Taste, information, and asset prices: Implications for the valuation of CSR

Henry L. Friedman and Mirko S. Heinle[1]

UCLA and University of Pennsylvania

January, 2015

Abstract

Firms often undertake activities that do not necessarily increase cash flows (e.g., costly investments in corporate social responsibility, or CSR), and some investors value these non-cash activities (i.e., they have a "taste" for these activities). We develop a model to capture this phenomenon and focus on the asset-pricing implications of differences in investors' tastes for firms' activities and outputs. Our model shows that, first, investor taste differences provide a basis for investor clientele effects that are endogenously determined by the shares demanded by different types of investors. Second, because the market must clear at one price, investors' demands are influenced by all dimensions of firm output even if their preferences are only over some dimensions. Third, information releases can cause predictable changes in the ownership mix, which in turn cause the influence of risk on expected returns to depend on expectations of CSR outcomes and the like. Fourth, information quality affects managers' incentives to make cash-costly investments in non-cash activities. And fifth, the existence of investors with different tastes weakens the effects of diversification in a large market.

[1]Henry Friedman can be reached at henry.friedman@anderson.ucla.edu. Mirko Heinle can be reached at miheinle@wharton.upenn.edu. We thank workshop participants at UCLA, Wharton, Chicago (Booth), Carnegie Mellon , Minnesota, Utah, Ohio State, Maastricht, and Tilburg.

1 Introduction

The discounted cash flow (DCF) framework provides the foundation for traditional asset pricing theories and suggests that a manager can maximize the firm's stock price by maximizing the net present value of its cash flows. In other words, the amount, timing, and risk of cash flows are the main factors to consider, while the process with which cash flows are generated is relatively less important. However, firms' production processes inevitably generate externalities. Examples of these externalities include the risks of oil spills or chemical leaks, social value generated by providing small business loans or investments in underdeveloped areas, and environmental impacts of changes in production inputs. This paper explores firms' asset prices and disclosure and investment decisions when some investors value a firm's production externalities separately from its cash flows. That is, we analyze the effect of heterogenous investor tastes for the different dimensions of outputs that a firm creates. Broadly defined, production externalities could include environmental effects, corporate social responsibility (CSR), and positive or negative publicity about the firm. While investors should value a dollar of cash flows today similarly, the externalities generated by firms' investments might be valued highly by some investors and ignored by others. We use a parsimonious model in which investors differ in how they value firms' production externalities like CSR to investigate the effects of investor taste on asset prices, corporate disclosures, and costly investments affecting production externalities. To fix ideas, we focus on CSR as a motivating example. The term CSR covers many of the examples listed above and generally covers a wide array of legal and "moral" responsibilities of firms.

Investor preferences for corporate social responsibility (CSR) are becoming increasingly important to the allocation of resources. Trillions of dollars are invested in socially responsible funds that tilt their portfolios in favor of firms that act in socially responsible ways.[1]

[1] The Forum for Sustainable and Responsible Investment reports that, based on research in mid-2012, "$3.31 trillion in US-domiciled assets was held by 443 institutional investors, 272 money managers and 1,000-plus community investing institutions that select or analyze their portfolios using various ESG [environmental, community, or other societal or corporate governance] criteria." (URL: http://www.ussif.org/blog_home.asp?Display=6, accessed April 30, 2014).

Evidence suggests that public pensions and socially responsible investment (SRI) funds prefer firms with higher CSR ratings while institutional investors overall prefer firms with lower CSR ratings (Di Giuli and Kostovetsky, 2014). In this paper we develop a model to explore the asset-pricing implications of differing tastes among investors, building on Fama and French (2007). Specifically, we assume that a representative firm has a production technology that results in a stochastic dividend and an uncertain externality and that there are two types of investors. While all investors value cash flows that are paid out today similarly, only a fraction of investors values the externality, which we model as a second output dimension. Consistent with the growing interest in socially responsible investment, we primarily interpret the second dimension as CSR performance and discuss alternative interpretations of the model below.[2] In this regard, our model departs from the CSR models of Baron (2007, 2009) that focus on firms donating realized cash flows. Our model generates results concerning stock-prices, expected returns, firm's investment choices, and the effects of diversification that differ in several ways from standard pure-exchange CAPM-style models where investors' preferences are homogeneous.

Our analysis starts with a model of a pure exchange economy with a single risky asset and perfectly competitive, risk-averse investors. We assume that there are two types of investors who we label type 1 and type 2. The risky asset represents shares in a firm that generates cash and engages in CSR activities. Cash flows and CSR outcomes are uncertain, but we assume they are uncorrelated to focus on investor tastes rather than investors using CSR information to update their cash-flow expectations. Allowing for correlation between cash flows and CSR would not qualitatively affect our general results. Investors have homogeneous information but heterogeneous tastes. All investors value cash flows, but CSR activities are valued only by type-2 investors. The model features a trading round in which the price of the risky asset is established and a payout round in which the risky outcomes (e.g., a liquidating dividend and CSR performance) are realized and consumed by investors according to their

[2] Clark and Viehs (2014) provide a review of the literature on CSR and ESG, focusing on the potential effects of these on firms' financial and market performance and costs of capital.

share ownership. While we assume that type-2 investors derive utility from owning shares in socially responsible firms, similar to Fama and French (2007), we differ from Fama and French (2007) in that we assume that the utility that type-2 investors derive from these shares is not fixed but depends on the actual CSR performance.[3]

We analyze the equilibrium share price and find that mean and variance of both output dimensions are priced as long as there is a non-trivial fraction of type-2 investors participating in the market. Since we analyze a model with a continuum of heterogeneous risk-averse investors, there is no marginal investor but, instead, the shares are priced according to the weighted average of investors' preferences. In a model with a unidimensional output and heterogeneous beliefs about the expected value of the output, stock price reflects the average discounted value of expected cash flows. In our model this is not necessarily the case because the impact of expected CSR outcome on share price depends on the uncertainty about both cash flows and the CSR outcome. The reason for this result is an investor clientele (or shareholder-base) effect: a higher expected CSR outcome encourages type-2 investors to take stronger positions in the risky asset. This allows cash-flow risk to be more broadly shared but is associated with a greater fraction of market participants considering and pricing CSR risk. In other words, expected value *and* uncertainty of CSR performance affect the composition of the firm's shareholder base, and, therefore, affect risk-sharing and prices. This implies that the relation between cash flow variance and price depends on the expected CSR outcome.

We extend the model in three ways. First, we allow for two rounds of trading to investigate the expected costs of capital and returns around information releases related to both cash flows and CSR outcomes. We find that expected returns are not only affected by how much information the disclosure provides about the cash-flow and CSR outcomes *in total* but also by the amount of available information regarding cash-flows *relative* to

[3] While type-1 and type-2 investors may benefit from the firm's pro-social activities even in the absence of share ownership (e.g., lower pollution) we abstract from such welfare externalities to focus on the implications of investor tastes over investments.

information about CSR. The relative amount of information matters because *in expectation*, the composition of the firm's shareholder base changes as information about the two dimensions of firm output becomes available. The expected change in composition depends on the relative amount of risk associated with the two outputs and the amount of risk resolved as information becomes available. Specifically, a more informative CSR disclosure increases the fraction of shares held by type-2 investors. Furthermore, this effect is stronger when ex-ante expected CSR performance is higher. The reason is that type-2 investors take stronger initial positions when the expected value of CSR performance is higher, and this effect is amplified when risk associated with this output dimension is reduced, for example through a more informative CSR disclosure. Essentially, there is a mean-precision complementarity with respect to the CSR outcome.

In a second extension, we investigate how taste differences among investors affect investment decisions by a manager who seeks to maximize stock price. In other words, we examine how *individual* social responsibility leads to *corporate* social responsibility. Similar to Gollier and Pouget (2012) we allow the firm to make costly investments in CSR activities before investors trade. This could represent a firm that sacrifices expected cash flows to protect the environment.[4] We find that, not surprisingly, the firm will sacrifice more expected cash flows to boost its expected CSR outcome when more investors value the latter. Additionally, by investing in CSR, the firm can affect the composition of its shareholder base. Specifically, even though expected cash flows have no direct effect on the shareholder base, the increase in expected CSR outcomes attracts type-2 investors that crowd out holdings of type-1 investors. Taken together, the results from the baseline model and from the extension with the firm's investment decision suggest that investment in CSR and investments in a reduction of the investors' assessed CSR risk go hand in hand. Specifically, (i) a firm that has a higher expected value of CSR outcomes has an interest in decreasing investors' assessments of CSR risk (i.e., increasing the precision of its CSR disclosure) and (ii) a firm that has a low

[4] We also allow for negative investments, which capture a firm sacrificing environmental sustainability to enhance cash flows.

assessed uncertainty about CSR outcomes should have a stronger incentive to invest in CSR outcomes since a larger fraction of its shareholder base will value this investment. Notably, result (i) departs from the standard pure-exchange model with homogeneous tastes where a firm's interest in affecting investors' assessments of risk is independent of expected output. When taste differences are included this is no longer the case because a larger expected CSR outcome leads to a reduction in price for CSR risk.

In our third extension, we add a second firm to the baseline model and assume that both firms have CSR activities and cash flows. Furthermore, while we continue to assume that cash flows are not correlated with CSR outcomes, we allow for cash flows and for CSR outcomes to be correlated in the cross-section. These assumptions allow us to approximate a large economy where one risky asset represents the market portfolio and the other asset represents a firm that in a large economy is an infinitesimally small component of the market portfolio. In standard pure-exchange models like the CAPM, such a setting leads to the well-known result that the idiosyncratic risk of an individual firm is not priced and, instead, only the exposure to systematic risk affects a firm's price. In our model, this is not the case. Here the extent to which systematic risks are priced depends on the firm's idiosyncratic risk. Specifically, the idiosyncratic cash flow and CSR uncertainties jointly determine the composition of the firm's shareholder base and therefore determine how the firm's shareholder base is affected by systematic risk. Furthermore, since the expected CSR outcome affects the shareholder base composition, it also affects the extent to which systematic risks are priced.

2 Related literature

Closely related to our study, but not focusing explicitly on CSR, Fama and French (2007) show how disagreement and investor tastes (potentially driven by preferences for CSR) cause deviations from the traditional CAPM model. The deviations from traditional CAPM-pricing result from the inability to define a single market portfolio when investors with heterogeneous beliefs or preferences hold differing portfolios in equilibrium. While their results on the effects of tastes on diversification are similar to ours, they focus on situations where investors either derive a non-random utility from their share holdings or where fundamental returns influence tastes for assets. In our setting the extra taste-based utility derived from share holdings is risky, because it depends on a risky CSR outcome, and does not depend on financial returns, because we assume additively separable utility and no covariance between fundamentals and CSR. As in Fama and French (2007), our taste-based model is closely related to models featuring investors who disagree about the distributions of financial returns. We discuss this and other interpretations of our model in Section 7.2.

Our model generates results related to recent studies on the importance of information about firms' CSR activities and firms' commitments to disclosing such information. Dhaliwal et al. (2011) and Dhaliwal et al. (2012) find that CSR disclosures affect analyst following and the properties of analysts' forecasts, potentially by changing the demand for analysts indirectly through an effect on the firm's investor base. Serafeim (2014) finds that firms that integrate their reporting of financial performance and sustainability activities (i.e., a dimension of CSR) tend to experience a shift towards more long-term and less short-term institutional investors. Bénabou and Tirole (2010) discuss relations between individual and corporate social responsibility, and their potential benefits and costs to social welfare. They highlight the importance of information about CSR and how well-studied issues in financial reporting (e.g., reporting externalities, intermediaries, aggregation, and benchmarking) are also important to CSR reporting. Baron (2007, 2009) and Graff Zivin and Small (2005) present models with investors who value firms' charitable contributions or activities to mitigate externalities (termed "moral management") in a setting where investors can also contribute their own cash for similar purposes. These studies develop some results on how investor preferences for moral management can affect stock prices that relate closely to special cases of our baseline model, but the focus of these studies is generally on why and how managers choose to engage in costly CSR activities including charitable donations. Bagnoli and Watts

(2014) explicitly model uncertainty about a firm's CSR activities, providing a justification based on information asymmetry for CSR disclosures and assurance of such disclosures in a setting with both Bayesian and heuristic users of the disclosures. Their users are not necessarily investors and, as such, they do not model a capital market or pricing mechanism explicitly. In contrast, we focus on a capital market setting with symmetric information to show how information affects returns and share holdings when some investors, while rational, gain utility from CSR (e.g., due to a consumption benefit).

CSR disclosures could be related to returns because they are indirectly informative about the firm's future cash flows or because some investors intrinsically care whether a company, for example, pays a fair wage and provides acceptable working conditions to all of its employees.[5] However, Cheng et al. (2014), Clark and Viehs (2014), and Bénabou and Tirole (2010) note that the empirical evidence on the relation between CSR and corporate financial performance is mixed and inconclusive, potentially due to methodological differences. While the associations between CSR and financial performance are important, our model abstracts from such links. Our focus is instead more aligned with recent research showing that CSR activities are associated with shareholder base or clientele effects. Kim et al. (2014), for example, provides evidence that firms with higher CSR ratings have broader ownership in the sense of more institutional and individual investors holding the firm's shares. They also find that higher CSR ratings are associated with greater demand for information as reflected in Google and EDGAR search volume. Dhaliwal et al. (2011) find that firms initiating disclosure of CSR activities, who presumably have positive CSR activities to disclose, tend to attract institutional investors. Robinson et al. (2011) and Hawn and Chatterji (2014) show that the addition of a firm to the Dow Jones Sustainability Index is associated with positive abnormal returns, consistent with increased investor demand for shares of firms with positive

[5] Cheng et al. (2014) provide a concise overview of the theoretical and empirical literature linking CSR to corporate financial performance in both positive and negative ways related to CSR improving stakeholder (e.g., employee) engagement, positive product market effects of well-publicized CSR activities, private benefits to managers through CSR activities costly to shareholders, or CSR activities framed as misuses of corporate resources.

and visible CSR indicators. These findings corroborate our predictions that CSR is associated with investor holdings and that there is complementarity between firm information (about both CSR and fundamentals) and investor demand driven by CSR expectations.

In the next section we introduce the basic model that has one trading round before the risky outputs are realized. Section 4 introduces a second round of trading in the same asset after information is released but before all uncertainty is resolved. This enables us to make predictions on the expected returns of a firm without having to assume that the firm's shareholder base remains constant. Section 5 introduces an investment decision such that the firm chooses endogenously its exposure to non-fundamental risk. Section 6 introduces a second risky-asset into the pure-exchange economy and shows that the usual forces of diversification are altered in that the idiosyncratic risk of a firm affects the firm's shareholder base and, therefore, the extent to which systematic non-fundamental risk is priced. Finally, in Section 7 we discuss alternative interpretations of our model, derive implications beyond a CSR framework, and conclude.

3 The basic single-asset model

As a first step, we consider a two-period model with a single firm: in the first period investors choose portfolios and in the second period the assets in the portfolios realize value. There is one risk-free asset, money, which has a constant price and return of 1 and one risky asset, which represents ownership shares in the firm. We assume that the firm generates per-share cash flows of $\tilde{x}$ which result in a liquidating dividend. Furthermore, we express the outcome of the firm's CSR activities in dollar terms as $\tilde{y}$ per share.[6]We assume that all random

[6] We can think of the firm's shares as claims to bundled outcomes. There may be scope for an intermediary or the firm to unbundle the firm's cash flows and CSR activities and sell shares of $\tilde{x}$ and shares of $\tilde{y}$ separately. If this unbundling is costly, we expect it to be imperfect and for bundling to persist in equilibrium. For simplicity, we do not explore the possibility of unbundling here.

variables are normally distributed, with

$$E[\tilde{x}] = \bar{x},\ Var[\tilde{x}] = \sigma_x^2,$$
$$E[\tilde{y}] = \bar{y},\ Var[\tilde{y}] = \sigma_y^2, \text{ and}$$
$$Cov[\tilde{x}, \tilde{y}] = 0.$$

Cash flows and CSR outcomes are not correlated. This precludes investors from using information about $\tilde{y}$ to make inferences about $\tilde{x}$. Therefore, the zero-covariance assumption allows us to abstract from results that are based on using $\tilde{y}$ to learn about fundamentals represented by $\tilde{x}$. Allowing $Cov[\tilde{x}, \tilde{y}] \neq 0$ would not qualitatively affect our results, as we show in Appendix B.

3.1 Investors and their preferences

There is a unit-mass of risk-averse investors who can invest in the firm's shares and the risk-free asset. While all investors have constant absolute risk aversion (CARA) and value $\tilde{x}$, only a fraction, $\lambda \in [0, 1]$, of the investors values $\tilde{y}$. We distinguish investors by using the index $i \in \{1, 2\}$ to denote type-1 and type-2 investors. That is, type-1 investors have one-dimensional preferences over cash flows and type-2 investors have two-dimensional preferences over cash flows and the CSR outcome. Type-1 investors are indifferent across realizations of $\tilde{y}$, while type-2 investors' utility depends non-trivially on $\tilde{y}$. We focus on a two-type setting as the most parsimonious way to capture heterogeneous taste over production externalities or CSR. We assume that the utility of type-2 investors is multiplicatively separable such that $u_2 = -\exp[-r(q_2\tilde{x} + m_2 - p)] \cdot \exp[-rq_2\tilde{y}]$, where q_2 and m_2 represent the quantities of shares in the risky and risk-free asset held by the type-2 investor, respectively, and p represents the firm's price per share. Finally, a type-1 investor's utility is given by $u_1 = -\exp[-r(q_1\tilde{x} + m_1 - p)]$.

We effectively assume that type-2 investors are risk averse in both output dimensions (e.g., cash flows and CSR). While the risk aversion assumption is standard with regard to cash flows, there is no current standard for whether investors are, on average, risk averse, risk neutral, or risk seeking with regard to outcomes like CSR. The nature of some of our results depend on type-2 investors caring about risk related to $\tilde{y}$, so some curvature in their utility with respect to $\tilde{y}$ is important. Without curvature, they would not care about the variance of $\tilde{y}$, and this would change how they react to information. Consistent with our characterization of risk averse type-2 investors, recent experimental evidence suggests that individual donors are risk averse in the outcomes that stem from their donations (e.g., Brock et al., 2013; Exley, 2015). That is, recent experimental evidence provides a basis for assuming that individuals are risk averse in outcomes other than cash flows to themselves.[7]

Each investor maximizes her expected terminal utility subject to the budget constraint $w_i = q_i p + m_i$, where w_i is the initial wealth endowment. Substituting the budget constraint, it is straightforward to show that maximizing expected utility is equivalent to maximizing the following certainty equivalent

$$CE_i = q_i \left(E\left[\tilde{v}_i\right] - p \right) - \frac{1}{2} r q_i^2 Var\left[\tilde{v}_i\right], \tag{1}$$

where $\tilde{v}_1 = \tilde{x}$ and $\tilde{v}_2 = \tilde{x} + \tilde{y}$ denote the value of the firm's per-share outcome to type-1 and type-2 investors, respectively. This implies that $Var\left[\tilde{v}_1\right] = Var\left[\tilde{x}\right] = \sigma_x^2$ and $Var\left[\tilde{v}_2\right] = Var\left[\tilde{x}\right] + Var\left[\tilde{y}\right] = \sigma_x^2 + \sigma_y^2$. If $Cov\left[\tilde{x}, \tilde{y}\right] \neq 0$, then $Var\left[\tilde{v}_2\right] = \sigma_x^2 + \sigma_y^2 + Cov\left[\tilde{x}, \tilde{y}\right]$, which affects the expressions for equilibrium demand and prices but does not qualitatively affects the results of this section.

[7] Furthermore, Lam et al. (2015) find that firms with unlcear overall CSR performance (positive performance in some dimensions and negative performance in others) are "mispriced by the market compared to their 'neutral' peers, plausibly due to the ambiguity in their social performance." (Abstract)

3.2 Baseline equilibrium asset price

Solving the first order condition of (1) yields the optimal demand for a type-i investor:

$$q_i = \frac{E[\tilde{v}_i] - p}{rVar[\tilde{v}_i]}. \tag{2}$$

Prices are set such that aggregate demand equals aggregate supply. There is one share per investor so that, on average, the following market-clearing condition has to hold

$$(1-\lambda) q_1 + \lambda q_2 = 1. \tag{3}$$

Proposition 1 shows the equilibrium stock price, which is derived by substituting investors' optimal demand into the market-clearing condition.

Proposition 1 *The share price, p, is given by*

$$p = \bar{x} - r\sigma_x^2 + \frac{\lambda\sigma_x^2}{\sigma_x^2 + (1-\lambda)\sigma_y^2}\left(\bar{y} - r\sigma_y^2\right). \tag{4}$$

Note that when $\lambda \to 0$, the price approaches that in the standard framework with only type-1 investors, i.e., $p_{\lambda=0} = \bar{x} - r\sigma_x^2$. When $\lambda \to 1$, the price approaches that in a standard framework with y as a second cash flow, i.e., $p_{\lambda=1} = \bar{x} + \bar{y} - r\left(\sigma_x^2 + \sigma_y^2\right)$. In general, price is a weighted average of the price when $\lambda \to 0$ and the price when $\lambda \to 1$: $p = (1-\phi) p_{\lambda=0} + \phi p_{\lambda=1}$, where $\phi = \frac{\lambda\sigma_x^2}{\sigma_x^2+(1-\lambda)\sigma_y^2}$. That is, all investors' portfolio decisions depend on their expectations and perceived risk, so the distributions of $\tilde{x}$ and $\tilde{y}$ impact the relative holdings between type-1 and type-2 investors. Therefore, the higher the expected value of $\tilde{y}$, the larger are the holdings of type-2 investors. Furthermore, the larger the uncertainty associated with the non-fundamental output, the smaller are the equilibrium holdings of type-2 investors.

The weight ϕ on $p_{\lambda=1}$ in (4) derives from the relative holdings of shares in the market. A naive guess is that a fraction λ are held by type-2 investors. However, this is not the case because individuals' holding decisions are determined by expected returns and the riskiness of returns, which vary across investor classes. In equilibrium, the per-share holdings of type-1 and type-2 investors are given by

$$(1-\lambda)\,q_1 = (1-\lambda)\,\frac{-\frac{\lambda}{r}\bar{y}+\left(\sigma_x^2+\sigma_y^2\right)}{\sigma_x^2+(1-\lambda)\,\sigma_y^2} \text{ and} \tag{5}$$

$$\lambda q_2 = \lambda\frac{\frac{1-\lambda}{r}\bar{y}+\sigma_x^2}{\sigma_x^2+(1-\lambda)\,\sigma_y^2}. \tag{6}$$

The weight ϕ is in fact less than λ because CSR outcome risk causes type-2 investors to reduce their demand for the firm's shares. Since only type-2 investors demand a risk premium for CSR risks, the risk premium in (4) reflects a weighted average of σ_x^2 and $\sigma_x^2+\sigma_y^2$. Specifically, the weighted average is given by

$$(1-\phi)\,r\sigma_x^2+\phi r\left(\sigma_x^2+\sigma_y^2\right) = r\sigma_x^2\frac{\sigma_x^2+\sigma_y^2}{\sigma_x^2+(1-\lambda)\,\sigma_y^2}. \tag{7}$$

The impact of type-2 investors on the pricing of expected CSR outcomes is the same as their influence on the pricing of the riskiness of CSR outcomes, consistent with their pricing power being driven by their positions in the risky asset.

Comparative statics results are described in the following corollary, which can be shown by taking first derivatives of the price expression in (4).

Corollary 1 *Equilibrium share price is increasing in the expected value of $\tilde{y}$, and can be increasing or decreasing in the fraction of type-2 investors and the variance of cash flows and the CSR outcome:* $\frac{dp}{d\bar{y}}>0$, $\frac{dp}{d\lambda}\propto\left(\bar{y}-r\sigma_y^2\right)\gtrless 0$, $\frac{dp}{d\sigma_y^2}\propto-\left(\bar{y}\,(1-\lambda)+r\sigma_x^2\right)\gtrless 0$, *and* $\frac{dp}{d\sigma_x^2}\propto -r+\frac{\bar{y}\lambda(1-\lambda)\sigma_y^2}{\lambda\sigma_x^4+(1-\lambda)\left(\sigma_x^2+\sigma_y^2\right)^2}\gtrless 0$.

An increase in $\bar{y}$ increases the equilibrium price through two effects that reinforce each other. First, $\bar{y}$ has a direct positive impact on price. Second, increasing $\bar{y}$ makes type-2 investors trade more aggressively which further increases the positive impact of $\bar{y}$ on price. The uncertainty about cash flows and CSR outcomes affects how $\bar{y}$ influences price, since the uncertainties affect the demands from type-1 and type-2 investors (i.e., the endogenous degree of investor clienteles). Specifically, the effect of $\bar{y}$ on price is increasing in σ_x^2 and is decreasing in σ_y^2. That is, an increase in σ_y^2 causes type-2 investors to take weaker positions and to discount expected outcomes more. If $\bar{y}$ is positive (or not too negative), then this has a negative effect on price. For sufficiently negative $\bar{y}$ (i.e., $\bar{y} << 0$), the effect of an increase in σ_y^2 can be positive, since higher σ_y^2 decreases the type-2 investors' shareholdings which, in turn decreases the negative influence of $\bar{y}$ on price.

Increases in the fraction of type-2 investors, λ, can have positive or negative effects. The reason is that while type-2 investors include $\bar{y}$ in their valuation of the firm's shares, they also include σ_y^2. Therefore, when the expected CSR outcome is sufficiently positive (i.e., $\bar{y} > r\sigma_y^2$), increasing the fraction of type-2 investors has a positive effect on price because they impound the positive $\bar{y}$ more strongly into price. When this is not the case (i.e., $\bar{y} < r\sigma_y^2$), the negative effect of an increase in type-2 investors is driven by an increase in the risk perceived by the firm's shareholder base.

There are two potentially countervailing effects of increasing σ_x^2 on the firm's share price. First, an increase in σ_x^2 increases the risk perceived by all investors. Second, an increase in σ_x^2 increases the equilibrium share holdings of type-2 investors. The reason is that while higher values of σ_x^2 decrease the demand of all investors (holding price constant) this effect is stronger for type-1 investors. In equilibrium, price decreases and the total amount of shares held by type-2 investors increases. When investors have homogeneous preferences, an increase in risk has an unambiguously negative effect on price (i.e., $\lim_{\lambda\to 0} \frac{dp}{d\sigma_x^2} = \lim_{\lambda\to 1} \frac{dp}{d\sigma_x^2} = -r$). However, when $\bar{y}$ is sufficiently positive (i.e., $\bar{y} > \frac{r\left(\sigma_x^2+\sigma_y^2\right)^2}{\sigma_y^2\lambda} + \frac{r\sigma_x^4}{\sigma_y^2(1-\lambda)}$), the second effect can dominate the first and an increase in risk associated with $\tilde{x}$ increases the firm's stock price.

4 Price reactions and expected returns around CSR disclosures

This section extends the baseline model in two ways. First, we allow for the disclosure of information regarding both cash flows and CSR performance. Second, we assume that investors can trade before and after the disclosures. While modeling the release of information allows us to derive predictions on how CSR disclosure affects prices, introducing a second round of trading allows us to discuss expected returns.

The standard approach to estimating expected returns in a single-period pure-exchange model is to compare the expected terminal output or liquidating dividend of the firm with the firm's stock price. While for a going concern there is no terminal cash flow and returns are realized as the shares are traded on the market, the simplification of focusing on returns in a static model is usually appropriate as long as investor preferences are homogeneous (i.e., as long as the expected stock price at any point in time equals the agreed-upon discounted expected value of output). In the long run, the uncertainty associated with every component of output will be revealed and priced accordingly such that the researcher can take the difference between expected output and the firm's stock price as realized returns.

In our model, however, investors with different preferences disagree about the economic returns between the trading round and the outcome realization round. The reason is that only some investors value CSR. One potential solution to the problem of calculating returns would be to use a weighted average based on investor preferences (e.g., $ret_{total} = \lambda * ret_1 + (1 - \lambda) * ret_2$). However, this ignores investors' holdings, which determine prices. Since the composition of the shareholder base depends on the current assessed cash-flow risk, CSR outcome risk, and expected CSR outcome, the composition of the firm's shareholder base can change as information is released. In a one-period model, there is no scope for the shareholder base to change endogenously and, therefore, no scope for returns related to such changes. In a multi-period model, as we show below, a constant shareholder base only arises in knife-edge cases.

To capture the effects of potential changes in shareholder base, we add a second trading period and assume that a financial disclosure and a CSR disclosure are released between the first and second trading rounds. Specifically, we extend the above model in the following way. Investors first trade in period 1 as described above. In period 2, information about $\tilde{x}$ and $\tilde{y}$ is revealed to all market participants through the disclosures and a second round of trading occurs. The outputs $\tilde{x}$ and $\tilde{y}$ are realized in period 3. Since investors are not wealth constrained and live for the entire life of the firm without liquidity shocks, each investor's demand in each of the two periods can be computed independent of all other demands.

The revealed information in period 2 is given by two information signals which are independent of each other. Let the signals be

$$\tilde{m} = \tilde{x} + \tilde{\varepsilon}_m, \text{ and} \tag{8}$$

$$\tilde{n} = \tilde{y} + \tilde{\varepsilon}_n, \tag{9}$$

where $\tilde{\varepsilon}_m$ and $\tilde{\varepsilon}_n$ are normally distributed noise terms that are independent of all other random variables and have following properties:

$$\varepsilon_m \sim N\left(0, \frac{1}{\tau_m}\right) \text{ and} \tag{10}$$

$$\varepsilon_n \sim N\left(0, \frac{1}{\tau_n}\right). \tag{11}$$

Furthermore, let $\tau_x = 1/\sigma_x^2$ and $\tau_y = 1/\sigma_y^2$ be the prior precisions of $\tilde{x}$ and $\tilde{y}$, respectively. This implies that the round 1 price can be expressed as

$$p_1 = \bar{x} - r\frac{1}{\tau_x} + \frac{\lambda}{1 + (1-\lambda)\frac{\tau_x}{\tau_y}}\left(\bar{y} - r\frac{1}{\tau_y}\right). \tag{12}$$

As before, demand is given by the solution to investors' wealth-maximization problem, which takes a similar form as in the baseline model. Let $q_{i,2}$ be the shares held by a type-i investor after the second round of trade. Equilibrium second-period share demand from investor i is

$$q_{i,2} = \frac{E\left[\tilde{v}_i|m,n\right] - p_2}{rVar\left[\tilde{v}_i|m,n\right]}, \tag{13}$$

where p_2 denotes the second round price. The posterior distributions are given by $E\left[\tilde{x}|m,n\right] = \frac{\bar{x}\tau_x + m\tau_m}{\tau_x+\tau_m}$, $E\left[\tilde{y}|m,n\right] = \frac{\bar{y}\tau_y+n\tau_n}{\tau_y+\tau_n}$, $Var\left[\tilde{x}|m,n\right] = \frac{1}{\tau_x+\tau_m}$ and $Var\left[\tilde{y}|m,n\right] = \frac{1}{\tau_y+\tau_n}$.

Substituting the investors' demand into the market clearing condition yields the second round price in Proposition 2.

Proposition 2 *Share price in the second period of trading after the revelation of informative signals m and n is given by:*

$$\begin{aligned} p_2 &= \frac{\bar{x}\tau_x + m\tau_m}{\tau_x+\tau_m} - r\frac{1}{\tau_x+\tau_m} \\ &+ \frac{\lambda}{1+(1-\lambda)\frac{\tau_x+\tau_m}{\tau_y+\tau_n}}\left(\frac{\bar{y}\tau_y + n\tau_n}{\tau_y+\tau_n} - r\frac{1}{\tau_y+\tau_n}\right). \end{aligned} \tag{14}$$

The round 2 price in equation (14) consists of the updated expected value of $\tilde{x}$ minus the risk premium associated with $\tilde{x}$, plus a term related to the expected value net of risk associated with $\tilde{y}$. Since investors react to the disclosure of information, the price in Proposition 2 encompasses reaction coefficients to the two disclosed signals. While there is ample literature on earnings response coefficients (Kothari (2001) provides a review), to our knowledge we are the first to analytically develop a response coefficient to CSR disclosure. Corollary 2 analyzes the market response to CSR disclosure.

Corollary 2 *The price reaction to CSR disclosure is determined by the following response coefficient*

$$\alpha = \frac{\tau_n}{\tau_y+\tau_n}\frac{\lambda}{1+(1-\lambda)\frac{\tau_x+\tau_m}{\tau_y+\tau_n}}. \tag{15}$$

The CSR response coefficient increases in the precision of CSR disclosure and in the fraction of type 2 investors. The CSR response coefficient decreases in the precision of financial *disclosure, the prior precision of cash flows, and the prior precision of the CSR outcome. That is,* $\frac{d\alpha}{d\tau_n} \geq 0$ *,*$\frac{d\alpha}{d\lambda} \geq 0$ *,* $\frac{d\alpha}{d\tau_m} \leq 0$*,* $\frac{d\alpha}{d\tau_x} \leq 0$*, and* $\frac{d\alpha}{d\tau_y} \leq 0$*.*

Corollary 2 shows that some of the conjectures from the literature on earnings response coefficients carry over to our CSR response coefficient. That is, a higher precision of the report and a lower ex ante precision of CSR outcomes increase the price reaction to the CSR disclosure. Intuitively, a higher fraction of investors who are interested in CSR performance increases the price response to the disclosure. Furthermore, while CSR outcomes and cash flows are not correlated in our model, the characteristics of the financial disclosure have an impact on the price reaction to CSR disclosure. The reason is the endogenous shareholder base composition. Specifically, if the posterior precision of cash flows relative to CSR outcomes increases, then more shares will be held by type-1 investors, which reduces the price impact of the CSR disclosure.

Finally, note that the results concerning the precision of financial disclosure and CSR disclosure in Corollary 2 would carry over if we were to analyze the impact of CSR disclosure on returns. However, Corollary 1 shows that λ, τ_x, and τ_y all have an ambiguous effect on the price in round 1. Therefore, changes in these three parameters can also have ambiguous effects on the return reaction to CSR disclosure.

The second goal in this section is to examine the cost of capital, defined as expected returns from the first to second round of trading. This expected return is given in the following corollary

Corollary 3 *The expected stock return, which we use as a proxy for cost of capital, is given by* $R = E\left[\frac{p_2 - p_1}{p_1}\right] = \frac{E[p_2 - p_1]}{p_1}$*, where*

$$\begin{aligned} E\left[p_2 - p_1\right] &= r\frac{\tau_m}{\tau_x\left(\tau_x + \tau_m\right)} + r\lambda\frac{\tau_m\left(1-\lambda\right) + \tau_n}{\left(\tau_y + \tau_n + \left(1-\lambda\right)\left(\tau_x + \tau_m\right)\right)\left(\tau_y + \left(1-\lambda\right)\tau_x\right)} \\ &\quad + \bar{y}\frac{\lambda\left(1-\lambda\right)\tau_x\tau_y\left(\frac{\tau_n}{\tau_y} - \frac{\tau_m}{\tau_x}\right)}{\left(\tau_y + \tau_n + \left(1-\lambda\right)\left(\tau_x + \tau_m\right)\right)\left(\tau_y + \left(1-\lambda\right)\tau_x\right)}. \end{aligned} \tag{16}$$

We express the expected change in price in (16) as the sum of three terms: the first term reflects a reduction in risk related to $\tilde{x}$; the second term reflects a reduction in risk related to $\tilde{y}$; and the third term reflects a change in ownership stakes based on relative changes in risk. If $\frac{\tau_n}{\tau_y} - \frac{\tau_m}{\tau_x} > 0$, then investors who value $\tilde{y}$ are expected to play a larger role in the second-period market than in the first because their risk is reduced relatively more than investors who care only about $\tilde{x}$. If $\frac{\tau_n}{\tau_y} - \frac{\tau_m}{\tau_x} < 0$, then the fraction of shares held by type-2 investors will decrease. The sign of the effect of $\bar{y}$ on expected returns depends on the sign of $\frac{\tau_n}{\tau_y} - \frac{\tau_m}{\tau_x}$ because expected changes in investor base depend on the amount of relative uncertainty resolved about $\tilde{x}$ and $\tilde{y}$ between the first- and second-period trading rounds.

Similar to the classical pure-exchange model, the expected return decreases in the expected value of cash flows, $\bar{x}$.[8] This happens because all investors value cash equally in periods 1 and 2. So, an increase $\bar{x}$ is associated with an increase the denominator in expected returns (p_1) but no change in the numerator ($E[p_2 - p_1]$). The expected value of the non-fundamental component, $\bar{y}$, however, appears in the denominator and numerator of R, specifically in the third term in (16) related to the change in shareholder base. The reason is that the composition of the shareholder base need not stay constant. Assume that the same relative amount of information is released about both output components, $\frac{\tau_n}{\tau_y} = \frac{\tau_m}{\tau_x}$, making the third term in (16) equal to zero. In this case the composition of the shareholder base remains constant, $\bar{y}$ is valued equally in both rounds, and, therefore, an increase in $\bar{y}$ reduces expected returns. When the amount of cash-flow uncertainty that is expected to be resolved is different than that of CSR outcome uncertainty, the shareholder base changes and $\bar{y}$ receives a different weight in the second round of trading. This affects the expected return, as shown in the following corollary.

Corollary 4 *Expected returns can be increasing or decreasing in the expected value of the CSR outcome,* $\bar{y}$*. When* $\frac{\tau_m}{\tau_x} > \frac{\tau_n}{\tau_y}$*, expected returns are decreasing in* $\bar{y}$*. When* $\frac{\tau_n}{\tau_y} > \frac{\tau_m}{\tau_x}$

[8] In discussing expected returns, we assume the parameters are such that $p_1 > 0$ so a positive expected return implies $E[p_2] > p_1$.

expected returns are increasing in $\bar{y}$ if and only if $\lambda < \lambda_{\$}$, with

$$\lambda_{\$} = 1 - \frac{r\left(\tau_n + \tau_m \frac{\tau_y(\tau_n+\tau_y)}{\tau_x(\tau_m+\tau_x)}\right)}{\bar{x}\tau_x\tau_y\left(\frac{\tau_n}{\tau_y} - \frac{\tau_m}{\tau_x}\right)} \tag{17}$$

Interestingly, expected returns can be increasing or decreasing in $\bar{y}$. Expected returns will be decreasing in $\bar{y}$ when there is more uncertainty resolved about $\tilde{x}$ than about $\tilde{y}$ between the two trading periods for any $\lambda \in (0,1)$. When more uncertainty is resolved about $\tilde{y}$ than about $\tilde{x}$ (i.e., $\frac{\tau_n}{\tau_y} > \frac{\tau_m}{\tau_x}$), expected returns may be increasing in $\bar{y}$, but only if λ is sufficiently low. Low λ allows for large shifts in investor base involving more ownership by type-2 investors.

5 Investment decisions

Following the traditional pure-exchange asset pricing literature, in the analysis so far we have assumed that the firm's cash flow and CSR processes are exogenous and have analyzed various implications of allowing for heterogeneous investor taste. In this section we partly endogenize the firm's production decisions. We return to the model with a single round of trading and allow the firm to increase its expected CSR outcome by sacrificing expected cash flows.

To facilitate the analysis and provide clean intuition, assume that the firm has a technology for transforming $\bar{x}$ into $\bar{y}$ according to a linear function with quadratic costs. The technology does not affect uncertainty associated with $\tilde{x}$ or $\tilde{y}$. Specifically, assume that the firm can choose investment balance $k \in \mathbb{R}$ and that the expected cash flow and CSR outcome are given by

$$E[\tilde{x}] = (1-k)\bar{x} - k^2/2 \text{ and} \tag{18}$$

$$E[\tilde{y}] = k\bar{y}. \tag{19}$$

Note that k can be positive or negative. This technology can be thought of as shifting resources from cash-flow-generating activities providing expected cash flows of $(1-k)\,\bar{x}$, to CSR activities providing an expected outcome of $k\bar{y}$, at an increasing cost of adjustment, $k^2/2$. The adjustment cost has to be paid in cash and, therefore, affects the expected cash flows and is relevant to all investors. Thus, the firm can choose to increase its expected CSR outcome but sacrifices increasing amounts of expected cash flows in the process. In this setting, a firm that chooses $k=0$ is a traditional one-dimensional firm that does not invest in CSR activities. A firm that chooses $k>0$ sacrifices cash flows to improve CSR, and a firm that chooses $k<0$ sacrifices CSR to boost its expected cash flows. Note that a negative k still has a quadratic cost which implies decreasing marginal returns to sacrificing CSR. The optimal k will be interior because, at some point, the convex cost will outweigh the linear benefit of transformation between $\bar{x}$ and $\bar{y}$.

Assume that the firm's manager makes the investment decision and is interested in maximizing the firm's stock price, which is given by

$$p\left(k\right)=\left(1-k\right)\bar{x}-k^2/2+k\bar{y}\frac{\lambda\sigma_x^2}{\sigma_x^2+\left(1-\lambda\right)\sigma_y^2}-r\frac{\sigma_x^2\left(\sigma_x^2+\sigma_y^2\right)}{\sigma_x^2+\left(1-\lambda\right)\sigma_y^2}. \tag{20}$$

Lemma 1 shows the manager's optimal investment choice.

Lemma 1 *In our 2 period model with a linear-convex production technology the price-maximizing level of investment is given by*

$$k^*=\bar{y}\frac{\lambda\sigma_x^2}{\sigma_x^2+\left(1-\lambda\right)\sigma_y^2}-\bar{x}. \tag{21}$$

The optimal investment in Lemma 1 shows that the manager trades off the increase in valuation from increasing $E\left[\tilde{y}\right]$ with a decrease in valuation from reducing $E\left[\tilde{x}\right]$. A firm with high $\bar{x}$ faces a higher cost of increasing $\bar{y}$. Therefore, all else equal, when $\bar{x}$ is sufficiently high ($\bar{x}\geq\bar{y}\frac{\lambda\sigma_x^2}{\sigma_x^2+(1-\lambda)\sigma_y^2}$), the firm will choose to sacrifice CSR in order to increase its expected cash flows. For example, when the cash-flow benefits from building an environmentally-unfriendly factory are sufficiently high, the firm will build the factory by setting $k^* < 0$. Stock-price should increase as a result. However, the benefit that a firm derives from polluting the environment depends on the fraction of investors that are interested in preserving the environment (in our case, λ) and how active these investors are in the stock market, which depends on the riskiness of both cash flows and the CSR outcome. That is, Lemma 1 shows that even though the investment does not affect assessed uncertainty, the optimal level of investment is affected by both cash flow and CSR uncertainty. Corollary 5 summarizes comparative static results for a firm's optimal level of investment, k^*.

Corollary 5 *The optimal level of investment in CSR is increasing in the fraction of type-2 investors, decreasing in CSR uncertainty, and increasing in cash-flow uncertainty: $dk/d\lambda > 0$, $dk/d\sigma_y^2 < 0$, and $dk/d\sigma_x^2 > 0$.*

Corollary 5 provides the intuitive result that the higher is the fraction of investors that are interested in CSR, the higher the investment in CSR activities will be. The results concerning σ_y^2 and σ_x^2 are both driven by their effects on the trading behavior of type-2 investors. On the one hand, higher CSR outcome uncertainty makes type-2 investors hold a smaller fraction of the firm's shares and, therefore, decreases the payoff to investing in CSR. A higher cash-flow uncertainty, on the other hand, makes both types of investors trade less aggressively. However, the demand of type-1 investors decreases more than that of type-2 investors which, in equilibrium, leads to a higher fraction of shares being held by type-2 investors. Therefore, a higher cash-flow uncertainty increases the payoff to investment in CSR.

The last two comparative static results are particularly interesting in conjunction with the results concerning price levels and expected returns. The latter results point to the fact that a firm with a higher expected CSR outcome has a stronger interest in decreasing the assessed CSR outcome uncertainty, for example by increasing the precision of its CSR disclosure. The comparative static result that $dk/d\sigma_y^2 < 0$ shows that a firm with lower CSR outcome uncertainty has a stronger interest in investing in increasing the expected CSR outcome. This suggests that, for example, CSR disclosure and CSR investments go hand in hand. In contrast, increasing the precision of disclosure related to fundamentals has the opposite effect and decreases a firm's interest in investing in CSR.

6 Limits to Diversification

So far, our analysis has focused on a single-firm setting and therefore cannot speak to the potential effects of diversification on asset prices. In this section we extend the model by including an additional firm. We assume that the firms' cash flows are correlated and that their CSR outcomes are correlated but maintain our earlier assumption of no correlation between cash flows and CSR outcomes. To capture some central features of a large-economy CAPM-style model, we assume that there are γ and $(1-\gamma)$ shares per investor of firm 1 and firm 2, respectively. Letting γ approach zero (i.e., in the limit as $\gamma \rightarrow 0$) approximates a setting in which firm 2's shares represent the market portfolio, and firm 1 represents a small firm in a large market. Absent taste heterogeneity, all investors would hold approximately 1 share of the market portfolio and 0 shares of firm 1, and only the covariance of firm 1 with the market portfolio would be priced. As we show below, this is not the case in our model with taste heterogeneity, because idiosyncratic variances determine the composition of the firm's shareholder base and, therefore, the extent to which covariances are priced. Fama and French (2007) also derive this result in settings with investor disagreement and heterogeneous tastes, focusing on how disagreement or tastes cause investors to deviate from choosing mean-variance efficient tangency portfolios as implied by the traditional CAPM.

The two risky assets in this subsection are indexed by $k = 1, 2$. As above, the outcome of each of these assets is two-dimensional: asset k has a per share output of $(\tilde{x}_k, \tilde{y}_k)$. To simplify the analysis and show the intuition for the main point of this subsection we assume that $E[\tilde{x}_1] = E[\tilde{x}_2] = \bar{x}$ and $E[\tilde{y}_1] = E[\tilde{y}_2] = \bar{y}$. Furthermore, we assume that the cash flows and the CSR outcomes of the two assets may be correlated. Finally, we extend our one-firm assumption of $Cov(\tilde{x}, \tilde{y}) = 0$ to the two firm case by assuming that $Cov(\tilde{x}_i, \tilde{y}_j) = 0 \; \forall \; i, j \in$

$\{1, 2\}$. In other words, CSR performance is not correlated with fundamental performance but the fundamental and CSR outcomes of different firms may be cross-sectionally correlated. Therefore, the respective covariance matrices are given by

$$Cov\left[(\tilde{x}_1, \tilde{x}_2)\right] = \mathbf{\Sigma}_x = \begin{bmatrix} \sigma_{x1}^2 & \sigma_{x12} \\ \sigma_{x12} & \sigma_{x2}^2 \end{bmatrix} \text{ and } Cov\left[(\tilde{y}_1, \tilde{y}_2)\right] = \mathbf{\Sigma}_y = \begin{bmatrix} \sigma_{y1}^2 & \sigma_{y12} \\ \sigma_{y12} & \sigma_{y2}^2 \end{bmatrix}. \tag{22}$$

As above, there is a unit mass of risk-averse investors that can invest in the firms' shares and the risk-free asset and a fraction $\lambda \in [0, 1]$ of the investors has a non-zero preference over CSR outcomes, $\tilde{y}_k$. Lemma 2 summarizes the equilibrium prices.

Lemma 2 *In our two-firm economy, the prices of firm* 1 *and* 2 *are given by the vector*

$$\mathbf{P} = \bar{x}\mathbf{1} + \left((1-\lambda)\,\mathbf{\Sigma}_x^{-1} + \lambda\left(\mathbf{\Sigma}_x + \mathbf{\Sigma}_y\right)^{-1}\right)^{-1}\left(\lambda\left(\mathbf{\Sigma}_x + \mathbf{\Sigma}_y\right)^{-1}\bar{y}\mathbf{1} - r\mathbf{\Gamma}\right), \tag{23}$$

where $\mathbf{\Gamma} = (\gamma, 1-\gamma)^T$ *denotes the supply vector and* $\mathbf{1} = (1, 1)^T$.

Lemma 2 shows that, as above, when $\lambda \to 0$, the price vector approaches that in the standard framework, i.e., $\mathbf{P} = \bar{x}\mathbf{1} - \frac{1}{r}\mathbf{\Sigma}_x\mathbf{1}$ such that the price of firm k is given by $p_k = \bar{x} - r\left(\gamma_k\sigma_{xk}^2 + (1-\gamma_k)\,\sigma_{x12}\right)$, where γ_k denotes the shares per investor for firm k, i.e., $\gamma_1 = \gamma$ and $\gamma_2 = (1-\gamma)$. When instead $\lambda \to 1$, the price vector approaches that in the standard framework when $\tilde{y}$ is a second cash flow, i.e.,the price of firm k is given by $p_k = \bar{x} + \bar{y} - r\left(\gamma_k\left(\sigma_{xk}^2 + \sigma_{yk}^2\right) + (1-\gamma_k)\left(\sigma_{x12} + \sigma_{y12}\right)\right)$.

In order to simulate a large market where asset 2 represents the market portfolio and asset 1 represents an infinitesimally small part of the market portfolio we assume that $\gamma \to 0$. Note that in a situation with homogeneous tastes, e.g., when $\lambda = 0$, the prices of the two assets would collapse to $p_1 = \bar{x} - r\sigma_{x12}$ and $p_2 = \bar{x} - r\sigma_{x2}^2$. In other words, when the shares per investor approach zero for one of the assets in the conventional model, investors are perfectly diversified with respect to idiosyncratic risk (σ_{x1}^2) and only price systematic risk

(σ_{x2}^2) and the exposure to systematic risk (σ_{x12}), respectively. Proposition 3 shows that in a model with heterogeneous investor taste, the traditional forces of diversification are limited.

Proposition 3 *In our two-firm economy with heterogeneous investor taste, the price of an infinitesimally small firm is affected by its idiosyncratic risks.*

Proposition 3 shows that even when we let γ approach zero such that the number of shares of firm 1 per investor approaches zero, the price of firm 1 is still a function of its idiosyncratic risks. Specifically, the firm's idiosyncratic risks determine the pricing of $\bar{y}$ and the firm's risk premium (or the weights on $\bar{y}$ and r in the price expression). This result can also be inferred from the solution in Lemma 2. Here, the risk premium is given by $r\left((1-\lambda)\boldsymbol{\Sigma}_x^{-1}+\lambda\left(\boldsymbol{\Sigma}_x+\boldsymbol{\Sigma}_y\right)^{-1}\right)^{-1}\boldsymbol{\Gamma}$. Note that the risk premium is determined, in part, by the inverse of the weighted average of the investors' inverse covariance matrices. Firm 1's idiosyncratic risks (σ_{x1}^2 and σ_{y1}^2) enter non-trivially, since the inverse of a sum of inverse matrices contains the elements of the main diagonal of the original matrices (even when $\gamma \to 0$). However, also note that this only happens when there exist taste differences between investors; when $\lambda = 1$ and $\gamma \to 0$, for example, the price of firm 1 reduces to $p_1 = \bar{x} + \bar{y} - r\left(\sigma_{12x} + \sigma_{12y}\right)$ such that only systematic risks are priced.

The reason that idiosyncratic risks still matter even when the forces of diversification apply is that the composition of the firm's shareholder base arises endogenously. Since the two investor groups are affected by different risks, the extent to which systematic risks are priced depends on the composition of the shareholder base. The composition of the shareholder base, in turn, is determined by the firm's *total* risks, not just its systematic risks. In a traditional factor model, the β-factor is given by the correlation of the firm's cash flow to the market cash flow. Our model implies that the β-factor would not be given solely by the correlation but, instead, would be affected by the firm's idiosyncratic risks. Furthermore, it is impossible in our setting to express price as a linear function of the market portfolio variance, as in a traditional CAPM model (see also Fama and French, 2007). Fundamentally, the existence of type-2 investors causes the type-1 investors to deviate from their otherwise optimal portfolio. Similarly, type-2 investors do not hold the portfolio that they would hold if all investors were type-2 investors. These deviations occur because the market must clear in equilibrium. Therefore, no investor holds the "market-portfolio" as the weights in their portfolios are affected by the other investors' valuations and trading strategies.

7 Discussion and conclusion

7.1 Empirical Implications

Our results have a number of empirical implications for researchers interested in capital market implications of firms' CSR activities and their disclosures about these activities. We discuss empirical implications of our model under alternative interpretations (e.g., where $\tilde{y}$ represents other dimensions of investor taste) in the next subsection. All of the empirical implications we highlight are driven by shareholder base effects that follow from our assumption of heterogeneous investor taste.

First, we find that investor tastes can cause firms' market values to be increasing in the riskiness of their cash flows, in contrast to the usual result that market value is decreasing in cash flow risk. This is not a general result, but rather occurs only when the expected CSR outcomes are sufficiently positive. The mechanism underlying this result involves cash flow risk deterring type-1 investors, allowing type-2 investors who value the firms' high expected CSR outcome to have a more significant influence on the firm's share price. Empirically, this result can be operationalized in settings where CSR outcomes are likely to be a significant driver of investment choices.[9]

Second, we predict that market responses to disclosures about CSR will be stronger when the quality of (potentially concurrent) disclosures about fundamentals is lower. This results from the mix of type-1 and type-2 investors in the marketplace. When the quality

[9] While this is unlikely to be descriptive of national stock markets like the NYSE, it is plausibly descriptive in novel online markets like Kiva, which connects lenders and borrowers online with the explicit goal of reducing poverty and has facilitated over $600 million in loans from 2005 through mid-2014.

of financial information is higher, more of the firm's shares are held by type 1 investors. The response to CSR disclosure is muted because a smaller fraction of the firm's shareholder base values CSR performance. Additionally, when the market is primarily composed of either all type-1 or all type-2 investors, there is little scope for shareholder base effects. Therefore, the relation between market responses to CSR disclosures and the quality of cash-flow disclosures is expected to be greatest when there are significant portions of both type-1 and type-2 investors, and weakest when the market is dominated by either type-1 or type-2 investors (i.e., $\lambda = 0$ or $\lambda = 1$). These predictions can be operationalized in public stock markets with data on investor holdings (e.g., holdings of socially responsible funds) and proxies for the quality of CSR and fundamental disclosures.

In a setting where CSR disclosures are informative about cash flows, we would also expect to find a negative relation between the market response to CSR disclosures and the quality of disclosures explicitly about fundamentals. To illustrate, consider a firm that discloses a signal about fundamentals, $\tilde{m} = \tilde{x} + \tilde{\varepsilon}_m$, as above, in a setting without type-2 investors, such that CSR disclosures are used only to make inferences about cash flows. In this example, market returns would be associated with the CSR disclosure as long as there is noise in the disclosure about fundamentals (i.e., $Var\left[\varepsilon_m\right] \neq 0$). As the noise in the disclosure about fundamentals goes to zero the incremental information from the CSR disclosure disappears and the market ceases to react to the CSR disclosure. This mechanism, of substitution between informative signals, however, is very different from the mechanism we identify based on shareholder base effects. We caution that an empirical study identifying a market price reaction to CSR disclosures should be wary about inferring that CSR disclosures are informative about cash flows, because such a reaction could be driven by investor tastes and shareholder base effects. An effective empirical strategy to disentangle the two competing explanations could test whether the distribution of the shareholder base affects the negative relation between market reactions to CSR disclosures and the quality of disclosures about fundamentals. The effect we identify is significant only with a mix of type-1 and type-2 investors, while the alternative explanation based on signal substitution should be independent of the mix of shareholder types.

Third, we find that firms' investments in CSR are complementary with CSR disclosures and dis-complementary with fundamental or cash flow disclosure quality. Essentially, when firms improve their expected CSR outcomes at the expense of expected cash flows, they want the market to place more weight on CSR and less weight on cash flows. Conditional on the distribution of type-1 and type-2 investors, firms can achieve this goal by improving the quality of CSR disclosures to attract more type-2 investors, or by weakening the quality of cash flow disclosures to deter type-1 investors and increase the proportion of type-2 investors. We therefore predict that firms engaged in CSR activities will tilt their disclosure strategies to emphasize CSR and, if possible, weaken the quality of disclosures about fundamentals. Relatedly, if changes in disclosure standards increase the quality of mandated CSR disclosures, we predict that firms will invest more in CSR activities, even at the expense of expected cash flows valued by all investors.

Fourth, our results on the relation between idiosyncratic risk and price in a large economy with heterogeneous investor tastes suggests predictable variation in how well the CAPM holds across securities with different investor base characteristics. We predict that investor base heterogeneity is associated with deviations from CAPM-style pricing, consistent with Fama and French (2007). When the investor base of a firm has more mixed taste, we expect idiosyncratic risk to have more significant price implications and for a factor model of returns to have less power. When the investor base has more homogeneous tastes (e.g., few or no socially responsible investors), a pricing model like the CAPM is expected to be more descriptive.

7.2 Alternative interpretations beyond CSR

Finally, we discuss applications of our model to areas beyond CSR where investor tastes have been shown to have an impact on demand for shares. Several empirical studies have documented areas in which differences in investors' preferences affect stock ownership in the cross-section. Graham and Kumar (2006) find evidence for age and tax clienteles related to dividends, whereby older and lower-income retail investors display a stronger preference for dividend yields than younger and higher-income retail investors.[10] Grinblatt and Keloharju (2000) find that different classes of investors (local vs. foreign) display heterogeneous preferences for recent stock returns (engaging in momentum vs. contrarian investing strategies). Grinblatt and Keloharju (2001) document investor preferences based on cultural and language similarity to management. Bushee (2001) finds that institutional investors with shorter horizons display a preference for near-term earnings relative to long-term value. The investment "home bias" is a pervasive phenomenon, whereby investors prefer to invest in local stocks rather than foreign or distant stocks (e.g., Coval and Moskowitz, 1999; Huberman, 2001). While we focus on CSR, our non-cash-flow outcome could straightforwardly be adapted to one of the applications above.

Investor tastes could also be related to insider status. Cohen (2009) finds that employee loyalty influences individuals' portfolio preferences in favor of holding their employers' stock. Insiders who obtain private benefits of control also can be interpreted as having additional tastes for owning shares beyond cash flows available to all investors (e.g., Barclay and Holderness, 1989; Dyck and Zingales, 2004). An important difference is that private benefits of control often involve information asymmetry between insiders and outsiders, which would be between type-1 and type-2 investors in our model. Adding such information asymmetry would complicate our model and potentially alter some of our findings related to the importance of shareholder base.

We treat investor tastes as reflecting a fundamental disagreement in valuation based on

[10] Taste differences in our model are closely related to the effects of tax clienteles (e.g., Allen et al., 2000) but differ for a substantive reason. In our model, $\tilde{x}$ and $\tilde{y}$ could represent the payouts to two different groups of investors. In a model that captures tax-based clienteles, $\tilde{x}$ and $\tilde{y}$ would have to be perfectly correlated, because differential income tax treatment of equity distributions implies that payouts to one group are proportional to (i.e., perfectly correlated with) payouts to the other groups. We assume that $\tilde{x}$ and $\tilde{y}$ are orthogonal to ensure that type-1 investors cannot use $\tilde{y}$ to learn about $\tilde{x}$ so that only type-2 investors incorporate information about $\tilde{y}$ into their valuations.

preferences, but operationally this could also be related to disagreement based on heterogeneous beliefs regarding the drivers of firm value or behavioral factors that affect subsets of investors (e.g., incomplete information as in Merton (1987)). Investors can disagree about whether and how corporate governance policies affect firm value, for instance, or about how shocks to product markets and the competitive landscape affect firms. in the model, $\tilde{y}$ could represent observable board characteristics, like size and demographics, with investor disagreement about the relation between board characteristics and firm performance. From a behavioral perspective, the model could be interpreted as capturing some investors' optimism, pessimism, or overconfidence. With $\bar{y} = 0$ and $\sigma_y^2 > 0$ for example, the investors could be interpreted as having differential perceptions of firm risk, with type-2 investors perceiving higher risk than type-1 investors, who would be considered overconfident given their underestimation of risk. With $\bar{y} > 0$ ($\bar{y} < 0$), type-2 investors could be interpreted as relatively optimistic (pessimistic) for reasons unrelated to firm fundamentals represented by $\tilde{x}$. See Fama and French (2007) for further discussion of the similarity in the asset-pricing implications of differences in investor tastes and differences in investor beliefs.

7.3 Conclusion

This paper presents a simple model that examines the capital market implications of heterogeneous investor taste. We link heterogeneous tastes to several predictions related to asset prices, returns, and firms' investment choices. Our results have implications for researchers and practitioners interested in investor clienteles (i.e., shareholder base effects) and how endogenous clienteles affect returns, reactions to information, firms' investment trade-offs, and diversification.

References

Allen, F., A. E. Bernardo., and I. Welch. 2000. A theory of dividends based on tax clienteles. *The Journal of Finance* 55(6): 2499–2536.

Bagnoli, M., and S. G. Watts. 2014. Voluntary assurance of voluntary csr disclosure. Working paper.

Barclay, M. J., and C. G. Holderness. 1989. Private benefits from control of public corporations. *Journal of Financial Economics* 25(2): 371–395.

Baron, D. P. 2007. Corporate social responsibility and social entrepreneurship. *Journal of Economics & Management Strategy* 16(3): 683–717.

Baron, D. P. 2009. A positive theory of moral management, social pressure, and corporate social performance. *Journal of Economics & Management Strategy* 18(1): 7–43.

Bénabou, R., and J. Tirole. 2010. Individual and corporate social responsibility. *Economica* 77(305): 1–19.

Brock, J. M., A. Lange., and E. Y. Ozbay. 2013. Dictating the risk: Experimental evidence on giving in risky environments. *American Economic Review* 103(1): 415–437.

Bushee, B. J. 2001. Do institutional investors prefer near-term earnings over long-run value? *Contemporary Accounting Research* 18(2): 207–246.

Cheng, B., I. Ioannou., and G. Serafeim. 2014. Corporate social responsibility and access to finance. *Strategic Management Journal* 35(1): 1–23.

Clark, G. L., and M. Viehs. 2014. The implications of corporate social responsibility for investors. University of Oxford working paper.

Cohen, L. 2009. Loyalty-based portfolio choice. *Review of Financial Studies* 22(3): 1213–1245.

Coval, J. D., and T. J. Moskowitz. 1999. Home bias at home: Local equity preference in domestic portfolios. *The Journal of Finance* 54(6): 2045–2073.

Dhaliwal, D. S., O. Z. Li., A. Tsang., and Y. G. Yang. 2011. Voluntary nonfinancial disclosure and the cost of equity capital: The initiation of corporate social responsibility reporting. *The Accounting Review* 86(1): 59–100.

Dhaliwal, D. S., S. Radhakrishnan., A. Tsang., and Y. G. Yang. 2012. Nonfinancial disclosure and analyst forecast accuracy: International evidence on corporate social responsibility disclosure. *The Accounting Review* 87(3): 723–759.

Di Giuli, A., and L. Kostovetsky. 2014. Are red or blue companies more likely to go green? politics and corporate social responsibility. *Journal of Financial Economics* 111(1): 158–180.

Dyck, A., and L. Zingales. 2004. Private benefits of control: An international comparison. *The Journal of Finance* 59(2): 537–600.

Exley, C. L. 2015. Excusing selfishness in charitable giving: The role of risk. Working paper.

Fama, E. F., and K. R. French. 2007. Disagreement, tastes, and asset prices. *Journal of Financial Economics* 83(3): 667–689.

Gollier, C., and S. Pouget. 2012. Asset prices and corporate behavior with socially responsible investors. Working paper.

Graff Zivin, J., and A. Small. 2005. A modigliani-miller theory of altruistic corporate social responsibility. *Topics in Economic Analysis and Policy* 5(1).

Graham, J. R., and A. Kumar. 2006. Do dividend clienteles exist? evidence on dividend preferences of retail investors. *The Journal of Finance* 61(3): 1305–1336.

Grinblatt, M., and M. Keloharju. 2000. The investment behavior and performance of various investor types: a study of finland's unique data set. *Journal of Financial Economics* 55(1): 43–67.

Grinblatt, M., and M. Keloharju. 2001. How distance, language, and culture influence stockholdings and trades. *The Journal of Finance* 56(3): 1053–1073.

Hawn, O., and A. Chatterji. 2014. How firm performance moderates the effect of changes in status on investor perceptions: Additions and deletions by the dow jones sustainability index. Working paper.

Huberman, G. 2001. Familiarity breeds investment. *Review of Financial Studies* 14(3): 659–680.

Kim, J.-B., B. Li., and Z. Liu. 2014. Does social performance influence breadth of ownership? Working paper.

Kothari, S. 2001. Capital markets research in accounting. *Journal of Accounting and Economics* 31: 105 – 231.

Lam, S.-S., W. Zhang., and G. H. Jacob. 2015. The mispricing of socially ambiguous grey stocks. Working paper.

Merton, R. C. 1987. A simple model of capital market equilibrium with incomplete information. *The Journal of Finance* 42(3): 483–510.

Robinson, M., A. Kleffner., and S. Bertels. 2011. Signaling sustainability leadership: Empirical evidence of the value of djsi membership. *Journal of Business Ethics* 101(3): 493–505.

Serafeim, G. 2014. Integrated reporting and investor clientele. Harvard Business School working paper.

A Proofs

Proposition (1): *The first order condition to (1) with respect to demand in shares of the risky asset for an investor of type i is given by*

$$E\left[\tilde{v}_i\right] - p - rq_i Var\left[\tilde{v}_i\right] = 0. \tag{24}$$

Solving this for q_i yields the demands in (2). Substituting q_i into the market clearing condition and solving for p proves the claim.

Corollary (1): *The expressions for the comparative statics are*

$$\begin{aligned}
\frac{dp}{d\bar{y}} &= \frac{\lambda\sigma_x^2}{\sigma_x^2 + (1-\lambda)\,\sigma_y^2} > 0 && (25)\\
\frac{dp}{d\sigma_y^2} &= \frac{-\left(\bar{y}\,(1-\lambda) + r\sigma_x^2\right)\lambda\sigma_x^2}{\left(\sigma_x^2 + \sigma_y^2\,(1-\lambda)\right)^2} \gtrless 0 && (26)\\
\frac{dp}{d\lambda} &= \frac{\left(\bar{y} - r\sigma_y^2\right)\left(\sigma_x^2 + \sigma_y^2\right)\sigma_x^2}{\left(\sigma_x^2 + \sigma_y^2\,(1-\lambda)\right)^2} \gtrless 0 && (27)\\
\frac{dp}{d\sigma_x^2} &= -\frac{r\left(\sigma_x^4 + \sigma_y^4\,(1-\lambda) + 2\sigma_y^2\sigma_x^2\,(1-\lambda)\right) - \sigma_y^2\lambda\bar{y}\,(1-\lambda)}{\left(\sigma_y^2\,(1-\lambda) + \sigma_x^2\right)^2} \gtrless 0 && (28)
\end{aligned}$$

Proposition (3): *Substituting precisions into eqn. (4) in lieu of variances yields*

$$p_1 = \bar{x} - \frac{r}{\tau_x} + \lambda\left(\frac{\bar{y}\tau_y - r}{\left(\tau_x\,(1-\lambda) + \tau_y\right)}\right). \tag{29}$$

Expected price in period 2 is defined by $E\left[\tilde{m}\right] = \bar{x}$ and $E\left[\tilde{n}\right] = \bar{y}$ as

$$E\left[p_2\right] = \bar{x} - r\frac{1}{\tau_x + \tau_m} + \lambda\left(\frac{\bar{y}\left(\tau_y + \tau_n\right) - r}{\tau_y + \tau_n + (1-\lambda)\left(\tau_x + \tau_m\right)}\right).$$

The expected change in price is therefore:

$$
\begin{aligned}
E\left[p_2 - p_1\right] &= r\frac{\tau_m}{\tau_x\left(\tau_m+\tau_x\right)} && (30)\\
&\quad +\lambda r\frac{\tau_n+(1-\lambda)\,\tau_m}{\left(\tau_y+(1-\lambda)\,\tau_x\right)\left(\tau_y+\tau_n+(1-\lambda)\left(\tau_x+\tau_m\right)\right)} && (31)\\
&\quad +\lambda\bar{y}\frac{(1-\lambda)\left(\tau_n\tau_x-\tau_m\tau_y\right)}{\left(\tau_y+(1-\lambda)\,\tau_x\right)\left(\tau_y+\tau_n+(1-\lambda)\left(\tau_x+\tau_m\right)\right)} && (32)
\end{aligned}
$$

Corollary (2): *The respective derivatives are given by*

$$
\begin{aligned}
\frac{d\alpha}{d\tau_n} &= \lambda\frac{(1-\lambda)\left(\tau_m+\tau_x\right)+\tau_y}{\left(\tau_y+\tau_n+(1-\lambda)\left(\tau_x+\tau_m\right)\right)^2}\geq 0, && (33)\\
\frac{d\alpha}{d\lambda} &= \frac{\tau_n\left(\tau_m+\tau_n+\tau_x+\tau_y\right)}{\left(\tau_y+\tau_n+(1-\lambda)\left(\tau_x+\tau_m\right)\right)^2}\geq 0, && (34)\\
\frac{d\alpha}{d\tau_m} &= \frac{-\lambda(1-\lambda)\,\tau_n}{\left(\tau_y+\tau_n+(1-\lambda)\left(\tau_x+\tau_m\right)\right)^2}\leq 0, && (35)\\
\frac{d\alpha}{d\tau_x} &= \frac{-\lambda(1-\lambda)\,\tau_n}{\left(\tau_y+\tau_n+(1-\lambda)\left(\tau_x+\tau_m\right)\right)^2}\leq 0,\ \textit{and} && (36)\\
\frac{d\alpha}{d\tau_y} &= \frac{-\lambda\tau_n}{\left(\tau_y+\tau_n+(1-\lambda)\left(\tau_x+\tau_m\right)\right)^2}\leq 0. && (37)
\end{aligned}
$$

Corollary (4): *The expression for* $\frac{dR}{d\bar{y}}$ *is*

$$
\frac{dR}{d\bar{y}} = \frac{\lambda\left((1-\lambda)\,\tau_x\tau_y\left(\frac{\tau_n}{\tau_y}-\frac{\tau_m}{\tau_x}\right)\bar{x}-r\left(\tau_n+\tau_m\frac{\tau_y(\tau_n+\tau_y)}{\tau_x(\tau_m+\tau_x)}\right)\right)}{\left(\tau_y+\tau_n+(1-\lambda)\left(\tau_x+\tau_m\right)\right)\left(\tau_y+(1-\lambda)\,\tau_x\right)\left(\bar{x}-\frac{r}{\tau_x}+\lambda\frac{\bar{y}\tau_y-r}{\tau_x(1-\lambda)+\tau_y}\right)^2} \qquad (38)
$$

The denominator is positive. When $\frac{\tau_n}{\tau_y}-\frac{\tau_m}{\tau_x}<0$*, the numerator is negative, implying* $\frac{dR}{d\bar{y}}<0$*. When* $\frac{\tau_n}{\tau_y}>\frac{\tau_m}{\tau_x}$*, the numerator is positive if and only if*

$$
\begin{aligned}
(1-\lambda)\,\tau_x\tau_y\left(\frac{\tau_n}{\tau_y}-\frac{\tau_m}{\tau_x}\right)\bar{x} &> r\left(\tau_n+\tau_m\frac{\tau_y\left(\tau_n+\tau_y\right)}{\tau_x\left(\tau_m+\tau_x\right)}\right)\\
\Leftrightarrow \lambda &< 1-\frac{r\left(\tau_n+\tau_m\frac{\tau_y(\tau_n+\tau_y)}{\tau_x(\tau_m+\tau_x)}\right)}{\bar{x}\tau_x\tau_y\left(\frac{\tau_n}{\tau_y}-\frac{\tau_m}{\tau_x}\right)}=\lambda^{\$}.
\end{aligned}
$$

Lemma (1): *The first order condition is given by* $\frac{dp(k)}{dk} = -\bar{x} - k + \bar{y}\frac{\lambda\sigma_x^2}{\sigma_x^2+(1-\lambda)\sigma_y^2} = 0$*. Solving for* k *proves the conjecture.*

Lemma (2): *Investors utility can be expressed as* $u_i = -\exp\left\{r\left(\mathbf{q}_i^T\mathbf{v}_i + m_i\right)\right\}$, $i \in \{1,2\}$ *where* r *is their level of risk aversion,* $q_i = (q_{i1}, q_{i2})^T$ *represents the* 2×1 *vector of investor* i*'s demand for shares in the 2 firms,* $v_1 = x = (\tilde{x}_1, \tilde{x}_2)^T$*, and* $v_2 = x + y = (\tilde{x}_1 + \tilde{y}_1, \tilde{x}_2 + \tilde{y}_2)^T$*. Each investor maximizes her expected terminal utility subject to the budget constraint*

$$w_i = \mathbf{q}_i^T\mathbf{P} + m_i$$

where w_i *is the initial wealth endowment and* $P = (p_1, p_2)^T$ *is the price vector. Note that the price per share of the risk-free asset, like its return, has been normalized to one. Substituting the budget constraint, it is straightforward to show that maximizing expected utility is equivalent to maximizing the following certainty equivalent*

$$CE_i = \mathbf{q}_i^T\left(E\left[\mathbf{v}_i\right] - \mathbf{P}\right) - \frac{1}{2}r\mathbf{q}_i^T Cov\left[\mathbf{v}_i\right]\mathbf{q}_i,$$

where $Cov\left[\mathbf{v}_1\right] = \Sigma_x$ *and* $Cov\left[\mathbf{v}_1\right] = \Sigma_x + \Sigma_y$*. The first order condition for an investor of type* i *is given by*

$$E\left[\mathbf{v}_i\right] - \mathbf{P} - rCov\left[\mathbf{v}_i\right]\mathbf{q}_i = 0$$

such that the optimal demand for a type-i *investor is given by*

$$\mathbf{q}_i = \frac{1}{r}Cov\left[\mathbf{v}_i\right]^{-1}\left(E\left[\mathbf{v}_i\right] - \mathbf{P}\right).$$

Prices are set such that aggregate demand equals aggregate supply and we assume that per investor there are γ *shares of firm 1 and* $(1-\gamma)$ *shares of firm 2, where we denote* $\Gamma = (\gamma, 1-\gamma)^T$ *the supply vector. Therefore, it has to be the case that, on average,*

$$(1-\lambda)\mathbf{q}_1 + \lambda\mathbf{q}_2 = \mathbf{\Gamma}.$$

Substituting the optimal demands yields

$$\frac{1-\lambda}{r} Cov\left[\mathbf{v}_1\right]^{-1}\left(E\left[\mathbf{v}_1\right]-\mathbf{P}\right)+\frac{\lambda}{r} Cov\left[\mathbf{v}_2\right]^{-1}\left(E\left[\mathbf{v}_2\right]-\mathbf{P}\right)=\mathbf{\Gamma}$$

Rearranging terms yields

$$\frac{1-\lambda}{r}\mathbf{\Sigma}_x^{-1}\bar{\mathbf{x}}+\frac{\lambda}{r}\left(\mathbf{\Sigma}_x+\mathbf{\Sigma}_y\right)^{-1}\left(\bar{\mathbf{x}}+\bar{\mathbf{y}}\right)-\mathbf{\Gamma}=\left(\frac{1-\lambda}{r}\mathbf{\Sigma}_x^{-1}+\frac{\lambda}{r}\left(\mathbf{\Sigma}_x+\mathbf{\Sigma}_y\right)^{-1}\right)\mathbf{P}.$$

Therefore, the equilibrium price vector is given by

$$\mathbf{P}=\bar{\mathbf{x}}+\left(\left(1-\lambda\right)\mathbf{\Sigma}_x^{-1}+\lambda\left(\mathbf{\Sigma}_x+\mathbf{\Sigma}_y\right)^{-1}\right)^{-1}\left(\lambda\left(\mathbf{\Sigma}_x+\mathbf{\Sigma}_y\right)^{-1}\bar{\mathbf{y}}-r\mathbf{\Gamma}\right).$$

Proposition (3): *Let $\gamma \rightarrow 0$, this implies that*

$$p_1=\bar{x}+\lambda C_1\bar{y}-rRP_1, \tag{39}$$

where $C_1=\frac{\sigma_{x1}^2\sigma_{x2}^2-\sigma_{x12}^2+\left(\sigma_{x1}^2\left(\sigma_{y2}^2-\sigma_{y12}\right)+\sigma_{x12}\left(\sigma_{y1}^2-\sigma_{y12}\right)\right)(1-\lambda)}{\sigma_{x1}^2\sigma_{x2}^2-\sigma_{x12}^2+(1-\lambda)^2\left(\sigma_{y1}^2\sigma_{y2}^2-\sigma_{y12}^2\right)+\left(\sigma_{x1}^2\sigma_{y2}^2+\sigma_{x2}^2\sigma_{y1}^2-2\sigma_{x12}\sigma_{y12}\right)(1-\lambda)}$ *and* $RP_1=\frac{-\sigma_{x12}(\sigma_{x12}+\sigma_{y12})^2+\lambda\sigma_{y12}\left(\sigma_{x12}^2+\sigma_{x1}^2\sigma_{x2}^2+\sigma_{x12}\sigma_{y12}\right)+\sigma_{x12}\left(\sigma_{x1}^2\sigma_{x2}^2+\left(\sigma_{x1}^2\sigma_{y2}^2+\sigma_{x2}^2\sigma_{y1}^2+\sigma_{y1}^2\sigma_{y2}^2\right)(1-\lambda)\right)}{\sigma_{x1}^2\sigma_{x2}^2-\sigma_{x12}^2+(1-\lambda)^2\left(\sigma_{y1}^2\sigma_{y2}^2-\sigma_{y12}^2\right)+\left(\sigma_{x1}^2\sigma_{y2}^2+\sigma_{x2}^2\sigma_{y1}^2-2\sigma_{x12}\sigma_{y12}\right)(1-\lambda)}$. *The risk premium, RP_1, contains both systematic and idiosyncratic risk. In other words, $\frac{\partial RP_1}{\partial\sigma_{x1}^2}\neq 0$ and $\frac{\partial RP_1}{\partial\sigma_{y1}^2}\neq 0$.*

B Non-zero correlation between x and y

B.1 The basic single-asset model

This section discusses the differences to the main text that arise when x and y are correlated with $Cov\left[\tilde{x},\tilde{y}\right]=\rho\sigma_x\sigma_y$. While a type-1 investor's certainty equivalent and, therefore, demand is not affected in the base model, a type-2 investor's certainty equivalent and demand are given by

$$CE_2 = q_2\left(\bar{x}+\bar{y}-p\right)-\frac{1}{2}rq_2^2\left(\sigma_x^2+\sigma_y^2+2\rho\sigma_x\sigma_y\right) \text{ and} \tag{40}$$

$$q_2 = \frac{\bar{x}+\bar{y}-p}{r\left(\sigma_x^2+\sigma_y^2+2\rho\sigma_x\sigma_y\right)}. \tag{41}$$

The market-clearing condition is then given by

$$(1-\lambda)\frac{\bar{x}-p}{r\sigma_x^2}+\lambda\frac{\bar{x}+\bar{y}-p}{r\left(\sigma_x^2+\sigma_y^2+2\rho\sigma_x\sigma_y\right)}=1. \tag{42}$$

This implies that the equilibrium price is

$$p = \bar{x}+\frac{\lambda\sigma_x^2}{\sigma_x^2+(1-\lambda)\left(\sigma_y^2+2\rho\sigma_x\sigma_y\right)}\bar{y}-r\frac{\sigma_x^2\left(\sigma_x^2+\sigma_y^2+2\rho\sigma_x\sigma_y\right)}{\sigma_x^2+(1-\lambda)\left(\sigma_y^2+2\rho\sigma_x\sigma_y\right)} \tag{43}$$

$$= \bar{x}-r\sigma_x^2+\frac{\lambda\sigma_x^2}{\sigma_x^2+(1-\lambda)\left(\sigma_y^2+2\rho\sigma_x\sigma_y\right)}\left(\bar{y}-r\left(\sigma_y^2+2\rho\sigma_x\sigma_y\right)\right). \tag{44}$$

This implies that an increase in the correlation, ρ, decreases the extent to which $\bar{y}$ is priced. The reason is that an increase in ρ increases the perceived risk of type-2 investors and, therefore, decreases their equilibrium holdings. The increase in perceived risk and the decrease in holdings have countervailing effects on the risk premium, however, the first effect dominates such that the risk premium increases when ρ increases,

$$\frac{\partial\left(r\frac{\sigma_x^2\left(\sigma_x^2+\sigma_y^2+2\rho\sigma_x\sigma_y\right)}{\sigma_x^2+(1-\lambda)\left(\sigma_y^2+2\rho\sigma_x\sigma_y\right)}\right)}{\partial\rho}=2r\frac{\lambda\sigma_x^5\sigma_y}{\left(\sigma_x^2+(1-\lambda)\left(\sigma_y^2+2\rho\sigma_x\sigma_y\right)\right)^2}>0.$$

This implies that when $\bar{y}>0$ then $\frac{dp}{d\rho}<0$.