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# The source of information in prices and investment-price sensitivity☆

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## ARTICLE INFO

## ABSTRACT

This paper shows that real decisions depend not only on the *total* amount of information in prices, but the *source* of this information—a manager learns from prices when they contain information not possessed by him. We use the staggered enforcement of insider trading laws across 27 countries as a shock to the source of information that leaves total information unchanged: enforcement reduces (increases) managers' (outsiders') contribution to the stock price. Consistent with the predictions of our theoretical model, enforcement increases investment-$q$ sensitivity, even when controlling for total price informativeness. The effect is larger in industries where learning is likely to be stronger, and in emerging countries where outsider information acquisition rises most post-enforcement. Enforcement does not increase the sensitivity of investment to cash flow, a non-price measure of investment opportunities. These findings suggest that extant measures of price efficiency should be rethought when evaluating real efficiency. More broadly, our paper provides causal evidence that managers learn from prices, by using a shock to price informativeness.

## 1. Introduction

Efficient financial markets can promote efficient real decisions. When prices are more informative, outside investors suffer less information asymmetry. As a result, they are more willing to provide capital to firms in primary financial markets, facilitating investment (Stiglitz and Weiss, 1981). Under this channel, the extent to which financial markets support capital raising, and thus real investment, depends on the *total* amount of information in prices. In a recent survey, Bond et al. (2012) term this notion Forecasting Price Efficiency (FPE), i.e., the extent to which prices predict fundamental values. Due to this conventional view, regulatory changes (e.g., short-sale constraints and transaction taxes) are typically evaluated according to their likely impact on total price informativeness.

However, Bond et al. (2012) note that most activity occurs in secondary financial markets, where no new capital is raised by firms. Secondary markets improve real decisions through a different channel: they aggregate the information of millions of investors (Hayek, 1945), which can guide managerial actions. The value of secondary markets for real decisions may not depend on the total information in prices (FPE), because some of this information is already known to the decision maker. Since he will use his own information regardless of the degree to which it is in the price, this degree does not matter for real efficiency. Instead, the value of secondary markets depends on the amount of information prices reveal for decision-making—i.e., *the amount of information not already possessed by the decision maker*. Bond et al. term this notion Revelatory Price Efficiency (RPE) and propose it as a new measure of financial efficiency. However, RPE has no natural empirical proxy, making it difficult to study empirically.

Our goal is to study whether real decisions depend on RPE, and thus the source of information in prices, rather than only total information (FPE). This question is important, because if RPE indeed matters, standard measures of financial efficiency are not sufficient for gauging real efficiency. We study this question in the context of investment, a major corporate decision. Specifically, we hypothesize that the manager uses the stock price as a signal of his investment opportunities, and so the sensitivity of investment to Tobin's $q$ will be increasing in the amount of information in prices not possessed by him.

We address the absence of a natural measure for RPE by studying a plausible shock to RPE that need not affect FPE. Such a shock should satisfy three criteria. First, it should increase the amount of outsider information in the stock price, by raising outsiders' incentives to acquire information. Second, it should not increase total information, i.e., FPE, and thus should also decrease the amount of insider information in the stock price. Satisfying both criteria simultaneously is difficult, since commonly used shocks to the ability to trade on information, and thus the incentives to acquire it in the first place (e.g., decimalization) affect both insiders and outsiders. Third, it should not affect investment-$q$ sensitivity directly.

We build a theoretical model which demonstrates how insider trading enforcement (ITE) satisfies the above criteria. Our model features an insider, multiple outsiders, and liquidity traders. While most models of learning from prices cap trading volumes (e.g. between −1 and +1) and assume that traders are exogenously informed or uninformed, our model features endogenous trading volumes and endogenous information acquisition, which are both critical for understanding the effect of ITE on price efficiency and real efficiency. Despite this richness, we are able to solve for all key quantities in closed form, leading to clear empirical predictions. In our model, the insider (the firm's manager) has private information, and outsiders can acquire it at a cost; both trade on their information. The manager also takes an investment decision whose value depends on private information. The insider and informed outsiders have different components of private information—the manager is better informed about internal firm conditions and outsiders about industry

prospects—and so the manager wishes to learn outsiders' information from prices. The extent to which he does so depends on the relevance of outsiders' information for investment.

By deterring insiders from trading, ITE reduces competition, thus leading to outsiders gathering more information and increasing the information in prices not possessed by the manager (RPE). However, ITE has an ambiguous effect on total information (FPE), depending on whether the rise in outsider information in prices is larger or smaller than the fall in insider information. Regardless of the sign of the effect on FPE, investment-$q$ sensitivity rises due to the increase in RPE, if outsiders' information is sufficiently relevant for investment.[1] The model's results apply to both cross-sectional and time-series investment-$q$ sensitivity. The greater the new information in stock prices, the greater the extent to which managers of different firms will base their investment levels on their respective stock prices (increasing cross-sectional investment-$q$ sensitivity) and to which a given manager will vary his investment level around the firm mean depending on how his stock price varies around the firm mean (increasing time-series investment-$q$ sensitivity).

The strength of the effect of ITE on RPE (and thus investment-$q$ sensitivity) and FPE depends on various parameters. Empirically, Bushman et al. (2005) find that analyst coverage (a measure of outsider information acquisition) rises after ITE, particularly in emerging countries, and Fernandes and Ferreira (2009) find that total price informativeness is unchanged following ITE in emerging countries[2] (while it rises in developed countries). Thus, the model predicts that the increase in investment-$q$ sensitivity will be stronger in emerging countries, even though FPE does not rise in such countries. In addition to the theoretical justifications, a separate advantage of ITE is that it was staggered over time across 27 countries, reducing the risk that any single event was correlated with other factors that drive investment-$q$ sensitivity.

We test the model's predictions using a difference-in-differences analysis, conducted using three specifications. The first is a single-stage analysis, where we regress investment on $q$ and its interactions with ITE. We control not only for country and year fixed effects to capture between-country and across-year differences in investment (as in a standard difference-in-differences analysis), but also these fixed effects interacted with $q$ to capture between-country and across-year differences in investment-$q$ sensitivity. Our specification thus extends the generalized difference-in-differences framework to a setting where the outcome of interest is a slope coefficient (investment-$q$ sensitivity), rather than a level variable. We find that ITE increases investment-$q$ sensitivity by 38%, significant at the 1% level.

One potential concern is that ITE affects investment-$q$ sensitivity because it leads to an increase in FPE, rather

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[1] Fishman and Hagerty (1992) also show that ITE encourages outsiders to gather more information, but do not study its effect on RPE or investment-$q$ sensitivity.

[2] Fernandes and Ferreira (2009) find that the effect of ITE on total price informativeness in emerging countries is insignificantly *negative*, controlling for other country-level variables.

than RPE. We address this issue in two ways. First, we show that the results remain robust to controlling for two measures of FPE (firm-specific return variation and the fraction of non zero return days in the year) and their interactions with $q$. Second, we find that the effect of ITE is stronger in emerging countries, where prior research has found that FPE is unchanged and RPE increases more strongly.

The second specification is a two-stage analysis that focuses on changes in cross-sectional investment-$q$ sensitivity. We first estimate investment-$q$ sensitivity for each country-year and then regress these estimated sensitivities on ITE indicators, country controls, and country and year fixed effects. The third specification is a two-stage analysis that captures both time-series and cross-sectional investment-$q$ sensitivity. The first stage estimates investment-$q$ sensitivity over one panel for the pre-enforcement period and a second panel for the post-enforcement period. The second stage regresses these country-period investment-$q$ sensitivities on ITE indicators. Both two-stage analyses show that investment-$q$ sensitivity rises significantly post-ITE for emerging countries.

In addition to potential changes in FPE, a second concern is that ITE is not random. Countries choose whether to enforce insider trading laws, and this decision could be correlated with omitted macroeconomic variables that also drive investment-$q$ sensitivity. For example, ITE could be correlated with improvements to the financial sector that weaken financing constraints, or with laws that improve governance and lead to the manager investing more efficiently. Both channels could lead to the firm responding more readily to investment signals (such as $q$).[3]

We address the endogeneity of ITE with several findings which, taken together, narrow the range of admissible alternative explanations. First, as described above, the effect of ITE is stronger in emerging countries, where outsider information acquisition rises most (Bushman, Piotroski and Smith, 2005). Second, the sensitivity of investment to cash flow, a non-price measure of investment opportunities, is unchanged following ITE. This finding is consistent with the manager learning more from prices when they contain more information not known to him, but not with him responding more readily to investment opportunities in general after ITE.

Third, our model predicts that the effect of ITE on investment-$q$ sensitivity is increasing in the relevance of outsiders' information for the investment decision. Allen (1993) predicts that the manager will rely less on price signals in industries with high competition (since he can already estimate his firm's production function by observing the actions of his numerous rivals) and low production function uncertainty (since there is less to learn). Consis-

tent with both predictions, the effect of ITE in emerging countries is only significant in concentrated industries, defined either using the price-cost margin or Herfindahl index of sales, or industries with high sales volatility. Separately, the effect of ITE in emerging countries is only significant for firms with low analyst coverage. In such firms, there is most potential for analyst coverage (i.e., outside information acquisition) to rise post-ITE; furthermore, additional analysts are more impactful if a firm had few analysts to begin with.

Fourth, if ITE increases investment-$q$ sensitivity by loosening financial constraints, the effects should be stronger in previously constrained firms. We identify such firms as either firms unable to raise much external financing (Rajan and Zingales, 1998) or small firms (Bakke and Whited, 2010). Using both measures, we find that the effect of ITE in emerging countries is only significant for less constrained firms, inconsistent with the financing channel but consistent with ITE increasing RPE, since less constrained firms are more able to respond to greater new information in prices. Note also that these cross-sectional tests further address the concern that our results are driven by FPE—for this to be the case, FPE must be correlated with not only ITE but also all of our splitting variables.

Fifth, if the effect of ITE arises from correlation with general improvements to the financial sector or governance, then the announcement of insider trading laws might also coincide with such improvements and increase investment-$q$ sensitivity. In contrast, Bhattacharya and Daouk (2002) find that the mere announcement, rather than enforcement, of insider trading laws does not reduce the cost of capital or increase stock liquidity, suggesting that it does not deter insider trading. Similarly, Bushman et al. (2005) find that announcement does not increase analyst coverage. Thus, it does not change the source of information in prices and should not increase investment-$q$ sensitivity, which is what we find.

Finally, we show that there are no differential changes in investment-$q$ sensitivity between enforcers and non-enforcers in the years prior to ITE, addressing concerns that ITE was part of a general trend. A dynamic treatment analysis shows that, while the increase in investment-$q$ sensitivity is positive and significant at the 10% level in the year of ITE and the following year, it is significant at the 1% level from the second year onwards. This result is consistent with outsiders taking time to acquire information post-ITE.

Our paper builds on a recent empirical literature showing that managers learn from prices when making real decisions. Chen et al. (2007) show that investment is particularly sensitive to $q$ for firms with more information in stock prices, measured by both price non-synchronicity and the probability of informed trading. They also note that $q$ should only affect investment to the extent to which it captures information not previously known to the manager, and thus control for insider trading and earnings surprises, two measures of managerial information. Foucault and Frésard (2012) find that investment-$q$ sensitivity is higher in cross-listed firms, which have a wider set of outside investors, and the effect is stronger when cross-listing is more likely to trigger information new to

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[3] A third alternative explanation is that insider trading is a way of compensating the manager, and so the firm must increase compensation post-ITE to keep the manager at his reservation utility (Baiman and Verrecchia, 1996). However, this increased compensation could be paid in fixed salary, and thus not affect investment-$q$ sensitivity. If it were paid in equity, it might increase managerial efficiency in a similar way to superior governance, and so we address this hypothesis using the same tests as for governance. For example, we show that investment-cash flow sensitivity does not increase, and insider trading announcement has no effect.

the manager. Foucault and Frésard (2014) show that firms learn from peer stock prices, particularly when managers were previously uninformed, and thus peer stock prices are more likely to contain new information. Luo (2005), Bakke and Whited (2010), and Edmans et al. (2012) also provide evidence of managerial learning from prices. In addition to our theoretical model, we make two related empirical contributions. First, correlations between price informativeness and real decisions may result from omitted variables. Prior studies recognize the endogeneity of price informativeness and either show that the correlation is stronger where learning is more likely and/or directly test and refute alternative explanations. We identify a shock to price informativeness which helps us move further towards identifying causality.[4] Thus, independently of the FPE/RPE distinction, we provide evidence that managers learn from prices using a plausibly exogenous shock. Second, our shock to price informativeness is a shock specifically to outsider information in the stock price, rather than total information. We can thus study the effect of ITE on investment-$q$ sensitivity while controlling for total information, allowing us to more cleanly separate the effects of FPE and RPE. The first contribution allows us to demonstrate a causal effect of price informativeness in general on investment-$q$ sensitivity; the second allows us to demonstrate a causal effect of RPE in particular.

Bai et al. (2016) also note the distinction between FPE and RPE. They use the efficiency of real decisions (the predictability of cash flows from investment, and the cross-sectional dispersion of investment) to infer RPE, i.e., infer from the rise in real efficiency that RPE must have risen. In contrast, we study an event that is likely to increase RPE on a priori grounds and *then* study the consequences of this shock on real decisions.

Our paper also contributes to the literature on the effects of insider trading on real efficiency, reviewed by Bhattacharya (2014). This literature typically focuses on two channels. First, insider trading increases adverse selection and thus reduces outsiders' incentives to invest in primary markets (Leland, 1992), support real investment by the firm (Manove, 1989), or engage in real investment themselves (Ausubel, 1990). Second, insider trading increases the extent to which an incumbent's stock price reflects industry prospects, and thus guides a newcomer's entry decision (Fishman and Hagerty, 1992). In both channels, what matters is total information in prices (FPE). Our paper argues that the real effects of insider trading depend instead on how it affects new information in prices (RPE). In contrast to this literature, insider and outsider information are not substitutes.

An independent paper by Chen et al. (2016) shares our headline result that ITE increases investment-$q$ sensitivity. However, our papers address quite different research questions. Our goal is to show that the impact of financial markets on real decisions depends not only on the total amount of information in prices, but the source of this information. In this context, we use ITE as a shock to

RPE that does not affect FPE. In contrast, their goal is to study the impact of corporate transparency on capital allocation efficiency, and use ITE as a shock to corporate transparency. Their angle is more related to the total price informativeness channel, as transparency is generally thought of as increasing total price informativeness. These different research questions in turn lead to different supplementary analyses. To isolate the learning channel, we show that the sensitivity of investment to non-price measures of investment opportunities is unchanged, and that our effects are stronger in emerging countries, firms with low prior analyst coverage, and industries where outsiders' information is more relevant for investment. In contrast, their supplementary analyses study settings in which corporate transparency is more likely to be important, such as firms that are opaque or have agency problems. In addition, we build a theoretical model to demonstrate the impact of ITE on RPE and investment-$q$ sensitivity, and how this effect depends on the relevance of outsider information for the investment decision.

This paper is organized as follows. Section 2 presents the theoretical model. Section 3 describes the data and empirical specifications, and Section 4 analyzes the results. Section 5 details robustness tests and Section 6 concludes. All proofs are in Appendix A.

## 2. The model

Consider a publicly traded firm with assets in place $\theta = \theta_1 + \theta_2$. The firm's securities (normalized to zero) are traded by three types of risk-neutral traders: multiple outsiders ("she"), one insider ("he"), and liquidity traders ("they"). There are three periods. At $t = 1$, traders may acquire information and trade. Outsider $i$ can pay a fixed cost $F$ to acquire information on assets in place. If she does so, she privately observes the signal $s_i = \theta_1 + \theta_2 + \eta_i$; if not, she remains uninformed and does not trade. Let "speculator" refer to an outsider who chooses to become informed, $a$ denote the number of speculators, and $x_i$ the trade of speculator $i$. As in Fishman and Hagerty (1992), we allow the number of speculators to be a continuous variable to avoid integer issues. The insider is the firm's manager who costlessly and privately observes the signal $s_M = \theta_1$, and trades $y$ on his personal account.[5] The random variables $\{\theta_1, \theta_2, \eta_i\}$ are mutually independent and normally distributed with zero means and precisions $\{h_\theta, h_\theta, h_\eta\}$.[6] This information structure captures the fact that insiders and outsiders are informed about different dimensions of assets in place. The variable $\theta_1$ ($\theta_2$) represents the component about which insiders (outsiders) have superior information, such as internal information on firm

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[5] Consistent with the corporate finance literature, we assume that the manager automatically has private information as a result of running the firm. If the manager has to bear a cost to acquire private information, it may seem that ITE will reduce his incentives to do so. However, if the manager has an incentive contract that aligns him with firm value (as in practice), he will wish to acquire information to guide his investment decision, and so ITE will have little effect on his private information.

[6] As in Goldstein and Yang (2015), both components of assets in place are drawn from the same distribution and thus have the same precision, which significantly simplifies the analysis.

profitability (external information on industry prospects). Outsiders' signal is imprecise due to the noise term $\eta_i$, and so they are less informed about $\theta_1$ than the insider, who has a perfect signal.

Liquidity traders' demands are exogenous and price-dependent. Let $L(z, p) = z - \frac{1}{\lambda}p$ denote their net market order, where $z$ is normally distributed with mean zero and precision $h_z$, and independent of all other random variables. The component $-\frac{1}{\lambda}p$, where $\lambda > 0$, leads to a downward-sloping demand curve as in De Long et al. (1990), Hellwig et al. (2005), and Goldstein et al. (2013). It means that liquidity trader demand $L$, and thus total demand $d = \sum_{i=1}^{a} x_i + y + z - \frac{1}{\lambda}p$, depends on the price, allowing the price to be determined by market clearing ($d = 0$). The higher $\lambda$ is, the more the price $p$ must change to maintain market clearing. We thus refer to $\lambda$ as price impact.

At $t = 2$, the manager invests $K$ units in a growth opportunity at cost $\frac{1}{2}cK^2$, where $c > 0$. The profitability of the growth opportunity is correlated with either $\theta_1$ or $\theta_2$ (or both). He chooses $K$ to maximize expected firm value (assets in place, plus the growth opportunity, minus the cost of investment), based on his private signal $s_M$ and information inferred from the security price $p$:

$$\max_{K} E\left[\underbrace{\theta_1 + \theta_2}_{\text{assets in place}} + \underbrace{((1-\omega)\theta_1 + \omega\theta_2)K}_{\text{growth opportunities}} \right.$$
$$\left. - \underbrace{\frac{1}{2}cK^2}_{\text{investment cost}} \mid s_M, p\right], \tag{1}$$

where $\omega \in [0, 1]$ determines the correlation between growth opportunities and each component of assets in place. An increase in $\omega$ raises the dependence of the investment return on $\theta_2$ and thus the manager's incentive to learn $\theta_2$ from the price. At $t = 3$, all payoffs are realized.

As in Subrahmanyam and Titman (1999) and Foucault and Gehrig (2008), we consider securities that are a claim only to assets in place $\theta$, rather than the sum of assets in place and growth opportunities. This substantially simplifies the model because it means that the investment decision is influenced by the security price, but the security price does not depend on the investment decision. If the security were also a claim to the new investment, its payoff, and thus price, would no longer be normally distributed, and the manager's signal extraction problem becomes intractable. Our assumption is also similar to Fishman and Hagerty (1992) where a potential entrant makes the investment decision, observing the stock price of an incumbent (whose value they assume to be unaffected by the entry decision). It also corresponds to the case in which a conglomerate has a publicly traded division, whose stock price informs the conglomerate's investment in another division.[7]

The equilibrium is defined as follows: (i) A trading strategy $x(s_i) : \mathbb{R} \to \mathbb{R}$ by each speculator that maximizes expected trading profits $x_i(\theta - p)$, given the price function and the insider's trading strategy; (ii) A trading strategy $y(s_M) : \mathbb{R} \to \mathbb{R}$ by the insider that maximizes expected trading profits $y(\theta - p)$, given the price function and the strategy of speculators; (iii) A price function $P(s_M, \{s_i\}_{i=1}^{a}, z) : \mathbb{R}^{a+2} \to \mathbb{R}$ that clears the security market; (iv) An investment decision $K(s_M, p) : \mathbb{R}^2 \to \mathbb{R}$ by the manager that maximizes expected firm value, given the equilibrium security price; and (v) all agents have rational expectations in that each player's belief about the other players' strategies is correct in equilibrium.

Before solving the model, we discuss its assumptions. First, the model does not require the manager to have no signal about $\theta_2$, nor even a less precise signal than speculators. It only requires him to have an imperfect signal of $\theta_2$ (we feature no signal for simplicity), and outsiders to have some information on $\theta_2$, so that he has an incentive to learn from the price. Second, outsiders and the insider have correlated signals, so that they compete and so insider trading reduces outsiders' incentives to become informed. Here, this correlation arises since $s_M$ and $s_i$ share the common component $\theta_1$. We do not require the insider to be perfectly informed on the common signal $\theta_1$; the results would continue to hold if he had a noisy signal, and even if his signal were less precise than outsiders'. This common signal could alternatively be on $\theta_2$, i.e., outsiders could have no signal on $\theta_1$, and the insider a (noisy) signal on $\theta_2$ in addition to $\theta_1$.

### 2.1. Equilibrium

We consider two variants of the model, one in which insider trading is allowed and one in which it is prohibited. Let $a'$ denote the number of speculators when insider trading is prohibited. Taking as given $a$ ($a'$), Lemmas 1 (2) give equilibrium trades and security prices for the cases in which insider trading is allowed (prohibited).

**Lemma 1.** *There is a unique security market equilibrium with insider trading in which:*

1. *Outsiders' demand is given by $x_i = d_x s_i$, where $d_x = \frac{3h_\eta}{4\lambda h_\theta + \lambda(3a+4)h_\eta}$.*
2. *Insider demand is given by $y = d_y s_M$, where $d_y = \frac{2(h_\eta + h_\theta)}{4\lambda h_\theta + \lambda(3a+4)h_\eta}$.*
3. *The security price satisfies $p = \lambda(\sum_{i=1}^{a} x_i + y + z)$.*

**Lemma 2.** *There is a unique security market equilibrium without insider trading in which:*

1. *Outsiders' demand is given by $x_i' = d_x' s_i$, where $d_x' = \frac{h_\eta}{\lambda(h_\theta + (a'+1)h_\eta)}$.*
2. *Insider demand is given by $y' = 0$.*
3. *The security price satisfies $p' = \lambda\left(\sum_{i=1}^{a'} x_i' + y' + z\right)$.*

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[7] Other learning models use other assumptions to avoid the intractability that arises if the security price also depends on the investment opportunity. For example, Goldstein et al. (2013) assume that firm value is gross

of the investment cost, and Leland (1992) assumes that the returns from investment go entirely to new shareholders, not existing ones.

The above lemmas are as in standard insider trading models and so we defer the intuition to Appendix A. More specific to our framework are the optimal investment level $K$, its sensitivity to the security price $\beta_{Kp} \equiv \frac{Cov(K,p)}{Var(p)}$, expected firm value (a measure of real efficiency), and our two price efficiency measures. FPE is the extent to which the security price can forecast its actual payoff $\theta = \theta_1 + \theta_2$, i.e., $Var^{-1}(\theta_1 + \theta_2|p)$. RPE is the extent to which the price provides information over and above the manager's existing signal $s_M$, i.e., $Var^{-1}(\theta_1 + \theta_2|s_M, p)$. Lemma 3 gives these quantities for the case of insider trading; the case of no insider trading is analogous.

*Lemma 3. In the security market equilibrium with insider trading, we have the following:*

1. *Firm investment is given by*

$$K = \frac{1}{c}\left( (1-\omega)\theta_1 + \omega \frac{h_p}{h_\theta + h_p} s_p \right), \tag{2}$$

*where $s_p \equiv \frac{\frac{1}{\lambda}p - y}{ad_x} - \theta_1 = \theta_2 + \frac{1}{a}\sum_{i=1}^{a}\eta_i + \frac{z}{ad_x}$ is an unbiased signal of $\theta_2$ with precision $h_p \equiv \frac{d_x^2 a^2 h_\eta h_z}{h_\eta + d_x^2 a h_z}$.*

2. *Forecasting price efficiency is given by*

$$FPE \equiv \frac{1}{Var(\theta_1 + \theta_2|p)} = \frac{1}{Var(\theta)\left(1 - \rho_{\theta,p}^2\right)} \tag{3}$$

$$= \frac{4h_\theta\left(h_\eta h_\theta + 2d_x^2 a^2 h_\eta h_z + d_x^2 a h_\theta h_z + 2d_y d_x a h_\eta h_z + d_y^2 h_\eta h_z\right)}{2h_\eta h_\theta + 2d_x^2 a h_\theta h_z + d_y^2 h_\eta h_z}.$$

3. *Revelatory price efficiency is given by*

$$RPE \equiv \frac{1}{Var(\theta_1 + \theta_2|s_M, p)} = h_p. \tag{4}$$

4. *Expected firm value is given by*

$$V = \frac{1}{2c}\left( \frac{1 - 2\omega + 2\omega^2}{h_\theta} - \frac{\omega^2}{h_p} \right). \tag{5}$$

5. *Investment-price sensitivity is given by*

$$\beta_{Kp} = \frac{Cov(K,p)}{Var(p)} = \frac{(1-\omega)}{c}\frac{Cov(\theta_1, p)}{Var(p)}$$
$$+ \frac{\omega}{c}\sqrt{\frac{1}{h_\theta Var(p)} - \frac{1}{h_p Var(p)}}, \tag{6}$$

*where*

$$Cov(\theta_1, p) = \frac{d_y + ad_x}{h_\theta}. \tag{7}$$

The intuition is as follows. The optimal investment level $K$ is proportional to the manager's conditional expectation of the investment return $(1-\omega)\theta_1 + \omega\theta_2$. This expectation depends partially on $s_p$, an unbiased signal of $\theta_2$ learned from the price $p$, which has precision $h_p$. Turning to RPE, interestingly, it equals the precision of the price signal $h_p$. Even though these are somewhat different concepts (RPE concerns the precision of information on the overall investment opportunity $\theta_1 + \theta_2$ and the price signal concerns only the precision of $\theta_2$), they are mathematically identical since the insider already knows $\theta_1$. This result suggests that the importance of prices for investment depends on RPE, since it equals the amount of information on $\theta_2$ that the manager can learn from the price. In contrast, FPE is a quite different concept and not related to $h_p$. Expected firm value is increasing in RPE (for any $\omega > 0$) and unrelated to FPE; all other variables are exogenous. Thus, Lemma 3 provides a theoretical justification for RPE as the relevant measure of price efficiency, as argued verbally by Bond et al. (2012).

Finally, investment-price sensitivity $\beta_{Kp}$ arises from two sources of covariance between investment $K$ and the security price $p$. The first is the "trading effect" and given by $Cov(\theta_1, p)$: if the manager receives a high signal $\theta_1$, he invests more (if $\omega < 1$) and also buys securities (if insider trading is allowed), increasing the price; since outsiders' signal is correlated with $\theta_1$, they also buy. Thus, investment-price sensitivity can arise even if the manager did not learn from prices—i.e., even if financial markets had no real effects. The magnitude of the trading effect depends on the number of insiders (1) and trading aggressiveness ($d_y$), plus the number of speculators ($a$) and their trading aggressiveness ($d_x$), as in (7). The second is the "learning effect" : when the price is high, the manager infers that $\theta_2$ is high and invests more. Importantly, the magnitude of the learning effect is increasing in RPE ($h_p$).[8]

### 2.2. The effect of insider trading enforcement

We now analyze the effect of ITE on the equilibrium. Lemma 4 starts with its impact on the number of speculators, FPE, and RPE.

*Lemma 4. ITE increases the number of speculators by $\frac{1}{3}(1 + \frac{h_\theta}{h_\eta})$, and thus increases RPE. The change in FPE has the same sign as $2h_\eta - h_\theta$, which may be positive or negative.*

The intuition is as follows. ITE reduces competition from insiders and thus encourages more outsiders to gather information. This greater number of speculators $a$ in turn increases RPE from Eq. (4).[9] In contrast, the effect on FPE is ambiguous, because FPE depends not only on the amount of outsider information in the price (as with RPE) but also the amount of insider information. While the former rises post-ITE, the latter falls. The overall effect depends on which dominates, and thus the underlying parameters; as discussed previously, Fernandes and Ferreira (2009) find that FPE is constant in emerging countries and rises in developed ones. In sum, ITE satisfies the requirement for a shock that increases RPE but may not change FPE.

The rise in the number of speculators, $\frac{1}{3}(1 + \frac{h_\theta}{h_\eta})$ is increasing in $h_\theta$ and decreasing in $h_\eta$, because high $h_\theta$ and low $h_\eta$ increase speculators' trading aggressiveness $d_x$ (see

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[8] In the limit as $h_p \to 0$, because either $a$, $h_\eta$, or $h_z$ go to zero, the learning effect term disappears. Then the manager cannot learn any valuable information about $\theta_2$ from the security price, and so investment is uncorrelated with $\theta_2$.

[9] Note that $d_x' = d_x$: speculators' trading aggressiveness is unchanged, since the exit of the insider is exactly offset by the entry of the new speculators. Thus, they face the same competition as before, and so trade with the same intensity. All other variables in Eq. (4) are exogenous.

Lemma 1). Intuitively, the extra profit that becomes available post-ITE can accommodate fewer new speculators if these new speculators trade aggressively. The increase in the number of speculators (and thus RPE) will thus be greater in firms about which speculators have a smaller information advantage. Indeed, Bushman et al. (2005) find that outside information acquisition rises more in emerging countries post-ITE, potentially because outsiders' signals are noisier in such countries.

Armed with Lemma 4, we can now analyze the effect of ITE on investment-price sensitivity. This is given by Proposition 1, which forms the main prediction for our empirical tests.

*Proposition 1. ITE increases real efficiency for any $\omega > 0$. The increase in investment-price sensitivity post-ITE, $\beta'_{K'p'} - \beta_{Kp}$, is increasing in $\omega$. There exists $\overline{\omega} \in (0, 1)$ such that the increase is positive if and only if $\omega \geq \overline{\omega}$.*

The intuition is as follows. ITE has opposite effects on the trading and learning effects in Eq. (6). First, it leads to $d'_y = 0$ and $Cov(\theta_1, p') < Cov(\theta_1, p)$, weakening the trading effect and thus decreasing $\beta_{Kp}$. Intuitively, the insider no longer buys and increases the security price when he invests. Second, it increases RPE (Lemma 4), strengthening the learning effect and thus raising $\beta_{Kp}$. Intuitively, ITE reduces competition by insiders and thus increases information acquisition by outsiders. Prices contain more information that is not known to the manager, and so his investment decision responds more strongly to the security price.

The trading effect is increasing in $1 - \omega$, the importance of the manager's signal (which he trades on) for his investment decision. The learning effect is increasing in $\omega$, the importance of speculators' signal (which he learns from prices). Thus, if and only if $\omega$ is sufficiently high, ITE increases $\beta_{Kp}$.[10] In contrast, ITE increases real efficiency for any $\omega > 0$. This is because real efficiency depends only on the learning effect and not the trading effect—since the manager uses his signal on $\theta_1$ regardless, the extent to which it is incorporated in prices does not matter. ITE always has a positive learning effect, and it does not matter for real efficiency whether it is outweighed by the negative learning effect (i.e., $\omega$ is small). We do not test the impact of ITE on real efficiency as it can occur through many channels other than learning—for example, Bhattacharya and Daouk (2002) show that ITE reduces the cost of capital and Bushman et al. (2005) show that it affects analyst coverage (in turn, Derrien and Kecskés, 2013 show that analyst coverage has real effects).

The above model considers a single firm at a single point in time, and so the investment-q sensitivity coefficient $\beta_{Kp}$ captures the hypothetical link between investment and prices for different realizations of the model, which in turn correspond to different realizations of the random variables. The model's results also apply to both cross-sectional investment-q sensitivity for multiple firms at a given point in time, and time-series investment-q sensitivity for a given firm across multiple periods. Starting with the former, the greater the new information in stock prices, the greater the extent to which managers of different firms will be basing their investment levels on their respective stock prices, thus increasing cross-sectional investment-q sensitivity. This result echoes Bai et al. (2016) who use the cross-sectional standard deviation in predicted earnings from investment as a measure of economic efficiency—if prices are totally uninformative, firms will all invest at the same level regardless of prices; the more informative prices are, the greater the cross-sectional dispersion in investment (and thus predicted earnings from investment). Moving to the latter, the greater the new information in stock prices, the greater the extent to which a single manager will vary his investment level around the firm mean, based on how the stock price varies around the firm mean.

## 3. Data and empirical approach

This section describes our data sources, the calculation of the variables used in the empirical analysis, and our regression specifications.

### 3.1. Sample and sources

We take ITE dates hand-collected by Bhattacharya and Daouk (2002), stock prices from Datastream, financial data from Worldscope, and country-level macroeconomic variables from the World Bank's World Development Indicators (WDI) database. We begin with the 48 countries in Worldscope studied by Fernandes and Ferreira (2009) and use their start date of 1980; we end in 2009.[11] We measure investment as of the following year, and so study it from 1981–2010. Since our two-stage analysis estimates investment-q sensitivity for each country-year, we require countries to have data on at least 100 firms in each year. Our final sample comprises 328,588 firm-year observations on 43,006 unique firms that span 552 country-years, 40 nonfinancial industries, and 39 countries out of which 27 enforced insider trading laws between 1980 and 2009 ("enforcers"), seven had not enforced by 2009 ("non-enforcers"), and five had enforced prior to 1980 ("already-enforcers").[12] We divide these countries into emerging and

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[10] ITE has a third effect on $\beta_{Kp}$: in addition to changing the numerator $Cov(K, p)$ via the trading and learning effects, it also changes the denominator $Var(p)$. However, rearranging (3) yields $Var(p) = \frac{2(h_\theta + (3a+1)h_\eta)^2}{(1-FPE^{-1})h_\theta(4h_\theta + (3a+4)h_\eta)^2}$. Thus, the effect on $Var(p)$ is independent of $\omega$.

[11] We have verified that the results are robust to different end dates. One possibility is to include as much data as possible and end in 2015. However, this end date is quite distant from the last enforcement date, 1998. Another possibility is to end in 2003, which is five years after the last enforcement date. However, we wish the sample to cover not only upturns but also economic downturns, and thus end in 2009, to include the 2007–8 financial crisis. In Section 5.2 we show that the results are robust to studying a narrow window around ITE dates.

[12] We start with 351,493 nonfinancial observations for the 48 countries identified in Fernandes and Ferreira (2009). The requirement of 100 firms per year reduces us to 39 countries and 328,594 observations. Our results are unaffected by this restriction: without it, our key coefficient of interest (on $Q \times ITE$) remains positive and significant at the 1% level. We lose six observations without an industry affiliation, leading to a final sample of 328,588 observations.

**Table 1**

List of countries.

The list of first-time enforcers and non-enforcers is from Bhattacharya and Daouk (2002). ITE year (ITA year) denotes the year of first-time enforcement (announcement) of insider trading laws. Firm-years denotes the number of firm-year observations on Worldscope within each country, while Country-years represents the number of country-year (predicted) observations of investment-*q* sensitivity. Countries with fewer than 100 observations per year are excluded from both samples. The sample period is 1981–2010. Emerging countries are denoted by an asterisk (*).

| Country | ITE year | ITA year | Firm-years | Country-years |
|---|---|---|---|---|
| Australia | 1996 | 1991 | 14,277 | 21 |
| Belgium | 1994 | 1990 | 322 | 3 |
| Brazil* | 1978 | 1976 | 322 | 3 |
| Canada | 1976 | 1966 | 20,247 | 25 |
| Chile* | 1996 | 1981 | 1,605 | 11 |
| China | – | 1993 | 14,085 | 13 |
| Denmark | 1996 | 1991 | 1,969 | 17 |
| Finland | 1993 | 1989 | 1,115 | 10 |
| France | 1975 | 1967 | 10,416 | 22 |
| Germany | 1995 | 1994 | 13,526 | 22 |
| Greece* | 1996 | 1988 | 1,216 | 5 |
| Hong Kong | 1994 | 1991 | 10,000 | 18 |
| India* | 1998 | 1992 | 11,902 | 18 |
| Indonesia* | 1996 | 1991 | 3,512 | 15 |
| Israel* | 1989 | 1981 | 2,018 | 6 |
| Italy | 1996 | 1991 | 3,123 | 21 |
| Japan | 1990 | 1988 | 42,967 | 30 |
| Malaysia* | 1996 | 1973 | 10,228 | 19 |
| Mexico* | – | 1975 | 203 | 2 |
| Netherlands | 1994 | 1989 | 2,652 | 20 |
| New Zealand | – | 1988 | 533 | 5 |
| Norway | 1990 | 1985 | 1,710 | 13 |
| Pakistan* | – | 1995 | 621 | 5 |
| Peru* | 1994 | 1991 | 100 | 1 |
| Philippines* | – | 1982 | 1,785 | 11 |
| Poland* | 1993 | 1991 | 1,341 | 7 |
| Russia* | – | 1996 | 859 | 4 |
| Singapore | 1978 | 1973 | 5,998 | 16 |
| South Africa* | – | 1989 | 4,062 | 18 |
| South Korea* | 1988 | 1976 | 12,195 | 17 |
| Spain | 1998 | 1994 | 1,567 | 14 |
| Sri Lanka* | 1996 | 1987 | 701 | 5 |
| Sweden | 1990 | 1971 | 3,458 | 15 |
| Switzerland | 1995 | 1988 | 2,687 | 17 |
| Thailand* | 1993 | 1984 | 8,741 | 19 |
| Turkey* | 1996 | 1981 | 1,563 | 9 |
| UK | 1981 | 1980 | 29,443 | 30 |
| USA | 1961 | 1934 | 74,141 | 29 |
| Total | | | 328, 588 | 552 |

**Table 2**

Descriptive statistics.

The sample comprises 328,588 firm-year observations on 43,006 unique firms that span 39 countries and 40 nonfinancial industries over 1980–2009. Detailed variable definitions are in Appendix B.

| Variable | Obs. | Mean | Median | S.D. | Min | Max |
|---|---|---|---|---|---|---|
| *AGE* | 328,588 | 11.112 | 9.000 | 7.881 | 1.000 | 36.000 |
| *CASH* | 328,588 | 0.168 | 0.100 | 0.193 | 0.000 | 0.902 |
| *CF* | 328,588 | −0.005 | 0.075 | 0.418 | −2.999 | 0.393 |
| *FSRV* | 324,423 | 0.665 | 0.675 | 0.070 | 0.441 | 0.940 |
| *GDP* ($) | 317,263 | 9.801 | 10.267 | 1.137 | 5.628 | 11.444 |
| *GDPGROW* (%) | 317,263 | 2.207 | 2.109 | 3.172 | −14.321 | 13.605 |
| *INFL* (%) | 317,263 | 2.571 | 2.192 | 3.614 | −6.663 | 75.271 |
| *INV* | 328,588 | 0.072 | 0.036 | 0.111 | 0.000 | 0.728 |
| *LEV* | 328,588 | 0.133 | 0.066 | 0.172 | 0.000 | 0.842 |
| *ME* ($m) | 328,588 | 4.516 | 4.421 | 1.948 | 0.652 | 9.444 |
| *NZRET* | 324,423 | 0.942 | 1.000 | 0.126 | 0.250 | 1.000 |
| *Q* | 328,588 | 2.298 | 1.267 | 4.199 | 0.411 | 34.817 |
| *RETAINED* | 291,769 | −1.114 | 0.059 | 5.491 | −43.918 | 0.713 |
| *SGR* | 276,486 | 0.187 | 0.070 | 0.687 | −0.908 | 4.921 |
| *TRADE* | 317,263 | 0.397 | 0.331 | 0.295 | 0.127 | 1.514 |

### 3.2. Hypotheses, variable construction, and regression specifications

Our hypothesis is that, as predicted by Proposition 1, ITE increases investment-*q* sensitivity if outside information is sufficiently important. We test this hypothesis using a difference-in-differences approach that compares changes in investment-*q* sensitivity before and after ITE for treated countries (enforcers) to control countries. These control countries include not only non-enforcers, but also countries that previously enforced these laws and those that will subsequently enforce these laws. For example, to identify the effect of ITE on investment-*q* sensitivity for Belgium (that enforced insider trading laws in 1994), we implicitly compare Belgium's changes in investment-*q* sensitivity to four sets of controls—non-enforcers (e.g., China), already-enforcers (e.g., France), enforcers during our sample period before 1994 (e.g., Norway), and enforcers during our sample period after 1994 (e.g., Italy). The staggered enforcement across the 27 enforcers means that our identification comes from several events scattered over time, which attenuates (but does not eliminate) concerns that one particular event may be correlated with unobservable factors that also drive investment-*q* sensitivity. We implement our approach in three ways, which we now describe.

### 3.2.1. Single-stage specification

Our main specification is a single-stage, firm-level regression, given by Eq. (8) below:

$$
\begin{aligned}
INV_{i,c,t+1} = {} & \beta_1 Country_c + \beta_2 Year_t + \beta_3 ITE_{c,t} + \beta_4 Q_{i,c,t} \\
& + \beta_5 Q_{i,c,t} \times Country_c + \beta_6 Q_{i,c,t} \times Year_t \\
& + \beta_7 Q_{i,c,t} \times ITE_{c,t} + \beta_8 CF_{i,c,t} + \beta_9 CF_{i,c,t} \\
& \times Country_c + \beta_{10} CF_{i,c,t} \times Year_t + \beta_{11} CF_{i,c,t} \\
& \times ITE_{c,t} + \beta_{12} CTRY\_CTRL + \varepsilon_{i,c,t}. \qquad (8)
\end{aligned}
$$

$INV_{i,c,t+1}$ represents investment for firm *i* headquartered in country *c* during year $t+1$. *Country* is a vector of country indicators and *Year* is a vector of year indicators. *ITE* is an indicator that equals one on or after ITE for enforcers,

developed following the classification of Bhattacharya and Daouk (2002).

Table 1 presents the list of our sample countries and the year in which they first enforced insider trading laws. We also tabulate the year when insider trading laws are first announced, which we use in Section 5.1 as a falsification test. The final two columns present the number of firm-year and country-year observations. Table 2 provides summary statistics. The median investment rate, defined as capital expenditures scaled by lagged total assets, is 3.6%. The median Tobin's *q*, the ratio of market value of assets (market value of equity plus book value of debt) divided by book value of assets, is 1.267. Market equity for the median firm is $83 million.

and is zero for already-enforcers, non-enforcers, and enforcers pre-ITE.

A standard difference-in-differences framework studies the effect of an event on a level variable. In our context, this would equate to studying the impact of *ITE* on investment, i.e., the coefficient $\beta_3$. The standalone fixed effects *Country* and *Year* capture between-country and across-year differences in investment, and so $\beta_3$ captures the increase in investment in enforcing countries post-ITE, over and above any change in other countries and controlling for the average level of investment within each country.

However, in our setting, we are interested not in a level variable, but in a slope coefficient—investment-*q* sensitivity. The standalone fixed effects only capture differences in the level of investment, not investment-*q* sensitivity. We thus add the interactions $Q \times Country$ and $Q \times Year$ to capture between-country and across-year differences in investment-*q* sensitivity. As a result, the coefficient $\beta_7$ captures the increase in investment-*q* sensitivity in enforcers as a result of ITE, controlling for between-country differences and time trends. To our knowledge, Eq. (8) is the first to extend the standard difference-in-differences framework to a setting in which the outcome of interest is not a level variable but a slope coefficient.[13]

While *Q* is a price-based measure of a firm's investment opportunities, *CF* (cash flow, defined as operating earnings plus depreciation and amortization, scaled by total assets) is a non-price-based measure. We similarly interact *CF* with *Country*, *Year*, and *ITE* indicators to allow us to study whether investment-cash flow sensitivity increases around ITE. *CTRY_CTRL* is a vector of country-level controls. These are macroeconomic variables that capture economic growth and bilateral trade, which could be correlated with the decision to enforce insider trading laws and also drive investment. These variables are log Gross Domestic Product per capita (*GDP*), annual growth in GDP per capita (*GDPGROW*), annual inflation (*INFL*), and global trade (*TRADE*), defined as the log of exports plus imports scaled by annual GDP. Detailed variable definitions are in Appendix B. In our main specification, we do not include additional firm-level controls, since firm-level variables may be affected by ITE, as found by Bushman et al. (2005) and Fernandes and Ferreira (2009). As Roberts and Whited (2012) argue, "any covariates included as controls must be unaffected by the treatment." However, we will include additional firm-level controls as a robustness check in Section 5.[14]

The null hypothesis is that $\beta_7 = 0$, i.e., that investment-*q* sensitivity is unaffected by ITE. This hypothesis would hold in two scenarios. First, we have a "weak event" — ITE does not have a significant effect on insider trading or outsiders' incentives to gather information, so that we re-

main in Lemma 1 and all variables are unchanged. Second, the event is not weak, and the manager learns from prices, but the extent to which he does depends on total information (FPE) rather than RPE. This would arise if the manager did not have a signal on $\theta_1$ and instead the insider were separate from the manager (e.g., a director or blockholder). We consider this model in Appendix C. In this case, the manager seeks to learn all information from the stock price, and it is FPE that matters for investment-*q* sensitivity. Then, $\beta_7 = 0$ would arise either if FPE is unchanged after ITE (which Fernandes and Ferreira, 2009 find is the case for emerging countries) or the regression controls for FPE.

Our hypothesis is that $\beta_7 > 0$. This hypothesis requires two conditions to hold: the manager learns sufficiently from prices because they contain information relevant for investment ($\omega > \overline{\omega}$), and the extent to which he learns depends on RPE, not FPE (since he already has a signal $\theta_1$). While the former condition (learning in general) has been shown by prior literature, cleanly identifying the latter (that learning depends on information in prices not known to the manager) is the focus of this paper. We call this the "RPE hypothesis."

An alternative hypothesis is that outsider information is not sufficiently relevant for prices ($\omega < \overline{\omega}$), in which case the correlation between investment and *q* stems primarily from the trading effect. This alternative hypothesis would predict $\beta_7 < 0$, since ITE weakens the trading effect.

While finding that $\beta_7 > 0$ would support the RPE hypothesis, it would also be consistent with ITE leading to firms responding more to investment opportunities in general (rather than just to price-based measures of investment opportunities)—perhaps because ITE is correlated with improvements in capital markets, which facilitate the financing of investment, or improvements in governance, which induce the manager to respond more to investment signals. Thus, we wish to show that investment does not also become more sensitive to cash flow post-ITE. We therefore predict that $\beta_{11}$ is non-positive.

We estimate Eq. (8) at the firm level, including industry and year fixed effects. Our baseline specification excludes firm fixed effects for two reasons. First, Roberts and Whited (2012) argue that, since investment is the first difference of capital stock, the fixed effect has already been differenced out of the regression and so adding it reduces efficiency. Second, as discussed in Section 2, our model has implications for both time-series and cross-sectional investment-*q* sensitivity. In alternative specifications, we include additional fixed effects. First, we replace industry fixed effects with firm fixed effects to address the concern that investment may vary across firms for reasons other than differences in *q*; for example, one firm may systematically be financially constrained or risk-averse. There is a trade-off as firm fixed effects remove cross-sectional investment-*q* sensitivity and focus on time-series sensitivity, so this specification can be viewed as more conservative. The next specification in Section 3.2.2 will focus on cross-sectional investment-*q* sensitivity. Second, our most stringent specification includes country-year as well as firm fixed effects, i.e., two-dimensional fixed effects as recommended by Gormley and Matsa (2014). We include country-year fixed effects to attenuate (although

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[13] A number of papers, e.g., Gormley et al. (2012) and Gormley et al. (2013) study a difference-in-differences on a slope coefficient with fixed effects. We interact both year and country fixed effects with the independent variable in the regression slope (*Q*, in our case) to capture between-country and across-year differences in this slope.

[14] We include cash flow as the only control to test whether investment becomes more sensitive to non-price measures of investment opportunities, which would not be consistent with the learning channel.

not eliminate) the concern that ITE is endogenous: countries' decision to enforce insider trading laws could be correlated with unobservable country-level, time-varying macroeconomic factors that drive investment. As suggested by Bertrand et al. (2004), we cluster standard errors at the country level.

### 3.2.2. Two-stage specification

While the single-stage specification treats every firm-year observation equally, one potential drawback is that the results may be skewed by a small number of countries with many firms. We thus now study two two-stage specifications where the analysis is at the country level and thus weights each country equally. Our first two-stage specification is given below:

$$INV_{i,c,t+1} = \alpha_{c,t} + \beta_{c,t}^{Q} Q_{i,c,t} + \beta_{c,t}^{CF} CF_{i,c,t} + \varepsilon_{i,c,t+1} \qquad (9)$$

and

$$\widehat{\beta}_{c,t}^{Q} = \gamma_1 Country_c + \gamma_2 Year_t + \gamma_3 ITE_{c,t} \\ + \gamma_4 CTRY\_CTRL_{c,t} + \varepsilon_{c,t}. \qquad (10)$$

This analysis focuses on how cross-sectional investment-$q$ sensitivity changes for a particular country after ITE. The first stage (Eq. (9)) is a firm-level regression that estimates cross-sectional investment-$q$ sensitivities $\widehat{\beta}_{c,t}^{Q}$ in a given country-year. The second stage is a country-level regression that regresses these (predicted) investment-$q$ sensitivities on ITE, country and year fixed effects, and country-level controls − similar to a standard generalized difference-in-differences. We cluster standard errors at the country level. Our hypothesis is that $\gamma_3 > 0$, i.e. cross-sectional investment-$q$ sensitivity, for a particular country in a given year, rises after that country enforces insider trading laws.

While Eqs. (9) and (10) represent a two-stage analysis at the country-year level, focusing on cross-sectional investment-$q$ sensitivity, we can also conduct a two-stage analysis at a country-period level:

$$INV_{i,c,p,t+1} = \alpha_{c,p} + \beta_{c,p}^{Q} Q_{i,c,p,t} + \beta_{c,p}^{CF} CF_{i,c,p,t} + \varepsilon_{i,c,p,t+1} \quad (11)$$

and

$$\widehat{\beta}_{c,p}^{Q} = \alpha + \delta ITE_{c,p} + \varepsilon_{c,p}, \qquad (12)$$

where the $p$ subscript corresponds to a period. There are two periods, pre-ITE and post-ITE, and the analysis is restricted to enforcers. Thus, the first stage (Eq. (11)) estimates investment-$q$ sensitivity for a country either in the pre-ITE period or the post-ITE period. Pre-ITE (post-ITE) investment-$q$ sensitivity captures both time-series and cross-sectional investment-$q$ sensitivity for that country before (after) enforcement. The second stage regresses $\widehat{\beta}_{c,p}^{Q}$ on an ITE indicator to study whether the country's investment-$q$ sensitivity rose post-ITE.

In short, the country-year analysis studies the time series of a cross-section, analyzing whether cross-sectional investment-$q$ sensitivity rises post-ITE. The country-period analysis studies the time series of a panel, analyzing whether panel investment-$q$ sensitivity rises post-ITE.

## 4. Results

### 4.1. Full sample

Table 3 presents results of the single-stage specification. The regression in column 1 has *Q, CF*, and their interactions with *Year*, *Country*, and *ITE* as explanatory variables. We find that ITE leads to an increase in investment-$q$ sensitivity that is significant at the 5% level. Column 2 adds country-level controls and column 3 then replaces industry fixed effects with firm fixed effects; the results are unchanged. Column 4 is our most stringent specification which includes country-year as well as firm fixed effects; the former subsume the country-level controls. The coefficient on $Q \times ITE$ is now significant at the 1% level. In terms of economic significance, the average of the $Q \times Country$ interactions is 0.559 while that of the $Q \times Year$ interactions is −2.791 (untabulated). Thus, the benchmark investment-$q$ sensitivity is 3.279 (the coefficient on $Q$) +0.559 − 2.791 = 1.047. The coefficient of 0.402 on $Q \times ITE$ thus corresponds to a 38% increase. This result is economically significant but also plausible. For example, Foucault and Frésard (2012) find that cross-listing leads to a doubling of investment-$q$ sensitivity, suggesting that learning effects can be substantial. In all four columns, the coefficient on $CF \times ITE$ is insignificantly negative, and so the increase in investment-$q$ sensitivity is not part of a general trend of investment becoming more responsive to investment opportunities in general.

While the results of Table 3 are supportive of the RPE hypothesis, they could also be consistent with FPE, rather than RPE, increasing post-enforcement. Table 4 investigates this concern in two ways (Section 4.2 will later do so in a third way). First, it adds controls for both FPE and its interaction with $Q$. We use two measures of FPE, both defined at the firm-year level. The first is *FSRV*, firm-specific return variation, as used by Chen et al. (2007). We regress firm-level monthly stock returns on value-weighted local market excess returns and US market excess returns, and calculate the log of one minus the $R$-squared of this regression. The second is *NZRET*, the fraction of trading days in a year with nonzero returns. Lesmond et al. (1999) argue that a high fraction of zero-return days indicates high transaction costs, which reduce investors' incentives to both gather and trade on information, likely decreasing price informativeness.[15]

Column 1 adds *FSRV* and $Q \times FSRV$ as additional controls. In column 2, we discretize *FSRV* to address concerns that this measure is potentially noisy. Specifically, we split *FSRV* into per-country terciles and define *FSRV_LO* and *FSRV_HI* as indicator variables indicating the bottom and top terciles, respectively. We include these indicators independently and interacted with $Q$. Columns 3 and 4 instead include continuous and discrete measures of *NZRET*,

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[15] They write "a key feature of [the insider trading] literature is that the marginal (informed) investor will trade on new (or accumulated) information not reflected in the price of a security only if the trade yields a profit net of transaction costs. The cost of transacting constitutes a threshold that must be exceeded before a security's return will reflect new information."

**Table 3**
Investment-*Q* sensitivity after ITE: single-stage specification.

The dependent variable is investment (*INV*). All variables are as defined in Appendix B. Robust standard errors, clustered by country, are in parentheses. *** (**) (*) indicates significance at 1% (5%) (10%) two-tailed levels. The sample period is 1980–2009. The coefficient on any term containing *Q* has been multiplied by 100.

|  | (1) | (2) | (3) | (4) |
|---|---|---|---|---|
| *ITE* | −0.006 | −0.004 | −0.006 | |
|  | [0.008] | [0.008] | [0.007] | |
| *Q* | 3.521 | 3.231 | 2.994 | 3.279 |
|  | [0.482]*** | [0.630]*** | [0.347]*** | [0.563]*** |
| *Q × ITE* | 0.433 | 0.438 | 0.375 | 0.402 |
|  | [0.186]** | [0.183]** | [0.147]** | [0.130]*** |
| *CF* | 0.181 | 0.196 | 0.173 | 0.135 |
|  | [0.034]*** | [0.034]*** | [0.017]*** | [0.027]*** |
| *CF × ITE* | −0.036 | −0.038 | −0.028 | −0.004 |
|  | [0.030] | [0.028] | [0.021] | [0.023] |
| *GDP* |  | 0.004 | −0.004 | |
|  |  | [0.007] | [0.009] | |
| *GDPGROW* |  | 0.160 | 0.125 | |
|  |  | [0.060]** | [0.069]* | |
| *INFL* |  | 0.020 | 0.001 | |
|  |  | [0.026] | [0.023] | |
| *TRADE* |  | 0.002 | −0.004 | |
|  |  | [0.027] | [0.028] | |
| Adjusted *R*² | 0.15 | 0.15 | 0.41 | 0.50 |
| Observations | 328,588 | 317,263 | 317,263 | 328,588 |
| *Country, Year*, and interactions with *Q* and *CF* | Yes | Yes | Yes | Yes |
| Additional fixed effects | Industry | Industry | Firm | Firm, country-year |

respectively. In column 4, the coefficient on *Q × NZRET_LO* is negative and significant at the 5% level, and the coefficient on *Q × NZRET_HI* is positive and significant at the 1% level. These results suggest that investment-*q* sensitivity is higher in firms with greater total price informativeness. Thus, the Chen et al. (2007) result, initially discovered for the US, continues to hold in an international context – at least when measuring investment-*q* sensitivity with *NZRET* and discretizing it to address potential mismeasurement.[16] Despite controlling for FPE, *Q × ITE* is positive and significant at the 1% level in all specifications, suggesting that investment-*q* sensitivity depends not only on total information in prices, but also the source of this information. The coefficient on *CF × ITE* is insignificantly negative in all specifications.

The second way to address concerns that our results are driven by FPE is to decompose our *ITE* indicator into *ITE_EM* (*ITE_DV*), indicators for whether an emerging (developed) country enforced insider trading laws. Fernandes and Ferreira (2009) find that FPE does not rise in emerging countries post-ITE, while it rises in developed ones. In addition, Bushman et al. (2005) find that analyst coverage increases post-ITE in emerging but not developed countries, suggesting that RPE increases in the former. They argue that this differential effect arises because there is greater opacity in emerging countries and thus more private information to trade on. Thus, the RPE hypothesis predicts that investment-*q* sensitivity should rise for emerging countries

in particular. Column 5 controls for discretized *FSRV* and column 6 controls for discretized *NZRET*. In both columns, the increase in investment-*q* sensitivity is significant at the 1% level in emerging countries and at the 5% level in developed countries. The difference in coefficients is significant at the 1% level. The change in investment-cash flow sensitivity is insignificant in both specifications.

Table 5.A concerns the two-stage specifications; for brevity, we only report the results of the second stage. In columns 1–3 we analyze the model of Eqs. (9) and (10). The first stage is a country-year cross-sectional analysis of investment-*q* sensitivity, and the second stage regresses these predicted investment-*q* sensitivities on ITE indicators and country and year fixed effects. In this second stage, we also wish to control for FPE to ensure that any increase in investment-*q* sensitivities around ITE is not due to changes in FPE. In Table 4, the interaction of *Q* with FPE is most significant in columns 4 and 6, i.e., when FPE is measured using *NZRET_LO* and *NZRET_HI*, suggesting that discretized *NZRET* is the best measure of FPE. Since our goal is to show that RPE matters for investment-*q* sensitivity even after controlling for FPE, we wish to use the best measure of FPE to give it the greatest chance of driving out RPE. Thus, we include *NZRET_CY_LO* and *NZRET_CY_HI*, the country-year analog of *NZRET_LO* and *NZRET_HI*, as additional controls. These are defined by taking the country-year averages of firm-level *NZRET* and then splitting them into terciles. Column 1 shows that cross-sectional investment-*q* sensitivity rises post-ITE, but the coefficient is not significant when pooled across all countries. Column 2 decomposes *ITE* into *ITE_EM* and *ITE_DV* and finds that the rise in investment-*q* sensitivity post-ITE is significant at the 1% level for emerging countries, but insignificant for developed countries. The difference between the coefficients on

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[16] In column 2, the coefficient on *Q × FSRV_HI* is insignificant, but that on *Q × FSRV_LO* is positive and significant at the 5% level. We do not make strong inferences from this result as it disappears when we split *FSRV* into terciles based on the entire sample (rather than within-country). The significance of *Q × ITE* continues to hold under both specifications.

**Table 4**

Disentangling *RPE* from *FPE*.

The dependent variable is investment (*INV*). The empirical specification is similar to model (4) of Table 3, i.e., includes firm and country-year fixed effects, plus *Country* and *Year* alone and interacted with $Q$ and *CF*. All variables are as defined in Appendix B. Robust standard errors, clustered by country, are in parentheses. *** (**) (*) indicates significance at 1% (5%) (10%) two-tailed levels. The sample period is 1980–2009. The coefficient on any term containing $Q$ has been multiplied by 100.

| | (1) | (2) | (3) | (4) | (5) | (6) |
|---|---|---|---|---|---|---|
| $Q$ | 3.413 [0.595]*** | 3.354 [0.584]*** | 3.364 [0.569]*** | 3.409 [0.576]*** | 3.375 [0.568]*** | 3.430 [0.561]*** |
| $Q \times ITE$ | 0.419 [0.132]*** | 0.421 [0.132]*** | 0.419 [0.132]*** | 0.418 [0.133]*** | | |
| $Q \times ITE\_EM$ (1) | | | | | 0.728 [0.138]*** | 0.711 [0.142]*** |
| $Q \times ITE\_DV$ (2) | | | | | 0.297 [0.124]** | 0.298 [0.125]** |
| $CF$ | 0.137 [0.027]*** | 0.137 [0.026]*** | 0.137 [0.027]*** | 0.137 [0.027]*** | 0.138 [0.026]*** | 0.138 [0.026]*** |
| $CF \times ITE$ | −0.005 [0.023] | −0.005 [0.023] | −0.005 [0.024] | −0.004 [0.024] | | |
| $CF \times ITE\_EM$ (3) | | | | | 0.023 [0.019] | 0.024 [0.019] |
| $CF \times ITE\_DV$ (4) | | | | | −0.021 [0.030] | −0.021 [0.030] |
| $FSRV$ | 0.005 [0.005] | | | | | |
| $Q \times FSRV$ | −0.056 [0.287] | | | | | |
| $FSRV\_LO$ | | 0.000 [0.001] | | | 0.000 [0.001] | |
| $FSRV\_HI$ | | 0.000 [0.001] | | | 0.000 [0.001] | |
| $Q \times FSRV\_LO$ | | 0.050 [0.023]** | | | 0.051 [0.023]** | |
| $Q \times FSRV\_HI$ | | 0.009 [0.024] | | | 0.009 [0.024] | |
| $NZRET$ | | | −0.003 [0.005] | | | |
| $Q \times NZRET$ | | | 0.014 [0.113] | | | |
| $NZRET\_LO$ | | | | 0.000 [0.001] | | 0.000 [0.001] |
| $NZRET\_HI$ | | | | −0.002 [0.002] | | −0.002 [0.002] |
| $Q \times NZRET\_LO$ | | | | −0.072 [0.034]** | | −0.072 [0.034]** |
| $Q \times NZRET\_HI$ | | | | 0.431 [0.137]*** | | 0.432 [0.136]*** |
| *p*-Value (1)=(2) | | | | | 0.001 | 0.001 |
| *p*-Value (3)=(4) | | | | | 0.187 | 0.178 |
| Adjusted $R^2$ | 0.50 | 0.50 | 0.50 | 0.50 | 0.50 | 0.50 |
| Observations | 324,423 | 324,423 | 324,423 | 324,423 | 324,423 | 324,423 |
| *Country*, *Year*, and interactions with $Q$ and *CF* | Yes | Yes | Yes | Yes | Yes | Yes |
| Firm, country-year fixed effects | Yes | Yes | Yes | Yes | Yes | Yes |

*ITE_EM* and *ITE_DV* is significant at the 10% level. Column 3 includes country controls and the results are unchanged.

Columns 4–6 concern the country-period analysis. The first stage estimates investment-*q* sensitivity at the country-period level, i.e., pre- and post-ITE separately. In column 4, the second stage regresses investment-*q* sensitivity for enforcers on the *ITE* indicator and finds no significant change. Column 5 adds *EM*, an indicator for whether a country is an emerging country, and its interaction with *ITE*.[17] This interaction is positive and significant (albeit at

the 10% level as we only have two observations per country), suggesting that country-period investment-*q* sensitivity rose for emerging countries post-ITE. Column 6 clusters standard errors at the country level and shows that the results are unchanged.[18]

Table 5.B repeats the analyses in Table 5.A except for investment-cash flow sensitivity. The country-period anal-

enforcers. In columns 5 and 6, since we do not have a control group, we cannot include both *ITE_EM* and *ITE_DV*, and so we instead include an interaction with *EM* to capture the incremental effect of *ITE* in emerging countries compared to developed ones.

[18] We present results both with and without country-level clustering since we have only two observations per country.

[17] In columns 2 and 3, *ITE_EM* and *ITE_DV* estimate the differential impact of *ITE* for each of these groups relative to non-enforcers and already-

**Table 5.A**

Two-stage analysis: investment-Q sensitivity.

The first stage regresses *INV* on *Q* and *CF*. The second stage regresses the estimated sensitivities of investment to *Q* ($\widehat{\beta}_{c,t}^{Q}$) on ITE indicators and country-level controls. Models (1) to (3) present results based on estimating the first-stage investment-q sensitivities at the country-year level. Models (4) to (6) present results based on estimating these sensitivities per period (i.e., pre- and post-ITE) and only for enforcers. All other variables are as defined in Appendix B. Robust standard errors, clustered by country, are in parentheses. *** (**) (*) indicates significance at the 1% (5%) (10%) two-tailed level, respectively. The sample period is 1980–2009.

| Dependent variable | $\widehat{\beta}_{c,t}^{Q}$ | | | $\widehat{\beta}_{c,p}^{Q}$ only enforcers | | |
|---|---|---|---|---|---|---|
| | (1) | (2) | (3) | (4) | (5) | (6) |
| *ITE* | 0.406 | | | 0.244 | −0.334 | −0.334 |
| | [0.339] | | | [0.518] | [0.615] | [0.616] |
| *ITE_EM* (1) | | 0.908 | 1.072 | | | |
| | | [0.325]*** | [0.376]*** | | | |
| *ITE_DV* (2) | | 0.236 | 0.275 | | | |
| | | [0.382] | [0.375] | | | |
| *EM* | | | | | −1.594 | −1.594 |
| | | | | | [0.964] | [0.971] |
| *ITE* × *EM* | | | | | 1.849 | 1.849 |
| | | | | | [0.981]* | [0.988]* |
| *p*-Value (1)=(2) | | 0.083 | 0.063 | | | |
| Adjusted $R^2$ | 0.21 | 0.22 | 0.22 | 0.01 | 0.15 | 0.15 |
| Observations | 536 | 536 | 536 | 41 | 41 | 41 |
| *NZRET_CY_LO* and *NZRET_CY_HI* | Yes | Yes | Yes | No | No | No |
| Country-level controls | No | No | Yes | No | No | Yes |
| Fixed effects | Year, country | Year, country | Year, country | No | No | No |
| Country clustering | Yes | Yes | Yes | No | No | Yes |

**Table 5.B**

Two-stage analysis: investment-CF sensitivity.

The first stage regresses *INV* on *Q* and *CF*. The second stage regresses these estimated sensitivities of investment to *CF* ($\widehat{\beta}_{c,t}^{CF}$) on ITE indicators and country-level controls. Models (1) to (3) present results based on estimating the first-stage investment-cash flow sensitivities at the country-year level. Models (4) to (6) present results based on estimating these sensitivities per period (i.e., pre- and post-ITE) and only for enforcers. All other variables are as defined in Appendix B. Robust standard errors, clustered by country, are in parentheses. *** (**) (*) indicates significance at the 1% (5%) (10%) two-tailed level, respectively. The sample period is 1980–2009.

| Dependent variable | $\widehat{\beta}_{c,t}^{CF}$ | | | $\widehat{\beta}_{c,p}^{CF}$ only enforcers | | |
|---|---|---|---|---|---|---|
| | (1) | (2) | (3) | (4) | (5) | (6) |
| *ITE* | 0.027 | | | −0.146 | −0.163 | −0.163 |
| | [0.040] | | | [0.034]*** | [0.037]*** | [0.036]*** |
| *ITE_EM* (1) | | 0.065 | 0.065 | | | |
| | | [0.048] | [0.057] | | | |
| *ITE_DV* (2) | | 0.014 | 0.011 | | | |
| | | [0.045] | [0.042] | | | |
| *EM* | | | | | 0.026 | 0.026 |
| | | | | | [0.082] | [0.082] |
| *ITE* × *EM* | | | | | 0.024 | 0.024 |
| | | | | | [0.084] | [0.082] |
| *p*-Value (1)=(2) | | 0.280 | 0.352 | | | |
| Adjusted $R^2$ | 0.45 | 0.45 | 0.46 | 0.43 | 0.47 | 0.39 |
| Observations | 536 | 536 | 536 | 41 | 41 | 41 |
| *NZRET_CY_LO* and *NZRET_CY_HI* | Yes | Yes | Yes | No | No | No |
| Country-level controls | No | No | Yes | No | No | Yes |
| Fixed effects | Year, country | Year, country | Year, country | No | No | No |
| Country clustering | Yes | Yes | Yes | No | No | Yes |

ysis of columns 4–6 shows that investment-cash flow sensitivity decreases significantly (at the 1% level) following ITE, suggesting that managers shift weight from non-price to price measures of investment opportunities. There is no difference between emerging and developed countries. The country-year analysis of columns 1–3, consistent with Table 3, finds no change in investment-cash flow sensitivity following ITE.

### 4.2. Cross-sectional analyses

Our model suggests that ITE should have greatest effect on investment-*q* sensitivity in situations where the manager is particularly likely to learn from prices, or where outside information is likely to rise most strongly following ITE. We have already shown that the effect of ITE is stronger in emerging countries, where RPE rises

most prominently post-ITE (Bushman, Piotroski and Smith, 2005). This section performs additional cross-sectional analyses in this spirit. In addition to providing further evidence for the learning hypothesis, these cross-sectional tests will further help us address the concern that our results are driven by FPE (over and above the two tests conducted in Table 4). In particular, for our results to be driven by FPE, it would have to be that FPE not only increases with ITE, but also increases most in the subsamples in which our results are stronger—i.e., FPE must be correlated with not only ITE but also all of our splitting variables.

We control for FPE using *NZRET_LO* and *NZRET_HI* and their interactions with *Q,* since Table 4 suggests that they are the best measures of FPE, as well as firm and country-year fixed effects. Since $Q \times ITE$ but not $CF \times ITE$ is only significant in the full sample, our goal here is to study how the change in $Q \times ITE$ varies across subsamples. Because we have less power in subsamples, we include *CF* only as a control, rather than including all the interactions. Our specification is therefore that of columns 4 and 6 of Table 4, without the *CF* interactions. For brevity, all tables only report the coefficients on $Q \times ITE$, $Q \times ITE\_EM$, and $Q \times ITE\_DV$.

*4.2.1. Industry concentration and sales volatility*

Proposition 1 predicts that the rise in investment-*q* sensitivity is increasing in $\omega$, managers' incentive to learn from prices. This subsection considers two industry-level measures of this incentive. First, Allen (1993) argues that managers are more likely to use stock prices as a source of information in more concentrated industries. In competitive industries, managers can already learn about their production function by observing competitors' behavior, since there are several competitors to learn from. In concentrated industries, there are fewer rivals to learn from; these rivals are of different size and likely have different production functions.

Following this argument, we hypothesize that the effect of ITE on investment-*q* sensitivity is stronger in concentrated industries. We compute industry concentration in two ways. One is the sales-based Herfindahl index for each industry-country-year. While this is the most standard measure of industry concentration for US studies, it does not take into account private firms, which are particularly important in emerging countries, nor foreign competitors. Thus, our main measure is the price-cost margin, which is affected by both private and foreign competitors. We calculate the margin at the firm level and then take the median for each industry-country-year. For both measures, we split our sample into high and low concentration groups, comparing industry concentration in a particular industry-country-year with the median level for the entire sample and estimate the single-stage regression individually for each subsample. This split-sample design allows the control variables and fixed effects to vary with industry concentration.

Tables 6.A and 6.B present these results. In columns 1 and 2 of Table 6.A, where industry competition is measured using the price-cost margin, the coefficient on $Q \times ITE$ is significant at the 10% level in concentrated industries and insignificant in competitive industries, although the coeffi-

cients are not statistically different. Since the effect of ITE is highest in emerging countries (Table 4), we hypothesize that the difference in concentrated versus competitive industries will be greatest in emerging countries. Columns 3 and 4 investigate this hypothesis by decomposing *ITE* into *ITE_EM* and *ITE_DV*. We find that the increase in investment-*q* sensitivity is positive and significant at the 1% level in concentrated industries in emerging countries. This increase is significantly higher (at the 1% level) than in concentrated industries in developed countries, and also significantly higher (at the 5% level) than in competitive industries in emerging countries. Table 6.B measures industry competition using the Herfindahl index and finds similar results.

Second, Allen (1993) also predicts that learning from the stock price is likely to be stronger in firms where the production function changes frequently so that learning is particularly valuable. To test this hypothesis, Table 6.C stratifies industries according to sales volatility. We calculate the time-series standard deviation of the median log sales within each industry-country pair. We split our sample into high and low concentration groups, comparing sales volatility in a particular industry-country with the median level for the entire sample. Columns 1 and 2 show that, pooling across all countries, the coefficient on $Q \times ITE$ is positive and significant at the 5% level in high-volatility industries, but insignificantly positive in low-volatility industries, and the differences are significant at the 5% level. Columns 3 and 4 show that the increase in investment-*q* sensitivity is positive and significant at the 1% level in volatile industries in emerging countries. The coefficient is significantly higher (at the 5% level) than in high-volatility industries in developed countries. It is nearly five times higher than in low-volatility industries in emerging countries, although the difference is not statistically significant since the latter coefficient has a high standard error. Overall, the results of Tables 6.A–6.C are consistent with the prediction of Proposition 1, that the rise in investment-*q* sensitivity is increasing in the manager's incentive to learn from prices, and Allen's (1993) proxies for this incentive.

*4.2.2. Analyst coverage*

Our next split exploits variation in analyst coverage. We predict that the effect of ITE on investment-*q* sensitivity will be stronger in firms with low prior analyst coverage.[19] First, these firms have the greatest scope to enjoy an increase in analyst coverage, and thus RPE, post-ITE. Second, the impact of one additional analyst is stronger if a firm had few analysts to begin with. To test our prediction, we quantify the number of analysts in Institutional Brokers' Estimate System ("I/B/E/S") that follow a firm in the pre-enforcement period.[20] We split the sample based on the

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[19] An alternative would be to examine institutional ownership. We are aware of only one publicly available database (Factset) with institutional ownership for international firms. Unfortunately, Factset data coverage only starts in 1998.

[20] The results are unchanged when calculating the number of analysts in the year directly before ITE, or averaged across the three years before ITE, rather than across the whole pre-enforcement period. Since the pre-period is only defined for enforcers, we use the entire sample period for

**Table 6.A**

Cross-sectional analyses: price-cost margin.

The dependent variable is investment (*INV*). Price-cost margin is defined using the median of the firm-level difference between sales and cost-of-goods-sold, scaled by the latter, within each industry-country-year. Low and High subsamples are formed based on the median across the entire sample. Average value corresponds to the mean value of price-cost margin within each subsample. The specification in models (1) and (2) is similar to model (4) of Table 4, i.e., includes firm and country-year fixed effects, *NZRET_LO* and *NZRET_HI* alone and interacted with *Q*, plus *Country* and *Year* alone and interacted with *Q*, but does not have *CF* interactions. Models (3) and (4) are the same except for decomposing *ITE* into *ITE_EM* and *ITE_DV*. All other variables are as defined in Appendix B. Only the coefficients on *Q × ITE*, *Q × ITE_EM*, and *Q × ITE_DV* are reported for parsimony. Robust standard errors, clustered by country, are in parentheses. *** (**) (*) indicates significance at 1% (5%) (10%) two-tailed levels. The sample period is 1980–2009. The coefficient on any term containing *Q* has been multiplied by 100.

| | Low margin 0.228 (1) | High margin 0.374 (2) | Low margin 0.228 (3) | High margin 0.374 (4) |
|---|---|---|---|---|
| Average value | | | | |
| $Q \times ITE$ | 0.044 [0.119] | 0.286 [0.174]* | | |
| $Q \times ITE\_EM$ (1) | | | 0.289 [0.144]** | 0.729 [0.141]*** |
| $Q \times ITE\_DV$ (2) | | | −0.125 [0.144] | 0.213 [0.140] |
| *p*-Value of (1)=(2) | | | 0.001 | 0.003 |
| *p*-Value of diff. in: | | | | |
| $Q \times ITE$ | 0.245 | | | |
| $Q \times ITE\_EM$ | | | 0.028 | |
| $Q \times ITE\_DV$ | | | 0.088 | |
| *NZRET_LO*, *NZRET_HI*, $Q \times NZRET\_LO$, and $Q \times NZRET\_HI$ | Yes | Yes | Yes | Yes |
| Adjusted $R^2$ | 0.51 | 0.52 | 0.51 | 0.52 |
| Observations | 162,369 | 162,054 | 162,369 | 162,054 |
| *Country*, *Year*, and interactions with *Q* | Yes | Yes | Yes | Yes |
| Firm, country-year fixed effects | Yes | Yes | Yes | Yes |

**Table 6.B**

Cross-sectional analyses: Herfindahl index.

The dependent variable is investment (*INV*). The Herfindahl index is calculated using firm-level sales within each industry-country-year. Low and High subsamples are formed based on the median across the entire sample. Average value corresponds to the mean Herfindahl index within each subsample. The specification in models (1) and (2) is similar to model (4) of Table 4, i.e., includes firm and country-year fixed effects, *NZRET_LO* and *NZRET_HI* alone and interacted with *Q*, plus *Country* and *Year* alone and interacted with *Q*, but does not have *CF* interactions. Models (3) and (4) are the same except for decomposing *ITE* into *ITE_EM* and *ITE_DV*. All other variables are as defined in Appendix B. Only the coefficients on *Q × ITE*, *Q × ITE_EM*, and *Q × ITE_DV* are reported for parsimony. Robust standard errors, clustered by country, are in parentheses. *** (**) (*) indicates significance at 1% (5%) (10%) two-tailed levels. The sample period is 1980–2009. The coefficient on any term containing *Q* has been multiplied by 100.

| | Low conc. 639 (1) | High conc. 3,049 (2) | Low conc. 639 (3) | High conc. 3,049 (4) |
|---|---|---|---|---|
| Average value | | | | |
| $Q \times ITE$ | 0.365 [0.242] | 0.316 [0.172]* | | |
| $Q \times ITE\_EM$ (1) | | | 0.040 [0.350] | 0.777 [0.193]*** |
| $Q \times ITE\_DV$ (2) | | | 0.551 [0.242]** | 0.173 [0.167] |
| *p*-Value of (1)=(2) | | | 0.209 | 0.002 |
| *p*-Value of diff. in: | | | | |
| $Q \times ITE$ | 0.856 | | | |
| $Q \times ITE\_EM$ | | | 0.077 | |
| $Q \times ITE\_DV$ | | | 0.211 | |
| *NZRET_LO*, *NZRET_HI*, $Q \times NZRET\_LO$, and $Q \times NZRET\_HI$ | Yes | Yes | Yes | Yes |
| Adjusted $R^2$ | 0.52 | 0.53 | 0.52 | 0.53 |
| Observations | 162,502 | 161,921 | 162,502 | 161,921 |
| *Country*, *Year*, and interactions with *Q* | Yes | Yes | Yes | Yes |
| Firm, country-year fixed effects | Yes | Yes | Yes | Yes |

**Table 6.C**
Cross-sectional analyses: sales volatility.

The dependent variable is investment (*INV*). Sales volatility is defined at the industry level using the standard deviation of (log of) sales within each industry-country. Low and High subsamples are formed based on the median across the entire sample. Average value corresponds to the mean value of sales volatility within each subsample. The specification in models (1) and (2) is similar to model (4) of Table 4, i.e., includes firm and country-year fixed effects, *NZRET_LO* and *NZRET_HI* alone and interacted with *Q*, plus *Country* and *Year* alone and interacted with *Q*, but does not have *CF* interactions. Models (3) and (4) are the same except for decomposing *ITE* into *ITE_EM* and *ITE_DV*. All other variables are as defined in Appendix B. Only the coefficients on $Q \times ITE$, $Q \times ITE\_EM$, and $Q \times ITE\_DV$ are reported for parsimony. Robust standard errors, clustered by country, are in parentheses. *** (**) (*) indicates significance at 1% (5%) (10%) two-tailed levels. The sample period is 1980–2009. The coefficient on any term containing *Q* has been multiplied by 100.

| | Low vol. | High vol. | Low vol. | High vol. |
|---|---|---|---|---|
| Average value | 0.308 | 0.717 | 0.308 | 0.717 |
| | (1) | (2) | (3) | (4) |
| $Q \times ITE$ | 0.035 | 0.513 | | |
| | [0.139] | [0.211]** | | |
| $Q \times ITE\_EM$ (1) | | | 0.194 | 0.922 |
| | | | [0.302] | [0.251]*** |
| $Q \times ITE\_DV$ (2) | | | −0.059 | 0.409 |
| | | | [0.068] | [0.201]** |
| *p*-Value of (1)=(2) | | | 0.388 | 0.018 |
| *p*-Value of diff. in: | | | | |
| $Q \times ITE$ | 0.047 | | | |
| $Q \times ITE\_EM$ | | | 0.133 | |
| $Q \times ITE\_DV$ | | | 0.003 | |
| *NZRET_LO*, *NZRET_HI*, $Q \times NZRET\_LO$, and $Q \times NZRET\_HI$ | Yes | Yes | Yes | Yes |
| Adjusted $R^2$ | 0.45 | 0.52 | 0.45 | 0.52 |
| Observations | 162,428 | 161,981 | 162,428 | 161,981 |
| *Country*, *Year*, and interactions with *Q* | Yes | Yes | Yes | Yes |
| Firm, country-year fixed effects | Yes | Yes | Yes | Yes |

country median, and estimate our single-stage specification separately within each subsample.

Columns 1 and 2 of Table 6.D show that coefficient on $Q \times ITE$ is positive and significant at the 5% level in low-coverage firms but insignificant in high-coverage firms; the coefficients are statistically different at the 5% level. Columns 3 and 4 show that the increase in investment-*q* sensitivity is positive and significant at the 1% level in low-coverage firms in emerging countries, and significantly higher (at the 5% level) than in low-coverage firms in developed countries. The coefficient is insignificantly negative in high-coverage firms in emerging countries, although again it is not statistically different from low-coverage firms in emerging countries since the former coefficient has a high standard error.

*4.2.3. Financing constraints*

Our final split concerns financing constraints. The RPE hypothesis is that price informativeness increases investment-*q* sensitivity through a secondary markets channel: the price contains more information not known to the manager. An alternative explanation is a primary markets channel: ITE coincides with a loosening of financial constraints, which allows firms to vary investment more readily in response to investment opportunities. Under this channel, ITE should increase the sensitivity of investment to non-price measures of investment opportunities, not only *q*, contrary to what we find. In this subsection, we perform an additional test to evaluate this chan-

nel. If the effect of ITE operates through loosening financial constraints, it should be stronger in firms that were more constrained to begin with. In contrast, the RPE channel predicts that the effect is stronger in unconstrained firms, since such firms can respond more to the increased information in prices post-ITE.

We use two measures of financial constraints. The first is the main measure of financial constraints used in the international finance literature: the balance between external and internal financing (Rajan and Zingales, 1998). It is defined at the industry-level as the difference between capital expenditures and cash flows scaled by capital expenditures, where higher (lower) values indicate industries with greater external (internal) financing and thus lower (higher) financial constraints. The second is firm size, as used by Bakke and Whited (2010), where low size indicates higher financial constraints.

Consistent with the RPE hypothesis, and inconsistent with the financing channel, columns 1 and 2 of Table 6.E show that the coefficient on $Q \times ITE$ is positive and significant at the 5% level for firms with high external financing (i.e., low financial constraints), but insignificantly positive in constrained firms. Columns 3 and 4 show that the coefficient on $Q \times ITE$ is positive and significant at the 1% level for firms with high external financing in emerging countries, but only at the 10% level for high-financing firms in developed countries and insignificantly positive for low-financing firms in both types of countries. While the coefficient for firms with high external financing in emerging markets is over 48% higher than in any other category, the differences are not statistically significant, again due to high standard errors in the sub-group estimation. Table 6.F

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non-enforcers and for already-enforcers. Time trends in analyst coverage within these two control groups will be purged by the year fixed effects.

**Table 6.D**
Cross-sectional analyses: analyst coverage.

This table uses the single-stage specification. The dependent variable is investment (*INV*). Analyst coverage is obtained from I/B/E/S and defined based on the pre-enforcement period for enforcers and the entire sample period for non-enforcers and already-enforcers. Low and High groups are formed based on the median pre-enforcement analyst coverage in each country. Firms with no analyst coverage are included in the Low group. Average value corresponds to the mean value of analyst coverage within each subsample. The specification in models (1) and (2) is similar to model (4) of Table 4 , i.e., includes firm and country-year fixed effects, *NZRET_LO* and *NZRET_HI* alone and interacted with *Q*, plus *Country* and *Year* alone and interacted with *Q*, but does not have *CF* interactions. Models (3) and (4) are the same except for decomposing *ITE* into *ITE_EM* and *ITE_DV*. All other variables are as defined in Appendix B. Only the coefficients on $Q \times ITE$, $Q \times ITE\_EM$, and $Q \times ITE\_DV$ are reported for parsimony. Robust standard errors, clustered by country, are in parentheses. *** (**) (*) indicates significance at 1% (5%) (10%) two-tailed levels. The sample period is 1980–2009. The coefficient on any term containing *Q* has been multiplied by 100.

| | High coverage 4.588 (1) | Low coverage 0.174 (2) | High coverage 4.588 (3) | Low coverage 0.174 (4) |
|---|---|---|---|---|
| Average value | | | | |
| $Q \times ITE$ | −0.103 [0.147] | 0.336 [0.142]** | | |
| $Q \times ITE\_EM$ (1) | | | −0.035 [0.462] | 0.535 [0.150]*** |
| $Q \times ITE\_DV$ (2) | | | −0.131 [0.081] | 0.270 [0.149]* |
| *p*-Value of (1)=(2) | | | 0.839 | 0.043 |
| *p*-Value of diff. in: | | | | |
| $Q \times ITE$ | 0.037 | | | |
| $Q \times ITE\_EM$ | | | | 0.314 |
| $Q \times ITE\_DV$ | | | | 0.024 |
| *NZRET_LO*, *NZRET_HI*, $Q \times NZRET\_LO$, and $Q \times NZRET\_HI$ | Yes | Yes | Yes | Yes |
| Adjusted $R^2$ | 0.55 | 0.49 | 0.55 | 0.49 |
| Observations | 36,972 | 287,451 | 36,972 | 287,451 |
| *Country*, *Year*, and interactions with *Q* | Yes | Yes | Yes | Yes |
| Firm, country-year fixed effects | Yes | Yes | Yes | Yes |

**Table 6.E**
Cross-sectional analyses: financial constraints (external financing).

The dependent variable is investment (*INV*). External versus internal financing follows the methodology of Rajan and Zingales (1998) and is defined at the industry-level as the difference between capital expenditures and cash flows scaled by capital expenditures, where higher (lower) values indicate industries with greater external (internal) financing. Low and High groups are based on the median pre-enforcement values for each country. Average value corresponds to the mean value of external financing within each subsample. The specification in models (1) and (2) is similar to model (4) of Table 4, i.e., includes firm and country-year fixed effects, *NZRET_LO* and *NZRET_HI* alone and interacted with *Q*, plus *Country* and *Year* alone and interacted with *Q*, but does not have *CF* interactions. Models (3) and (4) are the same except for decomposing *ITE* into *ITE_EM* and *ITE_DV*. All other variables are as defined in Appendix B. Only the coefficients on $Q \times ITE$, $Q \times ITE\_EM$, and $Q \times ITE\_DV$ are reported for parsimony. Robust standard errors, clustered by country, are in parentheses. *** (**) (*) indicates significance at 1% (5%) (10%) two-tailed levels. The sample period is 1980–2009. The coefficient on any term containing *Q* has been multiplied by 100.

| | Low financing −0.158 (1) | High financing 1.128 (2) | Low financing −0.158 (3) | High financing 1.128 (4) |
|---|---|---|---|---|
| Average value | | | | |
| $Q \times ITE$ | 0.153 [0.134] | 0.418 [0.168]** | | |
| $Q \times ITE\_EM$ (1) | | | 0.400 [0.276] | 0.591 [0.220]*** |
| $Q \times ITE\_DV$ (2) | | | 0.064 [0.114] | 0.342 [0.190]* |
| *p*-Value of (1)=(2) | | | 0.212 | 0.346 |
| *p*-Value of diff. in: | | | | |
| $Q \times ENF \times POST$ | 0.192 | | | |
| $Q \times ENF\_EM \times POST$ | | | | 0.658 |
| $Q \times ENF\_DV \times POST$ | | | | 0.157 |
| *NZRET_LO*, *NZRET_HI*, $Q \times NZRET\_LO$, and $Q \times NZRET\_HI$ | Yes | Yes | Yes | Yes |
| Adjusted $R^2$ | 0.51 | 0.49 | 0.51 | 0.49 |
| Observations | 171,052 | 153,355 | 171,052 | 153,355 |
| *Country*, *Year*, and interactions with *Q* | Yes | Yes | Yes | Yes |
| Firm, country-year fixed effects | Yes | Yes | Yes | Yes |

**Table 6.F**

Cross-sectional analyses: financial constraints (firm size).

The dependent variable is investment (*INV*). Small and Large firms are defined based on the median market capitalization in each country. The specification in models (1) and (2) is similar to model (4) of Table 4, i.e., includes firm and country-year fixed effects, *NZRET_LO* and *NZRET_HI* alone and interacted with *Q*, plus *Country* and *Year* alone and interacted with *Q*, but does not have *CF* interactions. Models (3) and (4) are the same except for decomposing *ITE* into *ITE_EM* and *ITE_DV*. All other variables are as defined in Appendix B. Only the coefficients on $Q \times ITE$, $Q \times ITE\_EM$, and $Q \times ITE\_DV$ are reported for parsimony. Robust standard errors, clustered by country, are in parentheses. *** (**) (*) indicates significance at 1% (5%) (10%) two-tailed levels. The sample period is 1980–2009. The coefficient on any term containing *Q* has been multiplied by 100.

| Average value | Small firms $36m (1) | Large firms $1,178m (2) | Small firms $36m (3) | Large firms $1,178m (4) |
|---|---|---|---|---|
| $Q \times ITE$ | 0.169 [0.375] | 0.196 [0.145] | | |
| $Q \times ITE\_EM$ (1) | | | −0.076 [0.602] | 0.451 [0.137]*** |
| $Q \times ITE\_DV$ (2) | | | 0.369 [0.376] | 0.103 [0.163] |
| *p*-Value of (1)=(2) | | | 0.522 | 0.041 |
| *p*-Value of diff. in: | | | | |
| $Q \times ENF \times POST$ | 0.946 | | | |
| $Q \times ENF\_EM \times POST$ | | | 0.413 | |
| $Q \times ENF\_DV \times POST$ | | | 0.542 | |
| *NZRET_LO*, *NZRET_HI*, $Q \times NZRET\_LO$, and $Q \times NZRET\_HI$ | Yes | Yes | Yes | Yes |
| Adjusted $R^2$ | 0.53 | 0.58 | 0.53 | 0.58 |
| Observations | 161,119 | 163,304 | 161,119 | 163,304 |
| *Country*, *Year*, and interactions with *Q* | Yes | Yes | Yes | Yes |
| Firm, country-year fixed effects | Yes | Yes | Yes | Yes |

shows similar results using firm size, although now the coefficient on large firms in significantly higher (at the 1% level) in emerging countries than in developed ones.

Note that, while an increase in investment-*q* sensitivity is consistent with investment responding more readily to growth opportunities, and thus more efficient decisions, it is not a direct measure of real efficiency.[21] It may be that investment-*q* sensitivity arises because managers tend to overinvest due to empire-building concerns, but are limited by financial constraints; high *q* allows them to issue equity and overinvest more. Thus, high investment-*q* sensitivity may be a sign of inefficiency. Under this explanation, it is unclear why investment-*q* sensitivity should rise post-ITE. If ITE were correlated with improvements in governance, investment- *q* sensitivity should fall; if ITE were somehow correlated with declines in governance, the increase in investment-*q* sensitivity should be stronger in firms that were previously financially constrained, which is contradicted by the results in Tables 6.E and 6.F.

## 5. Robustness tests

This section presents the results of robustness tests. We continue to use the specification in column 4 of Table 4, which includes $Q \times NZRET\_LO$ and $Q \times NZRET\_HI$.

### 5.1. Effect of insider trading announcement

As stated previously, our main concern is that the association between ITE and increases in investment-*q* sensitivity arises because ITE is endogenous and coincides with general improvements to the financial sector or other laws that improve corporate governance. If so, we might expect the announcement of insider trading laws to be also correlated with such improvements, and also raise investment-*q* sensitivity. However, under the RPE hypothesis, the mere announcement, rather than enforcement, of insider trading laws should have no effect on RPE and thus investment-*q* sensitivity. Bhattacharya and Daouk (2002) find only enforcement, not announcement, reduces the cost of capital (which they argue arises from the deterrence of insider trading), and Bushman et al. (2005) find that only enforcement increases outside information acquisition as measured by analyst coverage.

We thus perform a falsification test using insider trading announcement rather than enforcement as the event. We replace *ITE* with *ITA*, an indicator that equals one on or after insider trading announcement for countries that announced insider trading laws within our sample period, and is zero otherwise. Column 1 of Table 7 shows that the coefficient on $Q \times ITA$ is insignificant.

### 5.2. Time trends around ITE

A second way to address the endogeneity of ITE is to study whether it captures ongoing time trends in investment-*q* sensitivity that may have started prior to the enforcement date. We thus study pre-ITE differences in investment-*q* sensitivity. Similar to Bertrand and Mul-

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[21] As discussed at the end of Section 2.2, we do not study real efficiency directly since it may change due to the other effects of ITE studied by prior literature (e.g., a reduction in the cost of capital), rather than ITE allowing the manager to learn more from prices.

**Table 7**

Alternative empirical specifications.

The dependent variable is investment (*INV*). The specification is that of model (4) of Table 4, i.e., includes firm and country-year fixed effects, *NZRET_LO* and *NZRET_HI* alone and interacted with *Q*, plus *Country* and *Year* alone and interacted with *Q* and *CF*. Only the coefficients on the relevant variables are reported for parsimony; all other variables are as defined in Appendix B. Robust standard errors, clustered by country, are in parentheses. *** (**) (*) indicates significance at 1% (5%) (10%) two-tailed levels. The sample period is 1980–2009. The coefficient on any term containing *Q* has been multiplied by 100. Specifications: (1): Insider trading announcement; (2): Verifying parallel trends; (3): Dynamic treatment effect; (4): Firm controls; (5): (−5, +5) event window.

|  | (1) | (2) | (3) | (4) | (5) |
|---|---|---|---|---|---|
| $Q \times ITE \times BEFORE2$ |  | 0.053 |  |  |  |
|  |  | [0.072] |  |  |  |
| $Q \times ITE \times BEFORE1$ |  | 0.086 |  |  |  |
|  |  | [0.106] |  |  |  |
| $Q \times ITE$ |  | 0.464 |  | 0.473 | 0.220 |
|  |  | [0.156]*** |  | [0.201]** | [0.072]*** |
| $Q \times ITA$ | 0.188 |  |  |  |  |
|  | [0.123] |  |  |  |  |
| $Q \times ITE \times AFTER0$ |  |  | 0.372 |  |  |
|  |  |  | [0.192]* |  |  |
| $Q \times ITE \times AFTER1$ |  |  | 0.236 |  |  |
|  |  |  | [0.123]* |  |  |
| $Q \times ITE \times AFTER2+$ |  |  | 0.469 |  |  |
|  |  |  | [0.145]*** |  |  |
| $CF \times ITE \times BEFORE2$ |  | −0.024 |  |  |  |
|  |  | [0.033] |  |  |  |
| $CF \times ITE \times BEFORE1$ |  | −0.014 |  |  |  |
|  |  | [0.039] |  |  |  |
| $CF \times ITE$ |  | −0.015 |  | −0.042 | 0.005 |
|  |  | [0.032] |  | [0.022]* | [0.029] |
| $CF \times ITA$ | −0.011 |  |  |  |  |
|  | [0.039] |  |  |  |  |
| $CF \times ITE \times AFTER0$ |  |  | −0.028 |  |  |
|  |  |  | [0.034] |  |  |
| $CF \times ITE \times AFTER1$ |  |  | 0.016 |  |  |
|  |  |  | [0.032] |  |  |
| $CF \times ITE \times AFTER2+$ |  |  | −0.004 |  |  |
|  |  |  | [0.023] |  |  |
| *ME* |  |  |  | −0.003 |  |
|  |  |  |  | [0.001]*** |  |
| *LEV* |  |  |  | −0.049 |  |
|  |  |  |  | [0.005]*** |  |
| *CASH* |  |  |  | 0.000 |  |
|  |  |  |  | [0.000] |  |
| *RETAINED* |  |  |  | −0.001 |  |
|  |  |  |  | [0.000]*** |  |
| *SGR* |  |  |  | 0.003 |  |
|  |  |  |  | [0.001]*** |  |
| *AGE* |  |  |  | -0.002 |  |
|  |  |  |  | [0.000]*** |  |
| *NZRET_LO*, *NZRET_HI*, $Q \times NZRET\_LO$, and $Q \times NZRET\_HI$ | Yes | Yes | Yes | Yes | Yes |
| Adjusted $R^2$ | 0.50 | 0.50 | 0.50 | 0.52 | 0.54 |
| Observations | 324,423 | 324,423 | 324,423 | 243,122 | 107,120 |
| *Country*, *Year*, and interactions with *Q* nd *CF* | Yes | Yes | Yes | Yes | Yes |
| Firm, country-year fixed effects | Yes | Yes | Yes | Yes | Yes |

lainathan (2003), we create a new indicator *BEFORE*1, which equals one in the year before ITE and zero in all other years. For example, for Belgium, which enforced insider trading laws in 1994, this variable is one only in 1993. We also create *BEFORE*2, which equals one two years before ITE (in 1992, in the above example).

Column 2 of Table 7 adds the new interactions $Q \times ITE \times BEFORE1$ and $Q \times ITE \times BEFORE2$. The new interactions are individually insignificant, suggesting that enforcers did not have different investment-*q* sensitivities to other countries in each of the two years priors to ITE. They are also insignificantly different from each other, suggest-

ing that their investment-*q* sensitivities were not trending prior to ITE differently from other countries. The coefficient on $Q \times ITE$ is positive and significant at the 1% level.

In column 3, we study how long it takes for ITE to affect investment-*q* sensitivity. We define the new indicator *AFTER*0, which equals one in the year of ITE (1994, in the Belgium example) and zero in other years. (This variable contrasts *ITE*, which equals one in the year of ITE and all future years.) We also create *AFTER*1, which equals one in the year after ITE (1995, in the above example), and *AFTER*2+, which equals one two years after ITE and in all future years (from 1996 onwards). Column 3 interacts *ITE*

with these three indicators. We find that the coefficients on *AFTER*0 and *AFTER*1 are significantly positive at the 10% level, and that on *AFTER*2+ is significantly positive at the 1% level. Thus, it takes two years for the effect of ITE on investment-$q$ sensitivity to have its full impact, which is consistent with it taking time for outsiders (e.g., analysts) to start gathering information about a firm.

*5.3. Alternative specifications*

This section presents the results of additional robustness tests. In column 4, we verify robustness to adding firm-level controls. While Roberts and Whited (2012) recommend against adding controls that may be affected by the treatment in a difference-in-differences, they also note that "if assignment is random, then including additional covariates should have a negligible effect on the estimated treatment effect." We thus add *FIRM_CTRL*, a vector of additional firm-level determinants of investment. These include log market equity (*ME*), which is the only additional control used in Foucault and Frésard (2012) , plus five variables from Asker et al. (2015): *SGR* (one-year sales growth), *AGE* (firm age), book leverage (*LEV*) defined as long-term debt divided by total assets, cash and short-term investments divided by total assets (*CASH*), and retained earnings scaled by total assets (*RETAINED*). The coefficient on $Q \times ITE$ is positive and significant at the 5% level, despite the sample size falling by 25%.

Column 5 uses a narrower event window around ITE, to focus on the years most affected by ITE and address concerns that our results are driven by general trends unrelated to the ITE event. We consider a ten-year window that begins five years before and ends five years after ITE, and delete all observations where the country is an enforcer and the current year is outside this window. All observations for already-enforcers and non-enforcers prior to 2003 are retained, since 1998 is the final ITE date in our sample and so there are no data for enforcers after 2003. The coefficient on $Q \times ITE$ is positive and significant at the 1% level. In unreported results, the findings are the same when using a six-year window that begins three years before and ends three years after ITE. In column 4, the change in investment-cash flow sensitivity is negative and significant at the 10% level; in other columns it is insignificant.

## 6. Conclusion

This paper tests the hypothesis that the real effects of financial markets—the effect of stock prices on real decisions—depend not on the total amount of information in prices (forecasting price efficiency) but the amount of information in prices not already known to the decision maker (revelatory price efficiency). We build a theoretical model which shows that ITE increases information acquisition by outsiders, and thus revelatory price efficiency and investment-$q$ sensitivity, particularly if outsider information is important for investment decisions. Consistent with the model's predictions, we find that such enforcement significantly increases the sensitivity of investment

to $q$, even when controlling for total price informativeness, but does not change its sensitivity to cash flow, a non-price measure of investment opportunities. We also control for between-country and across-year differences in investment-$q$ sensitivity, thus extending the generalized difference-in-differences framework to a setting in which the outcome of interest is a slope coefficient rather than a level variable. These results are particularly strong for emerging countries, in which information acquisition by outsiders rises most strongly post-ITE, but total price informativeness is unchanged. They are also stronger in situations in which managerial learning from the stock price is likely more important (concentrated and volatile industries), as well as firms with lower pre-enforcement analyst coverage (and thus higher potential for outsider information to rise post-ITE) and financial constraints (that would restrict their ability to respond to more informative prices).

Overall, these results suggest that it is not only the total amount of information in prices that matters for real efficiency, but the source of information in prices—whether this information is already known to the decision maker. As a result, measures of total price informativeness may be insufficient for measuring the contribution of financial markets to the efficiency of real decisions. The results suggest a new cost of insider trading that is absent from prior literature. Previous research studies the effect of insider trading on total price informativeness (e.g., Manove, 1989; Ausubel, 1990; Fishman and Hagerty, 1992; Leland, 1992), under the assumption that outsider and insider information are substitutes. However, this paper suggests that it is outsider information that matters for investment decisions. Thus, even if the decrease in outsider information in prices, that results from allowing insider trading, is offset by the increase in insider information, real efficiency may still decline.

More broadly, our results build on a recent literature that documents correlations between price informativeness and real decisions, shows that this correlation is stronger when learning is more likely, and/or directly tests non-learning explanations. We contribute to this literature by studying a shock to price informativeness, helping us move towards causal evidence that managers learn from prices, and that financial markets have real effects.

## Appendix A. Proofs

*Proof of Lemma 1.* Both types of traders maximize the conditional expectation of $\theta - p$ times their respective asset holding ($x_i$ and $y$), taking into account their impact on $p$. It follows that $x_i = \frac{1}{\lambda}E[\theta - p|s_i]$ and $y = \frac{1}{\lambda}E[\theta - p|s_M]$. Plugging in the functional form of $p$ and using Bayes' rule to compute the conditional expectations of $\theta$ ($E[\theta|s_M] = \theta_1$ and $E[\theta|s_i] = \frac{h_\eta}{h_\eta + \frac{h_\theta}{2}}s_i$) leads to the expressions for $x_i$ and $y$.

Turning to the comparative statics, outsiders' trading aggressiveness $d_x$ increases in $h_\eta$, because a more precise noise term increases the quality of their signal. It decreases in $h_\theta$, because more volatile $\theta$ increases their information

advantage, the number of speculators $a$ due to competition, and price impact $\lambda$. The insider's trading aggressiveness $d_y$ is decreasing in $h_\theta$, $a$, and $\lambda$ for the same reasons. In contrast to $d_x$, $d_y$ is decreasing in $h_\eta$: when outsiders are better informed, the insider trades less aggressively. $\square$

*Proof of Lemma 2.* This is a special case of Lemma 1 with insider trading with the additional restriction $y' = 0$. $\square$

*Proof of Lemma 3.*

1. The expression for firm investment follows from differentiating the objective function (1) to yield

$$K = \frac{1}{c}E[(1-\omega)\theta_1 + \omega\theta_2|s_M, p]. \tag{13}$$

From the equilibrium security price $p = \lambda\left(\sum_{i=1}^{a} x_i + y + z\right)$ we plug in $y = d_y s_M$ (with $s_M = \theta_1$) and $x_i = d_x s_i$ (with $s_i = \theta_1 + \theta_2 + \eta_i$) to yield:

$$p = \lambda\left(ad_x(\theta_1 + \theta_2) + d_y\theta_1 + z + d_x\sum_{i=1}^{a}\eta_i\right). \tag{14}$$

Rearranging yields $\frac{\frac{1}{\lambda}p - d_y\theta_1}{ad_x} - \theta_1 = \theta_2 + \frac{1}{a}\sum_{i=1}^{a}\eta_i + \frac{z}{ad_x}$. Since $\frac{1}{a}\sum_{i=1}^{a}\eta_i + \frac{z}{ad_x}$ is mean-zero, $s_p \equiv \frac{\frac{1}{\lambda}p - d_y\theta_1}{ad_x} - \theta_1$ is an unbiased signal of $\theta_2$. The precision of this signal can then be computed as $h_p \equiv \text{Var}\left(\frac{1}{a}\sum_{i=1}^{a}\eta_i + \frac{z}{ad_x}\right)^{-1} = \frac{d_x^2 a^2 h_\eta h_z}{h_\eta + d_x^2 ah_z}$.

From Bayes' rule, the conditional expectation of $\theta_2$ is equal to the precision-weighted sum of prior and posterior (price) information, i.e., $E[\theta_2|s_M, p] = \frac{h_p}{h_\theta + h_p}s_p$. Thus, optimal investment is given by:

$$K = \frac{(1-\omega)\theta_1 + \omega E[\theta_2|s_M, p]}{c}$$
$$= \frac{(1-\omega)\theta_1 + \omega\frac{h_p}{h_\theta + h_p}s_p}{c}. \tag{15}$$

2. Since $\theta$ and $p$ are jointly normally distributed, $\text{Var}(\theta|p) = \text{Var}(\theta)(1 - \rho_{\theta,p}^2)$, where $\text{Var}(\theta) = 2h_\theta^{-1}$ denotes the variance of $\theta_1 + \theta_2$. Using the expression for the security price in Lemma 1, the correlation between $\theta$ and $p$ ($\rho_{\theta,p}$) can be easily computed as $\rho_{\theta,p} = \frac{\text{Cov}(\theta,p)}{\sqrt{\text{Var}(\theta)\text{Var}(p)}}$.

3. First note that $\theta_1$ is part of the manager's information set and that $s_M = \theta_1$ is uncorrelated with $\theta_2$. We thus have $RPE = \text{Var}^{-1}(\theta_1 + \theta_2|s_M, p) = \text{Var}^{-1}(\theta_2|s_M, p) = \text{Var}^{-1}(\theta_2|p) = h_p$.

4. Unconditional expected firm value is given by assets in place plus the investment payoff minus the cost of investment:

$$V = E_0\left[\theta + ((1-\omega)\theta_1 + \omega\theta_2)K - \frac{1}{2}cK^2\right]. \tag{16}$$

Plugging in equilibrium investment (13) and using the law of iterated expectations yields

$$V = \frac{1}{2c}E_0\left[E[(1-\omega)\theta_1 + \omega\theta_2|s_M, p]^2\right]$$
$$= \frac{1}{2c}\text{Var}_0(E[(1-\omega)\theta_1 + \omega\theta_2|s_M, p])$$
$$= \frac{1}{2c}\left(\frac{1 - 2\omega + 2\omega^2}{h_\theta} - \frac{\omega^2}{h_p}\right), \tag{17}$$

where the second equality arises because $\theta_1$ and $\theta_2$ have zero means, and the third from the law of total variance.

5. First plug investment (2) and the equilibrium security price $p = \lambda(\sum_{i=1}^{a} x_i + y + z)$ into investment-price sensitivity $\beta_{Kp} = \frac{\text{Cov}(K,p)}{\text{Var}(p)}$. Using the definitions $s_p = \theta_2 + \frac{1}{a}\sum_{i=1}^{a}\eta_i + \frac{z}{ad_x}$, $x_i = d_x(\theta_1 + \theta_2 + \eta_i)$, and $y = d_y\theta_1$ immediately yields (6). $\square$

*Proof of Lemma 4.* For outsiders, the ex ante expected profit from becoming informed is given by $\pi(a) = E_0[x_i(\theta - p)]$; they will become informed until the expected profit equals $F$. Computing $E_0[x_i(\theta - p)]$ with and without insider trading gives:

$$\pi(a) = \frac{9h_\eta(2h_\eta + h_\theta)}{\lambda h_\theta(4h_\theta + (3a+4)h_\eta)^2} \tag{18}$$

and

$$\pi'(a') = \frac{h_\eta(2h_\eta + h_\theta)}{\lambda h_\theta(h_\theta + (a'+1)h_\eta)^2}. \tag{19}$$

In equilibrium, $\pi(a) = F$ and $\pi'(a') = F$. Then, setting $\pi(a) = \pi'(a')$ and yields $a' = a + \frac{1}{3}(1 + \frac{h_\theta}{h_\eta})$. From the definition of $RPE$ and the fact that $d_x' = d_x$, it follows that $h_p' > h_p$.

Plugging in the equilibrium values of $\{d_x, d_y, a'\}$ shows that the change in $FPE$ has the same sign as $2h_\eta - h_\theta$, which can be positive or negative. $\square$

*Proof of Proposition 1.* Real efficiency is monotonic in $h_p$, which increases post-ITE as proven in Lemma 4. Turning to investment-price sensitivity, first define $\Delta\beta \equiv \beta_{K'p'}' - \beta_{Kp}$. From the definition of $\beta_{Kp}$ and the expressions for $K$ and $p$, it follows that:

$$\Delta\beta = \frac{c(3a+1)h_\eta h_z(4h_\theta + (3a+4)h_\eta) + ch_\theta}{\lambda^2 h_\theta(4h_\theta + (3a+4)h_\eta)^2 + h_z(h_\theta + (3a+1)h_\eta)(5h_\theta + (6a+2)h_\eta)}$$
$$+ \frac{ch_\eta h_z(-3a + 2\omega - 2)(4h_\theta + (3a+4)h_\eta) + 2c(\omega - 1)h_\theta}{h_z(4h_\theta^2 + 2(9a^2 + 6a + 2)h_\eta^2 + (21a + 8)h_\eta h_\theta) + \lambda^2 h_\theta(4h_\theta + (3a+4)h_\eta)^2}. \tag{20}$$

Then, simple differentiation yields $\frac{\partial(\Delta\beta)}{\partial\omega} > 0$. Moreover, it follows that $\Delta\beta(\omega = 1) > 0$ and $\Delta\beta(\omega = 0) < 0$. Therefore, there exists a $\overline{\omega} \in (0, 1)$, such that $\Delta\beta \geq 0$ for $\omega \geq \overline{\omega}$. $\square$

## Appendix B. Definition of variables

Where applicable, Worldscope variable codes are given in parentheses.

| Variable | Definition | Source |
| --- | --- | --- |
| AFTER0 | Indicator variable that equals one in the year of insider trading enforcement, defined for enforcers only. | N/A |
| AFTER1 | Indicator variable that equals one in the first year after insider trading enforcement, defined for enforcers only. | N/A |
| AFTER2+ | Indicator variable that equals one in the second and subsequent years after insider trading enforcement, defined for enforcers only. | N/A |
| AGE | Firm age in years, defined as one plus current year minus the first year that the firm appears on Worldscope ("Base-Date"). | Worldscope |
| BEFORE2 | Indicator variable that equals one for the second year before insider trading enforcement, defined for enforcers only. | N/A |
| BEFORE1 | Indicator variable that equals one for the first year before insider trading enforcement, defined for enforcers only. | N/A |
| CASH | Cash and short-term investments (WC02001) scaled by total assets. | Worldscope |
| CF | Cash flows, defined as operating earnings plus depreciation and amortization, scaled by total assets. | Worldscope |
| FSRV | Firm-specific return variation, defined as the natural log of one minus the $R^2$ of a regression of firm-level monthly equity excess returns on value-weighted local market excess returns and US market excess returns. This measure is defined at the firm-year level. | Datastream |
| FSRV_LO | Indicator variable that equals one if FSRV is in the bottom tercile for that country. This measure is defined at the firm-year level. | Datastream |
| FSRV_HI | Indicator variable that equals one if FSRV is in the top tercile for that country. This measure is defined at the firm-year level. | Datastream |
| GDP | Natural log of GDP per capita in current $. | WDI |
| GDPGROW | One-year growth in GDP per capita expressed in percentage terms. | WDI |
| INFL | One-year rate of inflation expressed in percentage terms. | WDI |
| INV | Capital expenditures (WC04601) scaled by lagged total assets (WC02999). | Worldscope |
| ITE | Indicator variable that equals one for the post-enforcement period and is defined for enforcers only. | N/A |
| ITE_DV | Indicator variable that equals one for the post-enforcement period and is defined for developed country enforcers only. | N/A |
| ITE_EM | Indicator variable that equals one for the post-enforcement period and is defined for emerging country enforcers only. | N/A |
| LEV | Book leverage, defined as long-term debt (WC03251) scaled by total assets. | Worldscope |
| ME | Natural log of market value of equity (in $ millions), defined as shares outstanding (WC05301) times closing share price (WC05001). The exchange rate for converting local currency to $ is obtained from WDI. | Worldscope and WDI |
| NZRET | Fraction of trading days in a year with non-zero returns. This measure is defined at the firm-year level. | Datastream |
| NZRET_CY_LO | Indicator variable that equals one if the average firm-level NZRET for a given country-year is in the bottom tercile across all country-years. This measure is defined at the country-year level. | Datastream |
| NZRET_CY_HI | Indicator variable that equals one if the average firm-level NZRET for a given country-year is in the top tercile across all country-years. This measure is defined at the country-year level. | Datastream |
| NZRET_LO | Indicator variable that equals one if NZRET is in the bottom tercile for that country. This measure is defined at the firm-year level. | Datastream |
| NZRET_HI | Indicator variable that equals one if NZRET is in the top tercile for that country. This measure is defined at the firm-year level. | Datastream |
| Q | Tobin's q defined as the ratio of market value of assets (market equity plus book debt) to book value of assets. | Worldscope |
| RETAINED | Retained earnings, defined as the ratio of retained earnings (WC03495) to total assets (WC02999). | Worldscope |
| SGR | Sales growth, defined as the one-year growth in total revenues (WC01001). | Worldscope |
| TRADE | Natural log of global trade, defined as the sum of merchandise exports and imports scaled by annual GDP. | WDI |

## Appendix C. Alternative model: *FPE* (not *RPE*) matters

In this section, we consider a variant of the model in which the insider is separate from the manager (e.g., is a director or blockholder). In particular, the insider still receives a perfect signal $s_M = \theta_1$ about the payoff, but the manager is completely uninformed. Since the manager already has an incentive to learn $\theta_1$ from the security price, we do not need to include the second dimension of uncer-

tainty $\theta_2$ in order to generate an incentive to learn, and so we set $\theta_2 = 0$ for simplicity. Thus, speculator $i$ receives the noisy signal $s_i = \theta_1 + \eta_i$.

As before, the firm manager chooses $K$ to maximize expected firm value and traders choose their asset holdings to maximize expected return. As a result, Lemmas 1 and 2 become:

**Lemma 5.** *There is a unique security market equilibrium with insider trading in which:*

1. *Outsiders' demand is given by $x_i = d_x s_i$, where $d_x = \frac{h_\eta}{4\lambda h_\theta + \lambda(a+2)h_\eta}$.*

2. *Insider demand is given by $y = d_y s_M$, where $d_y = \frac{h_\eta + 2h_\theta}{4\lambda h_\theta + \lambda(a+2)h_\eta}$.*

3. *The security price satisfies $p = \lambda(\sum_{i=1}^{a} x_i + y + z)$.*

4. *Firm investment is given by $K = \frac{1}{c}((1-\omega)\frac{FPE}{h_\theta + FPE} s_p)$,*
   *where $s_p \equiv \frac{\frac{1}{\lambda}p}{d_y + ad_x} = \theta_1 + \frac{d_x \sum_{i=1}^{a} \eta_i + z}{d_y + ad_x}$ is an unbiased signal of $\theta_1$ with precision $FPE \equiv \frac{(d_y + ad_x)^2}{ad_x^2 h_\eta^{-1} + h_z^{-1}}$.*

**Lemma 6.** *There is a unique security market equilibrium without insider trading in which:*

1. *Outsiders' demand is given by $x_i' = d_x' s_i$, where $d_x' = \frac{h_\eta}{2\lambda h_\theta + \lambda(a'+1)h_\eta}$.*

2. *Insider demand is given by $y' = d_y s_M$, where $d_y' = 0$.*

3. *The security price satisfies $p' = \lambda(\sum_{i=1}^{a'} x_i' + z)$.*

4. *Firm investment is given by $K' = \frac{1}{c}((1-\omega)\frac{FPE'}{h_\theta + FPE'} s_p')$,*
   *where $s_p' \equiv \frac{\frac{1}{\lambda}p'}{a'd_x'} = \theta_1 + \frac{d_x' \sum_{i=1}^{a'} \eta_i + z}{a'd_x'}$ is an unbiased signal of $\theta_1$ with precision $FPE' \equiv \frac{(a'd_x')^2}{a'(d_x')^2 h_\eta^{-1} + h_z^{-1}}$.*

As before, the number of speculators post-ITE can be computed by equating $E_0[x_i(\theta - p)]$ and $E_0[x_i'(\theta - p')]$, i.e., the expected trading profits pre- and post-ITE. This leads to $a' - a = 1 + 2\frac{h_\theta}{h_\eta}$.

Investment-price sensitivity is given by:

$$\beta_{Kp} = \frac{1-\omega}{\lambda c} \frac{FPE}{(FPE + h_\theta)Cov(\theta_1, p)}, \tag{21}$$

where $FPE = Var^{-1}(\theta_1|p)$ and $Cov(\theta_1, p) = d_y + ad_x$.

Plugging in the expression for $p$ (and $p'$), it follows that $Cov(\theta_1, p) = \frac{2h_\theta + (a+1)h_\eta}{\lambda(4h_\theta + (a+2)h_\eta)} = Cov(\theta_1, p')$, i.e., the covariance between the security payoff and price does not change after ITE. Therefore, investment-price sensitivity is a function of only *FPE* and constants.

## References

Allen, F., 1993. Stock markets and resource allocation. In: Mayer, C., Vives, X. (Eds.), Capital Markets and Financial Intermediation. Cambridge University Press, pp. 81–115.

Asker, J., Farre-Mensa, J., Ljungqvist, A., 2015. Corporate investment and stock market listing: a puzzle? Review of Financial Studies 28, 342–390.

Ausubel, L., 1990. Insider trading in a rational expectations economy. American Economic Review 80, 1022–1041.

Bai, J., Philippon, T., Savov, A., 2016. Have financial markets become more informative? Journal of Financial Economics 122, 625–654.

Baiman, S., Verrecchia, R.E., 1996. The relation among capital markets, financial disclosure, production efficiency, and insider trading. Journal of Accounting Research 34, 1–22.

Bakke, T.-E., Whited, T.M., 2010. Which firms follow the market? An analysis of corporate investment decisions. Review of Financial Studies 23, 1941–1980.

Bertrand, M., Duflo, E., Mullainathan, S., 2004. How much should we trust differences-in-differences estimates? Quarterly Journal of Economics 119, 249–275.

Bertrand, M., Mullainathan, S., 2003. Enjoying the quiet life? Corporate governance and managerial preferences. Journal of Political Economy 111, 1043–1075.

Bhattacharya, U., 2014. Insider trading controversies: a literature review. Annual Review of Financial Economics 6, 385–403.

Bhattacharya, U., Daouk, H., 2002. The world price of insider trading. Journal of Finance 57, 75–108.

Bond, P., Edmans, A., Goldstein, I., 2012. The real effects of financial markets. Annual Review of Financial Economics 4, 339–360.

Bushman, R.M., Piotroski, J.D., Smith, A., 2005. Insider trading restrictions and analysts' incentives to follow firms. Journal of Finance 60, 35–66.

Chen, Q., Goldstein, I., Jiang, W., 2007. Price informativeness and investment sensitivity to stock price. Review of Financial Studies 20, 619–650.

Chen, Z., Huang, Y., Kusnadi, Y., Wei, K. J., 2016. The real effect of the initial enforcement of insider trading laws. Unpublished working paper. Hong Kong University of Science and Technology.

De Long, J.B., Shleifer, A., Summers, L.H., Waldmann, R.J., 1990. Positive feedback investment strategies and destabilizing rational speculation. Journal of Finance 45, 379–395.

Derrien, F., Kecskés, A., 2013. The real effects of financial shocks: evidence from exogenous changes in analyst coverage. Journal of Finance 68, 1407–1440.

Edmans, A., Goldstein, I., Jiang, W., 2012. The real effects of financial markets: the impact of prices on takeovers. Journal of Finance 67, 933–971.

Fernandes, N., Ferreira, M.A., 2009. Insider trading laws and stock price informativeness. Review of Financial Studies 22, 1845–1887.

Fishman, M.J., Hagerty, K.M., 1992. Insider trading and the efficiency of stock prices. Rand Journal of Economics 23, 106–122.

Foucault, T., Frésard, L., 2012. Cross-listing, investment sensitivity to stock price, and the learning hypothesis. Review of Financial Studies 25, 3305–3350.

Foucault, T., Frésard, L., 2014. Learning from peers' stock prices and corporate investment. Journal of Financial Economics 111, 554–577.

Foucault, T., Gehrig, T., 2008. Stock price informativeness, cross-listings, and investment decisions. Journal of Financial Economics 88, 146–168.

Goldstein, I., Ozdenoren, E., Yuan, K., 2013. Trading frenzies and their impact on real investment. Journal of Financial Economics 109, 566–582.

Goldstein, I., Yang, L., 2015. Information diversity and complementarities in trading and information acquisition. Journal of Finance 70, 1723–1765.

Gormley, T.A., Kim, B.H., Martin, X., 2012. Do firms adjust their timely loss recognition in response to changes in banking industry? Journal of Accounting Research 50, 159–196.

Gormley, T.A., Matsa, D.A., 2014. Common errors: how to (and not to) control for unobserved heterogeneity. Review of Financial Studies 27, 617–661.

Gormley, T.A., Matsa, D.A., Milbourn, T.T., 2013. CEO compensation and corporate risk: evidence from a natural experiment. Journal of Accounting and Economics 56, 79–101.

Hayek, F.A., 1945. The use of knowledge in society. American Economic Review 35, 519–530.

Hellwig, C., Mukherji, A., Tsyvinski, A., 2005. Self-fulfilling currency crises: the role of interest rates. American Economic Review 96, 1769–1787.

Leland, H., 1992. Insider trading: should it be prohibited? Journal of Political Economy 100, 859–887.

Lesmond, D.A., Ogden, J.P., Trzcinka, C.A., 1999. A new estimate of transaction costs. Review of Financial Studies 12, 1113–1141.

Luo, Y., 2005. Do insiders learn from outsiders? Evidence from mergers and acquisitions. Journal of Finance 60, 1951–1982.

Manove, M., 1989. The harm from insider trading and informed speculation. Quarterly Journal of Economics 104, 823–845.

Rajan, R.G., Zingales, L., 1998. Financial dependence and growth. American Economic Review 88, 559–586.

Roberts, M.R., Whited, T.M., 2012. Endogeneity in empirical corporate finance. In: Constantinides, G.M., Stulz, R.M., Harris, M. (Eds.), Handbook of the Economics of Finance, 2. Elsevier, North-Holland, pp. 493–572.

Stiglitz, J., Weiss, A., 1981. Credit rationing in markets with imperfect information. American Economic Review 71, 393–410.

Subrahmanyam, A., Titman, S., 1999. The going-public decision and the development of financial markets. Journal of Finance 54, 1045–1082.