The Popularity Asset Pricing Model

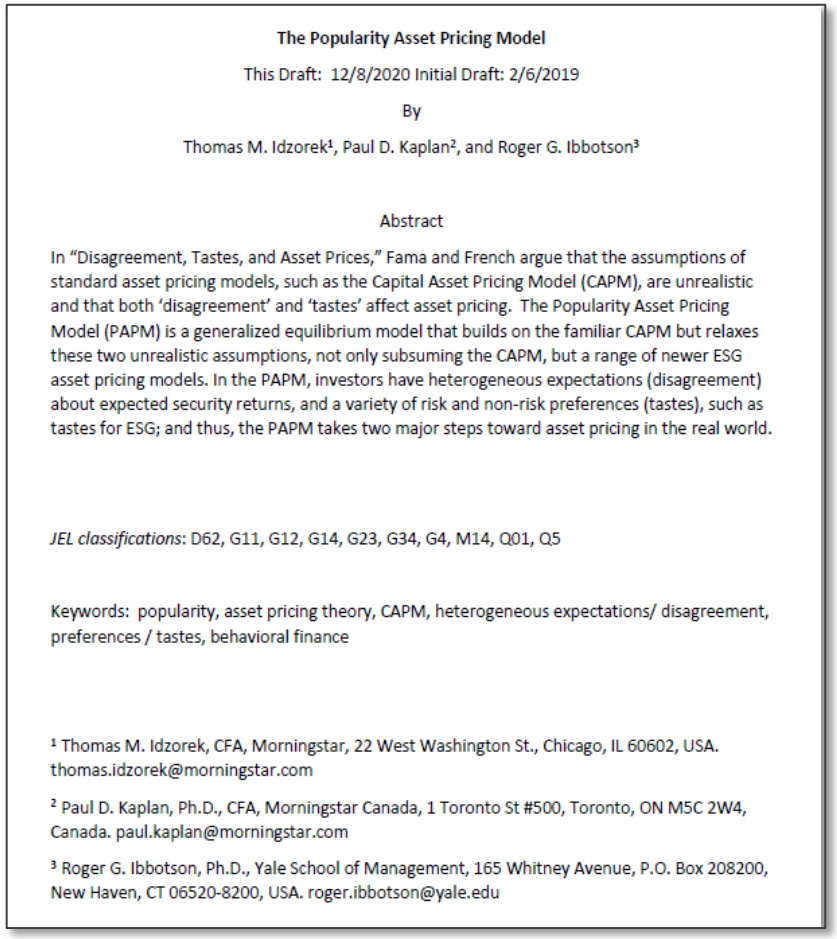
By Thomas M. Idzorek, Paul D. Kaplan, and Roger G. Ibbotson

March 16, 2021

Agenda

- Overview
- Our Journey to the Popularity Asset Pricing Model
- The Popularity Asset Pricing Model
- An ESG Application

Overview – The Popularity Asset Pricing Model



The Popularity Asset Pricing Model

This Draft: 12/8/2020 Initial Draft: 2/6/2019

By

Thomas M. Idzorek[1], Paul D. Kaplan[2], and Roger G. Ibbotson[3]

Abstract

In "Disagreement, Tastes, and Asset Prices," Fama and French argue that the assumptions of standard asset pricing models, such as the Capital Asset Pricing Model (CAPM), are unrealistic and that both 'disagreement' and 'tastes' affect asset pricing. The Popularity Asset Pricing Model (PAPM) is a generalized equilibrium model that builds on the familiar CAPM but relaxes these two unrealistic assumptions, not only subsuming the CAPM, but a range of newer ESG asset pricing models. In the PAPM, investors have heterogeneous expectations (disagreement) about expected security returns, and a variety of risk and non-risk preferences (tastes), such as tastes for ESG; and thus, the PAPM takes two major steps toward asset pricing in the real world.

JEL classifications: D62, G11, G12, G14, G23, G34, G4, M14, Q01, Q5

Keywords: popularity, asset pricing theory, CAPM, heterogeneous expectations/ disagreement, preferences / tastes, behavioral finance

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A new equilibrium asset pricing model that incorporates both heterogeneous expectations ('disagreement') and investor preferences beyond risk aversion ('tastes").

We believe it is the general model that not only subsumes the CAPM, but a variety of more specific asset pricing models in which these other models are simply special cases of the more general model.

Our Journey to The Popularity Asset Pricing Model

Ibbotson, Diermeier, and Siegel (1984)

By Roger G. Ibbotson, Jeffrey J. Diermeier and Laurence B. Siegel

The Demand for Capital Market Returns: A New Equilibrium Theory

Investors demand more of an asset, the more desirable the asset's characteristics. The most important characteristic is its price, or expected return. By varying price, any and all assets become desirable enough for the capital market to clear.

Asset characteristics other than price include both risk and non-risk characteristics. The Capital Asset Pricing Model and Arbitrage Pricing Theory have described the risk characteristics. The non-risk characteristics are not as well understood. They include taxation, marketability and information costs. For many assets, these non-risk characteristics affect price, or expected return, even more than the risk characteristics.

Investors regard asset characteristics as positive or negative costs, and investors evaluate expected returns net of these costs. The New Equilibrium Theory (NET) framework applies to all assets—including stocks and bonds, real estate, venture capital, durables and intangibles such as human capital—and incorporates all asset characteristics.

Our Journey to The Popularity Asset Pricing Model

Idzorek, Xiong, and Ibbotson (2012), Ibbotson et al (2013)

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The Liquidity Style of Mutual Funds

Thomas M. Idzorek, CFA, James X. Xiong, CFA, and Roger G. Ibbotson

Recent literature indicates that a liquidity investment style—the process of investing in less liquid stocks—has led to excess returns relative to size and value. The authors examined whether this style, previously documented at the security level, can be uncovered at the mutual fund level. Across a wide range of mutual fund categories, they found that, on average, mutual funds that held less liquid stocks significantly outperformed those that held more liquid stocks.

It is relatively well known that less liquid investments tend to outperform more liquid investments. The same holds true within the relatively liquid universe of publicly traded stocks. The generally accepted rationale for a liquidity premium is that all else equal, investors prefer greater liquidity; thus, in order to induce investors to hold less liquid assets, they must have the expectation (but not the guarantee) of a return premium. Using today's nomenclature, one could think of less liquidity as a risk factor, an exotic beta, or a structural alpha related to its extra costs.

Recent literature indicates that the liquidity investment style—the process of investing in relatively less liquid stocks within the liquid universe of publicly traded stocks—produces risk-adjusted returns that rival or exceed those of the three best-known market anomalies: small minus large, value minus growth, and high minus low momentum (see Carhart 1997). For example, Amihud and Mendelson (1986) used the quoted bid–ask spread to measure liquidity and tested the relationship between stock returns and liquidity over 1961–1980. They found evidence consistent with the notion of a liquidity premium. Datar, Naik, and Radcliffe (1998) used the turnover rate (the number of shares traded as a fraction of the number of shares outstanding) as a proxy for liquidity and found that stock returns are strongly negatively related to their turnover rates, which confirms the notion that less liquid stocks provide higher average returns. Overall, their results support the relationship between less liquidity and higher stock returns. Pástor and Stambaugh (2003) demonstrated that marketwide liquidity appears to be a state variable that is important in pricing common stocks. They found that expected stock returns are cross-sectionally related to the sensitivity of stock returns to aggregate liquidity. According to their measure, smaller stocks are less liquid and thus highly sensitive to aggregate liquidity. In addition, research by Li, Mooradian, and Zhang (2007) supports the hypothesis that marketwide liquidity is an important risk factor and has a significant effect on expected returns. Recently, Lou and Sadka (2011) documented the importance of distinguishing between liquidity level as measured by the illiquidity measure of Amihud (2002) and liquidity risk, which measures sensitivity to changes in marketwide liquidity. They found that liquidity risk is a better predictor of stock prices during a crisis than liquidity level.

Although stock-level liquidity has been explored by academics as an important explanatory "risk factor" (even though, as we shall see, the return premium associated with less liquid investments can be characterized by less risk) and as an ongoing concern for portfolios that need immediate liquidity, only recently has it been explored as an investment style similar to a preference for funds with a small-cap or value bias. To that end—and perhaps most importantly for our purposes—using monthly data for the largest 3,500 U.S. stocks by capitalization starting in 1972, Ibbotson, Chen, Kim, and Hu (2012) sorted stocks into equally weighted quartiles based on liquidity. Their results clearly show that annually rebalanced composites of relatively less liquid stocks significantly outperform composites of more liquid stocks after controlling for size, valuation, and momentum. Ibbotson et al. (2012) attempted to distinguish between risk

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Liquidity as an Investment Style

Roger G. Ibbotson, Zhiwu Chen, Daniel Y.-J. Kim, and Wendy Y. Hu

Liquidity should be given equal standing with size, value/growth, and momentum as an investment style. As measured by stock turnover, liquidity is an economically significant indicator of long-run returns. The returns of liquidity are sufficiently different from those of the other styles that it is not merely a substitute. Finally, a stock's liquidity is relatively stable over time, with changes in liquidity associated with changes in valuation.

William F. Sharpe suggested the idea of investment styles as early as 1978 in a general paper about investment (Sharpe 1978). He later refined the idea of style analysis (Sharpe 1988) and applied it to asset allocation (Sharpe 1992); in the latter study, Sharpe defined four criteria that characterize a benchmark style: (1) "identifiable before the fact," (2) "not easily beaten," (3) "a viable alternative," and (4) "low in cost."[1] The Morningstar Style Box popularized the size versus value categorizations during that same year.

In this article, we propose that equity liquidity is a missing investment style that should be given equal standing with the currently accepted styles of size (Banz 1981), value/growth (Basu 1977; Fama and French 1992, 1993), and momentum[2] (Jegadeesh and Titman 1993, 2001). When assembled into portfolios, these styles define a set of betas that can be beaten only if the portfolios provide a positive alpha.

The literature on the relationship between liquidity and valuation in the U.S. equity market has grown dramatically since Amihud and Mendelson (1986) used bid–ask spreads to show that less liquid stocks outperform more liquid stocks.[3] Using various measures of liquidity, other researchers have confirmed the impact of liquidity on stock returns. Despite this significant and multifaceted body of evidence, a recent survey of the last 25 years of literature on the determinants of expected stock returns found that liquidity is rarely included as a control (Subrahmanyam 2010).[4]

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In our study, we used stock turnover, which is a well-established measure of liquidity that is negatively correlated with long-term returns in the U.S. equity market. Haugen and Baker (1996) and Datar, Naik, and Radcliffe (1998) demonstrated that low-turnover stocks, on average, earn higher future returns than do high-turnover stocks. We examined stock-level liquidity in a top 3,500 market-capitalization universe of U.S. equities over 1971–2011 and subjected it to the four style tests of Sharpe (1992). Our empirical findings, which extend and amplify the existing literature, are that liquidity clearly meets all four criteria. In the sections that follow, we discuss each criterion in turn. Appendix A describes the datasets and stock universe that we used in our analysis.

Long-Term Return Comparisons

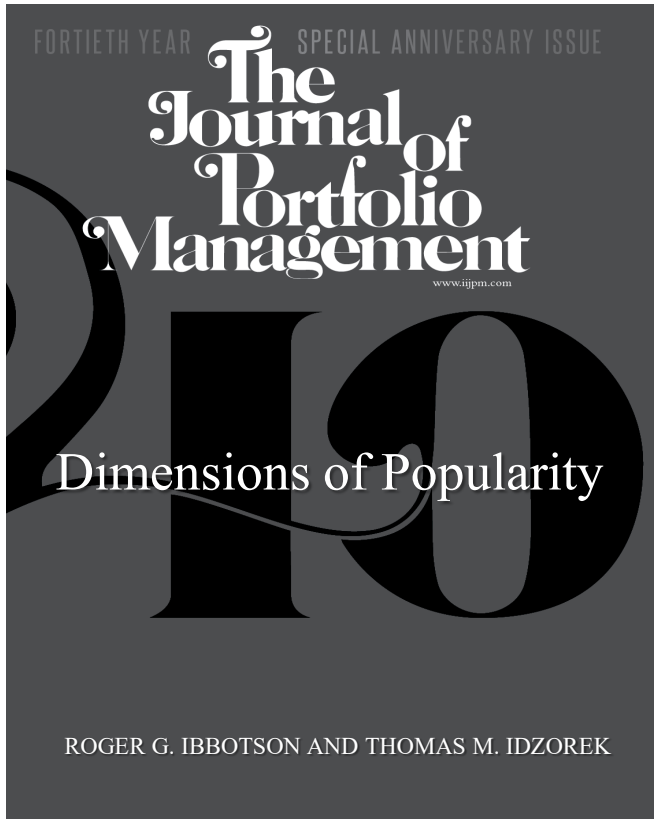
There are numerous ways to identify liquidity. Amihud and Mendelson (1986) used bid–ask spreads to explain a cross section of stock returns. Brennan and Subrahmanyam (1996) regressed the price impact of a unit trade size from microstructure trading data. Amihud (2002) developed a metric that uses the average price impact relative to the daily trading volume of each security. Pástor and Stambaugh (2003) demonstrated that stock returns vary with their sensitivity to marketwide liquidity.

We used stock turnover as our "before the fact" measure of liquidity. It is a characteristic, but it can also be expressed as a covariance factor. Another frequently used and readily measured liquidity metric is that of Amihud (2002), though Idzorek, Xiong, and Ibbotson (2012) showed that turnover exhibits greater explanatory power for U.S. mutual fund returns. A single "perfect" measure of liquidity is unlikely to exist: Brown, Crocker, and Foerster (2009) found that liquidity measures may encode momentum and information effects in large-cap stocks.

- Sorted stock and mutual fund universe based on liquidity
- Found that in numerous different 'sorts, less liquid investments nearly monotonically outperformed more liquid investments.
- Liquidity was a quintessential example of one of the many non-risk characteristics that investors like.

Our Journey to The Popularity Asset Pricing Model

Ibbotson and Idzorek (2014)



and different securities? Asset pricing theories have long recognized that expected returns should not be the same for the various instruments in the marketplace. The primary explanation for these differences has been differences in risk. Of course, risk is unpopular—investors do not like risk and want to be compensated for it.

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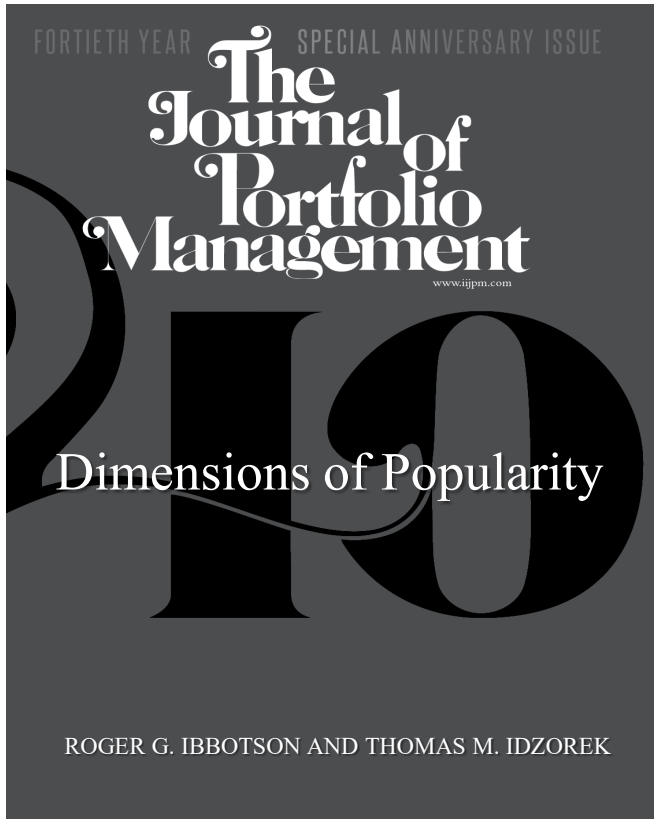

We believe that most of the best-known market premiums and anomalies can be explained by an intuitive and naturally occurring (social or behavioral) phenomenon observed in countless settings: popularity. Popularity is often defined as a

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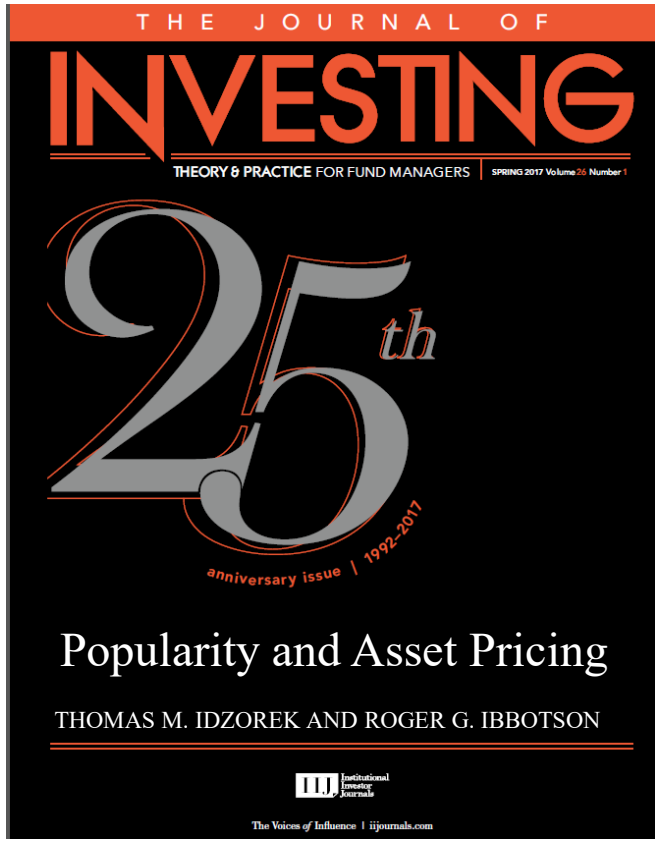
Idzorek and Ibbotson (2017)



starts with the concept of popularity.

In this article, we continue to refine the popularity framework, evaluate the well-known premiums and anomalies through the popularity lens, explain the linkage to classical finance and behavioral finance, and put forth a popularity-based asset pricing formula.

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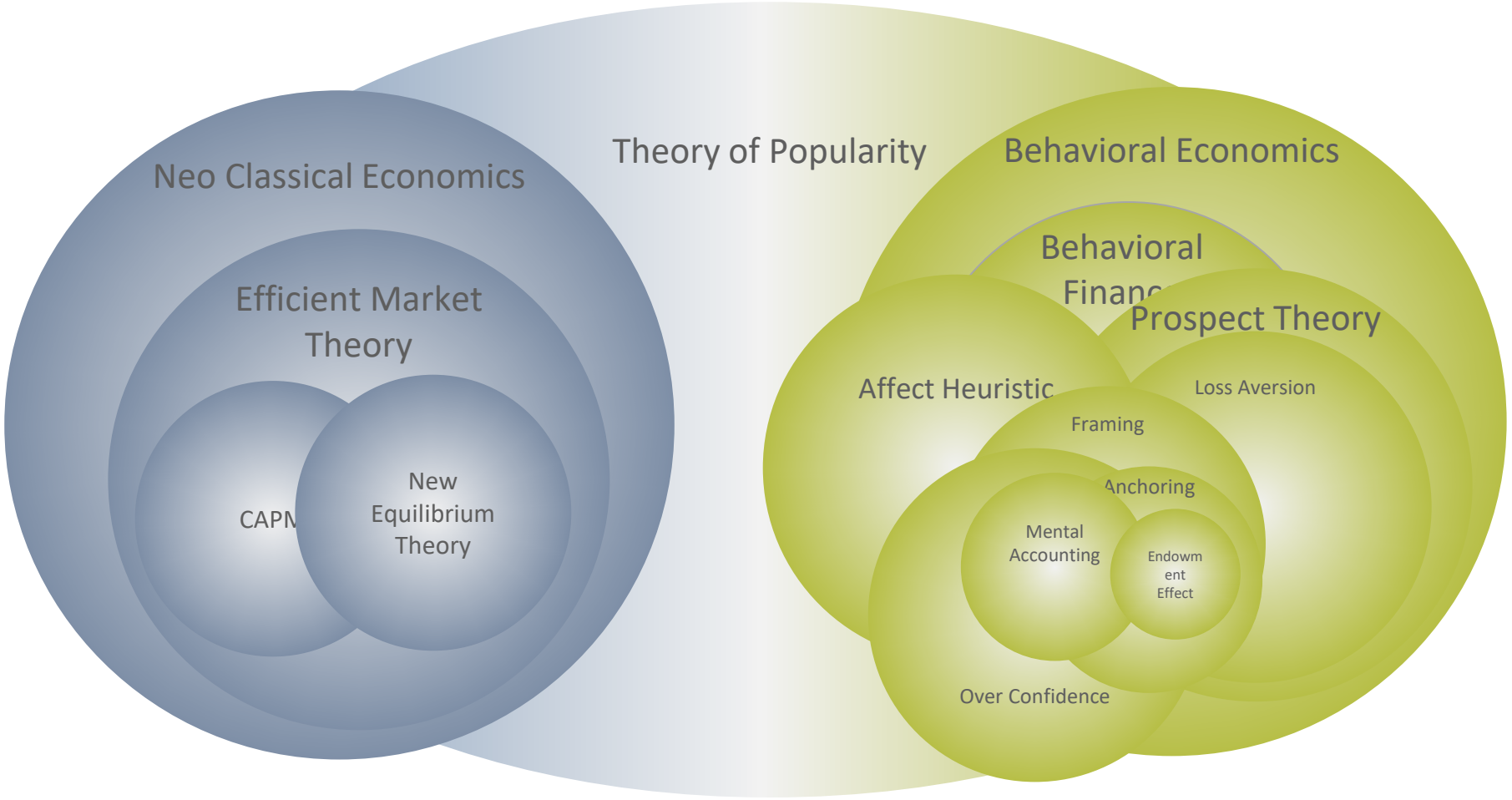
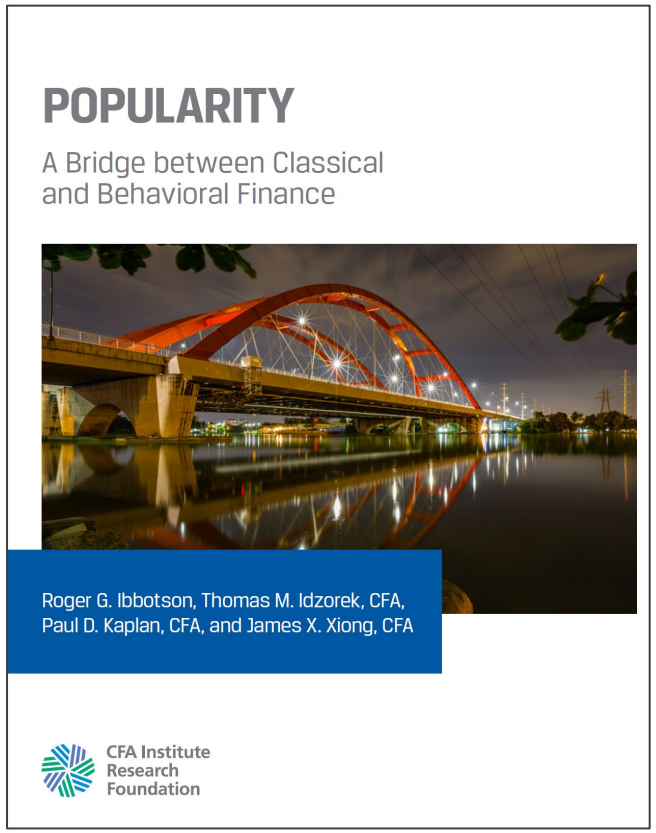
Idzorek and Ibbotson (2017)



Our Journey to The Popularity Asset Pricing Model

Ibbotson, Idzorek, Kaplan, and Xiong (2018)

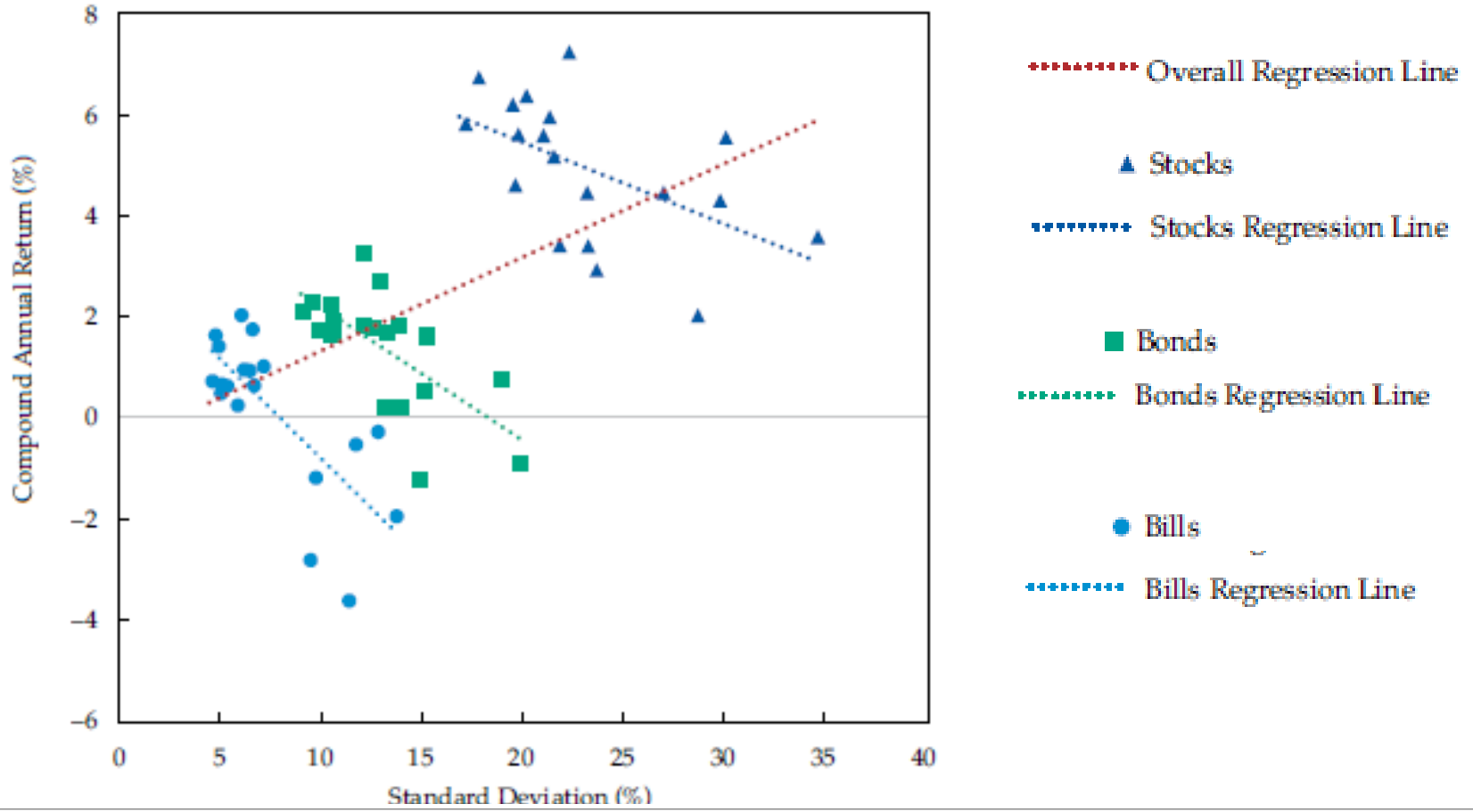


- Continue to develop the popularity asset pricing framework
- Present a wide range of empirical evidence associated with well-know premiums and anomalies
- Present empirical evidence based on three new dimensions of popularity: Brand, Reputation, and Competitive advantage
- Create the first version of the Popularity Asset Pricing Model, albeit with homogeneous expectations.

Our Journey to The Popularity Asset Pricing Model

Ibbotson, Idzorek, Kaplan, and Xiong (2018)

Figure 2.1. Risk and Return of Stocks, Bonds, and Government Bills of 19 Countries: 1901–2017



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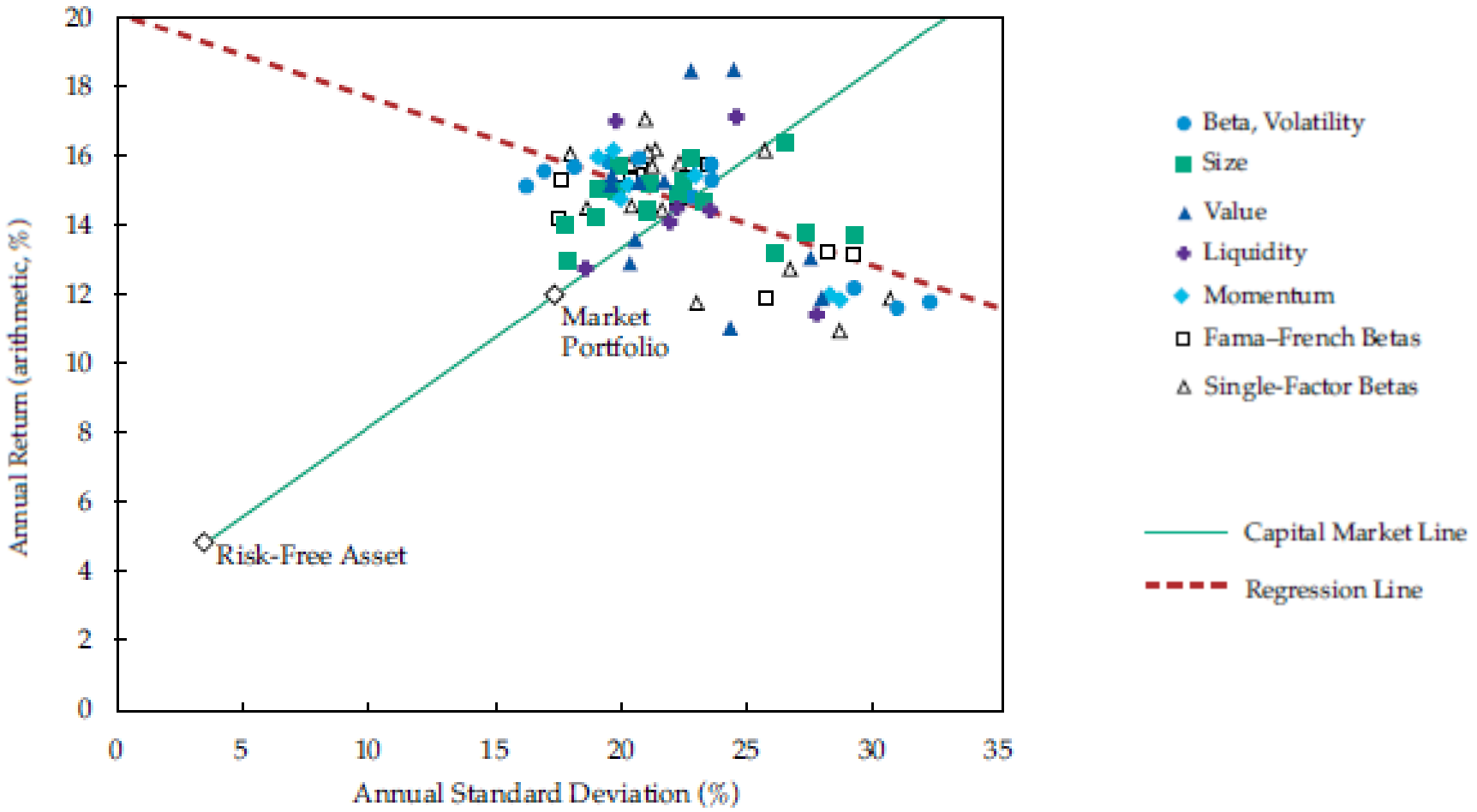
Ibbotson, Idzorek, Kaplan, and Xiong (2018)

Figure 2.2. Risk and Return for Factor-Based Equity Portfolios, 1972–2016



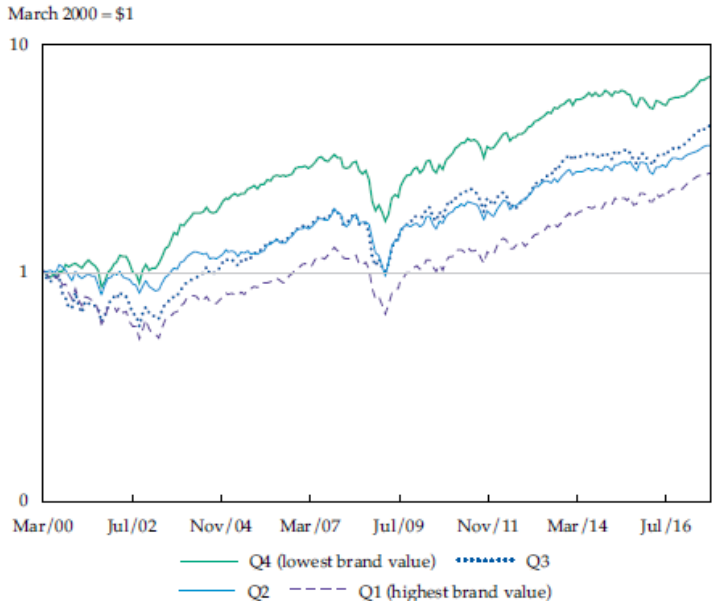
Sources: Ibbotson and Kim (2017); Ibbotson (2018).

Our Journey to The Popularity Asset Pricing Model

Ibbotson, Idzorek, Kaplan, and Xiong (2018)

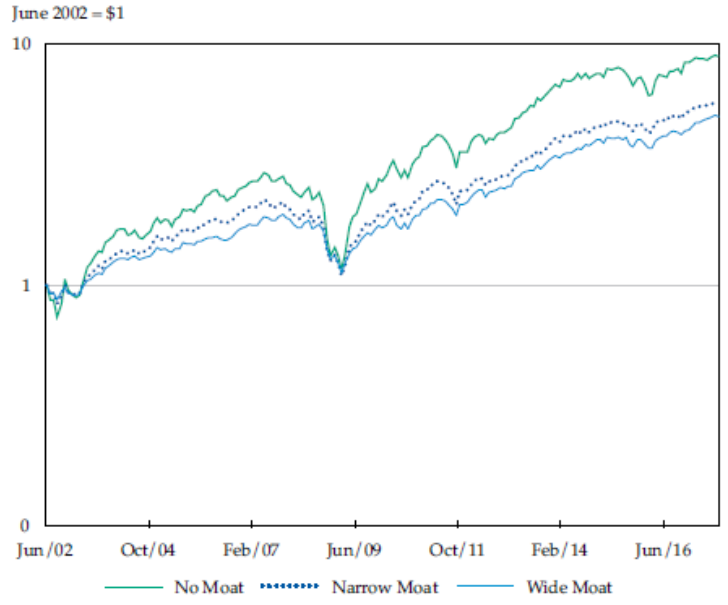
Weakest Brands do Best

Figure 6.1. Growth of $1 for Equally Weighted Quartiles Based on Interbrand's BV Rankings, April 2000–August 2017 (log scale)



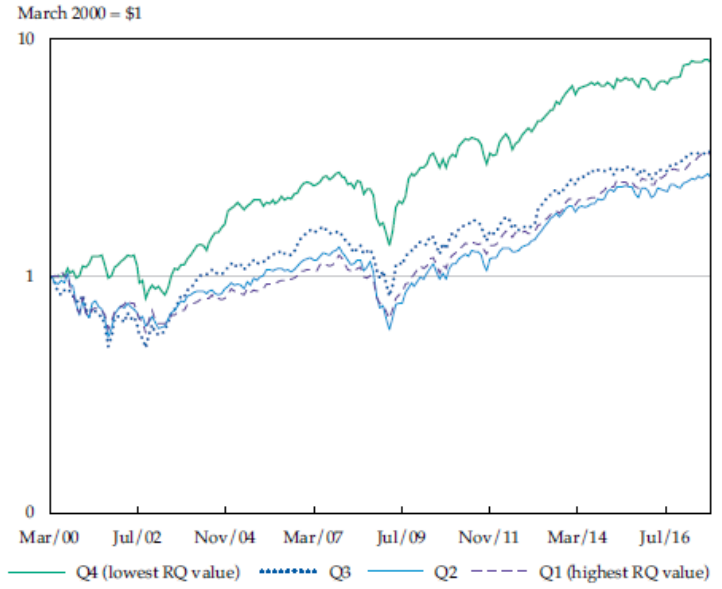
Lack of Competitive Advantage do Best

Figure 6.3. Growth of $1 for the Three Equally Weighted Portfolios Based on Morningstar Economic Moat Ratings, July 2002–August 2017 (log scale)



Worst Reputations do Best

Figure 6.4. Growth of $1 for the Equally Weighted Quartile Portfolios Based on Harris Poll RQs, April 2000–August 2017 (log scale)



Our Journey to The Popularity Asset Pricing Model

Fama and French (2007)

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www.elsevier.com/locate/jfec

Disagreement, tastes, and asset prices ☆

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Abstract

Standard asset pricing models assume that: (i) there is complete agreement among investors about probability distributions of future payoffs on assets; and (ii) investors choose asset holdings based solely on anticipated payoffs; that is, investment assets are not also consumption goods. Both assumptions are unrealistic. We provide a simple framework for studying how disagreement and tastes for assets as consumption goods can affect asset prices.

JEL classifications: G12; G11

Keywords: Asset pricing; Disagreement; Tastes

1. Introduction

Standard asset pricing models, like the capital asset pricing model (CAPM) of Sharpe (1964) and Lintner (1965), Merton's (1973) intertemporal CAPM (the ICAPM), and the consumption-based model of Lucas (1978) and Breeden (1979), share the complete agreement assumption: all investors know the true joint distribution of asset payoffs. The assumption is unrealistic, and there are two strands of research that relax it.

☆We are grateful for the comments of John Cochrane, Kent Daniel, Thomas Knox, Tobias Moskowitz, René Stulz, Richard Thaler, Joel Vanden, participants in the NBER Behavioral Finance workshop, and two anonymous referees.
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- In "Disagreement, Tastes, and Asset Prices," Fama and French argue that the assumptions of standard asset pricing models, such as the Capital Asset Pricing Model (CAPM), are unrealistic and that both 'disagreement' and 'tastes' affect asset pricing.

- While FF identify two key ingredients that should be part of an asset pricing model – disagreement and tastes – FF FAIL TO DEVELOP SUCH A MODEL!

Our Journey to The Popularity Asset Pricing Model

Fama and French (2007)

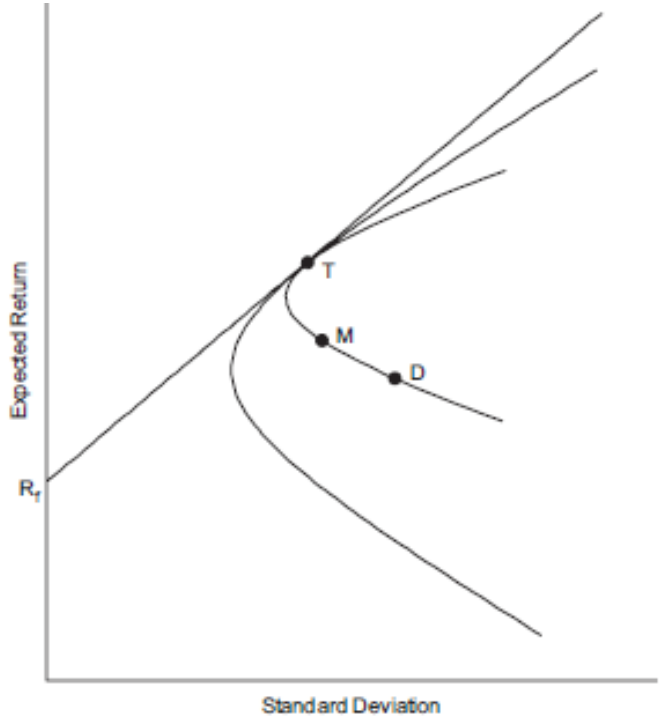

Fig 1. Investment opportunities including T, the tangency portfolio linking the risk-free return, R_f, and the minimum-variance frontier; D, the aggregate of the portfolios held by misinformed investors; and M, the market portfolio, which is the value-weight combination of T and D.

- This is the key illustration from FF 2007.
- They consider two scenarios, each with a pair of opposite investors, based on Disagreement and Tastes:

  Informed Investor vs. Misinformed Investor

  Investor with Tastes vs. Investor without Tastes

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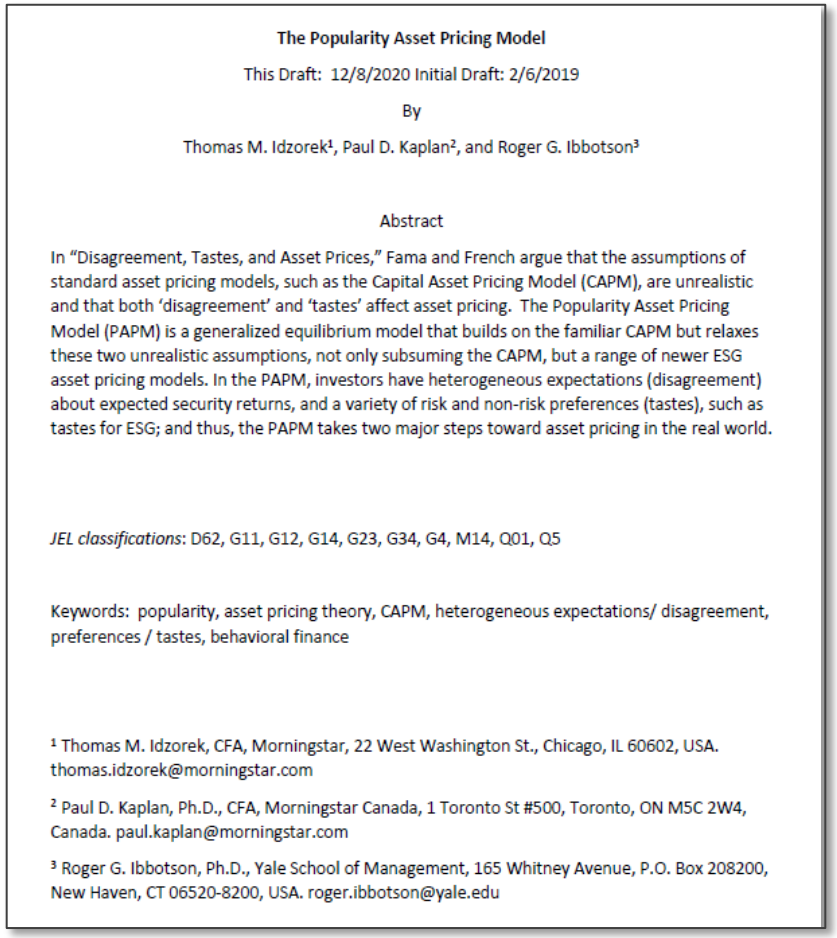

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The Popularity Asset Pricing Model

Contrasting PAPM with CAPM

- The PAPM is a generalization of the CAPM, presented in the CAPM equilibrium framework
- Securities have multiple risk and non-risk characteristics, which investors may like/dislike individually and/or in aggregate
  - Any characteristic liked/disliked in aggregate is priced, e.g. risk, liquidity, brand preference
- Expected security returns are the weighted average of investor (heterogeneous) expectations
  - Weighted by investor wealth (+) and risk aversion (-)
  - Some investors are more skilled than others, often leading to aggregate mispricing

The Popularity Asset Pricing Model

CAPM vs. PAPM (Both with Heterogeneous Expectations)

	CAPM	PAPM
Assumptions		
Expectations	Homogeneous ⚠	Homogeneous ⚠
Borrow/Lend	@Riskless Rate	@Riskless Rate
Adverse to	Risk	Multiple risk and non risk characteristics
Taxes, Transaction costs, etc.	Ignored	Included as characteristics
Conclusions		
Market Portfolio	Max Sharpe Ratio ⚠	Not max Sharpe Ratio
Investor Holdings	Market + Risk Free L/S ⚠	MVO portfolio
Security Expected Excess Returns	Proportional to systematic risk (Beta) and market risk premium	Linear function of beta and popularity loadings on security characteristics premiums

⚠ Does not hold with Heterogeneous Expectations

The Popularity Asset Pricing Model

Contrasting the PAPM with other Heterogeneous Models

- The PAPM is closely linked to Lintner (1969) who aggregates investor demand for securities (in price space) with heterogeneous expectations weighted by investor wealth(+), expectation uncertainty(-), and risk aversion(-).

- Williams (1977), Grossman and Stigletz (1980), Diamond and Verrecchia (1981) and others assume rationality and observed prices to arrive at non-fully revealing equilibriums.

- Behavioral models (like PAPM) do not assume complete rationality, with numerous papers assuming particular behavioral biases, e.g. Shefrin and Statman (1994), Barberis, Greenwood, Jin, and Schleifer (2015), Luo and Subrahmanyam (2019).

- The PAPM is not constrained by rationality and is a far simpler and more open framework than many of the other more specified behavioral models

The Popularity Asset Pricing Model

CAPM Heterogeneous Investor *i*'s Problem

$$\max_{\vec{x}_i} U_i(\vec{x}_i) = \vec{\mu}_i{}'\vec{x}_i - \frac{\lambda_i}{2}\vec{x}_i{}'\Psi\vec{x}_i \qquad (1)$$

where

n	= the number of risky securities in the market
$\vec{\mu}_i$	= the n-element vector of expected security returns in excess of the risk-free rate, reflecting investor i's views
Ψ	= the $n \times n$ variance-covariance matrix of returns on the risky securities
$\vec{x}_i$	= the n-element vector of investor i's allocations (portfolio weights) to the risky securities with the remainder going into a long / short position in the risk-free asset
λ_i	= the risk aversion parameter of investor i

Securities include a riskless asset and expected returns are expressed in excess of the riskless rate

The Popularity Asset Pricing Model

Security Weighted Average Excess Returns with Heterogeneous Expectations

The PAPM is a generalization of the CAPM, presented in the CAPM equilibrium. The security excess returns in the aggregate market $\vec{\boldsymbol{\mu}}_M$ reflect the weighted average of investor wealth w_i and risk aversion λ_i

$$\lambda_M = \frac{1}{\sum_{i=1}^{m} \frac{w_i}{\lambda_i}} \tag{4}$$

$$\vec{\boldsymbol{\mu}}_M = \lambda_M \sum_{i=1}^{m} \frac{w_i}{\lambda_i} \vec{\boldsymbol{\mu}}_i \tag{5}$$

$$\vec{\boldsymbol{x}}_M = \sum_{i=1}^{m} w_i \vec{\boldsymbol{x}}_i \tag{6}$$

where m is the number of investors and w_i is the fraction of wealth owned by investor *i*

The Popularity Asset Pricing Model

PAPM Heterogeneous Investor *i*'s Problem

$$\max_{\vec{x}_i} U_i(\vec{x}_i) = \vec{\mu}_i{}'\vec{x}_i + \vec{\phi}_i{}'\boldsymbol{C}'\vec{x}_i - \frac{\lambda_i}{2}\vec{x}_i{}'\boldsymbol{\Psi}\vec{x}_i \qquad (15)$$

where

p = the number of popularity characteristics

$\boldsymbol{C}$ = $n \times p$ matrix of characteristic exposures of the securities

$\vec{\phi}_i$ = p-element vector of investor i's attitudes toward the characteristics (The elements can be positive, negative, or zero.)

The Popularity Asset Pricing Model

Differences in Investor Holdings

$$\vec{x}_i = \frac{\lambda_M}{\lambda_i}\vec{x}_M + \frac{1}{\lambda_i}\boldsymbol{\Psi}^{-1}\left[(\vec{\mu}_i - \vec{\mu}_M) + \boldsymbol{C}\left(\vec{\phi}_i - \vec{\pi}\right)\right] \qquad (20)$$

Each investor i portfolio differs from the market portfolio due to differences in:

- Risk aversion
- Expected security excess returns relative to the market's expected security excess returns
- Preferences for the security characteristics relative to the aggregate market premiums

The Popularity Asset Pricing Model

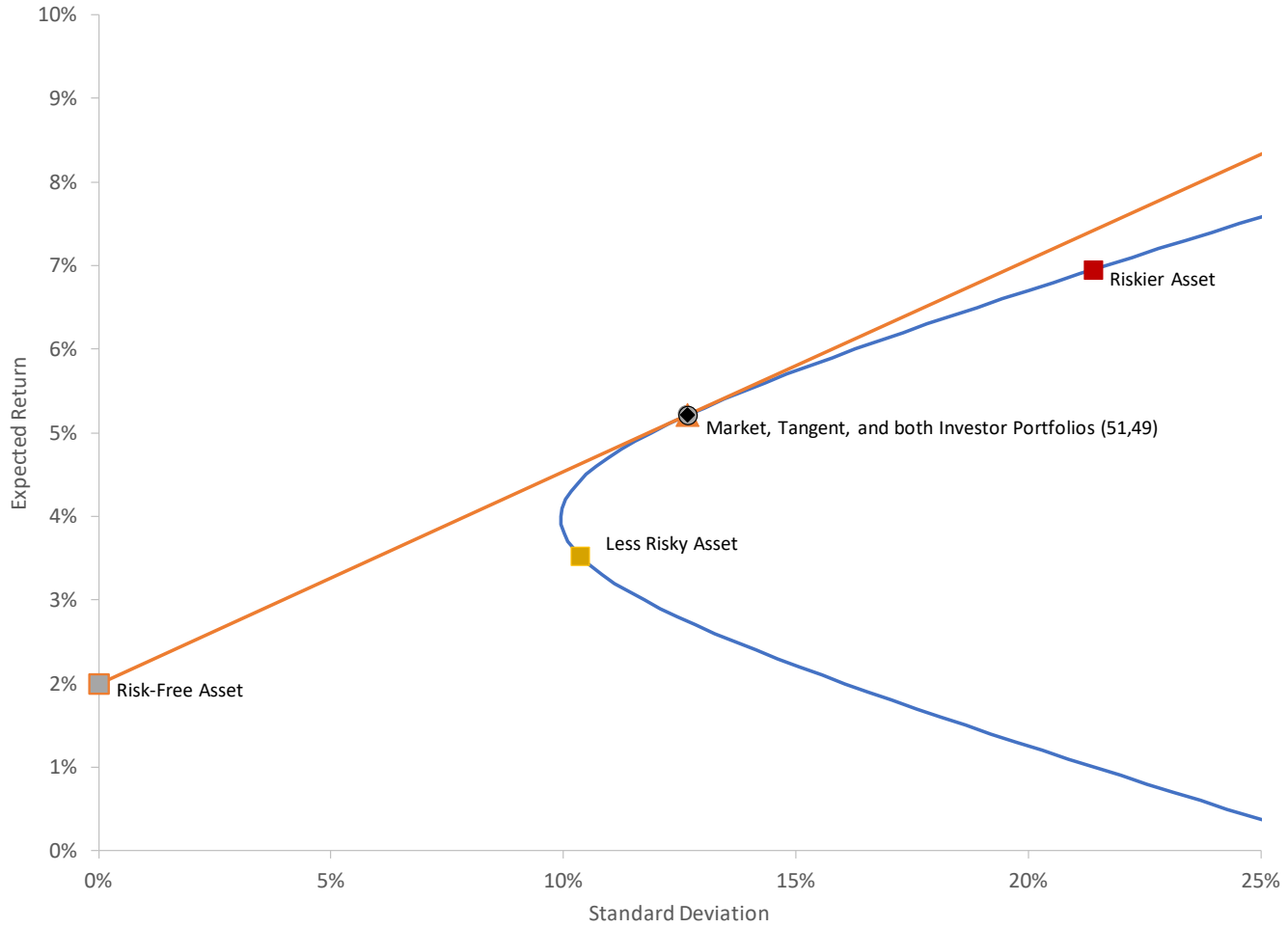
The Aggregate Expected Security Excess Returns

$$\vec{\mu}_M = \vec{\beta}\mu_M + \left(\vec{\beta}\vec{c}'_M - \boldsymbol{C}\right)\vec{\pi} \qquad (24)$$

- Each security has an aggregate expected excess return (weighted by wealth and risk aversion) that differs from the CAPM expected excess return due to popularity effects.
- There is a popularity effect for each of the *p* characteristics.
- For each security, the popularity effect is the product of
  - The security-specific popularity loadings $\left(\vec{\beta}\vec{c}'_M - \boldsymbol{C}\right)$
  - The characteristic-specific popularity premiums $\vec{\pi}$

The Popularity Asset Pricing Model

Figure 1. CAPM (No Disagreement and No Preferences / Tastes)

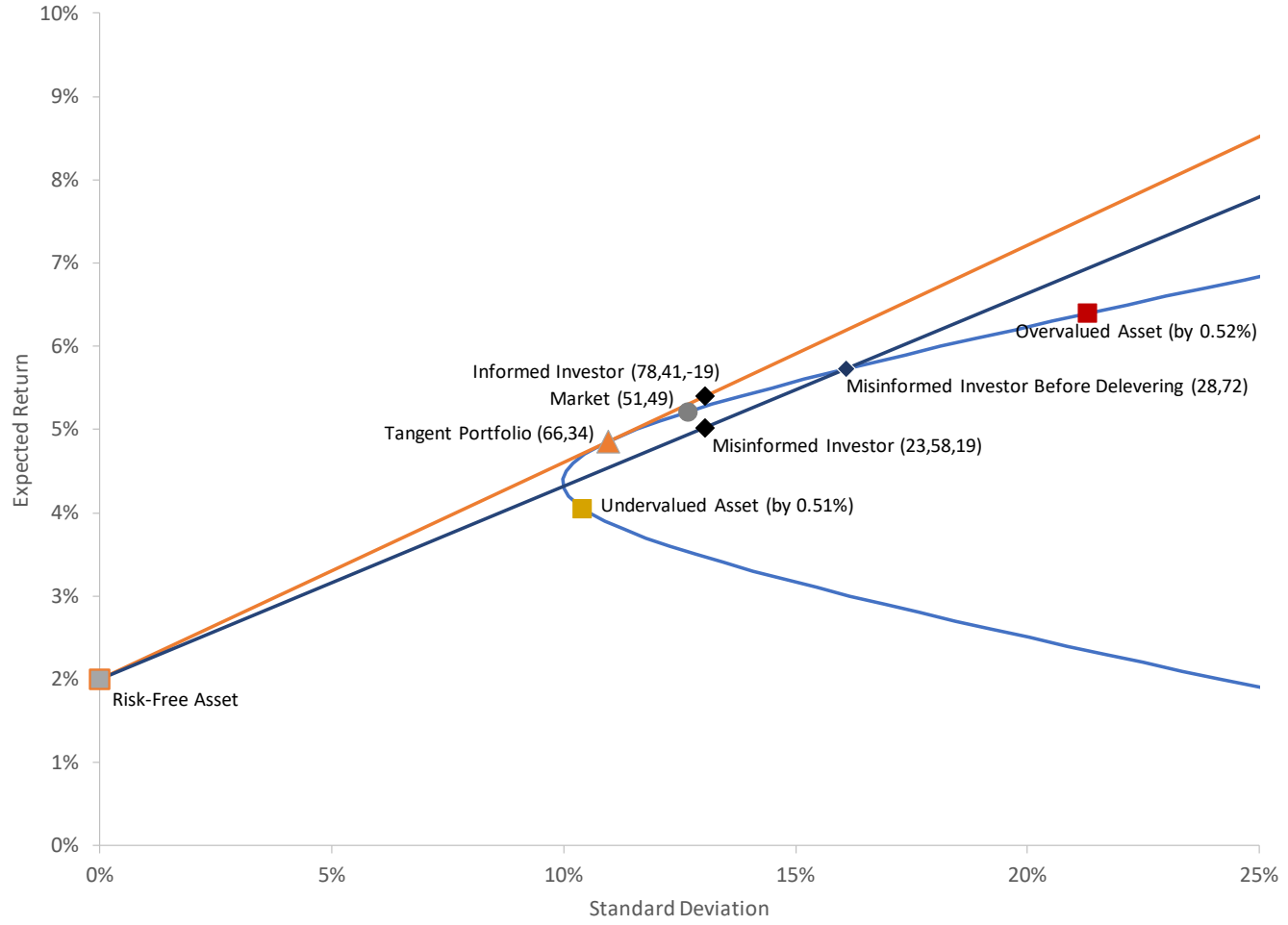


- 2 assets
- 2 investors
- Market is efficient

Fig. 1. The CAPM with two risky assets and two investors. The market portfolio and tangent portfolio are the same and both investors hold the market / tangent portfolio.

The Popularity Asset Pricing Model

Figure 2. CAPM with Heterogeneous Expectations (Disagreement) | Informed View

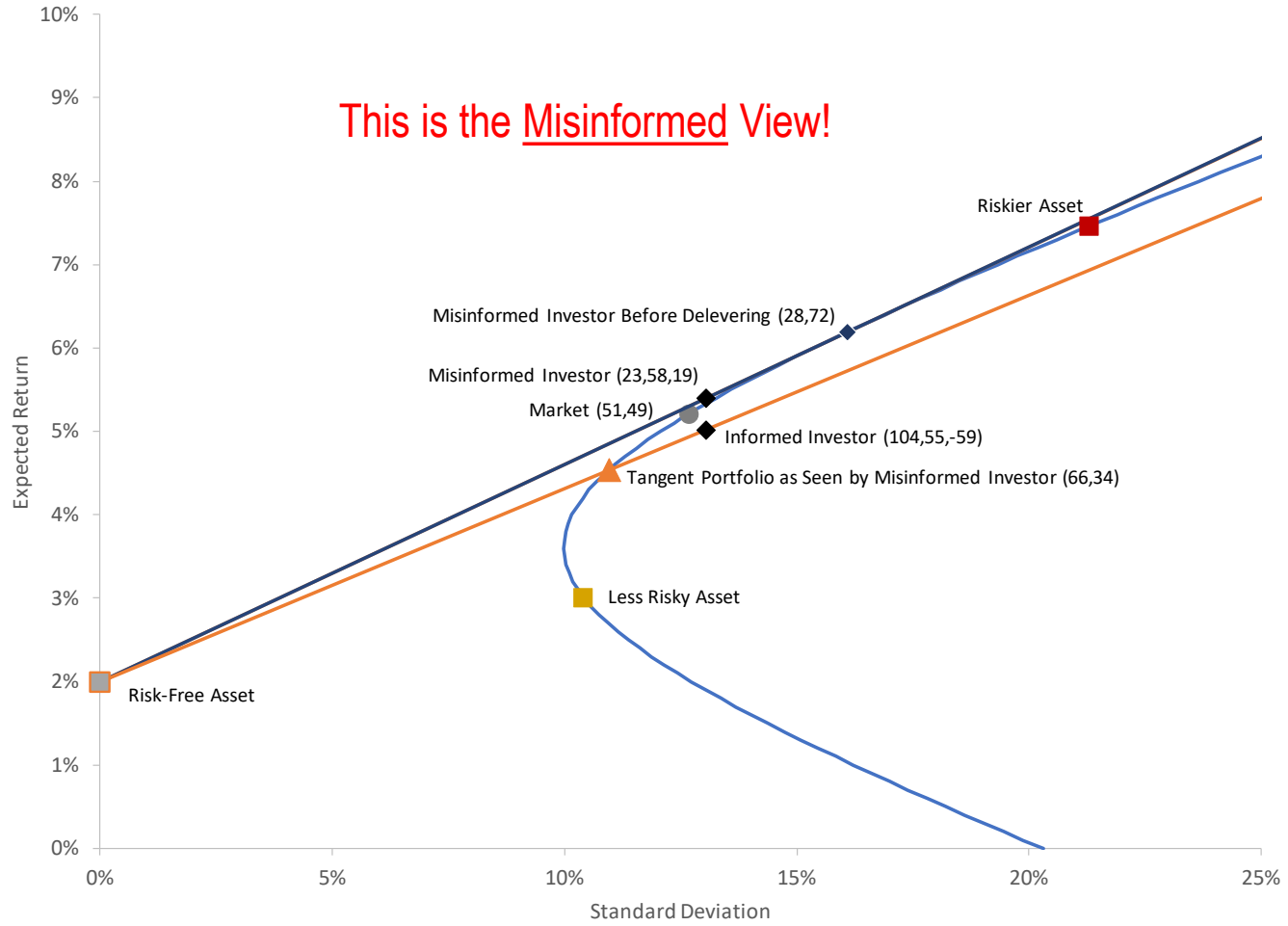


- 2 assets
- 2 investors
- Market is no longer efficient
- Informed investor levers the correct tangent portfolio
- Misinformed investor delevers what they think is the tangent portfolio

Fig. 2. The correct view of the informed investor in a world with two risky assets and two investors: an informed investor and a misinformed investor. Based on their respective expectations, both investors estimate the composition of the tangent portfolio, but reach different conclusions. The investors lever and delever their respective-estimated tangent portfolios based on their risk aversion preferences. The market portfolio and true tangent portfolio are not the same. The holdings of each investor are shown in the parentheses (undervalued asset, overvalued asset, riskless asset).

The Popularity Asset Pricing Model

Figure 3. CAPM with Heterogeneous Expectations (Disagreement) | Misinformed View

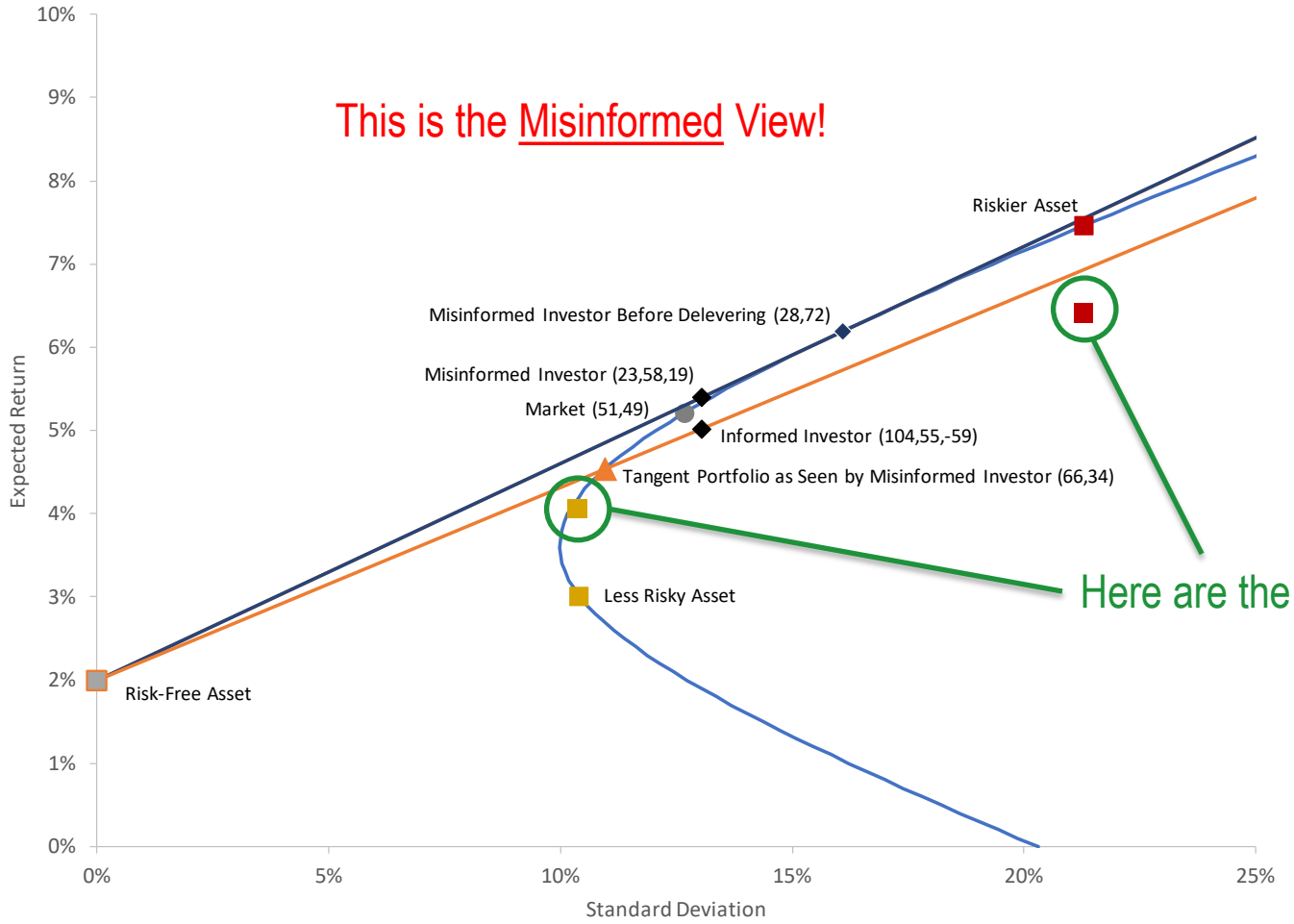


- 2 assets
- 2 investors
- Market is no longer efficient
- Informed investor levers the correct tangent portfolio
- Misinformed investor delevers what they think is the tangent portfolio

Fig. 3. The incorrect view of the uninformed investor in a world with two risky assets and two investors: an informed investor and a misinformed investor. Based on their respective expectations, both investors estimate the composition of the tangent portfolio, but reach different conclusions. They lever and delever their respectively-estimated tangent portfolio based on their risk aversion preference. The market portfolio and true tangent portfolio are not the same.

The Popularity Asset Pricing Model

Figure 3. CAPM with Heterogeneous Expectations (Disagreement) | Misinformed View

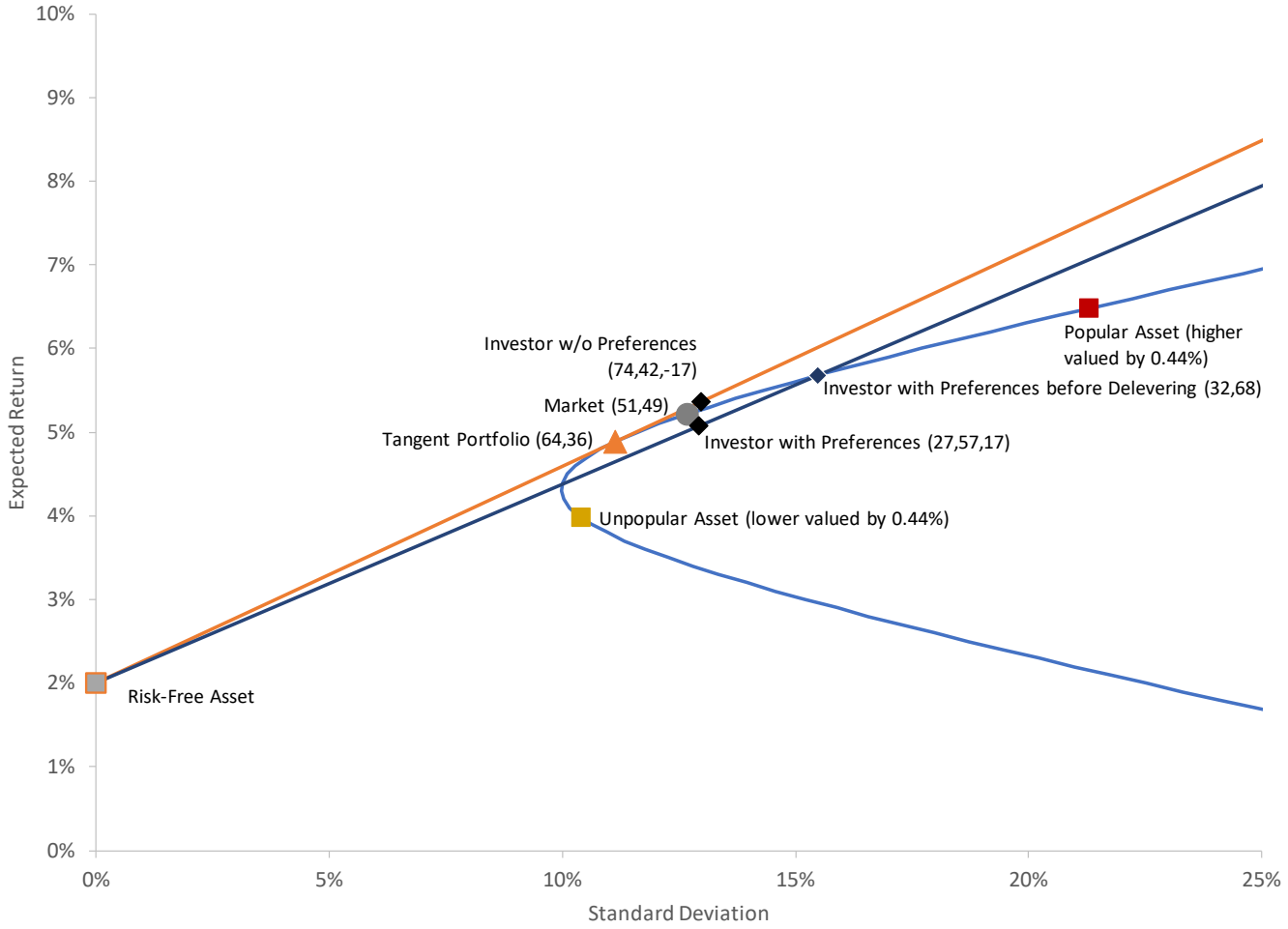


- 2 assets
- 2 investors
- Market is no longer efficient
- Informed investor levers the correct tangent portfolio
- Misinformed investor delevers what they think is the tangent portfolio

Fig. 3. The incorrect view of the uninformed investor in a world with two risky assets and two investors: an informed investor and a misinformed investor. Based on their respective expectations, both investors estimate the composition of the tangent portfolio, but reach different conclusions. They lever and delever their respectively-estimated tangent portfolio based on their risk aversion preference. The market portfolio and true tangent portfolio are not the same.

The Popularity Asset Pricing Model

Figure 4. PAPM with Homogeneous Expectations (No Disagreement) and Preferences / Tastes



- 2 assets
- 2 investors
- Market is no longer efficient
- The Investor with Tastes prefers the Popular asset and knowingly builds an inefficient portfolio
- The Investor without Tastes levers the tangent portfolio

Fig. 4. The correct view (shared by both investors) in a world with two risky assets and two investors: one with no preferences / tastes and one with preferences / tastes. Both investors agree on the composition of the tangent portfolio, although the investor with a preference for the characteristic holds a delevered position in a portfolio that largely consists of the riskier popular asset. The investor without preferences / tastes levers the tangent portfolio, which largely consists of the less risky unpopular asset. The market portfolio and true tangent portfolio are not the same.

The Popularity Asset Pricing Model

Heterogeneous Expectations (Disagreement) and Preferences / Tastes

Investor 1: Informed investor with *no* preferences / tastes (25% of wealth)

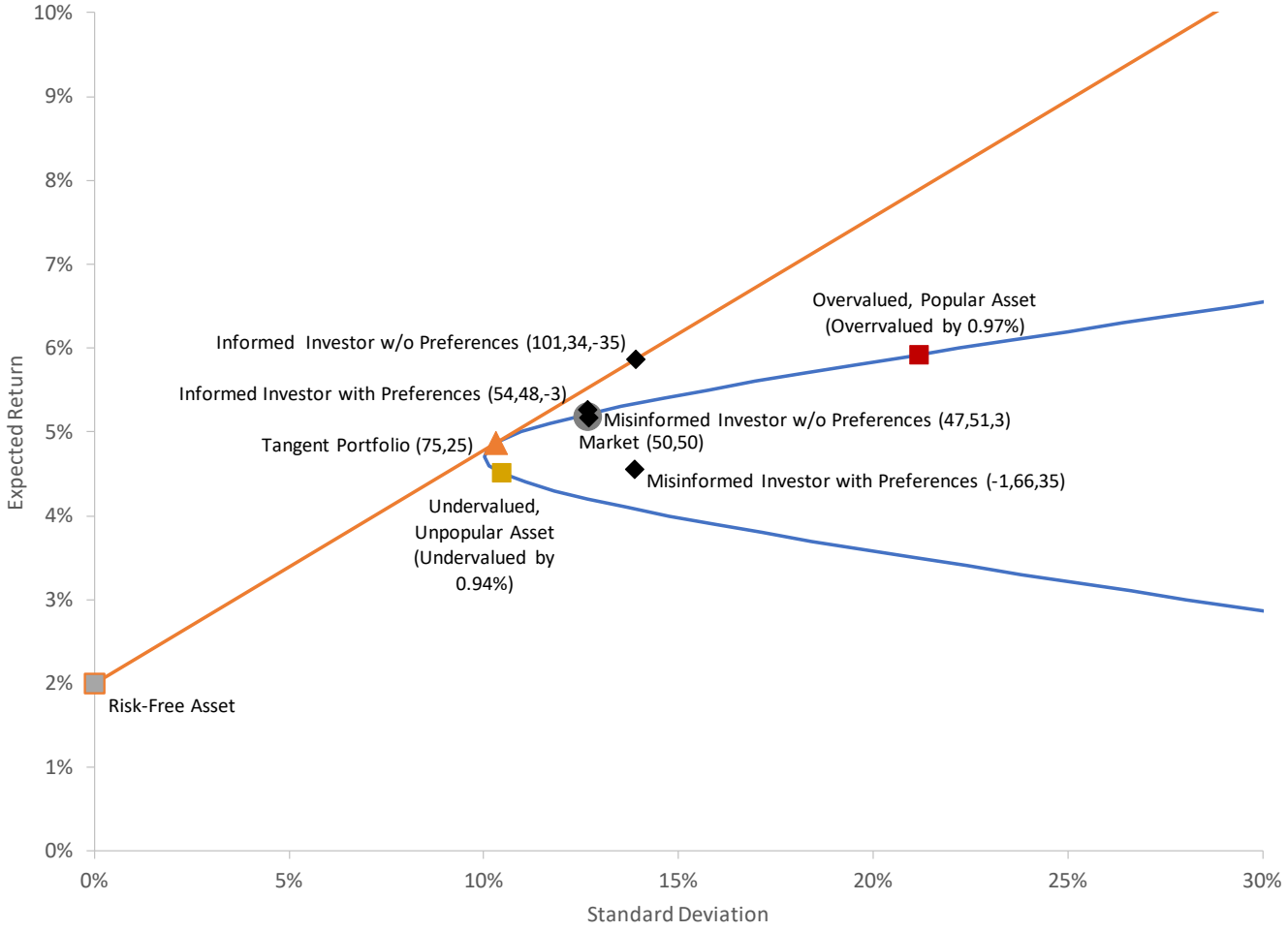
Investor 2: Informed investor with preferences / tastes (25% of wealth)

Investor 3: Misinformed investor with *no* preferences / tastes (25% of wealth)

Investor 4: Misinformed investor with preferences / tastes (25% of wealth)

The Popularity Asset Pricing Model

Figure 5. PAPM with Heterogeneous Expectations (Disagreement) and Tastes



- 2 assets
- 4 investors
- Market is no longer efficient
- #1 Informed Investor w/o Tastes levers true tangent portfolio
- #2 Informed Investor with Tastes *knowingly* invests in an inefficient portfolio tilted toward popular asset
- #3 Misinformed Investor w/o Tastes unknowingly invests in an inefficient portfolio
- #4 Misinformed Investor with Tastes underperforms for 2 reasons

Fig. 5. The correct view of the world with two risky assets and four investors: Investor 1: an informed investor with no preferences / tastes; Investor 2: an informed investor with preferences / tastes; Investor 3: a misinformed investor with no preferences / tastes; and, Investor 4: a misinformed investor with preferences / tastes. Investor 1 holds a levered position in the true tangent portfolio. Investors 2 and 3 hold a portfolio similar to the market portfolio, but for different reasons (preferences / tastes vs. misinformation). Investor 4 is misinformed, has preferences / tastes, and arrives at a portfolio that is substantially suboptimal relative to the tangent portfolio. The market portfolio and true tangent portfolio are not the same.

The Popularity Asset Pricing Model

Table 4. Sharpe Ratios, Betas, and Jensen's Alphas of Portfolios Resulting from Disagreement and Preferences / Tastes

	Tangent Portfolio	Market Portfolio	Investor 1 (Informed / No Tastes)	Investor 2 (Informed / With Tastes)	Investor 3 (Misinformed / No Tastes)	Investor 4 (Misinformed / With Tastes)
Sharpe Ratio	0.278	0.254	0.278	0.257	0.250	0.184
Beta	0.74	1.00	1.00	1.00	1.00	1.00
Jensen's Alpha	0.48%	0.00%	0.65%	0.05%	-0.05%	-0.65%

The Sharpe Ratio, Beta, and Jensen's alpha for the tangent portfolio; market portfolio; the portfolio of the informed investor 1 with no preferences / tastes; the portfolio of the informed investor 2 with preferences / tastes; the portfolio of the misinformed investor 3 with no preferences / tastes; and, the portfolio of a misinformed investor 4 with preferences / tastes in a world with two risky assets and four investors. The market portfolio is the aggregate of the four investors' portfolios. With the exception of the tangent portfolio, in this illustration all the portfolios have a beta indistinguishable from 1.00 relative to the market portfolio, thus enabling us to focus on departures from the CAPM. The informed investor with no preferences / tastes levers the tangent portfolio and thus has the same Sharpe Ratio as the tangent portfolio. The positive Jensen's alphas of the portfolios of the informed investors (1 & 2) are offset by the negative Jensen's alphas of the portfolios of the misinformed investors (3 & 4) and the Jensen's alpha of the market portfolio is zero. The differences in portfolios and their portfolio statistics are due to both disagreement and preferences / tastes.

The Popularity Asset Pricing Model

Introducing a Pseudo-Arbitrager

Investor 1: Informed investor with *no* preferences / tastes (24% of wealth)

Investor 2: Informed investor with preferences / tastes (24% of wealth)

Investor 3: Misinformed investor with *no* preferences / tastes (24% of wealth)

Investor 4: Misinformed investor with preferences / tastes (24% of wealth)

Investor 5: Pseudo-Arbitrager w/varying Levels of Risk Aversion (4% of wealth)

The Popularity Asset Pricing Model

Figure 6. Impact of Investor 5's Risk Aversion on Pricing

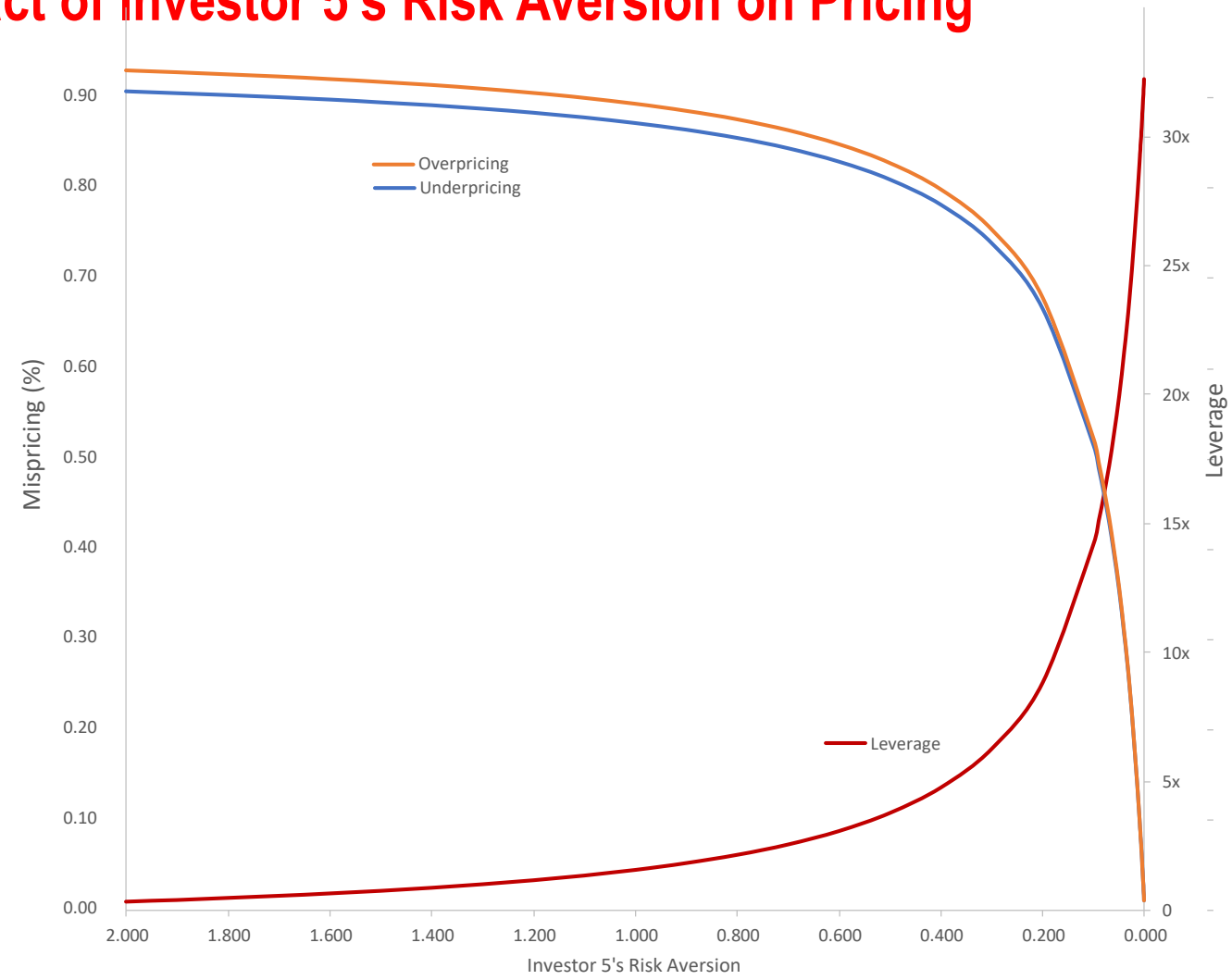


Fig. 6. We solve the PAPM for a range of different risk aversion coefficients for Investor 5: from 2.0 to near 0.0. The closer the risk aversion coefficient (x-axis) is to zero, the degree to which the two assets are mispriced approaches zero asymptotically (left side y-axis) and the amount of leverage increases (right side y-axis).

The Popularity Asset Pricing Model

Conclusions from the PAPM Paper (Prior to ESG Example)

- **PAPM** is a generalization of **CAPM,** relaxing assumptions allowing for heterogeneous investor:
  - Expectations (opinions) with potential mispricing
  - Multiple preferences for risk and non-risk characteristics

- Security expected returns reflect the weighted average of investor expectations, weighted by investor wealth, risk aversion, and preferences.

- **Popularity** provides a bridge between Classical (rational) and Behavioral (irrational) Finance combining investor heterogeneous opinions and preferences.

An ESG Application of the Popularity Asset Pricing Model

Kaplan (2021)

Strategies

The Two Sides of ESG Investing

How pecuniary and nonpecuniary ESG can affect the way investors form portfolios.

QUANT U

Paul D. Kaplan

Environmental, social, and governance factors are being greatly emphasized in investing these days. Unfortunately, there is some confusion about what it means to incorporate ESG into the investment process. This is because there are two sides of ESG that must be kept distinct when building a portfolio:

1 **Pecuniary ESG** This is the impact that ESG factors have on the risk and expected return of securities issued by a company.[1]

2 **Nonpecuniary ESG** This is the impact that ESG factors have on how desirable investors find securities apart from risk and expected return. For example, investors may prefer stocks issued by green companies because of their personal values and concerns about the environment.[2]

In this issue of Quant U, I present a framework for understanding how both pecuniary and nonpecuniary ESG can have an impact on how investors form portfolios in an equilibrium[3] setting using an ESG-specific version of the popularity asset pricing model, or PAPM, which I have discussed in previous issues of *Morningstar* magazine.[4] The model I present here is similar to one in the academic literature on ESG.[5]

Equilibrium with Pecuniary ESG Views and No Nonpecuniary Preferences

According the PAPM, investors can form portfolios based on pecuniary factors (risk and expected return) and possibly any number of nonpecuniary factors. Furthermore, investors can have different views regarding pecuniary factors. In the ESG version of the PAPM I discuss here, I assume that investors have one of two pecuniary views: ESG-unaware and ESG-aware.[6] For now, I assume that no investors have nonpecuniary preferences, but I will introduce those who do into the model later.

To model the impact of investors having different ESG views, I formed a simple model in which there are two stocks (ESG-positive and ESG-negative) and two investors (ESG-unaware and ESG-aware).

The PAPM is an extension and generalization of the capital asset pricing model, or CAPM.[7] Both the CAPM and the PAPM are single-period models in which investors trade securities (stocks and cash) at the beginning of the period and receive the payouts of the stocks at the end of the period. In the ESG-unaware view, I assume that the two stocks have the same *expected* payout but differ in the standard deviations of their payouts as well as in their systematic risks (betas). I assume that the ESG-positive stock has both greater total and systematic risk, so that it is both riskier and has a greater expected return than the ESG-negative stock.

I assume that the ESG-positive stock is issued by a company with good ESG practices that contribute to its expected payout being greater than that in the ESG-unaware view. Similarly, I assume that the ESG-negative stock is issued by a company with poor ESG practices that contribute to its expected payout being less than that in the ESG-unaware view. The ESG-aware view takes the ESG practices of both companies into account, while the ESG-unaware view ignores them, leading to a less accurate estimate of expected payout. To keep the example symmetric, I subtract the same amount from the ESG-negative stock's expected payout as I add to the expected payout of the ESG-positive stock.

I assume that both investors have no nonpecuniary preferences and identical pecuniary preferences for risk and expected return (that is, the same risk tolerance). Hence, as in the CAPM, each investor seeks to maximize risk-adjusted expected return.[8] I also assume that they have equal amounts of capital.

EXHIBIT 1 shows the expected returns and standard deviations of the stocks and investor portfolios under equilibrium under both the ESG-unaware and ESG-aware views. Under both views, the ESG-positive stock has the same standard deviation but a higher expected

1 The Sustainalytics ESG Risk Rating, which is the basis for the Morningstar Sustainability Rating for Funds (the globe rating) is a pecuniary ESG rating.
2 The Sustainalytics ESG Rating, which is distinct from the ESG Risk Rating, is a pecuniary ESG rating.
3 An asset market is in equilibrium when the prices are such that the demand for each asset matches its supply. I assume this is the case throughout this article.
4 In Kaplan (2019a) and (2019b), I discuss the PAPM as presented in Ibbotson, Idzorek, Kaplan, and Xiong (2018). See also Rekenthaler (2018). In Kaplan (2019), I discuss PAPM with heterogeneous expections as presented in Idzorek, Kaplan, and Ibbotson (2020).
5 This is Pedersen, Fitzgibbons, and Pomorski (2020), hereafter PFP). PFP present a PAPM-like model with both pecuniary and nonpecuniary ESG.
6 I adopted this terminology from PFP.
7 Alternatively, we can say that the CAPM is a special case of the PAPM in which everyone has the same expectations and no additional preferences beyond risk aversion.
8 I am using risk-adjusted expected return as a descriptive term for an investor's utility function in the CAPM. This is $U(\mu,\sigma) = \mu - \frac{1}{2}\lambda\sigma^2$, where μ is the expected return of the investor's portfolio, σ is the standard deviation of return on the investor's portfolio, and λ is the investor's risk aversion coefficient.

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Influence / Motivation

- Idzorek, Thomas M., Paul D. Kaplan, and Roger G. Ibbotson. 2020. "The Popularity Asset Pricing Model." Working paper, December.
- Pedersen, Lasse Heje, Shaun Fitzgibbons, and Lukasz Pomorski. 2020. "Responsible Investing: The ESG-Efficient Frontier." *Journal of Financial Economics*.

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An ESG Application of the Popularity Asset Pricing Model

The Two Sides of ESG

- Pecuniary
  - The impact that ESG factors have on the risk and expected return of securities issues by a company.
  - Differences in views are examples of disagreements in Idzorek, Kaplan, and Ibbotson (2020), and Fama and French (2007).

- Nonpecuniary
  - The impact that ESG factors have on how desirable investors find securities apart from risk and expected return.
  - Preferences for ESG factors are example of tastes in Idzorek, Kaplan, and Ibbotson (2020), and Fama and French (2007).

An ESG Application of the Popularity Asset Pricing Model

Differences in ESG Views

- Two Investors
  - 1. ESG-Unaware. Believes the expected payoffs of both stocks are the same.
  - 2. ESG-Aware. Believes that payoff of ESG Negative stock < under Unaware view < ESG Positive stock.
  - Identical in all other respects.
- Two Stocks
  - 1. ESG Negative – Poor ESG practices lead to lower than would be otherwise expected payoff
  - 2. ESG Positive – Good ESG practices lead to higher than would be otherwise expected payoff
  - σ(Positive) > σ(Negative)
  - Payoffs of the two stocks are positively correlated.

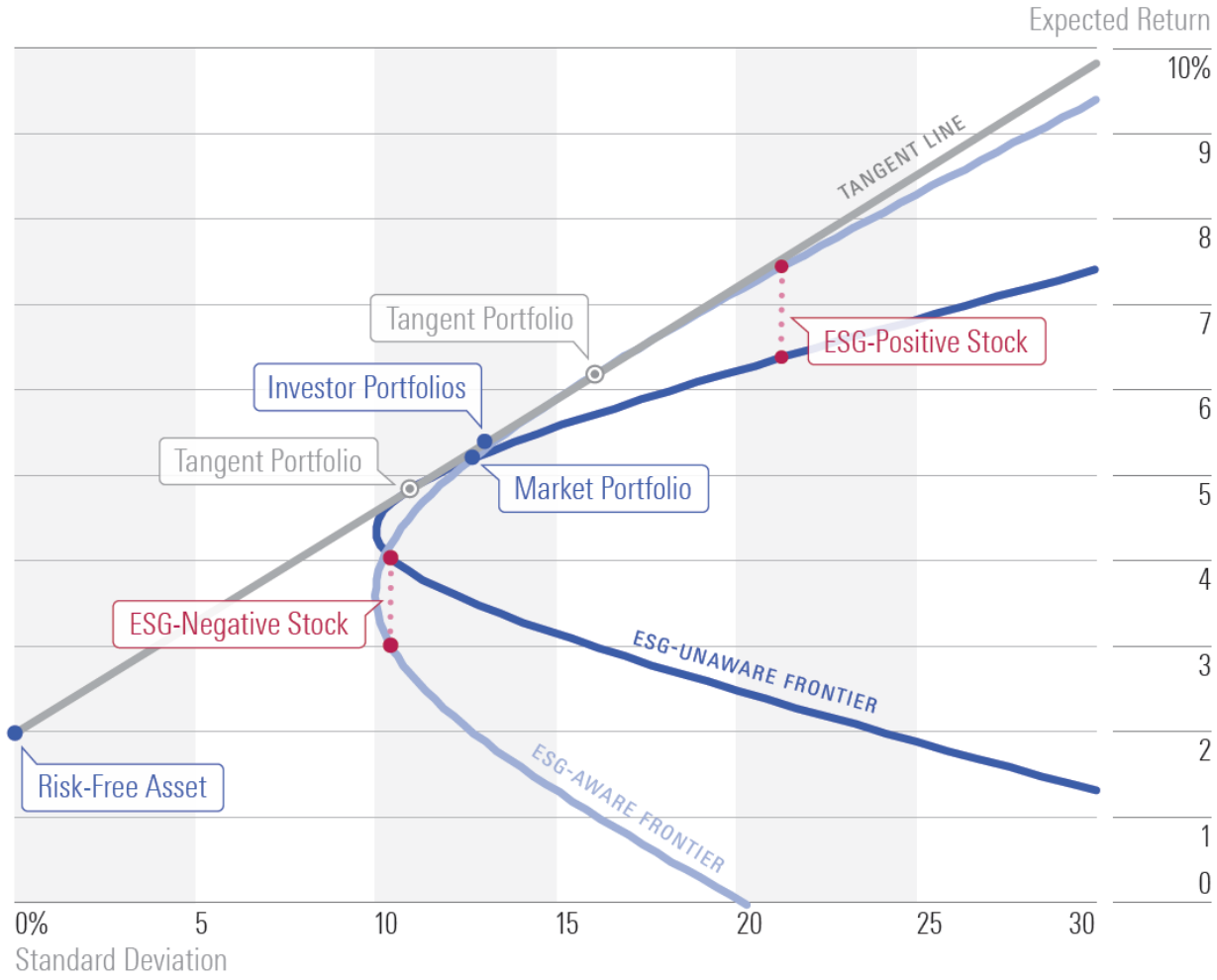
An ESG Application of the Popularity Asset Pricing Model

The Real Economy

Stock	Expected Payoff		Standard Deviation	Correlation	
	ESG-Unaware	ESG-Aware		ESG Neg.	ESG Pos.
ESG Negative	$10.00	$9.90	$1	1.0	0.2
ESG Positive	$10.00	$10.10	$2	0.2	1.0

An ESG Application of the Popularity Asset Pricing Model

Equilibrium with Different ESG Views and No Non-Pecuniary Preferences



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An ESG Application of the Popularity Asset Pricing Model

Portfolios with Different ESG Views and No Non-Pecuniary Preferences

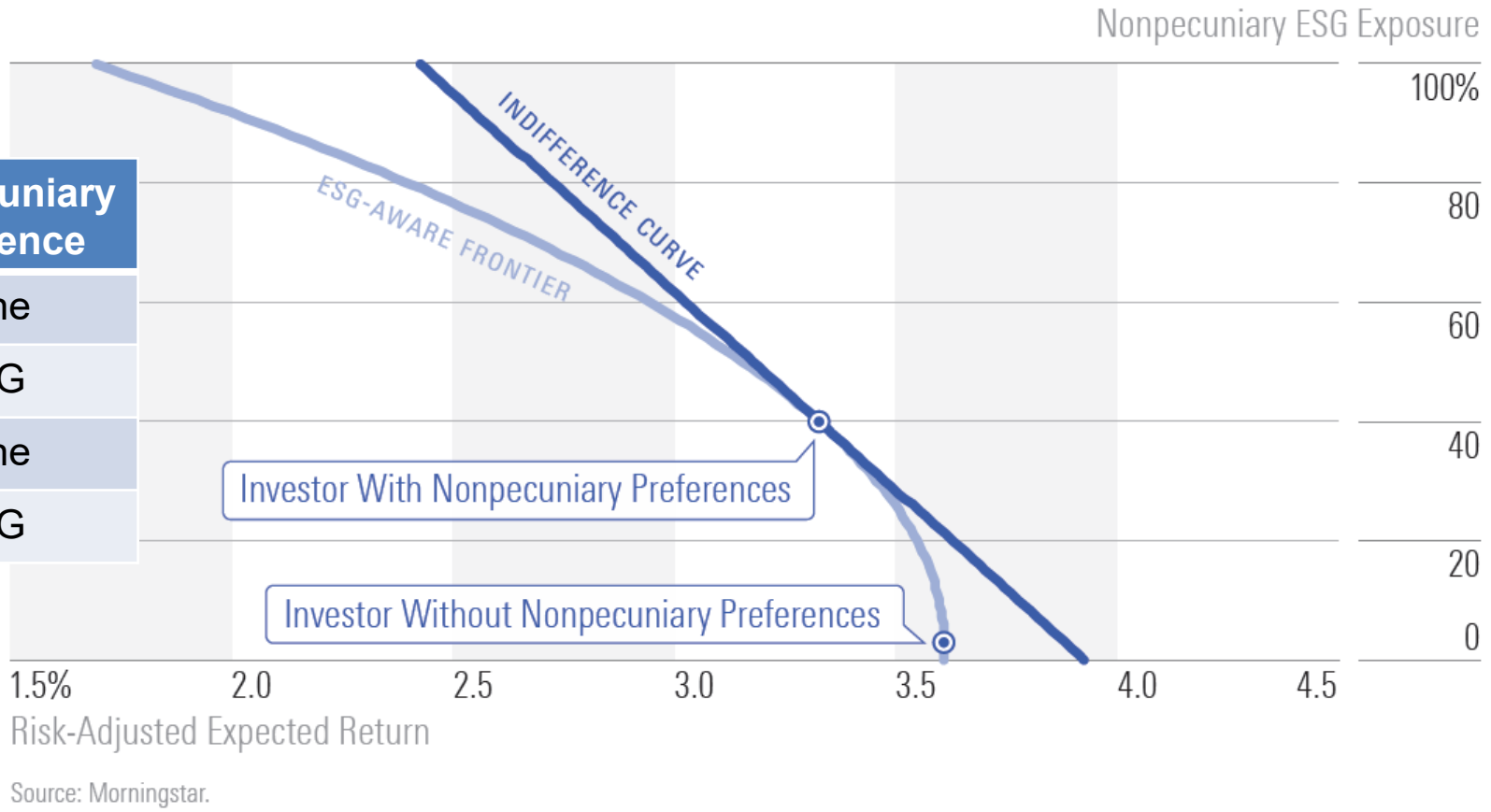
View	Portfolio	Portfolio Weights: ESG Pos. Stock (%)	Portfolio Weights: ESG Neg. Stock (%)	Cash (%)	Expected Return (%)	Standard Deviation (%)	Sharpe Ratio under ESG-Aware View
ESG-Unaware	Tangent	34.36	65.64	0.00	4.86	10.96	0.23
	Investor	40.88	78.09	–18.96	5.40	13.04	
ESG-Aware	Tangent	71.59	28.41	0.00	6.19	16.09	0.26
	Investor	58.01	23.03	18.96	5.40	13.04	
Both	Market	49.44	50.56	0.00	5.21	12.67	0.25

Source: Morningstar.

An ESG Application of the Popularity Asset Pricing Model

Introducing Non-Pecuniary Preferences

Investor	Pecuniary View	Nonpecuniary Preference
#1	ESG-Unaware	None
#2	ESG-Unaware	ESG
#3	ESG-Aware	None
#4	ESG-Aware	ESG



Source: Morningstar.

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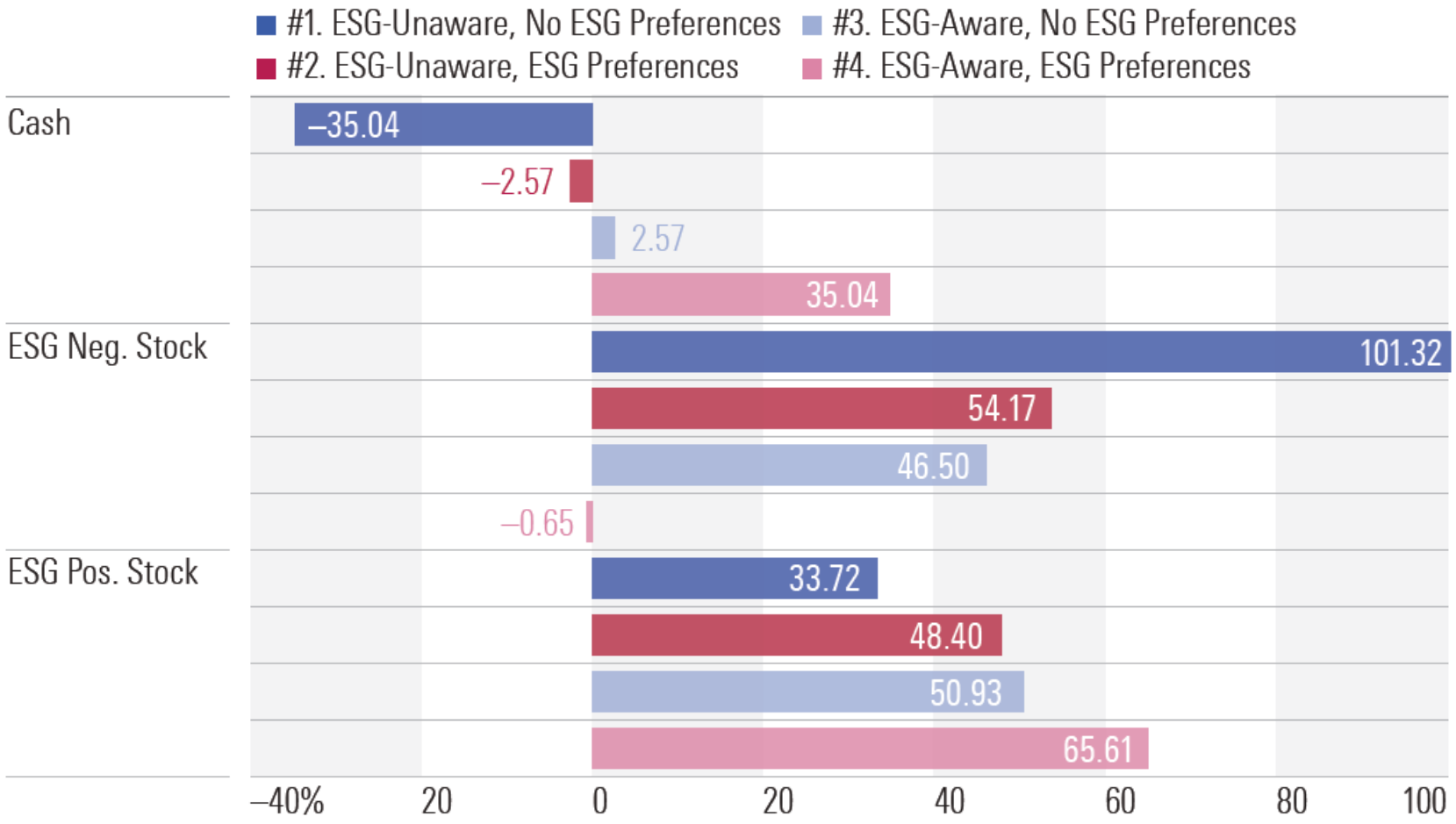
An ESG Application of the Popularity Asset Pricing Model

Investor Portfolios



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An ESG Application of the Popularity Asset Pricing Model

Conclusions

- PAPM allows for both differing economic views (disagreement) and nonpecuniary preferences (tastes).
- Well suited to address both pecuniary and nonpecuniary ESG factors.
- Addresses how both pecuniary and nonpecuniary ESG affect asset prices and investor portfolios.
- Investors who have nonpecuniary ESG preferences may face a trade-off between nonpecuniary ESG and pecuniary risk-adjusted return.
- The distinction between pecuniary ESG views and nonpecuniary ESG preferences is a key point of the ESG version of the PAPM.

Q & A