $ii)$ variation in the volatility of the underlying capital stock of the firm $\sigma_i(\cdot)$.

We would argue that the majority of the time variation in both the expected excess returns and stock return volatility is caused by variation in the leverage of the firm. Typically, equity-to-total assets ratios are about 60% on average in historical U.S. data, but they vary between roughly 30% and 90% over time. Therefore, the total assets-to-equity ratio $\frac{K_i(t)}{E_i(t)}$ varies between 111% and 333%, implying that high values of (levered) betas can be three times as large as low beta values, due solely to variation in leverage. Moreover, the capital structure of firms arguably is weakly linked to the real economy, whereas all other sources of time variation are directly linked to the real economy. In the real economy, we observe low and stable consumption growth and low and stable GDP growth, both of which are roughly identically and independently distributed; low and slowly changing interest rates; and moderate volatility in real capital stocks with no clear patterns of time-varying volatility.[2] Finally, Choi (2015) estimates the dynamic behavior of levered and unlevered betas and shows that unlevered betas are much more stable over time compared to levered betas. With these stylized facts in mind, we assert believe that the other sources of variation in (long-run) expected returns and volatility cannot be as volatile as the leverage ratio, so we make an additional simplifying assumption.

ASSUMPTION 3: *The variables $\lambda(t)$, $\sigma_i(t)$, $\rho_{ij}(t)$, and $w_i(t)$ are constant over time.*

The interest rate can still be time varying, but the time variation in expected excess returns and stock return volatility is only driven by variation in the leverage ratio. Such an equilibrium is consistent with, for example, the model by Cox, Ingersoll, and Ross (1985), which describes an economy in which investors exhibit log utility, production and invest-

[2]In the United States during 1946-2009, average real consumption growth per capita was approximately 2.2%, with a standard deviation of 2.1%; average real capital stock growth per capita was approximately 2.8%, with a standard deviation of 6.4%; and interest rates were on average 1.4%, with a standard deviation of 3.6%. Autocorrelations of these variables differ insignificantly different, from zero, with the exception of the interest rate, which exhibits an autocorrelation of 0.55 (Dam and Heijnen, 2015).

ment functions are linear, and a single state variable causes variation in the interest rate. Alternatively, such an equilibrium could be supported by a stochastic Ramsey model with a parameter restriction, as described by Dam and Heijnen (2015), such that the restriction results in consumption being a fixed fraction of total output. In their economy, investors exhibit constant relative risk aversion, production is Cobb-Douglas and identical for each firm, and investment technologies are linear.

Assumption 3 allows us to estimate an unconditional model – as we show in the next section – instead of trying to capture variation in the parameters of a conditional model with multiple risk factors. Assumption 3 further implies that the excess return process is a simplified version of Equation (7):

$$dR_i^e(t) = \frac{K_i(t)}{E_i(t)}\lambda\sigma_{\mathbf{K}}^2\beta_i dt + \frac{K_i(t)}{E_i(t)}\sigma_i dz_i(t). \tag{8}$$

The unlevered betas, or β_i's, are the regression coefficients of regressions of the firm-specific shocks $\sigma_i dz_i(t)$ on the market portfolio shocks $\sum_i w_i\sigma_i dz_i(t)$. The "traditional" or levered betas are time-varying and equal to the unlevered betas multiplied by the inverse of the leverage of the firm. Therefore, the main test of the model is to investigate whether the expected returns are proportional to the inverse leverage ratio $\frac{K_i(t)}{E_i(t)}$, times the unlevered beta β_i.[3]

III. Methodology

A. Econometric specification of the model

The discrete time equivalent of Equation (8) is:

$$R_{i,t+1} - r_{t+1} = \frac{K_{i,t}}{E_{i,t}}\lambda\sigma_{\mathbf{K}}^2\beta_i + \frac{K_{i,t}}{E_{i,t}}\epsilon_{i,t+1}, \tag{9}$$

[3]Even if this assumption is violated and unlevered betas are also time-varying, Chan and Chen (1988) show that we can estimate an unconditional model, as long as the sample is "long enough" and the unlevered betas are stationary.

where $\epsilon_{i,t} \sim N(0, \sigma_i^2)$, i.i.d and $E\left[\epsilon_{i,t+1}\frac{K_{i,t}}{E_{i,t}}\right] = 0, \forall t$. Thus, Equation (9) suggests a time-series regression of returns on leverage, in line with prior literature that uses deflated prices (e.g., E/P, D/P, and B/M ratios) to predict returns (e.g., Campbell and Shiller, 1988; Fama and French, 1988, Cochrane, 2008). It is also a model for volatility clustering, highlighting the leverage effect in stock return volatility (e.g., Schwert, 1989; Nelson, 1991). But it also suggests a cross-sectional test, which is the focus of this paper. A prima vista, Equation (9) seems problematic for this purpose, because it exhibits both a time-varying mean and time-varying volatility. However, the equation depends on the inverse of the lagged leverage ratio, which we observe, so we can divide both sides by $\frac{K_{i,t}}{E_{i,t}}$ to obtain:

$$(R_{i,t+1} - r_{t+1})\frac{E_{i,t}}{K_{i,t}} = \lambda\sigma_{\mathbf{K}}^2\beta_i + \epsilon_{i,t+1}.$$

Similarly, for the market portfolio, we have:

$$(R_{M,t+1} - r_{t+1})\frac{E_{M,t}}{K_{M,t}} = \lambda\sigma_{\mathbf{K}}^2 + \epsilon_{M,t+1},$$

where $\frac{E_{M,t}}{K_{M,t}}$ is the aggregate leverage ratio.

This transformation of excess equity returns offers a nice economic interpretation. As equation (5) shows, we basically transform levered equity returns into unlevered equity returns, which should be equal to the return on real capital. The return on real capital is not equal to the percentage changes in the capital stock dK_i/K_i, because the latter also include investments. The transformation thus shows how the available information on both equity prices (or returns) and equity quantity (or number of shares) helps us to disentangle returns on real capital from real capital investments.

As our transformed variable has a straightforward interpretation, we change our notation and combine the two preceding equations to obtain:

$$E_t[R^u_{i,t} - r_t] = \beta^u_i E_t[R^u_{M,t} - r_t], \tag{10}$$

where $R^u_{i,t} - r_t \equiv (R_{i,t+1} - r_{t+1}) \frac{E_{i,t-1}}{K_{i,t-1}}$ is defined as the *unlevered* excess return for asset i at time t, and $R^u_{M,t} - r_t \equiv (R_{M,t+1} - r_{t+1}) \frac{E_{M,t-1}}{K_{M,t-1}}$ is the *unlevered* market return. For sake of clarity, we add a superscript u to the betas defined by this equation to highlight that they are *unlevered* betas. Accordingly, we obtain the classic CAPM expression, but expressed in terms of unlevered returns and unlevered betas.

We can conduct the standard tests of the CAPM that have been suggested (Black, Jensen, and Scholes, 1972; or Fama and MacBeth, 1973), after having transformed the returns into unlevered returns. Specifically, because β^u_i is a regression coefficient of $\epsilon_{i,t}$ on $\epsilon_{M,t}$, we test the model by running time-series regressions for the equity of each firm i of the form:

$$R^u_{i,t} - r_{t+1} = a_i + b_i \left(R^u_{M,t+1} - r_{t+1}\right) + e_{i,t+1}, \tag{11}$$

where a_i, b_i are the coefficients to be estimated, and $e_{i,t}$ is the equity-specific residual at time t. The coefficient b_i is an estimate for the unlevered beta, β^u_i. According to the model, the pricing errors reflected by the intercepts a_i should be jointly zero. We can test this hypothesis with the Gibbons-Ross-Shanken (1989) (GRS) test. In addition, after estimating the unlevered betas, we can run a cross-sectional regression of the average unlevered returns on the unlevered betas obtain from the first-step regression for the asset pricing model:

$$E[R_{i,t} - r_t] = \alpha + \beta'_i \lambda,$$

In particular, we use the Fama-MacBeth (1973) procedure of running T cross-sectional regressions (one for each time-period) and calculate the average estimated alpha and lambda, and associated standards errors. We can then test whether the unlevered beta is a priced risk factor, reflected by the significance of λ, and if the intercept α is zero, as implied by the model.

B. Econometric specification for alternative models: Traditional implementation of the CAPM and Fama and French (1993) three-factor model

To compare the performance of our model, we also test the traditional implementation of the CAPM and the Fama and French (1993) three-factor model. The traditional implementation of the CAPM tests whether covariances of excess (levered) stock returns with the excess return on the market portfolio of equity capture variation in average equity returns, and assumes constant (levered) betas. Fama and French (1993) add two factors to this specification, namely a High-minus-Low (HmL) portfolio and a Small-minus-Big (SmB) portfolio.

The traditional implementation of the CAPM is to run time-series regressions for excess stock returns on the excess return on the market portfolio of equity:

$$R_{i,t} - r_t = a_i + b_i \left(R_{M,t} - r_t \right) + e_{i,t}, \tag{12}$$

which represents the way to test the CAPM as proposed by Black, Jensen, and Scholes (1972). For the Fama and French model, we run similar regressions, as outlined by Fama and French (1993):

$$R_{i,t} - r_t = a_i + b_i \left(R_{M,t} - r_t \right) + h_i HmL(t) + s_i SmB(t) + e_{i,t}. \tag{13}$$

Again, we use the GRS statistic to test whether the pricing errors a_i are jointly zero for the two models; after estimating betas, we also run cross-sectional regressions of the average returns on the betas using the Fama-MacBeth procedure to determine if the unlevered betas are a priced risk factor.

To avoid confusion, we will refer to the CAPM theory as simply "CAPM", to the traditional implementation of the CAPM as "traditional CAPM", and to our implementation of the CAPM as "unlevered CAPM".

IV. Data

We use five data sources to construct our data set. The firm-level data came from COMPUSTAT's North-America "Fundamentals Yearly," "Fundamentals Quarterly," and "Fundamentals Monthly." For the period prior to the 1970s, the amount of information on book values of equity is limited, so we augment these firm-level data with hand-collected book equity values from Moody's Industrial, Public Utility, Transportation, and Bank and Finance Manuals, as used by Davis, Fama, and French (2000) and provided on Kenneth French's website through Dartmouth. Monthly stock returns, stock prices, and the number of shares outstanding are from the Center of Research in Security Prices (CRSP). Aggregate stock market returns, the interest rate, and the Fama and French (1993) HmL and SmB factors came from the "Fama French and Liquidity Factors" resource in the Wharton Research Data Services (WRDS; the Fama and French factor data source again is Kenneth French's website). Quarterly data for total equity and total assets for the market as a whole are taken from the flows of funds (FoF) account from the Federal Reserve.

To construct a firm-level, market-based, monthly leverage ratio, we first used quarterly (for 1962-2014) or yearly (for 1952-1962) variables to calculate the *notional* value of quarterly/yearly debt for each firm as the difference between the book value of total assets and the book value of equity. For the early years of the sample, we also rely on hand-collected data, similar to Davis, Fama, and French (2000), to obtain missing values of book equity. If there were still missing values of debt constructed this way, we replace them with the book value of total liabilities, if available. Moving from quarterly or yearly data to monthly data, we simply assume a constant debt level in each quarter/year. This assumption is not completely accurate, but in the end, our variable of interest is the leverage ratio, for which variation is caused predominantly by variation in equity, not in debt.

We next calculate the monthly firm-level market value of equity as the number of shares outstanding times the closing price for that month from CRSP. We replace missing values for shares outstanding with either the lagged value of shares outstanding, or else use the entry in COMPUSTAT's Security Montly or Fundamentals Quarterly, where available. We then define the monthly market value of total assets as the sum of the market value of equity and book value of debt, and the monthly market-based firm-level leverage ratio as the ratio of the market value of equity to the market value of total assets. In summary, the main caveats in calculating the monthly market-based leverage factor is that we have adopted a book value of debt and have replaced the missing values for debt in the monthly data set with the quarterly or yearly observations.

Quarterly data for the market value of total equity for the aggregate market are taken from the FoF account from the Federal Reserve and defined as the total value of "Nonfinancial corporate business; public corporate equities less intercompany holdings; liability" (item: Z1/Z1/FL103164115.Q). Total debt is defined as "Nonfinancial corporate business; credit market instruments; liability" (item: Z1/Z1/FL104104005.Q). We define the total market value of assets as the sum of these two items. To reconcile the quarterly data for the market as a whole with our monthly data set, we again assume a value for debt that remains constant throughout the quarter, and we combine our quarterly data for equity with the aggregate monthly stock market returns to approximate monthly total equity and, in turn, monthly total assets. The monthly leverage ratio for the aggregate market again is defined as total equity divided by total assets.

Firm-level stock returns are from CRSP, and we subtract the risk-free rate to obtain excess returns. For both the aggregate market and individual firms, we calculate the monthly *unlevered* excess returns as the excess returns times the leverage ratio lagged by one month, in line with Equation (11).

TABLE 1—MEANS AND STANDARD DEVIATIONS FOR KEY VARIABLES, U.S., JANUARY 1952 - DECEMBER 2013

Variable	Observations	Mean	S.D
Aggregate Market			
Market Excess Return (%)	744	0.59	4.33
Market Leverage (%)	744	64.07	6.95
Market Unlevered Excess Return (%)	744	0.35	2.70
Small-minus-Big (%)	744	0.19	2.90
High-minus-Low (%)	744	0.36	2.70
Individual Firms			
Excess Return (%)	1472788	0.77	12.75
Leverage (%)	1472788	61.90	24.24
Unlevered Excess Return (%)	1472788	0.40	8.72
Total Equity, Market Value (Billion $)	1472788	1.67	10.40
Total Assets, Market Value (Billion $)	1472788	2.90	15.10

Note: The monthly excess returns on the market portfolio, the risk-free rate, and the Small-minus-Big and High-minus-Low Fama and French (1993) factors are all taken from the "Fama French and Liquidity Factors" in the Wharton Research Data Services (WRDS, items: "mktrf," "rf," "smb," and "hml," respectively). Quarterly data for the market value of total equity of the aggregate market are taken from the flows of funds account from the Federal Reserve and defined as the value of "Nonfinancial corporate business; public corporate equities less intercompany holdings; liability" (item: Z1/Z1/FL103164115.Q). Total debt of the aggregate market is defined as "Nonfinancial corporate business; credit market instruments; liability" (item: Z1/Z1/FL104104005.Q). We define the market value of assets of the aggregate market as the sum of these two items. Firm-level data are from COMPUSTAT North-America, Fundamentals Quarterly and Fundamentals Yearly, and missing values for book equity are replaced by data from Davis, Fama, and French (2000). Excess returns are from CRSP and defined as the monthly return (item: "ret") minus the risk-free rate. Market value of total assets is defined as the book value of total assets (item: "atq" or " at") minus the book value of equity (item: "seqq" or " seq") plus the market value of equity, where the market value of equity = shares outstanding (item: "shrout" from CRSP, or if missing "cshom" or "cshoq" from COMPUSTAT) multiplied by the closing price (item: "prc" from CRSP, or "prccm" or " prccq" from COMPUSTAT). To merge quarterly/yearly variables with monthly variables, we employ a constant debt level in each quarter/year and use monthly market returns to calculate approximate market values for total assets and equity, both for the aggregate market and individual firms. We define leverage as the market value of equity/market value of total assets, for both the market as a whole and individual firms. Unlevered excess returns in month t are calculated as excess returns(t) $\times$ leverage($t-1$). The data reflect an unbalanced panel of 7,563 firms for 744 months.

We omit observations for which the leverage ratio is less than 0 or larger than 1. We also calculate a measure of book leverage, defined as the book value of equity divided by the book value of total assets, and omit observations for which this ratio is less than 0.1. [4]

We lose some observations due to missing values and drop all firms for which the number of observations in the time series is less than 60 months. Finally, we drop firms in the

[4]For firms with extremely low, or even negative book equity values, the effect of leverage is no longer linear – in this case equity reflects a call option that is close to being at the money or even out of the money, so that the non-linear "delta" effect kicks in. It is in particular for this reason why Choi (2015) argues that detailed information on corporate bond yields is needed to obtain decent estimates of unlevered betas. Unfortunately, such information is difficult to obtain, hence our solution is to omit the firms for which the non-linearity becomes economically relevant. We justify this choice because we are not interested in the dynamic behavior of betas, but in the cross-section of returns, for which a sample over a long time period is preferred to get more precise estimates for average returns. Moreover, the impact on the sample is limited and many firms still exhibit market leverage ratios far below 0.1 after omitting the firms with low book leverage ratios.

financial and real estate sectors, because their balance sheets mainly consist of financial claims on other firms/assets, for which the underlying "true" leverage ratio is not observable. We trim the excess returns by the 1% and 99% quantiles (i.e., if a return is below the 1% or above the 99% quantile threshold). We thus end up with an unbalanced panel data set of 7,563 U.S. firms for the period January 1952 to December 2013. We summarize this data set in Table 1.

As expected, Table 1 shows that unlevered excess returns have lower means and standard deviations than (levered) excess returns, for both the market as a whole and individual firms. The leverage ratio is about 62% on average, and the standard deviation is 24% at the firm level, which shows that there is substantial variation in the leverage ratio. The market leverage ratio is somewhat larger at 64%, as this reflects a weighted average of firms' leverage.

V. Results

We compare the performance of the three models for (1) a large set of individual firms, and (2) for four different portfolio sorts, consisting of 25 portfolios each.

A. Individual Firm Tests

We first ran regressions corresponding to the three models for 7,563 individual U.S. firms. In this case, it is numerically impossible to calulate the GRS statistic, so we judge the performance of our model on the basis of Fama-MacBeth cross-sectional regressions only.

Table 2 shows the results of the Fama-MacBeth two-step procedure, using monthly data. In line with the predictions of our unlevered CAPM, we find an insignificant α equal to 0.02% (t-value=0.3); the estimated coefficient λ_{Market} is equal to 0.44% and significant at 1%. Therefore, assets for which unlevered returns are uncorrelated with unlevered market returns yield the risk-free rate, and the unlevered beta yields a positive and significant risk

TABLE 2—CROSS-SECTIONAL REGRESSIONS FOR INDIVIDUAL U.S. FIRMS, JANUARY 1952- DECEMBER 2013

Model	α (%)	λ_{Market} (%)	λ_{SmB} (%)	λ_{HmL} (%)	Avg. R^2
Unlevered CAPM	0.02	0.44***			0.05
	(0.30)	(3.59)			
Traditional CAPM	0.38***	0.45**			0.03
	(3.50)	(2.32)			
Fama and French (1993)	0.41***	0.59***	-0.11	-0.22*	0.06
three-factor model	(4.59)	(3.25)	(-0.95)	(-1.92)	

Note: This table reports the Fama-MacBeth (1973) cross-sectional regression estimation results for the asset pricing model:

$$E[R_{i,t} - r_t] = \alpha + \beta_i' \lambda.$$

Betas are estimated by the time-series regression of (unlevered/levered) excess monthly returns on the factors for an unbalanced panel of 7,563 U.S. firms between January 1952 and December 2013. The unlevered CAPM uses unlevered excess portfolio returns; the traditional CAPM and Fama and French (1993) three-factor model use (levered) excess portfolio returns. The factors are the unlevered excess return of the market portfolio for the unlevered CAPM, the excess return of the market portfolio for the traditional CAPM, and a vector of excess returns of the market portfolio, the HmL and the SmB factors for the Fama and French (1993) three-factor model. The unlevered excess return of firm i, is calculated as $R^u_{i,t} - r_t \equiv (R_{i,t+1} - r_{t+1}) \frac{E_{i,t-1}}{K_{i,t-1}}$, where $(R_{i,t+1} - r_{t+1})$ is the excess stock return of firm i for month t, and $\frac{E_{i,t-1}}{K_{i,t-1}}$ is the leverage ratio of total equity to total assets of firm i in month $t-1$. The estimation method is the Fama-MacBeth cross-sectional regression procedure; this table reports the time-series averages of the second-stage coefficients. The Fama-MacBeth t-statistics are reported in parentheses, adjusted for autocorrelation using the Newey-West procedure with 1 lag, and the last column gives the average R^2 of the cross-sectional regressions. *, ** and *** denote significance at 10%, 5% and 1% respectively. *Sources*: Flow of funds account, Federal Reserve; COMPUSTAT; CRSP; Fama French and Liquidity factors, WRDS; Davis, Fama, and French (2000).

premium. Even though the market risk premium may seem small, at about 5.3% annually, it is a rate of excess return for unlevered assets. With an average market leverage of 0.64, the implied risk premium for equity varies around 8.3% (=5.3%/0.64), on average.

The traditional CAPM exhibits a positive and significant risk premium for beta at 5%, but the intercept is rather large at 0.38%, compared with a risk premium of 0.45%, and the intercept is statistically different from zero at 1%, so these findings reject the the traditional CAPM. The risk premium itself is low compared with the historical average of 0.59%, so we obtain a common finding: The security market line is "too flat." The Fama and French three-factor model generates results for the intercept and the market beta that are similar to those from the traditional CAPM. In addition, the SmB factors is not priced, whereas the HmL factor is priced at 10% but it has a negative sign. On the basis of these results, we would reject the traditional CAPM and the Fama and French three-factor model, but we cannot reject the unlevered CAPM.

B. *Portfolio Tests*

Even though we find support for our model on the individual firm level, the R^2 is rather low, and it is generally advocated to group assets into portfolios in asset pricing tests, to reduce the noise in estimated average returns and betas. We test the models for a small number of portfolios, using various portfolio sorts. For each portfolio, we calculate value-weighted excess returns and value-weighted unlevered excess returns, using the value of total equity to construct the weights. Unlevered excess returns are calculated by using a portfolio leverage ratio that is a total assets-weighted average of the leverage ratio of each firm.

With the main portfolio sort, we aim to test our model directly; it is based on sorts of unlevered betas. We first estimate unlevered betas according to Equation (11) and sort the stocks according to unlevered betas, constructing 25 portfolios of roughly equal size in terms of number of assets. Portfolio 1 consists of stocks with the lowest unlevered betas, whereas Portfolio 25 consists of stocks with the highest unlevered betas. Because we only sort once, the portfolios are basically buy-an-hold portfolios, except for that companies may enter or drop out of the sample. Descriptive statistics of the portfolios are in Table A1 in the Appendix; note the high autocorrelation of the inverse of the leverage ratio.

First, we formally test whether the pricing errors of each portfolio are jointly different from zero using the GRS test, as suggested in Fama and French (1993). Table 3 shows the individual pricing errors (α), betas, and R^2s for each portfolio based on time-series regressions, as well as the associated GRS statistic. The unlevered CAPM and traditional CAPM pass the GRS test, but the Fama and French (1993) three-factor model is rejected at the 5% level of significance.

Second, we test whether the factors of the three models are priced. Table 4 shows the results of the Fama-MacBeth two-step procedure for the unlevered beta portfolio sort.

TABLE 3—BETAS, PRICING ERRORS, AND GRS TEST FOR 25 PORTFOLIOS BASED ON UNLEVERED BETAS SORTS, U.S. 1952-2014.

Pf#	Unlevered CAPM			Traditional CAPM			Fama and French (1993)				
	GRS: F=1.09			GRS: F=1.24			GRS: F=1.78**				
	$\alpha(\%)$	β^{u}_{Market}	R^2	$\alpha(\%)$	β_{Market}	R^2	$\alpha(\%)$	β_{Market}	β_{SmB}	β_{HmL}	R^2
1	0.00	0.02***	0.25	0.17	0.52***	0.22	0.05	0.47***	0.37***	0.16***	0.27
2	0.06**	0.20***	0.35	0.23**	0.53***	0.41	0.08	0.59***	-0.01	0.32***	0.47
3	0.09**	0.30***	0.31	0.26**	0.49***	0.32	0.09	0.58***	-0.12***	0.40***	0.41
4	0.10**	0.39***	0.44	0.23**	0.59***	0.46	0.06	0.67***	-0.08***	0.38***	0.54
5	0.09*	0.46***	0.46	0.22**	0.66***	0.53	0.15	0.72***	-0.15***	0.18***	0.56
6	0.07	0.55***	0.46	0.15	0.78***	0.54	0.06	0.85***	-0.13***	0.23***	0.57
7	0.08	0.54***	0.47	0.15	0.67***	0.52	0.07	0.73***	-0.16***	0.22***	0.56
8	0.17**	0.68***	0.52	0.26***	0.72***	0.57	0.18*	0.80***	-0.26***	0.23***	0.63
9	0.12**	0.74***	0.63	0.19**	0.82***	0.67	0.13	0.88***	-0.16***	0.17***	0.69
10	0.09	0.81***	0.62	0.16	0.87***	0.63	0.05	0.93***	-0.10***	0.26***	0.65
11	0.08	0.86***	0.73	0.14*	0.90***	0.75	0.08	0.95***	-0.15***	0.17***	0.77
12	0.02	0.91***	0.75	0.03	1.00***	0.77	-0.13	1.02***	0.19***	0.32***	0.80
13	0.12*	0.96***	0.68	0.16*	0.89***	0.72	0.15*	0.95***	-0.26***	0.07***	0.75
14	0.04	1.03***	0.74	0.06	0.96***	0.77	0.02	1.00***	-0.12***	0.12***	0.78
15	0.05	1.09***	0.72	0.06	0.94***	0.75	0.05	1.00***	-0.25***	0.08***	0.78
16	0.16*	1.13***	0.66	0.21**	0.93***	0.68	0.29***	0.93***	-0.15***	-0.15***	0.69
17	0.08	1.24***	0.77	0.11	1.03***	0.79	0.12	1.00***	0.14***	-0.04	0.80
18	0.16**	1.30***	0.77	0.21**	1.09***	0.80	0.26***	1.07***	0.00	-0.11***	0.80
19	0.06	1.39***	0.65	0.09	1.15***	0.67	0.15	1.10***	0.10***	-0.15***	0.68
20	0.02	1.48***	0.75	0.04	1.24***	0.77	0.06	1.15***	0.37***	-0.12***	0.80
21	0.16	1.66***	0.65	0.20	1.26***	0.68	0.38***	1.15***	0.19***	-0.43***	0.71
22	0.21	1.72***	0.50	0.30	1.35***	0.52	0.51**	1.17***	0.45***	-0.54***	0.58
23	0.16	2.00***	0.39	0.21	1.44***	0.43	0.43	1.28***	0.37***	-0.56***	0.47
24	0.13	2.15***	0.61	0.18	1.56***	0.62	0.38*	1.34***	0.53***	-0.56***	0.69
25	0.38*	2.58***	0.63	0.43*	1.79***	0.63	0.72***	1.51***	0.66***	-0.77***	0.72

Note: This table presents the pricing errors (α), betas, and R^2s for the unlevered CAPM, traditional CAPM, and Fama and French (1993) three-factor model. These are estimates of the time-series regressions:

$$R_{i,t} - r_t = \alpha_i + f_t'\beta_i + \epsilon_{i,t},$$

where $R_{i,t} - rt$ is the excess unlevered return for the unlevered CAPM and the excess return for the traditional CAPM and the Fama and French (1993) three-factor model, of portfolio i at time t, and $\epsilon_{i,t}$ is the error term. Moreover, f_t is the unlevered excess return of the market portfolio for the unlevered CAPM, the excess return of the market portfolio for the traditional CAPM, and a vector of excess returns of the market portfolio, the HmL and the SmB factors for the Fama and French (1993) three-factor model. Test portfolios are 25 portfolios based on sorts of unlevered betas; Portfolio 1 consists of stocks with the lowest unlevered beta, and Portfolio 25 consists of stocks with the highest unlevered beta. We use monthly data between January 1952 and December 2013. The GRS F-stat is reported at the top of the table; the null hypothesis is that the pricing errors are jointly zero. *, ** and *** denote 10%, 5% and 1% significance, respectively. Pf# indicates the portfolio number. *Sources*: Flow of funds account, Federal Reserve; COMPUSTAT; CRSP; Fama French and Liquidity factors, WRDS; Davis, Fama, and French (2000).

TABLE 4—CROSS-SECTIONAL REGRESSIONS FOR 25 PORTFOLIOS BASED ON UNLEVERED BETA SORTS, U.S. 1952-2014

Model	α (%)	λ_{Market} (%)	λ_{SmB} (%)	λ_{HmL} (%)	Avg. R^2
Unlevered CAPM	0.04	0.42***			0.39
	(0.58)	(3.10)			
Traditional CAPM	0.17	0.59**			0.29
	(0.90)	(2.23)			
Fama and French (1993)	0.63***	0.11	0.14	-0.44**	0.40
3-factor model	(2.69)	(0.41)	(0.74)	(-2.10)	

Note: This table reports the Fama-MacBeth (1973) cross-sectional regression estimation results for the asset pricing model:

$$E[R_{i,t} - r_t] = \alpha + \beta_i' \lambda,$$

Betas are estimated by the time-series regression of (unlevered/levered) excess monthly returns on the factors for a panel of 25 portfolios based on unlevered betas between January 1952 and December 2013. The unlevered CAPM uses unlevered excess portfolio returns; the traditional CAPM and the Fama and French (1993) three-factor model use (levered) excess portfolio returns. The factors are the unlevered excess return of the market portfolio for the unlevered CAPM, the excess return of the market portfolio for the traditional CAPM, and a vector of excess returns of the market portfolio, the HmL and the SmB factors for the Fama and French (1993) three-factor model. The unlevered excess return of portfolio i, is calculated as $R^u_{i,t} - r_t \equiv (R_{i,t+1} - r_{t+1}) \frac{E_{i,t-1}}{K_{i,t-1}}$, where $(R_{i,t+1} - r_{t+1})$ is the value weighted excess stock return of portfolio i for month t, and $\frac{E_{i,t-1}}{K_{i,t-1}}$ is the value weighted leverage ratio of total equity to total assets of portfolio i in month $t-1$. The estimation method is the Fama-MacBeth cross-sectional regression procedure; this table reports the time-series averages of the second-stage coefficients. The Fama-MacBeth t-statistics are reported in parentheses, adjusted for autocorrelation using the Newey-West procedure with 1 lag, and the last column gives the average R^2 of the cross-sectional regressions. *, ** and *** denote significance at 10%, 5% and 1% respectively. *Sources*: Flow of funds account, Federal Reserve; COMPUSTAT; CRSP; Fama French and Liquidity factors, WRDS; Davis, Fama, and French (2000).

Again, we find that the unlevered beta exhibits a positive and significant risk premium at 1% significance, and the intercept α is insignificantly different from zero. For the traditional CAPM and the Fama and French (1993) three-factor model, we find that the only factors that are priced is the market beta in the traditional CAPM, and the HmL factor for the Fama and French (1993) model, at 10% significance. Again the HmL factor has the "wrong" sign, it should be positive.

We also visualize the cross-sectional relationship between unlevered betas and unlevered returns. Figure 1 shows a plot of the fitted values against the actual values of the average unlevered returns of the 25 portfolios. We also report the simple ordinary least squares (OLS) cross-sectional R^2. We see that on average the pricing errors are low, and that the unlevered CAPM exhibits a cross-sectional fit with a simple R^2 of 94%. Figure

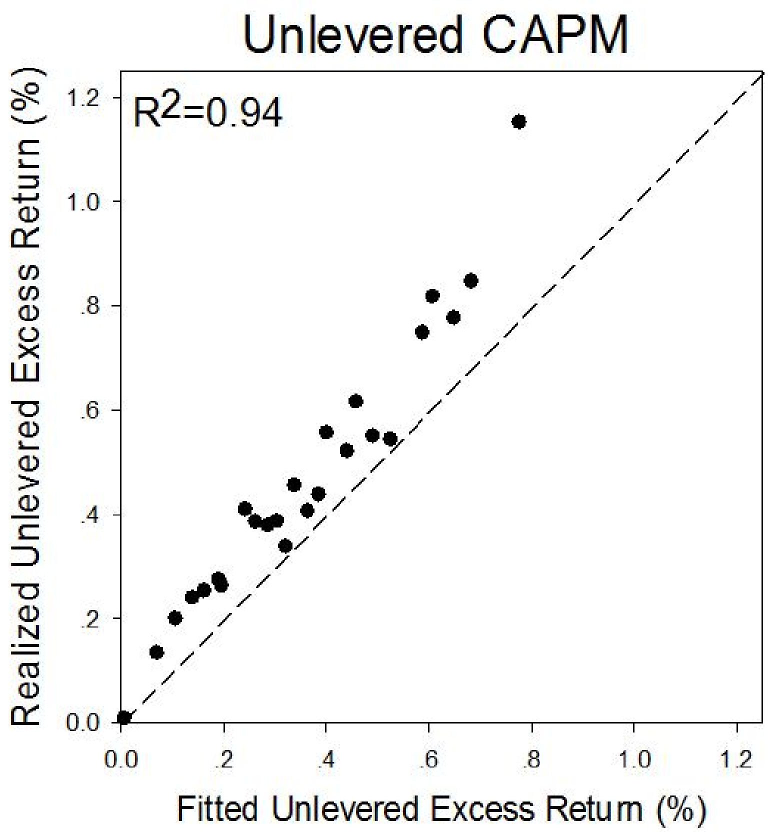

FIGURE 1. ACTUAL AND PREDICTED UNLEVERED RETURNS OF 25 PORTFOLIOS SORTED ON UNLEVERED BETAS

Note: This figure shows the actual and predicted average excess unlevered returns for 25 portfolios sorted on unlevered betas for the unlevered CAPM. The reported R^2 is based on a simple cross-sectional ordinary least squares regression of average unlevered returns on predicted unlevered returns. The fitted unlevered excess return of portfolio i, is calculated as the product of unlevered betas and the time-series average of the unlevered market return.

A1 in the appendix shows the same plot for both the traditional CAPM and the Fama and French (1993) model. The traditional CAPM also performs well in terms of the reported OLS R^2, but the fit of the unlevered CAPM is better. The Fama and French (1993) model exhibits large pricing errors and we report an R^2 of 20%. Overall, it appears that there is more support for our unlevered CAPM than for the two benchmark models.

C. Alternative Portfolio Sorts

It is well-known that the performance of asset pricing models may be subject to particular choices of test portfolios. As a robustness check, we investigate the performance of the model for three additional sets of portfolios. The first additional portfolio sort is based on sorts of traditional (levered) betas. We estimate traditional betas according to Equation (12) and sort the stocks according to the estimated betas. We construct 25 portfolios of roughly equal size, where Portfolio 1 consists of stocks with the lowest betas and Portfolio 25 comprises stocks with the highest betas. This portfolio sort is likely to favor the performance of the traditional CAPM.

The second additional portfolio sort is based on size and book-to-market values of equity, as in Fama and French (1993). A two-way sort, conducted each year, reflects the size and book-to-market quintiles and yields 25 portfolios that we can construct in the subsequent years.[5] This portfolio sort probably favors the Fama and French three-factor model the most.

Finally, the third additional set of 25 portfolios reflects industry classifications of the companies according to Standard Industrial Classification (SIC) codes. We use a combination of two- and three- digit SIC codes to group firms (the first two digits identify the major industry group, and the third digit identifies the industry group; for details, see Table A in the Appendix). This portfolio sort is not particularly favorable toward any of the three models.

Note that only the Fama and French (1993) portfolios can be considered actively managed portfolios; the others are basically buy-and-hold portfolios, except that companies may enter or drop out of the sample over time. The descriptive statistics for the three portfolio sorts are in Tables A2-A4 in the Appendix. One detail worth mentioning here about these statistics is that there is a relation between the Fama and French (1993) sort

[5]The quintiles are based on observations at the end of June each year, and then the portfolios are constructed in January in the subsequent year.

and the average leverage ratio of each portfolio – the average leverage ratio increases almost monotonically from the Big/Low portfolio to the Small/High portfolio. Moreover, the autocorrelation of the inverse of the leverage is highest for the value portfolios, with the highest monthly correlation at 0.99.

Panels A, B, and C in Table 5 contain the results of the cross-sectional regressions and the GRS F-statistics of the time-series regressions for the traditional CAPM beta sort, Fama and French (1993) portfolio sorts, and industry sorts, respectively. The results of the first-stage time-series regressions are in Tables A6-A8 in the Appendix.

The results in Panel A show that all models perform equally well, or equally poorly if you will, for the traditional CAPM beta sort. The models do not pass the GRS test for this sort, the alphas are significantly different from zero at 1% for all models, and the factor betas are all insignificant.

The results for the Fama and French (1993) portfolio sorts in Panel B show that the Fama and French three-factor model performs quite well, though it does not pass the GRS test at 1%, and the intercept α is also significant at 5%. However, both the market and HmL factor betas are positive and significant at 1%. The SmB factor beta is not significant, indicating that the size effect may be disappearing. The traditional CAPM does not perform well for this sort, with an alphas that is significantly different from zero at 5%, a market beta that is insignificant, and pricing errors that are significantly different from zero based on the GRS test. These findings are a result of traditional CAPM betas that all have values around one for the Fama and French (1993) sort. The market beta of the unlevered CAPM is marginally significant at 10%, but the alpha is significant at 1% and the GRS test rejects that the pricing errors are equal to zero at 1%.

In Panel C, we report the results for the portfolios based on industry classification. Here, the unlevered CAPM performs best compared with the other two models: The market beta is significantly priced at 1%, the intercept is zero, and the model passes the GRS test at 5%.

TABLE 5—CROSS SECTIONAL REGRESSIONS AND GRS TESTS FOR THREE ALTERNATIVE PORTFOLIO SORTS

Panel A: 25 Portfolios Based on Traditional CAPM Beta Sorts						
	α(%)	λ_{Market}(%)	λ_{SmB}(%)	λ_{HmL}(%)	Avg.R^2	GRS
Unlevered CAPM	0.22***	0.17			0.32	1.58**
	(2.77)	(1.20)				
Traditional CAPM	0.50***	0.19			0.33	1.68**
	(3.37)	(0.83)				
Fama and French (1993)	0.58***	0.12	-0.09	-0.30	0.49	2.20***
	(3.21)	(0.51)	(-0.51)	(-1.59)		
Panel B: 25 Portfolios based on Fama & French (1993) sorts						
	α(%)	λ_{Market}(%)	λ_{SmB}(%)	λ_{HmL}(%)	Avg.R^2	GRS
Unlevered CAPM	0.15**	0.25*			0.25	2.49***
	(2.38)	(1.79)				
Traditional CAPM	0.81**	-0.05			0.11	2.81***
	(2.25)	(-0.11)				
Fama and French (1993)	-0.79**	1.54***	0.18	0.54***	0.30	2.38***
	(-2.01)	(3.46)	(1.32)	(3.47)		
Panel C: 25 Portfolios based on industry						
	α(%)	λ_{Market}(%)	λ_{SmB}(%)	λ_{HmL}(%)	Avg.R^2	GRS
Unlevered CAPM	-0.05	0.52***			0.19	1.51*
	(-0.58)	(3.40)				
Traditional CAPM	0.19	0.57*			0.16	1.68**
	(0.84)	(1.91)				
Fama and French (1993)	0.58**	0.17	0.15	-0.40**	0.31	2.51***
	(2.08)	(0.51)	(0.84)	(-2.18)		

Note: This table reports the Fama-MacBeth (1973) cross-sectional regression estimation results for the asset pricing model:

$$E[R_{i,t} - r_t] = \alpha + \beta_i'\lambda,$$

Betas are estimated by the time-series regression of (unlevered/levered) excess monthly returns on the factors for the three panels of 25 portfolios based on traditional CAPM betas (Panel A), the Fama French (1993) test portfolios (Panel B), and industries (Panel C), between January 1952 and December 2013. The unlevered CAPM uses unlevered excess portfolio returns; the traditional CAPM and Fama and French (1993) three-factor model use (levered) excess portfolio returns. The factors are the unlevered excess return of the market portfolio for the unlevered CAPM, the excess return of the market portfolio for the traditional CAPM, and a vector of excess returns of the market portfolio, the HmL and the SmB factors for FF3. The unlevered excess return of portfolio i, is calculated as $R^u_{i,t} - r_t \equiv (R_{i,t+1} - r_{t+1}) \frac{E_{i,t-1}}{K_{i,t-1}}$, where $(R_{i,t+1} - r_{t+1})$ is the value weighted excess stock return of portfolio i for month t, and $\frac{E_{i,t-1}}{K_{i,t-1}}$ is the value weighted leverage ratio of total equity to total assets of portfolio i in month $t-1$. The estimation method is the Fama-MacBeth cross-sectional regression procedure; this table reports the time-series averages of the second-stage coefficients. The Fama-MacBeth t-statistics are reported in parentheses, adjusted for autocorrelation using the Newey-West procedure with 1 lag, and the first-to-last column gives the average R^2 of the cross-sectional regressions. The GRS F-statistic in the last column is based on the time-series regressions of the first-stage, where the null hypothesis is that the pricing errors (the time-series intercepts, α_i) are jointly zero. *, ** and *** denotes significance at 10%, 5% and 1% respectively. *Sources*: Flow of funds account, Federal Reserve; COMPUSTAT; CRSP; Fama French and Liquidity factors, WRDS; Davis, Fama, and French (2000).

For the traditional CAPM and Fama and French (1993) three-factor model, the factors that are priced are the market beta for the traditional CAPM at 10%, and the the HmL factor for the Fama and French model at 5%, but the sign of the risk premium of the HmL is negative instead of positive. In addition, these two models do not pass the GRS test, and the intercept of the Fama-MacBeth regressions is significantly different from zero for the Fama and French (1993) three-factor model.

Thus far, the results suggest that the Fama and French (1993) three-factor model performs best when we conduct sorts according to the size and book-to-market value, similar to in Fama and French (1993). For other sorts, the model is somewhat erratic, in the sense that the sign of the HmL factor switches from positive and significant to negative and significant depending on the particular portfolio sort. We further confirm that the traditional CAPM is an empirical failure. The statistics that emerge as significant in almost all results are the intercepts and the GRS-statistics of the pricing errors, which should in fact be insignificant.

Our unlevered CAPM outperforms the two benchmark models, but its performance as such based on these statistics is not that good for the traditional CAPM beta or Fama and French (1993) sort. Nonetheless, when we visualize actual versus predicted returns and look at the simple cross-sectional fit, we are inclined to be somewhat more optimistic about the performance of the unlevered CAPM. Panels A, B, and C in Figure 2 show the actual versus predicted returns for portfolios based on the traditional CAPM beta sort, Fama and French (1993) portfolio sort, and industry sort, respectively. We also report the OLS cross-sectional R^2 as a simple measure of fit. The unlevered CAPM exhibits much less erratic behavior in terms of fit. The second-stage OLS R^2 is decent and above 47% for the unlevered CAPM for all three portfolio sorts, whereas both the traditional CAPM and the Fama and French (1993) three-factor model vary between hardly fitting the average returns at all, to R^2s around 51%-54%. These findings in combination imply that the particular choice of the sorting method has a huge impact on the performance of the traditional CAPM and Fama and French (1993) three-factor model, but not as much on the

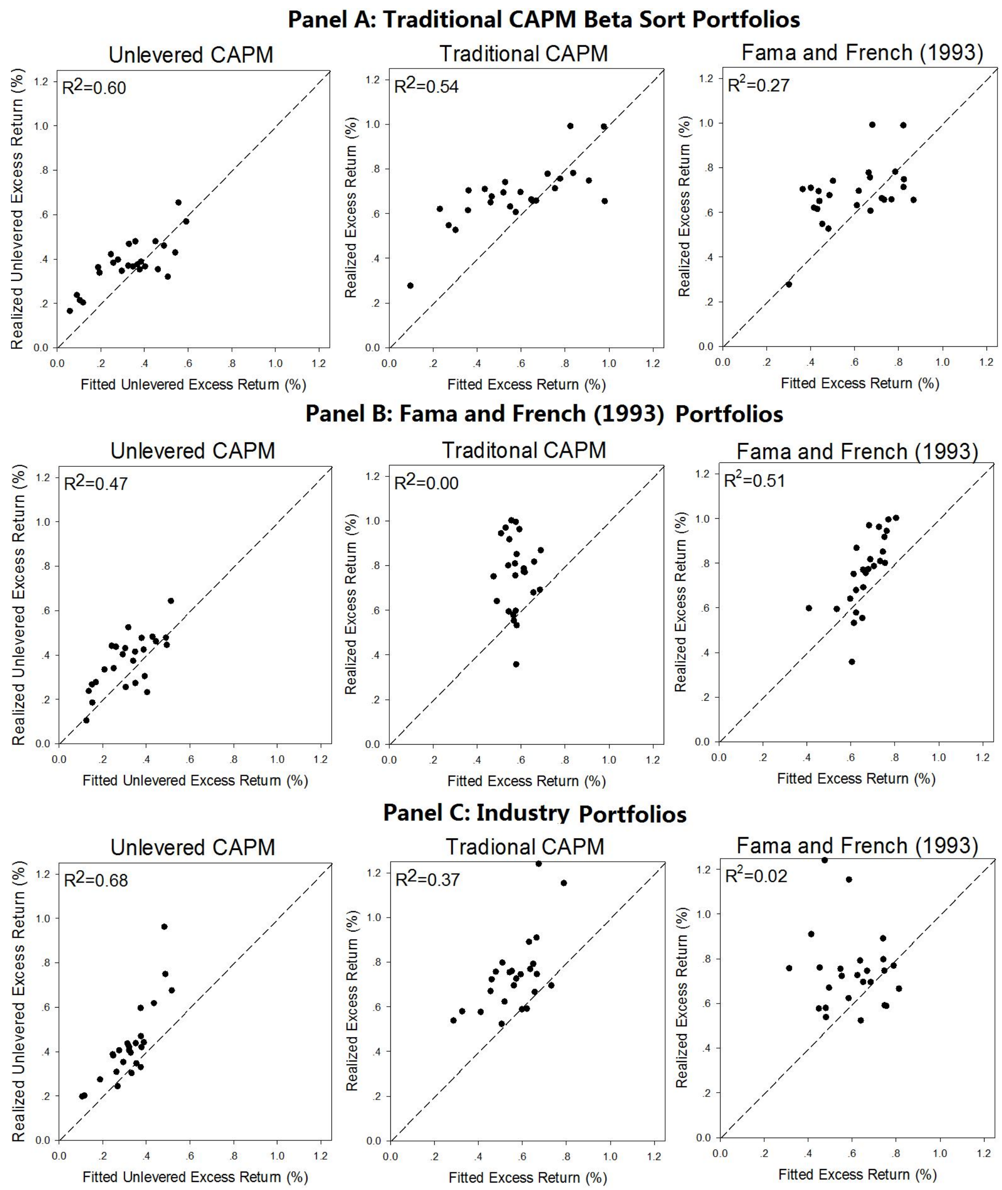

FIGURE 2. ACTUAL AND PREDICTED RETURNS FOR THREE ALTERNATIVE SETS OF 25 PORTFOLIOS

Note: This figure shows the actual and predicted average excess returns for 25 portfolios sorted on traditional CAPM beta (Panel A), 25 Fama and French (1993) test portfolios (Panel B), and 25 portfolios sorted by industry (Panel C). The three models being compared are the unlevered CAPM, the traditional CAPM, and the Fama and French (1993) three-factor model. The reported R^2 is based on a simple cross-sectional OLS regression of average returns on predicted returns. The fitted (unlevered) excess return of portfolio i, is calculated as the product of (unlevered) betas and the time-series average of the factors.

unlevered CAPM.

In a sense we are comparing apples and oranges by comparing the performance of the models, as the unlevered CAPM uses unlevered returns, whereas the benchmark models use levered returns. Consider a hypothetical portfolio sort such that the unlevered betas are all equal to 1, but each portfolio differs in the average leverage ratio. In this case, there should not be differences in unlevered returns, but there should be differences in levered returns. Moreover, the standard tests are likely to reject the unlevered CAPM in this case, since there is no variation in unlevered returns and all we feed the unlevered CAPM are pricing errors. Such a portfolio sort would result in a flat slope and a positive intercept in the cross-sectional tests. To some extent this phenomenon is going on in our evaluation of the model. It turns out that the alternative portfolio sorts exhibit far less variation in unlevered returns compared to our main portfolio sort based on unlevered betas, as can be seen when comparing figure 1 with 2. The average unlevered returns in figure 1 vary between 0% and 1.2%, while in figure 2 they vary between 0% and 0.8%. When there is less variation in unlevered returns to explain in the first place, while the pricing errors remain roughly of the same magnitude, the cross-sectional R^2 will of course be lower.

The results reveal that the unlevered CAPM performs best for a sort on unlevered betas and at the individual firm level. For alternative portfolio sorts, the performance of the unlevered CAPM is not as good in a statistical sense, but the model outperforms the two benchmark models. Moreover, the unlevered CAPM does not exhibit erratic behavior in terms of cross-sectional fit and sign of the factor prices, and absolute pricing errors are of a similar magnitude for all portfolio sorts. We therefore conclude that, on balance, adopting unlevered excess returns and unlevered betas is a reasonable and robust method of explaining cross-sectional differences in average returns.

VI. Conclusion

We argue that asset pricing tests should be conducted using unlevered betas and unlevered stock returns. Unlevered returns and unlevered betas reflect regular returns and betas if the firm were fully financed with equity. A leverage effect in equity returns arises due to the financial structure of the firm. Volatility in equity returns is a product of the inverse of the firm's leverage and the volatility of the underlying return on total assets, where leverage is measured as the ratio of equity to total assets. If the market portfolio of total assets is mean variance efficient, it implies that the equity betas and expected stock returns depend on the leverage ratio. The leverage ratio varies substantially over time, resulting in variation in conventional betas and expected returns over time.

To deal with the econometric issues associated with time-varying betas, volatility, and expected returns, we propose calculating the unlevered excess returns by multiplying excess returns with the leverage ratio. We then measure unlevered betas in standard way, using the transformed returns. With the observation that macro-economic variables such as consumption growth and real capital stock growth are roughly i.i.d. and not directly linked to the financial structure of the firm, we conjecture that unlevered betas should be relatively stable, so that we can test an unconditional model in line with the classic tests of the CAPM.

Our unlevered CAPM performs relatively well compared with the traditional implementation of the CAPM and the Fama and French (1993) three-factor model. Whereas these two models exhibit rather erratic behavior, depending on the particular choice of test portfolios, our unlevered CAPM is robust to these choices.

There are some obvious caveats to our analysis. First, the assumption of stable unlevered betas is perhaps rather heroic. Although unlevered betas may be stable over a long time period, in shorter time frames, it is possible to find variation in the unlevered betas that may need to be accounted for by multiple factors. Second, the market portfolio may not be the best candidate to construct a stochastic discount factor. Even in the case that the market portfolio is perfectly observable, and investors are rational and have perfect foresight, the market portfolio need not necessarily be mean-variance efficient. Third, corporate bond yields/prices can vary substantially, which challenges both the implied assumption of zero default risk and the empirical shortcut of using book values of debt instead of market values in calculating the leverage ratio. Finally, and somewhat related to the previous point, we basically value equity as a forward contract on the real assets of the firm. But shareholders have limited liability, and as such, equity should really be viewed as a barrier option on the real assets with a dynamic strike. Pricing errors may therefore be large for highly levered firms that are close to being "at the money".

Nonetheless, considering the robust performance of our unlevered CAPM, the theoretical underpinnings of our approach, the fact that the leverage effect is well-documented in literature on stock return volatility, and that this effect helps explain why scaled prices such as dividend-price or earnings-price ratios predict expected returns in time-series analyses, we urge scholars to use unlevered returns. A natural way to proceed would be to consider a multi-factor approach for unlevered returns or else to use an alternative variable to serve as the stochastic discount factor, for example, by reconsidering consumption growth.

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APPENDIX

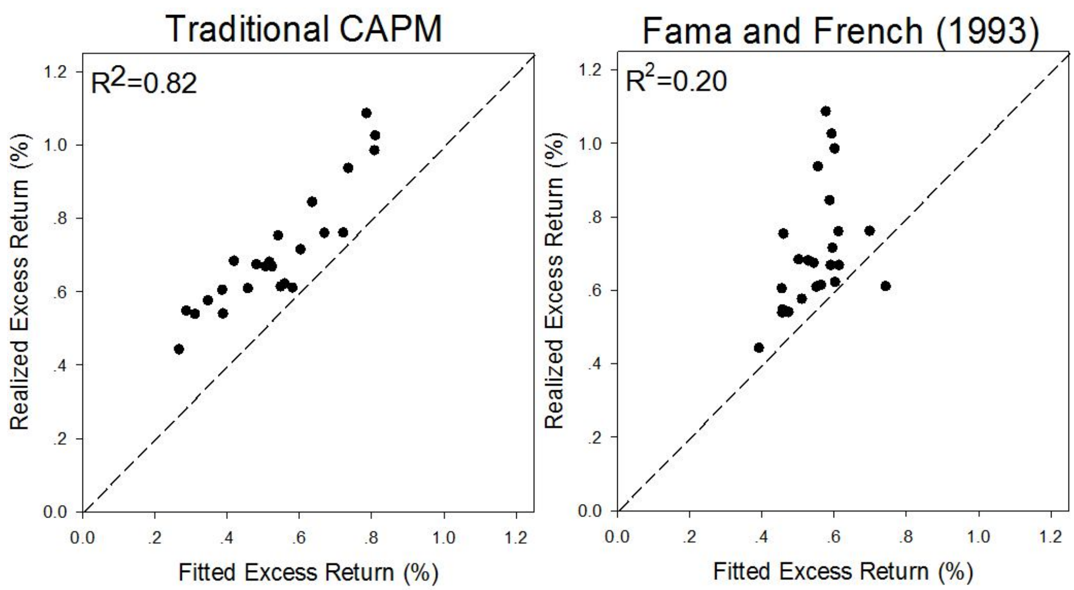

FIGURE A1. ACTUAL AND PREDICTED RETURNS OF 25 PORTFOLIOS SORTED ON UNLEVERED BETAS

Note: This figure shows the actual and predicted average excess returns for 25 portfolios sorted on unlevered betas for the the traditional CAPM and the Fama and French (1993) three-factor model. The reported R^2 is based on a simple cross-sectional ordinary least squares regression of average returns on predicted returns. The fitted excess return of portfolio i, is calculated as the product of betas and the time-series average of the factors.

TABLE A1—DESCRIPTIVE STATISTICS FOR 25 PORTFOLIOS SORTED ON UNLEVERED BETAS

β^u	Unlevered Excess Return (%)		Excess Return (%)		Leverage		
	Mean	S.D.	Mean	S.D.	Mean	S.D.	$\rho_{X_t,X_{t-1}}$
0.02	0.01	0.12	0.44	4.94	0.02	0.01	0.93
0.20	0.13	0.90	0.54	3.61	0.26	0.10	0.98
0.30	0.20	1.46	0.55	3.76	0.40	0.07	0.98
0.39	0.24	1.61	0.58	3.80	0.43	0.09	0.99
0.46	0.25	1.83	0.60	3.95	0.45	0.13	0.99
0.55	0.26	2.20	0.61	4.61	0.47	0.10	0.99
0.54	0.27	2.12	0.54	3.99	0.52	0.12	0.97
0.68	0.41	2.57	0.68	4.13	0.63	0.11	0.99
0.74	0.39	2.53	0.67	4.38	0.59	0.14	0.99
0.81	0.38	2.78	0.67	4.75	0.60	0.08	0.98
0.86	0.39	2.73	0.67	4.50	0.62	0.09	0.99
0.91	0.34	2.84	0.61	4.93	0.59	0.09	0.98
0.96	0.46	3.15	0.68	4.52	0.70	0.09	0.99
1.03	0.41	3.25	0.62	4.74	0.69	0.08	0.98
1.09	0.44	3.49	0.61	4.70	0.74	0.10	0.99
1.13	0.56	3.78	0.75	4.88	0.76	0.09	0.99
1.24	0.52	3.83	0.71	5.04	0.77	0.08	0.98
1.30	0.62	3.99	0.84	5.28	0.76	0.07	0.98
1.39	0.55	4.65	0.76	6.07	0.77	0.05	0.96
1.48	0.54	4.65	0.76	6.12	0.77	0.07	0.98
1.66	0.75	5.57	0.94	6.65	0.83	0.07	0.98
1.72	0.82	6.68	1.09	8.19	0.81	0.07	0.97
2.00	0.85	8.66	1.03	9.58	0.86	0.07	0.97
2.15	0.78	7.63	0.99	8.91	0.85	0.06	0.96
2.58	1.15	9.00	1.35	10.12	0.89	0.04	0.95

Note: This table reports the descriptive statistics of 25 portfolios sorted on unlevered betas. Unlevered betas are estimated by time-series regression of unlevered excess monthly returns on the factors for a panel of 25 portfolios between January 1952 and December 2013. The first column presents the unlevered betas of each portfolio; the unlevered excess return of portfolio i, is calculated as $R^u_{i,t} - r_t \equiv (R_{i,t+1} - r_{t+1}) \frac{E_{i,t-1}}{K_{i,t-1}}$, where $(R_{i,t+1} - r_{t+1})$ is the excess return of portfolio i for month t; and $\frac{E_{i,t-1}}{K_{i,t-1}}$ is the leverage ratio of total equity to total assets of portfolio i in month $t-1$. $\rho_{X_t,X_{t-1}}$ is the one month autocorrelation of $X_{i,t}$, where $X_{i,t} = \frac{K_{i,t}}{E_{i,t}}$, that is, the inverse of the leverage ratio.

TABLE A2—DESCRIPTIVE STATISTICS FOR 25 PORTFOLIOS SORTED ON TRADITIONAL CAPM BETAS

β	Unlevered Excess Return (%)		Excess Return (%)		Leverage		
	Mean	S.D.	Mean	S.D.	Mean	S.D.	$\rho_{X_t,X_{t-1}}$
0.18	0.17	3.60	0.28	5.71	0.56	0.14	0.98
0.39	0.24	1.43	0.62	3.47	0.43	0.08	0.98
0.46	0.21	1.39	0.55	3.51	0.42	0.08	0.99
0.52	0.20	1.51	0.53	3.65	0.42	0.09	0.98
0.62	0.36	2.25	0.70	3.97	0.54	0.11	0.98
0.61	0.34	2.12	0.61	3.68	0.57	0.10	0.98
0.74	0.42	2.54	0.71	4.14	0.61	0.13	0.99
0.79	0.40	2.71	0.65	4.24	0.65	0.09	0.98
0.80	0.38	2.58	0.68	4.35	0.59	0.11	0.99
0.90	0.47	3.08	0.74	4.59	0.65	0.11	0.98
0.89	0.48	3.45	0.69	4.77	0.71	0.11	0.99
0.94	0.35	2.66	0.63	4.54	0.58	0.15	0.99
0.99	0.37	3.11	0.61	4.84	0.66	0.12	0.98
1.02	0.37	2.81	0.70	4.90	0.58	0.09	0.97
1.11	0.37	3.15	0.66	5.29	0.61	0.10	0.98
1.12	0.39	3.33	0.66	5.40	0.63	0.10	0.97
1.15	0.35	3.30	0.66	5.54	0.61	0.10	0.97
1.23	0.48	4.06	0.78	6.07	0.65	0.11	0.99
1.29	0.37	3.48	0.71	6.20	0.57	0.10	0.97
1.33	0.46	4.44	0.76	6.69	0.66	0.07	0.96
1.41	0.65	5.42	0.99	7.49	0.69	0.12	0.98
1.43	0.35	4.51	0.78	7.51	0.58	0.11	0.95
1.56	0.43	5.14	0.75	8.17	0.62	0.13	0.97
1.68	0.32	5.10	0.66	8.87	0.55	0.17	0.97
1.89	0.57	6.84	0.99	10.22	0.66	0.12	0.95

Note: This table reports the descriptive statistics of 25 portfolios sorted on (levered) betas. Betas are estimated by time-series regression of (levered) excess monthly returns on the factors for a panel of 25 portfolios between January 1952 and December 2013. The first column presents the betas of each portfolio; the unlevered excess return of portfolio i, is calculated as $R^u_{i,t} - r_t \equiv (R_{i,t+1} - r_{t+1}) \frac{E_{i,t-1}}{K_{i,t-1}}$, where $(R_{i,t+1} - r_{t+1})$ is the excess return of portfolio i for month t; and $\frac{E_{i,t-1}}{K_{i,t-1}}$ is the leverage ratio of total equity to total assets of portfolio i in month $t-1$. $\rho_{X_t,X_{t-1}}$ is the one month autocorrelation of $X_{i,t}$, where $X_{i,t} = \frac{K_{i,t}}{E_{i,t}}$, that is, the inverse of the leverage ratio.

TABLE A3—DESCRIPTIVE STATISTICS FOR 25 FAMA AND FRENCH (1993) PORTFOLIOS SORTED ON SIZE AND BOOK-TO-MARKET RATIO

Small Big	High Low	Unlevered Excess Return (%)		Excess Return(%)		Leverage		
		Mean	S.D.	Mean	S.D.	Mean	S.D.	$\rho_{X_t,X_{t-1}}$
Big	Low	0.46	3.68	0.60	4.59	0.81	0.05	0.92
4	Low	0.64	4.48	0.87	5.77	0.78	0.06	0.94
3	Low	0.48	4.58	0.69	6.08	0.74	0.13	0.94
2	Low	0.44	5.07	0.68	6.50	0.77	0.11	0.95
Small	Low	0.23	5.68	0.36	7.27	0.73	0.18	0.97
Big	2	0.37	2.91	0.59	4.44	0.66	0.09	0.96
4	2	0.48	3.29	0.77	5.07	0.66	0.07	0.91
3	2	0.48	3.99	0.82	5.81	0.67	0.10	0.96
2	2	0.42	3.98	0.77	5.88	0.66	0.13	0.96
Small	2	0.30	4.55	0.53	6.42	0.69	0.12	0.98
Big	3	0.34	2.26	0.64	4.18	0.55	0.09	0.91
4	3	0.40	2.59	0.81	4.84	0.54	0.08	0.94
3	3	0.52	2.96	0.96	5.20	0.57	0.09	0.92
2	3	0.41	3.33	0.79	5.58	0.59	0.12	0.95
Small	3	0.27	4.08	0.55	6.20	0.61	0.14	0.98
Big	4	0.33	2.02	0.75	4.26	0.47	0.11	0.89
4	4	0.44	2.19	0.97	4.60	0.49	0.08	0.97
3	4	0.44	2.44	0.92	4.87	0.51	0.09	0.97
2	4	0.43	2.93	0.85	5.32	0.55	0.11	0.97
Small	4	0.25	3.52	0.58	5.97	0.57	0.15	0.98
Big	High	0.28	2.64	0.94	5.69	0.36	0.21	0.90
4	High	0.10	1.76	0.80	5.01	0.25	0.21	0.96
3	High	0.24	1.52	1.00	5.10	0.27	0.18	0.98
2	High	0.27	1.71	1.00	5.45	0.28	0.18	0.99
Small	High	0.18	1.70	0.76	5.71	0.28	0.18	0.98

Note: This table reports the descriptive statistics of 25 Fama-French portfolios. The two-way sort is conducted each year on the basis of size and book-to-market quintiles, yielding 25 portfolios that are constructed in the subsequent years.The quintiles are based on observations at the end of June each year, after which the portfolios are constructed in January in the subsequent year. The sample consists of monthly data from January 1952 to December 2013. The unlevered excess return of portfolio i, is calculated as $R^u_{i,t} - r_t \equiv (R_{i,t+1} - r_{t+1}) \frac{E_{i,t-1}}{K_{i,t-1}}$, where $(R_{i,t+1} - r_{t+1})$ is the excess return of portfolio i for month t; and $\frac{E_{i,t-1}}{K_{i,t-1}}$ is the leverage ratio of total equity to total assets of portfolio i in month $t-1$. $\rho_{X_t,X_{t-1}}$ is the one month autocorrelation of $X_{i,t}$, where $X_{i,t} = \frac{K_{i,t}}{E_{i,t}}$, that is, the inverse of the leverage ratio.

TABLE A4—DESCRIPTIVE STATISTICS FOR 25 PORTFOLIOS SORTED ON INDUSTRY CLASSIFICATION

Pf#	Unlevered Excess Return (%)		Excess Return (%)		Leverage		
	Mean	S.D.	Mean	S.D.	Mean	S.D.	$\rho_{X_t,X_{t-1}}$
1	0.31	3.36	0.52	6.43	0.55	0.22	0.98
2	0.44	4.11	0.70	6.39	0.65	0.10	0.97
3	0.41	2.71	0.67	4.24	0.64	0.07	0.98
4	0.35	3.25	0.59	5.19	0.63	0.10	0.97
5	0.39	2.67	0.72	4.75	0.57	0.14	0.98
6	0.30	2.99	0.59	5.31	0.56	0.10	0.97
7	0.24	2.51	0.67	5.65	0.45	0.17	0.99
8	0.35	2.80	0.77	5.75	0.50	0.07	0.96
9	0.27	2.08	0.58	4.20	0.50	0.12	0.97
10	0.44	3.25	0.75	5.30	0.62	0.13	0.99
11	0.47	3.83	0.73	5.48	0.69	0.06	0.97
12	0.41	3.06	0.75	5.39	0.59	0.10	0.99
13	0.38	3.47	0.80	6.49	0.53	0.11	0.97
14	0.42	3.38	0.75	5.70	0.61	0.10	0.97
15	0.44	3.83	0.79	5.96	0.62	0.12	0.97
16	0.20	1.45	0.58	3.85	0.38	0.09	0.98
17	0.33	3.47	0.69	6.28	0.54	0.14	0.98
18	0.75	5.79	1.15	8.32	0.64	0.18	0.98
19	0.39	3.12	0.62	4.66	0.67	0.12	0.98
20	0.60	4.01	0.76	4.88	0.81	0.07	0.99
21	0.42	3.49	0.89	6.68	0.54	0.10	0.97
22	0.96	6.66	1.24	8.41	0.79	0.08	0.95
23	0.67	5.23	0.91	6.57	0.79	0.10	0.99
24	0.20	1.50	0.54	3.83	0.41	0.07	0.98
25	0.62	4.53	0.76	5.42	0.82	0.08	0.99

Note: This table reports the descriptive statistics of 25 portfolios sorted by industry classification. Industry portfolios are constructed according to standard industrial classification) codes. We use three-digit SIC codes to group firms and construct 25 portfolios of roughly the same size. The first two digits of the SIC code identify the major industry group, and the third digit identifies the industry group, as we detail in Table A. The unlevered excess return of portfolio i, is calculated as $R^u_{i,t} - r_t \equiv (R_{i,t+1} - r_{t+1}) \frac{E_{i,t-1}}{K_{i,t-1}}$, where $(R_{i,t+1} - r_{t+1})$ is the excess return of portfolio i for month t; and $\frac{E_{i,t-1}}{K_{i,t-1}}$ is the leverage ratio of total equity to total assets of portfolio i in month $t-1$. Pf# indicates the portfolio number. $\rho_{X_t,X_{t-1}}$ is the one month autocorrelation of $X_{i,t}$, where $X_{i,t} = \frac{K_{i,t}}{E_{i,t}}$, that is, the inverse of the leverage ratio.

TABLE A5—CLASSIFICATION OF THE 25 INDUSTRY PORTFOLIOS

Port-folio	1st&2nd digit SIC	3rd digit SIC	Industry groups
1	01,02,07,08, 09,10,12	[ALL]	Agriculture, Forestry, Fishing, Metal Mining, Bituminous Coal and Lignite Mining
2	13	[ALL]	Oil and Gas Extraction
3	14,15,16,17, 20	[ALL]	Mining and Quarrying of Nonmetallic Minerals, except Fuels, Construction, Food and Kindred Products
4	24,25,26,27	[ALL]	Wood productions, Furniture, Paper, Print
5	21,22,23,29, 30	[ALL]	Tobacco Products, Textile Mill Products, Apparel and other Finished Products Made from Fabrics and Similar Materials, Petroleum Refining and Related Industries, Rubber and Miscellaneous Plastics Products
6	33,34,51	[ALL]	Primary Metal Industries, Fabricated Metal Products, except Machinery and Transportation Equipment, Wholesale Trade-Nondurable Goods
7	31,32,37	[ALL]	Leather and Leather Products, Stone, Clay, Glass, and Concrete Products, Transportation Equipment
8	39-47	[ALL]	Miscellaneous Manufacturing Industries, Transportation & Public Utilities (excluding Communications and Electric, Gas and Sanitary Services)
9	48,87	[ALL]	Communications, Engineering, Accounting, Research, Management, and Related Services
10	52-57	[ALL]	Retail Trade (exclude Eating and Drinking Places, Miscellaneous Retail)
11	50,58	[ALL]	Wholesale Trade-Durable Goods, Eating and Drinking Places
12	59,70,72,75, 76,78,82	[ALL]	Miscellaneous Retail, Hotels, Rooming Houses, Camps, and other Lodging Places, Personal Services, Automotive Repair, Services, and Parking, Miscellaneous Repair Services, Motion Pictures, Educational Services
13	79,80,81,83, 99	[ALL]	Amusement and Recreation Services, Health Services, Legal Services, Social Services, Non-classifiable Establishments
14	35	1-6	Industrial and Commercial Machinery and Computer Equipment (excluding Computer and Office Equipment, Refrigeration and Service Industry Machinery, Miscellaneous Industrial and Commercial)
15	38	1,2 & 5-9	Measuring, Analyzing, and Controlling Instruments; Photographic, Medical and Optical Goods; Watches and Clocks (exclude Surgical, Medical, and Dental Instruments and Supplies)
16	49	1,2	Electric Services, Gas Production and Distribution
17	36	1-6 & 8,9	Electronic and other Electrical Equipment and Components, except Computer Equipment (exclude Electronic Components and Accessories)
18	36	7	Electronic Components and Accessories
19	28	1,2 & 4-9	Chemicals and Allied Products (exclude Drugs)
20	28	3	Drugs
21	73	1-6 & 8	Business Services (excluding Computer Programming, Data Processing, and other Computer Related Services)
22	73	7	Computer Programming, Data Processing, and other Computer Related Services
23	35	7-9	Computer and Office Equipment, Refrigeration and Service Industry Machinery, Miscellaneous Industrial and Commercial)
24	49	3-9	Electric, Gas and Sanitary Services (exclude Electric Services, Gas Production and Distribution)
25	38	4	Surgical, Medical, and Dental Instruments and Supplies

TABLE A6—BETAS, PRICING ERRORS, AND GRS TEST FOR 25 PORTFOLIOS BASED ON TRADITIONAL CAPM BETA SORTS, U.S. 1952-2014.

Pf#	Unlevered CAPM			Traditional CAPM			Fama and French (1993)				
	GRS: F=1.58**			GRS: F=1.68**			GRS: F=2.20***				
	α(%)	β^u_{Market}	R^2	α(%)	β_{Market}	R^2	α(%)	β_{Market}	β_{SmB}	β_{HmL}	R^2
1	0.11	0.19***	0.02	0.18	0.18***	0.02	-0.03	0.16***	0.39***	0.33***	0.08
2	0.15***	0.26***	0.24	0.39***	0.39***	0.24	0.20*	0.46***	0.03	0.40***	0.33
3	0.11***	0.29***	0.33	0.28***	0.46***	0.33	0.09	0.55***	-0.10***	0.42***	0.44
4	0.08*	0.34***	0.37	0.22**	0.52***	0.38	0.04	0.61***	-0.12***	0.42***	0.48
5	0.17***	0.53***	0.41	0.34***	0.62***	0.46	0.34***	0.67***	-0.23***	0.05	0.49
6	0.14**	0.55***	0.50	0.26***	0.61***	0.52	0.18**	0.71***	-0.33***	0.22***	0.62
7	0.17***	0.70***	0.55	0.27***	0.74***	0.61	0.31***	0.82***	-0.39***	0.00	0.68
8	0.12*	0.79***	0.62	0.19**	0.79***	0.65	0.21**	0.83***	-0.24***	0.00	0.68
9	0.12**	0.73***	0.59	0.21**	0.80***	0.64	0.19**	0.88***	-0.33***	0.10***	0.69
10	0.14**	0.93***	0.67	0.21**	0.90***	0.73	0.24***	0.93***	-0.17***	-0.02	0.74
11	0.12	1.02***	0.64	0.17*	0.89***	0.66	0.26**	0.91***	-0.24***	-0.14***	0.68
12	0.05	0.84***	0.73	0.08	0.94***	0.81	0.02	0.97***	0.00	0.13***	0.82
13	0.02	0.99***	0.74	0.03	0.99***	0.78	-0.07	1.03***	-0.05	0.22***	0.80
14	0.04	0.92***	0.79	0.10	1.02***	0.82	0.08	1.05***	-0.07***	0.06***	0.82
15	0.01	1.04***	0.80	0.02	1.11***	0.82	-0.06	1.09***	0.19***	0.13***	0.84
16	0.00	1.09***	0.79	0.00	1.12***	0.81	-0.08	1.13***	0.11***	0.16***	0.82
17	-0.03	1.07***	0.77	-0.01	1.15***	0.80	-0.11	1.15***	0.14***	0.19***	0.82
18	0.03	1.27***	0.72	0.06	1.23***	0.78	0.11	1.17***	0.21***	-0.16***	0.79
19	-0.04	1.14***	0.79	-0.04	1.29***	0.82	-0.11	1.24***	0.35***	0.09***	0.84
20	-0.03	1.39***	0.72	-0.02	1.33***	0.75	0.09	1.20***	0.43***	-0.32***	0.80
21	0.10	1.57***	0.62	0.17	1.41***	0.67	0.31**	1.27***	0.44***	-0.40***	0.72
22	-0.11	1.31***	0.62	-0.06	1.43***	0.69	0.00	1.26***	0.71***	-0.25***	0.77
23	-0.11	1.53***	0.65	-0.16	1.56***	0.68	-0.08	1.38***	0.70***	-0.32***	0.76
24	-0.19	1.44***	0.58	-0.33*	1.68***	0.67	-0.21	1.47***	0.77***	-0.40***	0.76
25	-0.02	1.97***	0.63	0.01	1.89***	0.69	0.17	1.61***	0.83***	-0.54***	0.77

Note: This table presents the pricing errors (α), betas, and R^2s for the unlevered CAPM, traditional CAPM, and Fama and French (1993) three-factor model; these are estimates of the time-series regressions:

$$R_{i,t} - r_t = \alpha_i + f_t'\beta_i + \epsilon_{i,t},$$

where $R_{i,t} - rt$ is the excess unlevered return for the unlevered CAPM and the excess return for the traditional CAPM and Fama and French (1993) three-factor model of portfolio i at time t, and $\epsilon_{i,t}$ is the error term. Moreover, f_t is the unlevered excess return of the market portfolio for the unlevered CAPM, the excess return of the market portfolio for the traditional CAPM, and a vector of excess returns of the market portfolio, the HmL and the SmB factors for the Fama and French (1993) three-factor model. Test portfolios are 25 portfolios based on traditional beta sorts; Portfolio 1 consists of stocks with the lowest beta, and Portfolio 25 consists of stocks with the highest beta. We use monthly data between January 1952 and December 2013. The GRS F-statistic is reported at the top of the table; the null hypothesis is that the pricing errors are jointly zero. *, ** and *** denotes 10%, 5% and 1% significance, respectively. Pf# indicates the portfolio number. *Sources*: Flow of funds account, Federal Reserve; COMPUSTAT; CRSP; Fama French and Liquidity factors, WRDS; Davis, Fama, and French (2000).

TABLE A7—BETAS, PRICING ERRORS, AND GRS TEST FOR THE 25 FAMA AND FRENCH (1993) PORTFOLIOS, U.S. 1952-2014.

Pf#	Unlevered CAPM			Traditional CAPM			Fama and French (1993)				
	GRS: F=2.49***			GRS: F=2.81***			GRS: F=2.38***				
	$\alpha(\%)$	β^u_{Market}	R^2	$\alpha(\%)$	β_{Market}	R^2	$\alpha(\%)$	β_{Market}	β_{SmB}	β_{HmL}	R^2
1	-0.17	1.19***	0.33	-0.22	1.01***	0.38	-0.25	0.80***	1.03***	-0.16***	0.55
2	-0.09	1.11***	0.44	-0.05	0.99***	0.45	-0.08	0.85***	0.75***	-0.07	0.56
3	-0.08	0.99***	0.43	-0.01	0.97***	0.46	-0.10	0.83***	0.81***	0.03	0.59
4	-0.05	0.87***	0.44	0.01	0.97***	0.49	-0.05	0.83***	0.74***	-0.01	0.61
5	0.03	0.43***	0.48	0.18	0.98***	0.56	0.09	0.87***	0.69***	0.08	0.67
6	-0.05	1.40***	0.56	0.02	1.12***	0.56	0.05	0.92***	0.89***	-0.24***	0.73
7	0.03	1.10***	0.56	0.15	1.06***	0.61	0.11	0.90***	0.79***	-0.06	0.75
8	0.06	0.99***	0.64	0.17	1.05***	0.66	0.08	0.93***	0.74***	0.07***	0.80
9	0.13*	0.86***	0.63	0.27**	0.99***	0.66	0.10	0.88***	0.80***	0.22***	0.83
10	0.11**	0.43***	0.46	0.42***	0.99***	0.62	0.22**	0.92***	0.65***	0.31***	0.73
11	-0.01	1.39***	0.67	0.00	1.17***	0.70	0.03	1.00***	0.76***	-0.21***	0.84
12	0.05	1.21***	0.68	0.16	1.13***	0.71	0.13	1.00***	0.65***	-0.06***	0.81
13	0.21***	0.90***	0.68	0.37***	1.01***	0.72	0.23***	0.92***	0.70***	0.17***	0.85
14	0.17***	0.74***	0.67	0.37***	0.94***	0.70	0.16**	0.87***	0.65***	0.33***	0.85
15	0.10**	0.39***	0.47	0.45***	0.95***	0.66	0.20**	0.90***	0.68***	0.42***	0.82
16	0.13	1.45***	0.77	0.18*	1.18***	0.79	0.24***	1.05***	0.51***	-0.24***	0.87
17	0.10*	1.07***	0.78	0.16*	1.05***	0.80	0.09	0.96***	0.53***	0.05***	0.89
18	0.11**	0.83***	0.75	0.24***	0.98***	0.77	0.07	0.93***	0.49***	0.26***	0.86
19	0.20***	0.68***	0.72	0.44***	0.91***	0.73	0.29***	0.85***	0.53***	0.24***	0.84
20	-0.02	0.36***	0.30	0.26**	0.93***	0.64	0.04	0.92***	0.39***	0.40***	0.72
21	0.02	1.26***	0.86	0.02	0.99***	0.87	0.19***	0.96***	-0.18***	-0.33***	0.91
22	0.03	0.96***	0.80	0.05	0.93***	0.83	0.06	0.97***	-0.19***	0.02	0.84
23	0.09**	0.71***	0.72	0.15**	0.84***	0.76	0.04	0.90***	-0.08***	0.25***	0.79
24	0.12***	0.59***	0.63	0.28***	0.81***	0.69	0.14	0.86***	0.02	0.30***	0.72
25	0.11	0.52***	0.29	0.43***	0.94***	0.51	0.18	1.00***	0.16***	0.55***	0.58

Note: This table presents the pricing errors (α), betas, and R^2s for the unlevered CAPM, traditional CAPM, and Fama and French (1993) three-factor model; these are estimates of the time-series regressions:

$$R_{i,t} - r_t = \alpha_i + f_t'\beta_i + \epsilon_{i,t},$$

where $R_{i,t} - rt$ is the excess unlevered return for the unlevered CAPM and the excess return for the traditional CAPM and Fama and French (1993) three-factor model of portfolio i at time t, and $\epsilon_{i,t}$ is the error term. Moreover, f_t is the unlevered excess return of the market portfolio for the unlevered CAPM, the excess return of the market portfolio for the traditional CAPM, and a vector of excess returns of the market portfolio, the HmL and the SmB factors for the Fama and French (1993) three-factor model. Test portfolios are 25 Fama and French (1993) portfolios, for which the portfolio number (pf) corresponds to the High/Low and Small/Big classification in Table A3. We use monthly data between January 1952 and December 2013. The GRS F-statistic is reported at the top of the table; the null hypothesis is that the pricing errors are jointly zero. *, ** and *** denotes 10%, 5% and 1% significance, respectively. Pf# indicates the portfolio number. *Sources*: Flow of funds account, Federal Reserve; COMPUSTAT; CRSP; Fama French and Liquidity factors, WRDS; Davis, Fama, and French (2000).

TABLE A8—BETAS, PRICING ERRORS, AND GRS TEST FOR 25 PORTFOLIOS BASED ON INDUSTRY SORTS, U.S. 1952-2014.

Pf#	Unlevered CAPM			Traditional CAPM			Fama and French (1993)				
	GRS: F=1.51*			GRS: F=1.68**			GRS: F=2.51***				
	$\alpha(\%)$	β^u_{Market}	R^2	$\alpha(\%)$	β_{Market}	R^2	$\alpha(\%)$	β_{Market}	β_{SmB}	β_{HmL}	R^2
1	0.04	0.75***	0.36	0.02	0.87***	0.34	-0.12	0.87***	0.22***	0.25***	0.36
2	0.08	0.99***	0.43	0.13	0.96***	0.43	0.04	1.01***	-0.09	0.21***	0.44
3	0.13**	0.78***	0.61	0.21**	0.78***	0.64	0.17*	0.81***	-0.09***	0.10***	0.64
4	-0.01	1.00***	0.70	-0.01	1.03***	0.73	-0.17*	1.08***	0.03	0.34***	0.76
5	0.14**	0.70***	0.50	0.26**	0.79***	0.52	0.17	0.89***	-0.29***	0.26***	0.58
6	-0.03	0.94***	0.73	-0.03	1.06***	0.76	-0.16*	1.05***	0.26***	0.23***	0.78
7	-0.03	0.76***	0.67	0.01	1.12***	0.75	-0.15	1.13***	0.26***	0.30***	0.78
8	0.06	0.83***	0.65	0.13	1.09***	0.68	-0.02	1.11***	0.17***	0.30***	0.70
9	0.08	0.53***	0.48	0.17	0.70***	0.53	0.13	0.77***	-0.23***	0.13***	0.56
10	0.12	0.89***	0.55	0.21*	0.93***	0.58	0.21	0.92***	0.03	0.01	0.58
11	0.09	1.06***	0.56	0.15	0.98***	0.60	0.10	0.93***	0.31***	0.06	0.63
12	0.08	0.91***	0.65	0.15	1.02***	0.67	0.08	0.95***	0.42***	0.09***	0.71
13	0.13	0.83***	0.43	0.29	0.99***	0.46	0.05	0.95***	0.46***	0.35***	0.52
14	0.04	1.07***	0.73	0.08	1.14***	0.75	0.00	1.10***	0.33***	0.12***	0.78
15	0.05	1.10***	0.61	0.14	1.11***	0.66	0.15	1.01***	0.46***	-0.12***	0.71
16	0.08**	0.33***	0.38	0.25**	0.56***	0.40	0.10	0.65***	-0.15***	0.37***	0.48
17	-0.05	1.06***	0.69	-0.04	1.25***	0.75	0.01	1.15***	0.43***	-0.19***	0.80
18	0.26	1.38***	0.42	0.36*	1.35***	0.50	0.57***	1.20***	0.37***	-0.52***	0.54
19	0.06	0.93***	0.65	0.10	0.89***	0.68	0.04	0.95***	-0.19***	0.18***	0.71
20	0.22**	1.06***	0.51	0.28**	0.82***	0.53	0.44***	0.84***	-0.38***	-0.29***	0.60
21	0.10	0.91***	0.50	0.26	1.08***	0.49	0.15	1.00***	0.58***	0.13***	0.55
22	0.48***	1.77***	0.55	0.56**	1.40***	0.57	0.76***	1.20***	0.41***	-0.60***	0.64
23	0.16	1.46***	0.57	0.24	1.14***	0.56	0.49***	1.04***	0.04	-0.56***	0.62
24	0.09*	0.30***	0.29	0.25**	0.49***	0.31	0.06	0.59***	-0.13***	0.46***	0.43
25	0.18	1.23***	0.54	0.21	0.95***	0.57	0.31**	0.92***	-0.06	-0.21***	0.58

Note: This table presents the pricing errors (α), betas, and R^2s for the unlevered CAPM, traditional CAPM, and Fama and French (1993) three-factor model; these are estimates of the time-series regressions:

$$R_{i,t} - r_t = \alpha_i + f_t'\beta_i + \epsilon_{i,t},$$

where $R_{i,t} - rt$ is the excess unlevered return for the unlevered CAPM and the excess return for the traditional CAPM and Fama and French (1993) three-factor model of portfolio i at time t, and $\epsilon_{i,t}$ is the error term. Moreover, f_t is the unlevered excess return of the market portfolio for the unlevered CAPM, the excess return of the market portfolio for the traditional CAPM, and a vector of excess returns of the market portfolio, the HmL and the SmB factors for the Fama and French (1993) three-factor model. Test portfolios are 25 portfolios based on standard industry classification (SIC) codes; see Table A for more details. We use monthly data between January 1952 and December 2013. The GRS F-statistic is reported at the top of the table; the null hypothesis is that the pricing errors are jointly zero. *, ** and *** denotes 10%, 5% and 1% significance, respectively. Pf# indicates the portfolio number. *Sources*: Flow of funds account, Federal Reserve; COMPUSTAT; CRSP; Fama French and Liquidity factors, WRDS; Davis, Fama, and French (2000).