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journal homepage: www.elsevier.com/locate/jfecSize matters, if you control your junk[☆]Clifford Asness^a, Andrea Frazzini^a, Ronen Israel^a, Tobias J. Moskowitz^{a,b,c,*}, Lasse H. Pedersen^{a,d,e,f}^aAQR Capital Management, LLC, 2 Greenwich Plaza, Greenwich, CT 06830, USA^bYale University, SOM, 165 Whitney Ave., New Haven, CT 06511, USA^cNational Bureau of Economic Research (NBER), MA, USA^dDepartment of Finance, Copenhagen Business School, A4.12, Solbjerg Plads 3, 2000 Frederiksberg, Denmark^eStern School of Business, New York University, 44 West Fourth Street, New York, NY 10012, USA^fCentre for Economic Policy Research (CEPR), London, UK

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ABSTRACT

The size premium has been accused of having a weak historical record, being meager relative to other factors, varying significantly over time, weakening after its discovery, being concentrated among microcap stocks, residing predominantly in January, relying on price-based measures, and being weak internationally. We find, however, that these challenges disappear when controlling for the quality, or its inverse, junk, of a firm. A significant size premium emerges, which is stable through time, robust to specification, not concentrated in microcaps, more consistent across seasons, and evident for non-price-based measures of size, and these results hold in 30 different industries and 24 international equity markets. The resurrected size effect is on par with anomalies such as value and momentum in terms of economic significance and gives rise to new tests of, and challenges for, existing asset pricing theories.

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1. Introduction

Does size matter? With respect to capital markets, the answer to this question is unclear. Academic research on the relation between firm size and expected returns dates back to at least [Banz \(1981\)](#), who finds that small stocks in the US (those with lower market capitalizations) have higher average returns than large stocks, an effect not accounted for by the higher market beta of small stocks. The relation between firm size and expected returns is important for several reasons. First, the size effect has become a focal point for discussions about market efficiency. Second, a size factor has become one of the main building blocks of current asset pricing models used in the literature and in practice (e.g., [Fama and French, 1993, 2016](#)). Third, the size premium implies that small firms face larger costs of capital than large firms, having important implications for

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corporate finance, incentives to merge and form conglomerates, and broader industry dynamics. Fourth, the size effect has had a large impact on investment practice (Reinganum, 1983a), including spawning an entire category of investment funds, giving rise to small cap indices, and serving as a cornerstone for money management classification.

We provide new evidence on the size effect and test several competing theories for its existence:

1. *Risk-based theories of frictionless capital markets.*
 - (a) Standard asset pricing models such as the capital asset pricing model (CAPM): If size per se is not a risk, standard models predict that size does not matter when controlling for risk exposures.
 - (b) Size captures time-varying risk premia: Size can be correlated to expected returns only because size is measured by market value, which is influenced by risk premia (Ball, 1978; Berk, 1995a). Riskier firms have higher required returns, leading to lower market value, everything else equal. Hence, any misspecification of risk premia, due perhaps to time-varying risk or risk premia, will be picked up by market prices. According to this theory, size factors based on market prices will mechanically pick up these movements, but size measures other than market value should not predict returns.
 - (c) Theories of growth options: If small firms have more growth options and growth options are risky, then small firms are riskier and have higher required returns (Carlson et al., 2004; Garleanu et al., 2012). Hence, the size effect should be smaller when controlling for measures of risk and growth options.
2. *Behavioral finance theories.* Small firms are more difficult to arbitrage, making these firms more mispriced (Shleifer and Vishny, 1997). If this effect drives the size effect, then small stocks need to be underpriced on average relative to large stocks, and the size effect should be smaller when controlling for measures of mispricing such as investor sentiment, disagreement, and limited arbitrage activity (e.g., trading costs or short-sale costs). Investors could overreact to growth and other quality measures; so according to these theories, the size effect should be smaller when we control for such effects (Barberis et al., 1998; Daniel et al., 1998; Hong and Stein, 1999).
3. *Theories of liquidity and liquidity risk.* Size matters because small firms are less liquid (Amihud and Mendelson, 1986) and face more liquidity risk (Acharya and Pedersen, 2005), both requiring higher expected returns. Hence, the size premium should be related to liquidity level and risk measures, and the size and liquidity premia should be more evident when controlling for other risk exposures, especially those negatively correlated with size.

To test these theories, we consider the size effect controlling for other factors, which can proxy for other sources of risk, growth, mispricing, and liquidity. We focus on the interaction between size and firm quality (or its inverse,

junk). The interaction between size and quality is especially interesting for three reasons. First, quality can be defined as a characteristic of an asset that, all else equal, commands a higher price. As such, size, which is based on market values, should have a strong connection to quality. Second, Novy-Marx (2013) shows that quality, as measured by profitability, has a strong connection to the value effect and helps clean up the relation between value and expected returns. A similar argument can be made for the size effect, where size's relation to average returns can be clearer once we account for quality. Because size also interacts with value (Fama and French, 1993; 2012), sorting out the interactions between these three predictors of returns could help better characterize the cross section of expected returns. Third, quality has a direct theoretical link to some of the theories we aim to test, namely, quality can be related to growth options underlying rational theories for size or sources of overreaction underlying prominent behavioral theories, or both. Measures of quality such as profitability, stability, and growth are intuitively empirical proxies for growth options and have been used as variables related to overreaction by investors.

Supporting these motivations for looking at the size-quality interaction, we find empirically that the key control variable for the size effect is firm quality (measured by profitability, stability, growth, and safety) or its inverse, junk. The interaction between size and quality or junk is far stronger than size's interaction with other factors (beta, value, momentum) and accounting for it produces a more significant size premium that helps test some of the competing theories for size.

Controlling for quality or junk (along with the standard asset pricing factors such as value and momentum) resurrects a strong size effect and helps distinguish among the competing theories. The resurrected strong size effect controlling for other factors can be viewed as a rejection of theory 1(a). We find that non-price-based size measures perform just as well as price-based ones, rejecting theory 1(b). The fact that controlling for quality, including growth, makes the size effect stronger, not weaker, seems inconsistent with the growth theory 1(c), if growth options are more prevalent among the high growth firms as theory predicts. We find that small stocks have higher shorting costs and more disagreement, which, according to behavioral theories, makes them more likely to be overvalued not undervalued, which is inconsistent with behavioral theories 2. Finally, the fact that size matters more when controlling for other factors is consistent with liquidity-based theories 3, in which controlling for these other factors, particularly quality, helps clean up the relation between size, liquidity, and average returns. However, this result does not offer any additional direct evidence in favor of a liquidity story.

Given the importance and prominence of the size effect as the first major challenge to the CAPM, it has naturally come under heavy and often critical scrutiny. Considering almost a century-long sample of US stocks and a broad sample of global stocks in 24 different markets, we confirm the main criticisms of the standard size effect. Consistent with risk-based theories 1, size has a weak

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