The Economics of Foreign Bribery: Evidence from FCPA Enforcement Actions*

Jonathan M. Karpoff [a]
University of Washington

D. Scott Lee[b]
University of Nevada, Las Vegas

Gerald S. Martin[c]
American University

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Abstract

We develop and calibrate a model of bribery and its enforcement using data from enforcement actions initiated under the U.S. Foreign Corrupt Practices Act (FCPA) from 1978 through May 2013. We estimate that 22.9% of Compustat-listed firms with foreign sales engaged in a program of prosecutable bribery at least once during our sample period, and that the probability that a bribe-paying firm faces bribery charges is 6.4%. Bribes tend to be paid for important contracts, as the average ex ante NPV of a bribe-related contract is 2.6% of the firm's market capitalization. The costs for firms that are prosecuted for bribery depend on whether the bribery is comingled with charges of financial fraud. Firms with comingled fraud charges face large fines, investigation costs, and reputational losses, such that the ex post NPV is negative. Bribe-paying firms without comingled fraud charges face significant fines and investigation costs, but do not, on average, lose reputation in a way that impedes future operations or profitability.

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[a] Email: karpoff@uw.edu, Foster School of Business, University of Washington, Seattle, WA 98195, USA.
[b] Email: scott.lee@unlv.edu, Lee Business School, UNLV, Las Vegas, NV 89154, USA.
[c] Email: gmartin@american.edu, Kogod School of Business, American University, Washington, DC 20016, USA.

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1. Introduction

The Foreign Corrupt Practices Act of 1977 (FCPA) prohibits U.S. companies from paying bribes to foreign government officials to obtain business or influence regulation. Anti-bribery enforcement recently has become a priority for U.S. law enforcement agencies (Breuer, 2011). Of 143 anti-bribery enforcement actions that target publicly traded companies since the FCPA was enacted, 64% have occurred since the start of 2007. The increase in U.S. enforcement mirrors an increase in the passage and enforcement of anti-bribery laws throughout the world.[1]

The surge in bribery enforcement has spawned a debate over the prevalence and profitability of bribery, as well as the penalties imposed on firms that are caught bribing. Critics argue that anti-bribery enforcement actions impose large and unwarranted costs on firms (see Weismann and Smith, 2010). Defenders argue that bribery is pervasive and that anti-bribery enforcement efforts are required to decrease corruption that is socially inefficient (e.g., see Kennedy and Danielsen, 2011; the U.S. Department of Justice and Securities Exchange Commission, 2012). Both sides have worked to change U.S. anti-bribery laws, although recent trends favor increased enforcement.[2]

To date, the anti-bribery debate has proceeded without systematic evidence or analysis of the underlying economics of foreign bribery. As Lawler (2012) points out, there is little evidence on the prevalence of foreign bribery, the value of the contracts obtained with bribes, or the sizes of the bribes that are paid. The economic and policy debate centers on firms' costs from bribery enforcement actions, but there is no systematic evidence on the probability that a bribe-paying firm will be caught and face

[1] Member nations in the Organization of American States and Organization for Economic Cooperation and Development adopted anti-bribery conventions in 1996 and 1997, with anti-bribery laws adopted in most individual countries by 2009. The United Kingdom introduced particularly stringent anti-bribery rules in its 2010 Bribery Act, which was implemented in 2011. See also the U.S. Department of Justice (2012).

[2] U.S. Chamber of Commerce proposals to constrain the application of the FCPA motivated two Congressional hearings in 2010 and 2011. Despite these efforts, the Dodd-Frank Wall Street Reform and Consumer Protection Act of 2010 increases many firms' potential liability for bribery violations. HR-3513, introduced in the 112th Congress in 2012, seeks to provide a private right of action for persons and firms who are damaged by a foreign business that violates the FCPA, thus further increasing some firms' potential liabilities from bribery. See the Searle Civil Justice Institute (2012) for summaries of current policy disputes and reform efforts regarding the FCPA.

enforcement action, the types and sizes of the penalties it will face, or whether the enforcement action will harm the firm's reputation and long-term operations.[3] Becker's (1968) analysis implies that firms pay bribes because it is profitable to do so, but there is no evidence on the ex ante net present value of projects that are obtained with bribes, or the ex post value for firms that are caught.

We seek to address these issues with an economic model of bribe paying and the enforcement process and with data on all 143 enforcement actions that target publicly traded companies for foreign bribery initiated by the U.S. Department of Justice (DOJ) and Securities and Exchange Commission (SEC) from 1978 through May 2013. Our model includes 12 parameters in five equations that characterize the ex ante and ex post net present value (NPV) of bribery for firms that seek contracts in foreign countries and that face the possibility of enforcement action, the value of the contracts sought with bribe payments, the total cost to firms that face bribery-related enforcement action, and the portion of the total cost that arises from lost reputation.

To calibrate the model, we directly measure five model parameters, estimate two parameters, and solve for the remaining five parameters using the five-equation model. The five parameters we measure directly are the size of the bribe, the change in firm value when a bribe-related contract is announced, the change in firm value when the bribery and related enforcement activity are revealed, the direct costs to the firm from being targeted for enforcement action, and the effect on firm value of any financial restatement associated with the bribery. The two estimated parameters are the probability that a firm with foreign sales engages in bribery and the probability that a bribe-paying firm will be caught and targeted for enforcement action. To estimate these probabilities we employ signal detection theory, which was first developed by the U.S. Army during World War II to guide the deployment of radar technology to detect incoming enemy aircraft. We estimate that 22.9% of all Compustat-listed firms with foreign sales engaged in prosecutable foreign bribery programs at least once during our sample period, and the

[3] The costs to targeted firms are central to arguments that the FCPA should be amended (e.g., see the Committee on International Business Transactions, 2011). It also is common to argue that reputational costs are large, for example: "Bribery thus raises the risks of doing business, putting a company's bottom line and reputation in jeopardy. Companies that pay bribes to win business ultimately undermine their own long-term interests and the best interests of their investors" (U.S. Department of Justice and Securities and Exchange Commission, 2012, p. 3).

probability that a bribe-paying firm faces enforcement action is 6.4%. These probability estimates are somewhat sensitive to alternate assumptions in the estimation process. The other model parameters, however, are highly robust to even large changes in these probability estimates.

We use these empirical measures and our model of bribery to make inferences about the average values of five parameters: (i) the gross value of the projects for which firms may pay bribes, (ii) the ex ante net present value (NPV) of these projects for firms that pay bribes and face the possibility of penalties if they are caught, (iii) the ex post value of these projects for firms that are caught bribing, (iv) the total costs imposed on firms that are caught bribing, and (v) the portion of these costs that arise from reputational losses. We find that bribes tend to be paid for important contracts with values that average 3.6% of the bribing firm's market capitalization. Net of the expected costs of bribery, the mean ex ante NPV of a bribe-related contract is 2.6% of the firm's market capitalization. This implies that firms engage in bribery because it pays to bribe, on average. Firms that are caught and face enforcement action for bribery, however, face significant costs that average 5.1% of market capitalization, including 3.3% in direct costs and 1.0% in reputation losses. Because of these large costs, the average ex post NPV of the contract is negative for firms that are caught (-2.1% of market capitalization).

A small number of firms in our sample (13) have financial fraud charges comingled with their bribery charges. The firms with comingled fraud charges bid on more valuable contracts and pay larger bribes than the non-fraud firms. When caught, they experience higher direct costs and larger share price reactions to their financial restatements. But the most important difference is that, when their misconduct is revealed, firms with comingled fraud charges experience losses in share values that are 12 times the losses suffered by bribe-paying firms that do not face fraud charges (the mean loss is 33.1% compared to 2.6% for firms without fraud charges). The largest source of this difference is that firms with fraud charges experience large reputational losses – averaging 18.8% of share value – compared to negligible reputational losses for bribe-paying firms without fraud charges. Reputational losses measure the long-term impact on the firm's operations and contracting with investors, suppliers, or customers. These results indicate that the revelation of bribery, by itself, has little such long-term impact – as long as the

bribery is not comingled with charges of financial fraud. Because non-fraud firms face relatively small costs even when they are caught bribing, the average ex post NPV of the bribe-related activity is non-negative for the subset of firms without fraud charges (+0.3% of market capitalization). Thus, even for firms that are caught, the net benefits of bribery are non-negative if the firm avoids comingled financial fraud charges. For firms that face comingled bribery and financial fraud charges, however, the ex post NPV of the bribe-related activity averages -25.2% of the firm's market capitalization.

In addition to estimates of the ex ante and ex post value of bribery to firms that do business in foreign countries, the empirical tests yield four additional insights. First, our data include all bribery-related enforcement actions initiated by the SEC and DOJ. This allows us to document the frequency of these enforcement actions, their distributions across firm size and industry, and the countries in which bribes are paid. The countries that appear most frequently in our sample are China, Nigeria, Iraq, Indonesia, Saudi Arabia, India, and Mexico.

Second, our estimates allow us to describe the characteristics of bribe-paying firms. We find that the probability of paying bribes in any given firm-year is negatively related to current operating performance and positively related to: (i) firm size, leverage, and R&D intensity; (ii) the level of corruption within the firm's industry as measured by Transparency International; (iii) the number of geographic segments in which the firm operates and the level of corruption in those markets as measured by the World Bank's World Governance Institute Control of Corruption index; and (iv) an aggressive corporate culture as defined by Miles and Snow (2003). Example firms from our sample that generally fit these characteristics include HCA Hospital Corporation, General Electric, and Royal Dutch Petroleum.

Third, our results allow us to measure the division of gains from bribe-related business. We find that bribe recipients capture 16.3% of the value of the contracts for which bribes are paid, on average. This evidence is inconsistent with arguments that bribe recipients extract most of the surplus from bribe-related contracts, and suggests that the ex ante NPV of paying bribes is positive in large part because bribe-paying firms avoid transferring most of the contract value to bribe recipients.

Fourth, our analysis allows us to examine policy questions about the optimal penalties for bribery. Using the estimate that the probability of getting caught is 6.4%, total penalties imposed on bribe payers would have to increase by 9.2 times to drive the average ex ante NPV to zero. If the penalties remain at historical levels, the probability of getting caught would have to increase to 58.5% to achieve the same objective. This implies that bribery will continue to be profitable, at least on an ex ante basis, unless there is a substantial increase in the penalties for bribery or the probability of getting caught, or both. We do not address the debate over whether it is good public policy to discourage bribery in the first place (e.g., see Shleifer and Vishny, 1993). But if it is desirable to discourage bribery, our results support the view that enforcement efforts and penalties should be increased to approach an optimal level of deterrence.[4]

This paper proceeds as follows. Section 2 provides a brief history of the Foreign Corrupt Practices Act of 1977 and related research. Section 3 presents our economic model of foreign bribery and describes the inputs required to calibrate it. Section 4 describes the data used to calibrate the model. Section 5 presents evidence on the five model parameters we can measure directly, including changes in share values when bribe-related contracts are announced and when the bribery and its enforcement are revealed, the sizes of the bribes paid, and the direct costs imposed on firms that are penalized for bribing. Section 6 develops our empirical model to estimate the probability that firms with foreign sales pay bribes and the probability that a bribe-paying firm will face enforcement action for bribery. The results in Sections 5 and 6 are combined in Section 7 to calibrate the economic model and derive inferences about the ex ante and ex post NPV of bribery, the reputational loss associated with the revelation of bribery, the fraction of bribe-related contract values that is transferred to bribe recipients, and the implications for optimal penalties. Section 8 summarizes the results of several robustness tests, and Section 9 concludes.

[4] Our analysis applies to firm-level incentives and deterrence, as we do not consider other consequences to bribe-paying managers. In our sample, a total of 31 individuals have been sentenced to prison terms that average 15.3 months for foreign bribery. Greater deterrence also can be achieved by increasing expected penalties for individual managers.

2. The Foreign Corrupt Practices Act of 1977

Political pressure to enact anti-bribery legislation dates at least to 1975, when the International Chamber of Commerce established a committee to recommend steps to combat corporate extortion and bribery. The following year, the former Prime Minister of Japan was indicted for taking $2 million in bribes for assisting Lockheed Corporation in selling 21 passenger jets to a Japanese airline. Subsequent revelations indicated that many U.S. firms were bribing foreign officials to obtain business and misrepresenting their financial statements to avoid detection by auditors and investors. Contemporaneously, congressional investigations into the Watergate scandal revealed that many corporations maintained slush funds to court favor from both domestic and foreign government officials. In response, the SEC proposed an amnesty period to encourage firms to conduct independent internal investigations and voluntarily disclose questionable payments. More than 400 firms, including 100 firms in the Fortune 500, subsequently disclosed illicit payments that exceeded $300 million.

These events helped motivate Congress to pass the Foreign Corrupt Practices Act of 1977 (FCPA). As amended by the Act, 15 U.S.C. §§ 78dd (Section 30A in the Securities Exchange Act of 1934) prohibits any issuer, domestic concern, or other persons from making payments to foreign officials or foreign political parties to obtain or retain business. Before 1977, federal powers to prosecute foreign bribery relied primarily on anti-fraud and money laundering provisions of the Currency and Foreign Transactions Reporting Act and the Travel Act. Enforcing these older Acts proved difficult because they required either proof of intent (*scienter*), racketeering, or failure to report foreign currency transactions. With the FCPA, the SEC and DOJ could now impose civil and criminal penalties for bribery in and of itself.[5]

[5] For a more detailed history of the FCPA, see the Searle Justice Civil Institute (2012). To aid in the prosecution of its anti-bribery rules, the FCPA also added three financial reporting provisions: (i) 15 U.S.C. §§ 78m(b)(2)(A), which requires firms to keep and maintain books and records that accurately reflect all transactions; (ii) 15 U.S.C. §§ 78m(b)(2)(B), which requires firms to devise and maintain a system of internal accounting controls; and (iii) 15 U.S.C. §§ 78m(b)(5), in which no person shall knowingly circumvent or knowingly fail to implement a system of internal accounting controls or knowingly falsify any book, record, or account. See Maher (1981), Karpoff, Lee, and Martin (2008), and Shearing and Sterling (2012) for detailed descriptions and analyses of these provisions.

The FCPA is the topic of extensive coverage in the legal literature and blogosphere.[6] Researchers also have examined the general influence of corruption and trust on economic performance (e.g., see Shleifer and Vishny, 1993, 1994; Guiso, Sapienza, and Zingales, 2009; Rose-Ackerman, 2010) and whether bribery is inherently wrong (Green, 2005). There is comparatively little empirical research on the FCPA or anti-bribery enforcement activity. Hines (1995) reports that the FCPA decreased U.S. firms' operations in foreign countries, and Zeume (2013) finds that firms covered by the U.K. Bribery Act of 2010 also decrease their foreign direct investments. In contrast, Graham (1984) reports no effect of the FCPA on U.S. firms' market shares. Serafeim (2013) reports survey evidence suggesting that the detection of bribery can affect employee morale and firm competitiveness. Cheung, Rau, and Stouraitis (2012) examine the characteristics of bribes and bribe-payers using a worldwide sample of 107 publicly traded firms charged with bribery from 1971-2007. And Smith, Stettler, and Beedles (1984) examine share price reactions to announcements by 98 firms that voluntarily reported payments to foreign government officials during the SEC's pre-FCPA amnesty program that ended in 1978. The mean share price reaction is negative, and Smith et al. conjecture that this reaction reflects investors' expectations of future government sanctions or the loss of future business. This conjecture anticipates the current policy debate over the sizes of the direct and indirect penalties for firms that are targeted in FCPA-related bribery enforcement actions.

3. The value of bribery: A model

Assume that a firm bids for a contract in a foreign country at time t_0. If the contract is awarded at time t_1, it is worth X, where $X > 0$. If the firm pays no bribe, the probability that the firm's bid will be accepted is γ_n, where the n subscript stands for "no bribe." Before bidding, however, the firm receives a private signal i. With probability p_b, $i = 1$, indicating that the firm can increase its likelihood of winning the contract by paying a bribe B. As an example of such a private signal, the foreign official who decides

[6] For examples, see Cohen, Holland and Wolf, 2008; Davis, 2002; Dugan and Lechtman, 1997; Erbstoesser, Struck and Chesley, 2007; Huskins, 2007; and Timmeny, 1982; and also www.fcpaprofessor.com, www.anticorruptionblog.com, and www.fcpablog.com.

on the contract award can indicate through an intermediary that his decision can be influenced by a bribe payment. The bribe increases the probability of receiving the contract to $\gamma_b > \gamma_n$. We assume that $\gamma_b'(B) > 0$ and $\gamma_b''(B) < 0$ for all $B > 0$, and that $\gamma_b \to 1$ as $B \to \infty$. With probability $1–p_b$, $i = 0$, indicating that the signal indicates that the firm cannot influence its chances of winning the contract by paying a bribe. This intuition can be expressed as follows:

$$\begin{aligned} &\text{Signal:} && \Pr\{i = 1\} = p_b\text{:} && \gamma_b(B) > \gamma_n \text{ for } B > 0,\ \gamma_b'(B) > 0,\ \gamma_b''(B) < 0 \\ & && \Pr\{i = 0\} = 1 - p_b\text{:} && \gamma_b(B) = \gamma_n \text{ for all } B > 0\ . \end{aligned} \tag{1}$$

If the firm receives the signal $i = 0$, it does not pay a bribe and wins the contract with probability γ_n. If the firm receives the signal $i = 1$, paying a bribe can influence the bid outcome and increase the probability of winning the contract. The firm then weighs the benefits of bribing against the cost, which consists of the bribe itself, B, plus the expected cost p_cC of being caught bribing. Here, p_c is the probability of getting caught and C is the penalty imposed on the firm if it is caught bribing. We assume that both the probability and the penalty increase with the size of the bribe $C'(B) > 0$, $C''(B) \geq 0$, $p_c'(B) > 0$, and $p_c''(B) \geq 0$ for $p_c \in (0,1)$.[7] Conditional upon receiving the signal $i = 1$, the optimal bribe amount B satisfies the first-order condition:

$$\gamma_b'(B)X = 1 + \partial(p_cC)/\partial B \tag{2}$$

That is, the firm increases B until the marginal increase in the expected value of the contract award equals one plus the marginal increase in the expected cost of getting caught bribing.

At time t_1 the firm learns whether it wins the contract and announces the contract award to the public. If a bribe was paid, the value of the contract net of the expected penalty from being caught is:

[7] These assumptions imply that some positive bribe will be paid if $i = 1$. Without loss of generality, we could assume a fixed cost component to C, or a threshold level of B below which $\gamma_b(B) = \gamma_n$, which would rule out very small bribe payments.

$$Ex\ ante\ NPV = X - B - p_c C. \tag{3}$$

We call this the *Ex ante NPV* because it is the value of the contract before the firm learns whether it will be caught and face a bribe-related penalty.

If the firm pays a bribe, it learns whether it has been caught at time t_2. If so, the *Ex post NPV*, net of the realized penalty, is

$$Ex\ post\ NPV = X - B - C. \tag{4}$$

In this paper we do not focus on the firm's decision to pay the bribe at t_0, but rather, investors' inferences when they learn that the contract was awarded to the firm at t_1 and if the firm is caught bribing at t_2. We assume that investors know X, γ_n, $C(B)$, and $p_c(B)$. They also know p_b, the probability that the firm will receive the signal that bribery can be influential, and they know the function $\gamma_b(B)$. So, conditional on a bribe being paid, investors can infer the size of the bribe. But investors do not know whether the firm receives the signal i, and therefore do not know whether a bribe was paid to obtain the contract.

If the contract is awarded at t_1, the firm's share price increases to reflect the value of the contract and the possibility that a bribe was paid to get it:

$$\Delta V_1 = X - p_b B - p_b p_c C \tag{5}$$

At t_2, the firm and investors both learn whether the firm faces a penalty for paying a bribe. If no bribe was paid, the ex post value of the contract is X. If a bribe was paid and the firm is not caught, the ex post value is $X - B$. And if the firm is caught, the ex post value is $X - B - C$. If the firm is caught, its change

in value at t_2 will reflect the ex post NPV of the project minus the amount by which firm value previously was adjusted at t_1:

$$\begin{aligned} \Delta V_2 &= (X - B - C) - \Delta V_1 \\ &= -[(1 - p_b)B + (1 - p_b p_c)C] \end{aligned} \tag{6}$$

Previous research indicates that firms face both direct and indirect penalties when they break the law and are caught (e.g., see Alexander, 1999; Murphy, Shrieves, and Tibbs, 2009). Karpoff, Lee, and Martin (2008) partition the total cost into three components:

$$C = C_{direct} + C_{restate} + C_{reputation} \tag{7}$$

C_{direct} represents direct costs, which include all fines, penalties, and settlement costs imposed on the firm, plus any expenses paid by the firm to conduct an internal investigation of its (alleged) misconduct. $C_{restate}$ is the restatement correction, which is the amount that investors adjust the firm's value in light of any revelation that its financial statements previously were in error. As we discuss in section 5.4, firms that are charged with foreign bribery sometimes have to restate their financial statements to correct prior efforts to camouflage the bribery. $C_{restate}$ reflects the reversal of any price inflation that may have occurred because of these prior efforts. $C_{reputation}$ is the firm's reputation loss from the revelation of its misconduct. The reputation loss is the present value of the higher future costs and lower future revenues that are expected to accrue to the firm as its counterparties change the terms with which they are willing to trade with the firm. Many commentators argue that firms that are caught committing bribery incur large reputational losses (see footnote 3). This is an empirical matter we seek to address.

Equations (3) through (7) constitute the model we calibrate in the following sections. The table below summarizes the model's 12 parameters and how we estimate each one. We measure two parameters (B and C_{direct}) from data related to the SEC and DOJ's enforcement releases. We use event study methods to estimate ΔV_1, ΔV_2, and $C_{restate}$. The two probabilities, p_b and p_c, are estimated using a

procedure that is reported in Section 6. The remaining five parameters (*X, Ex ante NPV, Ex post NPV, C,* and $C_{reputation}$) are inferred from equations (3) through (7) of the model, as reported in Section 7.

Summary of the model parameters

Variable	Description	How measured
ΔV_1	Change in firm value when contract is awarded	Event study
ΔV_2	Change in firm value when bribery is revealed	Event study
X	Gross project value	Inferred from model
Ex ante NPV	Expected project value for firms paying bribes, with uncertain penalties for bribery	Inferred from model
Ex post NPV	Project value for firms paying bribes that are caught and pay penalties for bribery	Inferred from model
B	Bribe amount paid	Measured directly
C	Total penalty for firms caught bribing	Inferred from model
C_{direct}	Direct costs from being caught bribing	Measured directly
$C_{restate}$	Restatement correction from being caught	Event study
$C_{reputation}$	Reputation loss from being caught	Inferred from model
p_b	The probability that a bribe is paid	Estimated in Section 6
p_c	The probability that a bribe-paying firm is caught	Estimated in Section 6

4. Data

Our sample consists of all enforcement actions initiated by the SEC and DOJ from January 1, 1978 through May 31, 2013 for foreign bribery under the Foreign Corrupt Practices Act of 1977. To identify the enforcement actions, we searched for specific references to the bribery provisions of the FCPA (e.g. United States Code Sections 78dd-1 through 78dd-3 and 30A) using the CCH Wolters Kluwer Securities (Federal) Library and the PACER database.[8] To avoid missing any bribery enforcement actions that used other provisions of the U.S. code, we also searched for the terms "bribery," "Foreign

[8] CCH Wolters Kluwer Securities (Federal) Library (intelliconnect.cch.com) contains the SEC Docket, which is an archival collection of all releases, notices, settlements, orders, opinions, policy statements, reports and studies issued by the Securities and Exchange Commission since 1973, plus selected SEC releases published in the Federal Securities Law Reporter from 1940-1972. PACER (Public Access to Court Electronic Records) is an electronic public access service that allows users to obtain case and docket information from federal appellate, district and bankruptcy courts (see www.pacer.gov).

Corrupt Practices Act," and "FCPA," and read all resulting SEC and DOJ proceedings to determine if a violation included illegal payments to foreign officials. The Department of Justice provided us additional enforcement data for the civil and criminal enforcement proceedings for which the DOJ was involved, and we were able to cross-check our data for thoroughness and accuracy using websites that the SEC and DOJ recently posted that provide detailed histories of their FCPA-related enforcement activities.[9] Finally, we used EDGAR, PACER, Dow Jones' Factiva, Lexis-Nexis' Legal Research and General News categories, and Google News to gather additional information and news releases pertaining to the enforcement actions, including related class action and derivative lawsuits.

4.1. The time trend of enforcement actions

The DOJ and SEC initiated a total of 195 bribery-related enforcement actions from January 1978 through May 31, 2013. Of these, 52 enforcement actions target private entities, including individuals, closely-held firms with no publicly-traded securities, and one foreign affiliate of a private US accounting firm.[10] The remaining 143 enforcement actions involve bribery by agents working for domestic and foreign publicly traded companies, and constitute the sample used in this study. (In tests requiring return data our sample size is reduced to 140 because three actions involve publicly traded firms that lack return data for the relevant event dates.) Figure 1 shows the chronological distribution of these enforcement actions by the year in which the enforcement action began. From 1978 through 2006, the median number of actions per year is one. Enforcement activity increased sharply beginning in 2004, peaking with 22 actions initiated in 2010. As discussed in the introduction, the increase in enforcement activity largely reflects an increased emphasis on bribery-related enforcements by the U.S. Department of Justice.

[9] The SEC's "Spotlight on Foreign Corrupt Practices Act" is available at http://www.sec.gov/spotlight/fcpa/fcpa-cases.shtml and the DOJ's site is at http://www.justice.gov/criminal/fraud/fcpa/cases/a.html.

[10] One example of the 52 actions that target private entities is the highly publicized action against U.S. Representative William J. Jefferson (D-LA). Jefferson was convicted of using his office to solicit bribes to promote telecommunications deals in Nigeria, Ghana and elsewhere; oil concessions in Equatorial Guinea; satellite transmission contracts in Botswana, Equatorial Guinea and the Republic of Congo; and development of different plants and facilities in Nigeria.

Of the 107 actions initiated since 2004, 20 actions involve alleged abuses of the United Nations' Oil-for-Food Program in Iraq. Thirteen of these actions pertain solely to activities associated with the UN Oil-for-Food Program, while the other seven include bribery in other countries as well (see the Independent Inquiry Committee into The United Nations Oil-for-Food Programme at http://www.iic-offp.org/index.html). The results reported throughout this paper are qualitatively similar if we exclude these 20 actions.

4.2. The sizes, industries, and home countries of bribe paying firms

Table 1 reports on the industry and size distributions of the 143 sample firms. We use SIC codes to group firms according to the 19 industry sectors used by Transparency International, and list the industries in declining order of Transparency International's Bribe Payer's Index (BPI) Industry Sector Score. The Sector Score is an index that reflects survey respondents' view of the frequency with which firms in each industry pay bribes. It is scaled from 0 to 10, with lower numbers associated with industries in which bribe paying is common practice. According to the Sector Score, bribery is perceived to be most prevalent in Public Works Contracts and Construction and least prevalent in the Agriculture sector.

The industries with the most frequent bribery enforcement actions are Heavy Manufacturing (53 actions), Pharmaceutical and Healthcare (20), and Oil and Gas (19). Some, but not all, of this heavy representation can be attributed to the large number of firms in these industries. For example, Heavy Manufacturing comprises 15.6% of all public firms in the Compustat database, but accounts for 37.1% of the bribery-related enforcement actions; Oil and Gas comprises 8.7% of all public firms and accounts for 13.3% of the bribery-related enforcement actions. To assess the relative frequency of bribery enforcement actions within each industry, Table 1 also reports on the ratio of enforcement actions to the number of Compustat-listed firms in the industry. The Arms, Defense, and Military sector has the highest relative frequency (8.6%), followed by Agriculture (4.6%). Six of the 19 industries had no firms targeted for bribery-related enforcement actions. A test of equal proportional frequencies across industries is rejected with $\chi^2 = 219.93$ and p-value < 0.001.

Table 1 also shows that firms targeted for bribery enforcement actions tend to have high equity value, as measured the day before the bribery was revealed. More than half (80 or 55.9%) of the targeted firms reside in the largest decile of public firms, while only 13 (9.1%) reside in the bottom five deciles. A test of equal proportional frequencies between size-based deciles is rejected with $\chi^2 = 77.73$ and p-value < 0.001.

4.3. Where do bribes occur?

Appendix A reports on the countries in which bribes were paid. The country with the most bribery enforcement actions is China (28), followed by Nigeria (27), Iraq (24), Indonesia (16), Saudi Arabia (13), India (12), Mexico (12), and Brazil (11). Appendix Table A1 also shows that bribe payments associated with FCPA-related enforcement actions tend to occur in countries with reputations for corruption, as measured by Transparency International's 2011 Corruption Perceptions Index (CPI) and the 2011 World Governance Indicators Control of Corruption (COC) indicator.

4.4. Related charges of misconduct

In most enforcement actions, the SEC and DOJ file charges for other violations in addition to bribery. For example, violations of the FCPA's books and records (13(b)(2)(A)) and internal controls (13(b)(2)(B)) provisions are included in 110 and 102 of the 143 bribery-related actions, respectively. Most of these violations relate to these firms' efforts to circumvent normal internal control procedures to make bribe payments and to hide the payments in their financial reports. The DOJ brought charges of conspiracy (18 U.S.C. § 371) in 58 actions, aiding and abetting (18 U.S.C. § 2) in 29 actions, money laundering under RICO (18 U.S.C. 1956) in 11 actions, and wire fraud (18 U.S.C. § 1343) in 10 actions. Other related charges include proxy violations, false SEC filings, false statements to the SEC, currency and reporting violations, false income taxes, mail fraud, and bank fraud.

The most important related charges, in terms of their valuation effects and the calibration of our model, relate to financial fraud. Thirteen of the 143 enforcement actions have charges of financial fraud

comingled with the bribery charges, including 10(b) fraud under the Securities Exchange Act of 1934 and 17(a) fraud under the Securities Act of 1933. As reported below, many of our empirical measures differ significantly between the 13 firms with financial fraud charges and the 130 other firms in the sample (127 of which have available returns data), including the valuation effect of the bribe-related contract, the share price impact of the revelation of misconduct, the size of the bribe, the reputation loss, and the ex post NPV of the bribe-related contract. These differences help to reveal important aspects of the consequences of bribery, especially compared to the consequences of financial fraud. In our empirical tests and model calibration, we therefore report results separately for the subsets of fraud- and non-fraud related enforcement actions in our sample.

5. Direct measures of five model parameters

5.1. Share price reactions to contract awards (ΔV_1) and the revelation of bribery (ΔV_2)

In this section we use event studies to estimate ΔV_1 and ΔV_2, two of the inputs necessary to calibrate the model presented in Section 3. ΔV_1 is the change in firm value when the bribery-related contract is awarded. To estimate it, we adapt the procedure first used by Cheung, Rau, and Stouraitis (2012). For each firm in our sample, we use SEC and DOJ administrative proceedings, litigation releases, and press releases to identify the business activity that was procured with the aid of a bribe and the time period over which one or more bribes were paid. We then search Lexis-Nexis and Factiva for public announcements of the contract award, centering our search on the violation period identified by the SEC and DOJ. We are able to identify initial contract award announcements for 62 of the firms in our sample.

Table 2, Panel A, reports the mean and median market-adjusted one-day abnormal return for these 62 initial contract award announcements, using the CRSP value-weighted portfolio to calculate the market average return. The mean one-day abnormal return is 3.34%, with a median of 2.23%. (Results using two and three-day event windows yield similar inferences.) Five of the 62 firms have charges of financial fraud comingled with their bribery charges. For these five firms, the mean one-day abnormal return is 7.84%, compared to 2.94% for the 57 firms without any associated charges for financial fraud.

These results indicate that initial news of the bribery-related contract awards prompts meaningful and statistically significant increases in the sample firms' share values.

When these contracts were awarded, investors did not know if the firms paid bribes to obtain the contracts. ΔV_2 represents the change in share values when news of bribery is first publicly revealed. Panel B of Table 2 reports the mean and median one-day market-adjusted share returns upon the initial news that the firm engaged in bribery. Data to calculate abnormal share returns are available for 140 of our 143 sample firms. The mean one-day market-adjusted return for these firms is -3.07%. For the 13 firms with comingled charges of financial fraud, the mean return is -16.25%, compared to -1.72% for the 127 firms without comingled fraud charges. The t-statistic for the difference between these two means is significant at the 10% level, while the Wilcoxon signed-rank test statistic is significant at the 1% level. Hence, the average abnormal return is significantly lower (more negative) for firms that face contemporaneous fraud charges than it is for firms that do not face fraud charges. This indicates that the contemporaneous revelation of financial fraud is one reason that bribery enforcement actions are associated with negative abnormal returns.

Bribery-related enforcement actions usually involve a complex sequence of news reports, lawsuits, enforcement activities, and penalties that relate to the targeted firm's misconduct. These announcements reveal important information about the nature of the bribery, the financial misrepresentation in which the firm engaged to cover up the bribery, any comingled charges of financial fraud, and the penalties imposed on the targeted firm. To capture the full valuation effect of each enforcement action, we calculate one-day market-adjusted returns for all discrete and incremental announcements that pertain to each action and sum them into a compound cumulative abnormal return (CCAR). In addition to the initial revelation of misconduct, the additional announcements include revelations of informal inquiries by regulators, formal investigations, receipt of Wells Notices, earnings restatements, related private lawsuit filings and settlements, SEC enforcement releases, DOJ releases, and court filings relating to bribery charges. To avoid double-counting, we ignore multiple news stories that convey information that previously was made public in prior press releases or SEC and DOJ proceedings.

Counting all such incremental news revelations, there are a total of 767 incremental announcements related to the 140 bribery enforcement actions, an average of 5.48 per action.

As reported in Table 2, the mean CCAR for all 140 firms in the sample is -5.44% ($p < 0.001$) and the median is -1.69% ($p < 0.001$). The magnitude of the loss is significantly larger for enforcement actions that involve financial fraud. For the 13 actions with contemporaneous fraud charges, the mean CCAR is -33.06% ($p < 0.01$) and the median is -21.29% ($p < 0.01$). For the 127 actions without fraud charges, the mean CCAR is -2.61% ($p < 0.1$) and the median is -1.52% ($p < 0.001$). The differences between the fraud and no-fraud samples are statistically significant.

These results indicate that, on average, information that a firm is targeted for a bribery-related enforcement action triggers a significant reduction in share value. The loss, however, is much larger when the bribery violation is comingled with financial fraud charges. In calibrating our bribery model, we use the mean CCAR to measure ΔV_2, although our overall results are similar if we use the one-day initial revelation date return to measure ΔV_2.

5.2. Bribe amounts (B)

Data on the bribe amounts are provided in the administrative proceedings, litigation releases, and press releases filed by the SEC and DOJ during the enforcement action. There is a wide range of bribe amounts and time intervals over which they are made. In the largest bribery program, Siemens AG paid $1.79 billion in bribes in ten different countries over a 25-year period. The smallest amount, $1,250, is a one-time bribe by a Smith & Wesson employee as part of an FBI sting operation that led to a still ongoing investigation into foreign bribery at the company.[11] As reported in Panel A of Table 3, the mean bribery violation stretched out over a period of 5.36 years, with a median of 5.0 years. The mean bribe amount is $23.43 million, with a median of $1.05 million. Expressed as a fraction of the market value of equity at the end of the violation period, the mean bribe-to-market capitalization is 1.00%, with a median of 0.03%.

[11] These examples are outliers in our sample. Our results are qualitatively unaffected when either or both of these cases are removed from the sample.

The mean bribe-to-market capitalization ratio is affected by two extreme observations: Page Airways, a firm with a market capitalization of $7.2 million was accused of paying $2.5 million in bribes for $60 million in aircraft orders in the Middle East, yielding a bribe-to-market capitalization ratio of 34.6% (6.5 standard deviations from the mean value in the sample). And International Systems & Controls, with a capitalization of $46.5 million, was accused of paying $23 million in bribes to government officials and members of ruling families in the Middle East to obtain contracts for engineering and construction projects worth $230 million, yielding a bribe-to-market capitalization ratio of 49.5% (9.3 standard deviations from the mean). Winsorizing these two percentages to 12.62% (the third highest bribe-to-market capitalization ratio) reduces the mean bribe-to-market capitalization measure to 0.58%. In calibrating the bribery model, we use the mean Winsorized bribe-to-market capitalization ratio. The overall results are similar if we drop these two observations, or if we use the un-Winsorized mean value of 1.00%.

The bribe amounts are relatively large for the subsample of firms with comingled fraud charges. The thirteen firms with fraud charges paid a mean bribe amount of $36.1 million, and their mean bribe-to-market capitalization is 2.75%. For the majority of firms without comingled fraud charges, the mean bribe amount is $22.1 million and the mean bribe-to-market capitalization is 0.36%. The difference in the Winsorized means between the fraud and non-fraud firms is statistically significant at the 10% level.

5.3. Direct costs incurred by firms targeted for enforcement action (C_{direct})

Firms that are targeted for bribery-related enforcement actions face three types of direct costs: (i) fines and penalties; (ii) investigation and legal expenses; and (iii) monitoring expenses. Fines and penalties include all disgorgement, prejudgment interest, and fines ordered by regulators, plus settlements reached in civil class action and derivative lawsuits related to the misconduct. Panel A of Table 3 reports on the incidence and sizes of these monetary penalties. The mean total monetary penalty is $93.5 million, or 1.56% of the targeted firm's market capitalization measured at the end of the violation period. The mean bribe amount is affected by three very large bribe payments: Siemens AG paid bribes totalling

$1.79 billion, Montedison S.p.A. paid bribes totaling $398.25 million, and BAE Systems PLC paid bribes totaling $315 million. As a fraction of the firm's market value of equity, however, these three are not large outliers. We express both bribe and penalty amounts as a fraction of market capitalization in calibrating the model to reduce distributional skew and to permit direct comparison of bribe and penalty amounts to ΔV_1 and ΔV_2, which are measured as rates of return.[12]

Consistent with the proposition that fraud charges frequently are associated with egregious misconduct, the mean monetary penalties are much larger when fraud charges are included, $537.1 million, or 6.44% of market capitalization, compared to $48.1 million or 1.06% of market capitalization for non-fraud related bribery. This reflects a small number of very large penalties, however, as the median penalty for fraud-related bribery actions is only $0.53 million. Reflecting the large variance in penalty amounts, the mean difference in penalties between fraud and non-fraud related bribery actions is not statistically significant.

The U.S. Chamber of Commerce claims that firms that are targeted for anti-bribery enforcement actions, "… spend enormous sums on legal fees, forensic accounting, and other investigative costs before they are even confronted with a fine or penalty…" (Weissmann and Smith, 2010, p. 5). To investigate the magnitude of such investigation and legal expenses, we collected data on firms' reports of these expenses by searching all 10-K, 10-Q and 8-K filings for the period from the initial revelation of bribery to the fiscal year after final resolution of the enforcement action. We found self-reported data on these expenses for 48 of the sample firms, and use these data to construct an empirical model of a firm's investigation and legal expenses as a function of firm and bribery characteristics, including firm size, the bribe amount, the fraction of bribe-related sales to total firm sales, the geographical extent of the bribery, the number of related charges, and perceptions of the level of corruption in the firm's industry and the country or countries in which the bribe was paid. We then use this model to forecast the investigation and legal expenses for the firms in our sample for which we do not have reported expenses. Appendix B reports on

[12] Calibrating the bribery model in terms of dollar amounts rather than as a fraction of equity value yield similar inferences. The distributions of the input values, however, are skewed and the mean values of two of the five directly measured inputs (the bribe amounts and direct costs) are not significantly different from zero.

the model, the data used to estimate it, and the fitted values for firms with missing investigation cost data.[13]

The results from this procedure are summarized in Panel B of Table 3. As a percent of market capitalization, the mean investigation and legal expense is 1.53% with a median of 0.95%. Investigation costs are relatively high for firms with comingled fraud charges. The mean investigation expense is 2.71% for the fraud-related actions compared to 1.41% for non-fraud related actions, a difference that is statistically significant. This difference indicates that internal investigations tend to be more costly when fraud charges are comingled with the bribery charges, and is consistent with the view that fraud charges are associated with relatively complex and costly cases of misconduct.

In addition to (i) fines and penalties and (ii) investigation and legal expenses, 26 of the firms in our sample had to pay for an independent monitor during probationary periods that range from five months to five years. Monitors are most commonly associated with Deferred Prosecution Agreements, in which the DOJ agrees to drop any criminal charges at the end of the probationary period if the firm does not commit a similar violation. We are able to find the associated monitoring cost from company reports for five of the 26 firms. To estimate the monitoring cost for the 21 firms that did not report it, we multiplied the average cost per month for the five known enforcement actions by the number of months of independent monitoring required under the firm's Deferred Prosecution Agreement, and divide the total monitoring cost by the firm's market capitalization.

The mean length of the monitoring period for the five known actions is 3.2 years with a median of 3.0 years. The mean cost per month is $0.37 million with a median of $0.28 million. Applying these averages to the 21 unknown expenses and assigning a monitoring cost of zero to the 114 firms that have no required monitoring expenses produces a mean monitoring cost per firm that equals 0.18% of the

[13] We discussed and vetted our empirical model for investigation costs with representatives from the three insurance companies (Lloyds, AIG, and Marsh) that provide bribery-specific policies that insure for the investigation and legal expenses incurred as the result of an investigation into the possible violation of the FCPA or U.K. Bribery Act. One of these companies adopted our model to help determine their payout risks.

firm's market capitalization, with a median of 0.0%. The average monitoring cost is similar for the fraud-related and non-fraud subgroups of enforcement actions.

Panel B of Table 3 also reports on the total direct cost for all enforcement actions, which is the sum of (i) fines and penalties; (ii) investigation and legal expenses; and (iii) monitoring expenses. The mean total direct cost is 3.27% with a median of 1.21%. The mean direct cost for actions without financial fraud is 2.66% with a median of 1.15%. For firms with comingled fraud charges, the mean total direct cost is 9.31% with a median of 4.46%. The difference in means between the fraud and no-fraud groups is not statistically significant using a parametric t-statistic, but is significant using the Wilcoxon signed rank test. This evidence indicates that firms incur substantial direct costs when they are charged with foreign bribery, particularly when they also face comingled fraud charges.

5.4. Restatement correction ($C_{restate}$)

Many charges of bribery include revelations that the firm altered its financial reports to conceal the bribery. Indeed, in 13 of our cases the affiliated financial misrepresentation is severe enough to attract charges of financial fraud. We expect part of the price reaction when bribery is revealed to reflect investors' judgment that share prices previously were inflated by false financial information. Karpoff, Lee, and Martin (2008) estimate that the restatement correction accounts for a significant portion of the share price decline when firms are discovered to misrepresent their financial statements.

To measure the restatement correction, we calculate the market-adjusted abnormal share returns for all days on which the firm announced a restatement related to the bribery-related enforcement action. For firms that have more than one restatement announcement, we sum all the one-day abnormal returns over all such announcements. This measure essentially backs out the portion of ΔV_2 that can be attributed to news that the firm's financial statements were in error – most frequently as a result of efforts to cover up the bribery. The results are reported in Panel B of Table 3. Averaging over all 140 firms, the mean share value loss on restatement announcements that are associated with the bribery-related enforcement action is 0.78%. The median firm has no restatement events, so the median restatement correction is zero.

Among actions without financial fraud charges, the mean restatement correction is 0.52% of market capitalization, and among actions with fraud charges, the mean is 3.30%. This difference indicates that share prices react strongly to restatement announcements when the bribery charges are comingled with fraud charges. This is consistent with our reading of the restatement announcements. When fraud charges are involved, the restatements frequently correct extensive reporting violations that go far beyond the bribery. When fraud charges are not involved, the restatements typically reclassify bribe-related expenditures. Frequently, the reclassifications are minor and do not affect the firms' reported earnings.

6. Probabilities of committing bribery (p_b) and getting caught (p_c)

In this section we derive the final two inputs needed to calibrate the economic model in Section 3, p_b and p_c. We use a two-step process in which we first model the characteristics of firms that are caught committing bribery, and then apply a procedure called Receiver Operating Characteristic (ROC) analysis. The ROC procedure yields estimates that the probability that a Compustat-listed firm with foreign sales engaged in prosecutable bribery during our sample period is 22.9%, and the probability that a firm committing bribery will be caught is 6.4%.

6.1. Characteristics of bribe-paying firms

We begin by estimating an empirical model of firm and industry characteristics that are associated with bribe paying. Our sample is based on all firms in Compustat over the 36-year period from fiscal year 1975 through 2010.[14] The bribery provisions of the FCPA apply only to firms with foreign sales, so we eliminate firms that have no non-U.S. sales reported in the Compustat Geographic Segment data for at least one year. We also delete firms with insufficient data on the dependent variables identified below, resulting in a sample of 6,857 firms and 92,866 firm-years. A total of 108 of these firms are in our sample of bribery-related enforcement actions and have sufficient data to estimate the logistic

[14] While the FCPA was signed into law in 1977, enforcement actions cited instances of bribery as early as 1975. Our sample includes enforcement actions initiated as late as May 2013, but the violation periods for these actions extend only through 2010.

model.[15] These 108 firms paid bribes in 509 firm-years. Thus, the firms penalized for bribery violations comprise 1.58% of the sample of potential bribe paying firms, and these firms paid bribes in 0.55% of all firm-years in which bribery by a firm with foreign sales is possible.

Previous attempts to model the likelihood that firms engage in other types of misconduct focus on such firm characteristics as firm size, leverage, profitability, and asset mix (e.g., see Wang, 2013; Dechow et al., 2012). We include such controls, and add predictor variables that reflect aspects of the firm, industry, and country that are motivated by the reasons for bribing that are discussed in SEC and DOJ bribery-related enforcement releases. These include industry concentration, the scope and complexity of the firm's foreign operations, the perception of corruption in the firm's industry and in the country in which bribes were paid, and the culture or business strategy of the bribing firm.

In particular, we use the Herfindahl index based on four-digit SICs to measure industry concentration. To capture the scope and complexity of the firm's foreign operations, we use the fraction of the firm's total sales that comes from foreign sales, the number of geographic segments in which the firm operates, and the average distance from the company's headquarters to its foreign market. This distance variable is calculated from geocoded data using the centroid latitude and longitude coordinates for each reported geographic segment or country reported in Compustat's segment data. To reflect the perception of corruption at the country and industry levels we use the World Bank's Worldwide Governance Indicator (WGI) and Transparency International's Bribe-Payers' Index (BPI). Finally, to measure the company's overall culture or strategy we use the organizational theory of Miles and Snow (2003) as implemented by Bentley, Omer and Sharp (2013). In particular, we define the variable *Defender strategy flag* as having a value of one if it is classified as pursuing a "Defender strategy" using Bentley et al.'s (2013) empirical model. Firms pursuing a "Defender strategy" are less aggressive than other firms (classified as "Prospector," "Analyzer," or "Reactor" firms) in pursuing new markets. If bribe

[15]Although there are 143 bribery enforcement actions, 26 include firms that have insufficient Compustat data, and nine involve recidivist firms. Our model estimates the probability that a firm commits prosecutable bribery at least once during the sample period, so each recidivist firm is counted only once in our procedure. This leaves a sample of 108 firms.

paying is associated with aggressive attempts to enter new markets or capture foreign sales, we expect "Defender strategy" firms to be less likely to bribe than other firms.

Table 4 presents the results of logistic regressions in which the (untransformed) dependent variable equals one for each firm-year in which a firm engages in bribery. Standard errors clustered by firm are reported below the coefficients. Model 1 reports our initial model that includes all predictor variables. In Models 2 through 5 we remove the *Intangible-to-total assets* ratio, *Distance to regulator*, *% Foreign sales,* and *Herfindahl Inde*x variables as they provide no explanatory power as indicated by likelihood ratio tests. Model 5 satisfies several goodness-of-fit tests, and we use it to implement our Receiver Operating Characteristic (ROC) analysis.[16]

Although we develop the models in Table 4 as a step toward estimating p_b and p_c, they also provide insights into the characteristics of firms that engage in bribery. The likelihood of bribery is positively and significantly related to firm size, gross margin, leverage, R&D, and the number of geographic market segments in which the firm operates. It is negatively and significantly related to return-on-assets, whether the firm follows a "Defender strategy", Transparency International's Bribery Perception Index Industry Sector Score (in which smaller scores indicate a tendency to pay bribes), and the sales-weighted average of the World Bank's World Governance Institute Control of Corruption index for the geographic segments in which sales occur. Bribery is not significantly related to leverage, market-to-book, the Herfindahl Index, and the average distance to markets. These results are illustrated by the characteristics of many firms in our sample, including HCA Hospital Corporation, General Electric, IBM, Royal Dutch Petroleum, and Siemens AG. These are large firms that have large profit margins and low returns on book assets, that operate in research-intensive industries perceived to be relatively corrupt, and that operate in many geographic markets that are known for corruption. Additionally, these firms are known for aggressive business strategies that, in Miles and Snow's (2003) classification, are identified as Prospectors, Analyzers, or Reactors, but not Defenders.

[16] In particular, Model 5 displays a low level of multicollinearity among the independent variables as the maximum variance inflation factor (VIF) is 2.03 for *Return on assets*, with the next highest value of 1.77 for *Gross margin*. A specification link test is consistent with the inference that the model does not suffer from omitted variables.

6.2. ROC estimation of the probability of bribing (p_b) and getting caught (p_c)

In this section we use the results from Model (5) in Table 4 to derive estimates of the probability that a firm with foreign sales engaged in bribery at least once during the 1975-2010 period (p_b) and the probability that firms that engaged in bribery are subjected to enforcement (p_c). The challenge in estimating p_b and p_c is that we do not observe the commission of bribery. Rather, we observe only firms that both bribe and are caught. We postulate that p_b and p_c are affected by firm-specific characteristics:

$$p_b = \Pr\{i=1\} = f(Y^b_{jt}) \tag{8}$$

$$p_c = g(Y^c_{jt}) \ . \tag{9}$$

But the empirical tests reported in Table 4 are of the form:

$$p_b \text{ x } p_c = h(Y_{jt}), \tag{10}$$

where f(•), g(•), and h(•) are functions of firm-specific characteristics Y^b_{jt}, Y^c_{jt}, and Y_{jt}. Note that estimates of any two of the three dependent variables in Eqs. (8) through (10) imply an estimate of the third.

We are aware of three other approaches to isolating Eq. (8) and/or Eq. (9), all of which focus on financial misstatements instead of bribery. Wang (2013) uses a bivariate probit model to estimate Eqs. (8) and (9) directly using a sample of financial frauds, assuming $Y^b_{jt} \neq Y^c_{jt}$ and excluding different predictor variables from Y^b_{jt} and Y^c_{jt}. Wang focuses on the covariates in the equations, however, and does not calculate measures of p_b and p_c. Dyck, Morse, and Zingales (2013) examine the revelation of financial fraud among Arthur Andersen's former auditing clients after Arthur Andersen closed operations following Enron's 2001 financial fraud. They assume that p_c increased from zero to one for all such clients after switching from Arthur Andersen to new auditors. This allows the probability of committing financial fraud (analogous to our p_b) to be inferred among the former Arthur Andersen clients. By also assuming that all firms commit fraud at the same rate as former Arthur Andersen clients, Dyck et al. (2013) infer that the probability a firm engages in financial fraud in any given year is 14.5%. A third

approach proposed by Zakolyukina (2013) constructs a structural model of a CEO's decision to manipulate earnings. Her model's estimated parameters imply that 66% of CEOs manipulate earnings, and 9% of them are caught.

Our method of isolating p_b and p_c uses parameter estimates from Model 5 in Table 4 to calculate fitted values for all firm-years used to estimate the model.[17] We use these fitted values as probabilistic signals that a firm engaged in bribery. Firm-years whose fitted values exceed a specified threshold are classified as years in which the firm engaged in bribery, and firm-years whose fitted values fall below the threshold are classified as years in which the firm did not engage in bribery. Categorizing firm-years in this manner allows us to identify the fraction of firms that engage in bribery (p_b), and then to infer the fraction of firms that are caught (p_c).

Our estimation problem parallels one addressed when radar was developed at the beginning of World War II. New radar technology allowed the Army to identify incoming enemy planes, but with error. The radar signals had difficulty distinguishing between incoming planes and innocent phenomena such as flocks of birds. Setting a low signal detection threshold increased the radar's sensitivity, or the true positives rate, as it would detect most incoming enemy planes. But it also generated a large rate of false positives, resulting in defense forces rallying to intercept flocks of birds. Increasing the detection threshold increased the signal's specificity and decreased its false positives, but at the cost of detecting fewer enemy planes. To balance the benefits and costs of accurate detection versus false positives, Army analysts developed Receiver Operating Characteristic (ROC) theory, which has been applied in medical efficacy trials, psychophysics, epidemiology, radiology, machine learning, and data mining research.[18] We use ROC theory to guide our selection of the threshold above which firm-years are classified as involving bribery.

[17] In principle, we could use Wang's (2013) bivariate probit procedure to estimate p_b and p_c. However, we cannot get an empirical model based on the bivariate probit procedure to converge. The model's non-convergence may be due to the relatively small number of firm-years in which bribery is known to have been committed and in which bribery is revealed.

[18] See Green and Swets (1966), Grzybowski and Younger (1997), Swets (1988), Fawcett (2006), Metz (2006), and Zou, O'Malley, and Mauri (2007).

To begin, we note that the mean and median length of the bribery programs in our sample of bribery-related enforcement actions is five years. A five year duration coincides with the DOJ's and SEC's claims that they seek to bring enforcement action particularly when the bribery is "ongoing" and "pervasive" (see the U.S. Department of Justice and Securities and Exchange Commission, 2012). One-time or isolated bribery events therefore are less likely to receive enforcement attention from the SEC and DOJ. Following regulators' focus on longer-term bribery programs, we classify a firm as a bribe-payer if its fitted value from Model (5) in Table 4 exceeds the critical threshold for at least five consecutive years. (In Section 8 we show that the results are not sensitive to this assumption.) We then consider 108 possible threshold levels, corresponding to the 108 firms included in the Model (5) estimates that we know committed bribery. The first threshold level is set sufficiently low to classify all 108 firms correctly as bribe-payers – a 100% true positive, or sensitivity, rate. Applying this low threshold to all 6,857 firms in the analysis classifies many firms as bribe-payers and generates low true negative, or specificity rate (calculated to be 10.1% in our application). The second threshold level is set to correctly classify all but one firm as bribe payers, resulting in a sensitivity rate of 99.07% (= 107/108), with a specificity rate of 27.8%. As we consider each consecutively higher threshold level, the sensitivity rate decreases and the specificity rate increases. That is, the model captures fewer bribing firms, but it also results in fewer non-bribing firms being flagged (incorrectly) as bribing firms.

Figure 2 illustrates the results of this process in a Receiver Operating Characteristic (ROC) curve. The default optimum is the threshold that maximizes the average of the sensitivity and specificity rates, which equals the area under the ROC curve (Zou, O'Malley, and Mauri, 2007). In our application, this optimum occurs where the sensitivity rate is 92.6% (the model accurately classifies 100 of the 108 known bribe-paying firms) and the specificity rate is 78.3% (the model agrees with regulators' non-actions that 5,282 of the 6,749 firms in the analysis that did not face enforcement action also did not bribe). The area

under the ROC curve is 0.854 with a 95% confidence interval of 0.829 to 0.880 – numbers that indicate a very good fit (Swets, 1988).[19]

Table 5 presents a 2 x 2 contingency table of the classifications of all 6,857 firms used to construct the model. The ROC analysis classifies 1,567 firms as bribe-payers for at least one five-year period during the sample period. The 1,567 bribe-payers comprise 22.9% of all 6,857 firms in the analysis, implying that p_b = 22.9%. That is, 22.9% of all Compustat-listed firms with foreign sales engaged in prosecutable bribery at least once from 1975-2010. Among the 1,567 firms the model classifies as bribe-payers, 100 subsequently were charged with foreign bribery and faced enforcement action. This implies that, among firms with foreign sales that engage in bribery, the probability of getting caught (p_c) is 100/1,566 = 6.4%.

The key assumption in our ROC analysis is that firms that pay bribes and avoid detection have characteristics that are similar to those of bribe-paying firms that are caught. That is, all firms with annual fitted values above the critical threshold for any consecutive five-year period actually did engage in bribery, with the only important difference being that some firms attracted enforcement action while others did not. Our assumption of similarity between detected and undetected bribe payers parallels one of the key assumptions made by Dyck et al. (2013) to yield an estimate of the probability that firms misrepresent their financial statements – namely, that all firms are similar to Arthur Andersen clients in their tendencies to misrepresent their financial statements. To investigate the sensitivity of our results to this assumption, we calculated alternate values for p_b and p_c using different rules for determining the cutoff threshold, and under two extreme scenarios in which (1) all firms bribe or (2) all bribing firms get caught. Even when the alternate assumptions yield different estimates of p_b and p_c, the estimates of the other parameters in our model are very stable. The sole exception is that, under an extreme assumption that the probability of getting caught is 100%, our estimate of the *Ex ante NPV* of bribing is affected. Details of these sensitivity tests are reported in Section 8.

[19] Note that the ROC procedure weights gains from increases in the sensitivity and specificity rates equally. In Section 8.2 we show that are results are not materially affected if we apply different weights, e.g., if we consider gains from increased specificity to be twice, or four times, as important as equal gains in sensitivity.

7. Calibrating the economic model of bribery

7.1. Overall average estimates

The empirical results from Sections 5 and 6 allow us to calibrate the economic model developed in Section 3 and derive inferences about the ex ante and ex post NPV of bribery. The model consists of 12 parameters. Sections 5 and 6 yield measures of the first five, and section 7 yields measures of p_b and p_c. Table 6 reports mean values for the first five measures using data from our sample of 140 firms that have sufficient returns data. The right-hand columns in the table report results when we limit the sample to the 62 firms used to measure ΔV_1, the change in value when the bribery-related contracts are announced. The results using this 62 firm subset are similar to the overall sample results.[20]

For the overall sample, the size of the bribe (B) is 0.58% of the firm's market capitalization; the valuation effect of contract award announcement (ΔV_1) is 3.34%; the valuation effect of the enforcement action when the firm is caught bribing (ΔV_2) is -5.44%; the firm incurs a direct cost (C_{direct}) of 3.27%, and the firm loses 0.78% of market capitalization because of the restatement correction ($C_{restate}$). The best-fit model in Section 7 indicates that probability of bribing (p_b) equals 22.85% and the probability of getting caught (p_c) equals 6.38%.

The five remaining model parameters can be inferred using the model's five equations. The value of the contract for which a bribe is paid (X) is, on average, 3.55% of the firm's market capitalization. Net of the cost of the bribe and the expected cost of being caught bribing, the *Ex ante NPV* of the contract is 2.64% of market capitalization. This indicates that contracts obtained with a bribe payment are expected to increase firm value, on average. We do not observe bribes paid for contracts that are not obtained, so we cannot make a strong conclusion about the overall value of a bribery program. But this result suggests

[20] We report all numbers as a percent of the firm's market value of equity. We could equivalently report the average dollar value of each parameter. All dollar-based measures, however, are highly correlated with firm size, including the changes in the market value of equity when the contract award and bribery enforcement action are announced. The cross sections of parameter values expressed as a percentage of firm market capitalization are much less skewed than their dollar-based equivalents.

that bribe paying increases ex ante firm value, even considering the expected penalties that a bribe-paying firm could face.

For firms that are caught, however, the average *Ex post NPV* negative, -2.10%. This is because firms facing bribery charges and enforcement action pay direct costs that average 3.27% of market capitalization. They also lose 0.78% of value in restatement-related corrections and incur reputation losses that average 1.02%.

7.2. Bribery comingled with financial fraud

These average estimates using the full sample obscure an important distinction between most cases of bribery and the subset of cases that have comingled charges of financial fraud. Firms with comingled fraud charges pay larger bribes as a fraction of market capitalization (2.75% vs. 0.36%), bid on bribe-related contracts (*X*) that have significantly higher relative value (8.93% vs. 3.06%), have larger stock price reactions to the announcements of their bribe-related contracts (7.84% vs. 2.94%), and pay significantly higher direct costs when they are caught (9.31% vs. 2.66%). Fraud-related bribery is associated with a relatively large restatement correction (3.30% vs. 0.52%), consistent with the notion that financial fraud results in relatively large and meaningful financial restatements. The largest difference, however, occurs upon the revelation of the firm's misconduct. For firms that do not have comingled fraud charges, the average ΔV_2 = -2.61%, compared to ΔV_2 = -33.06% when fraud charges are included.

An important reason for the disparity in ΔV_2 is indicated in the bottom row of Table 6. The average *Reputation loss* when fraud charges are not included is negative, -0.81%. This implies that, on average, there is no reputation loss when firms face bribery charges but do not face comingled financial fraud charges. Indeed, the point estimate implies that there is a reputation benefit. It is conceivable that a reputation benefit could accrue from the additional scrutiny that typically accompanies a bribery enforcement action. Such internal and regulatory scrutiny could increase the firm's transparency and increase investors' confidence in the reliability of the firm's reporting. Such an inference is speculative,

however. A more conservative interpretation of our results is that, on average, there is no reputation loss when a firm is revealed to have engaged in bribery and there are no comingled charges of financial fraud.

For firms with comingled fraud charges, however, the mean *Reputation loss* is 18.79%. A large reputation loss is consistent with previous findings that the revelation of financial misrepresentation and fraud is associated with large reputation losses (Karpoff, Lee, and Martin, 2008). These reputation losses are the capitalized value of higher future costs and lower future revenues, as the firm's investors and other counterparties change the terms of contract with which they are willing to do business with the firm (e.g., see Graham, Li, and Qiu, 2008; Murphy, Shrieves, and Tibbs, 2009).

Karpoff (2012) summarizes previous research that finds evidence of large reputational losses for a wide range of misconduct, including consumer fraud, false advertising, product recalls, air safety disasters, investigations of IPO underwriters, defense procurement fraud, and opportunistic behavior by venture capital firms. Other types of misconduct, however, are associated with negligible reputational losses, including environmental violations (Jones and Rubin 2001; Karpoff, Lott, and Wehrly 2005) and frauds of unrelated parties (Alexander 1999; Murphy, Shrieves, and Tibbs 2009). Our findings indicate that, in its impact on firm reputation, bribery is more like an environmental violation and less like consumer fraud. That is, while the revelation of bribery is costly to the firm, it does not undermine the firm's trustworthiness with its counterparties. It is only when the bribe is accompanied by financial fraud that the reputational loss tends to be large. This indicates that the reputational loss is due to the financial fraud, not bribery.

Because the costs associated with comingled fraud charges are large, the presence or absence of fraud charges has a large effect on the ex post value of the bribe-related contract. For firms that do not also face comingled fraud charges, the *Ex post NPV* is positive, 0.33% of equity value. For firms that do face comingled fraud charges, the *Ex post NPV* is -25.22%. For both groups of firms, bribery increases value on an ex ante basis. Even for firms that are caught, the *Ex post NPV* is non-negative if they avoid comingled fraud charges. But for firms that are caught and face comingled fraud charges, the average *Ex post NPV* is strongly negative.

7.3. The division of bribe-related contract value

Our estimates can address an additional debate over the division of gains from bribe-related economic activity. In general, we should expect the surplus to accrue to the owners of the scarce resource.[21] One view is that the foreign officials who allocate contract awards are in the best position to capture most of the gains. In the extreme case, the bribed officials are the link in the vertical production chain with monopoly power, so they can extract the full surplus.

The results in Table 6, however, do not support this view. The average bribe amount is 0.58% of firm capitalization, while our estimate of the underlying project value (X) is 3.55%. This implies that the bribe recipients receive, on average, 16.3% of the underlying project value. When financial fraud is involved, bribe recipients capture a much larger fraction, 30.8%, of the project value. This is consistent with our finding that financial fraud charges tend to be comingled with bribery charges when the underlying project is particularly valuable. These projects attract much larger bribes, and it is plausible that the bribe paying firms are more likely to engage in financial fraud to cover up the relatively large bribe payments.

7.4. Optimal penalties

Our analysis does not address the question of whether foreign bribery imposes social costs and whether public policy should seek to discourage it.[22] However, our results shed light on whether the penalties for foreign bribery are sufficiently large to discourage it. The results tell us only about the average benefits and costs to bribe-paying firms that are caught, whereas what matters for deterrence are

[21] Rose-Ackerman (1975) and Lui (1985) consider different market conditions that affect the gains to bribe recipients and bribe payers. We expect the division of the surplus to depend on heterogeneity among potential bribe payers, expectations regarding contract performance, and whether all bidders pay bribes or only the winning bidder. If all (homogeneous) bidders pay bribes and the contract is awarded randomly among bribe paying firms, for example, risk-neutral firms each would offer bribes equal to the contract value divided by the number of bidding firms.

[22] For discussions of the social costs of bribery, see Shleifer and Vishny (1993), Kaufmann and Wei (1999), and Rose-Ackerman (2010).

the marginal benefits and costs. Nevertheless, these estimates indicate that, on average, bribery occurs because it is expected to increase firm value. Using the average estimates and assuming no change in the total penalties, the probability of getting caught would have to increase from 6.4% to 58.5% to drive the average *Ex ante NPV* to zero. Such an large increase in enforcement effort would exceed even the increases recently promised by the DOJ (Breuer, 2011).[23]

Alternatively, penalties for firms that are caught could be increased. Assuming the probability of getting caught remains at 6.4%, average penalties would have to increase by 9.2 times to drive the average *Ex ante NPV* to zero. Note that much of the current average penalty results from investigation costs, the restatement effect, and lost reputation. The SEC and DOJ have direct leverage over only fines, penalties, and monitoring costs, which for our overall sample average only 1.74% of market capitalization (see Panel B of Table 3). Assuming that the average investigation cost, restatement effect, and reputation loss remain the same, to achieve a 9.2 times increase in total costs, the SEC and DOJ would have to increase fines, penalties, and monitoring costs from 1.74% to 43.3% of the firm's market capitalization. That is, fines, penalties, and monitoring costs would have to increase by 24.9 times over their historical averages to drive the *Ex ante NPV* of bribery to zero. If the firm avoids charges of financial fraud (and knows that it will avoid such charges on an ex ante basis), the penalties required to make the *Ex ante NPV* of bribery equal to zero would be even larger.

8. Robustness tests

8.1. Sensitivity of p_b, p_c, and other model parameters to modeling choices

The point estimates in Table 6 rely on a complex sequence of data and modeling choices. In this section we examine the degree to which these modeling choices affect our inferences. To begin, we note that most of the inputs to our model have strong empirical support. Our sample of 143 FCPA-related enforcement actions involving publicly traded companies is uniquely comprehensive. It has been vetted

[23] The referee suggests that these estimates also shed light on how high managers' subjective probability of getting caught must be to drive the ex ante NPV to zero. The answer is 58.5%.

with employees at the U.S. SEC and DOJ, as well as through the Searle Civil Justice Institute (2012). Data on the bribe amounts, fines, and penalties are identified through SEC and DOJ releases. Data on other direct costs, including investigation and monitoring costs, come from company reports, primarily 10-Ks. In extending these cost estimates to firms that do not report them, we use empirical models that have been vetted with the three major providers of bribery-related insurance products. One of the three has adopted our models for investigation and monitoring costs in pricing their insurance products. Our estimates of the share price reactions to news of contract awards or bribery enforcement activities use conventional event study methods that also are unlikely to be controversial. Regardless, the event study results are similar if we use more complex return models, such as the Fama-French three factor model.

Our empirical estimates of p_b and p_c, in contrast, are more speculative. Table 7 reports the results of tests that examine the sensitivity of p_b and p_c to alternate assumptions in their estimation, and the effects of changes in p_b and p_c on other model parameters. Panel A of Table 7 reports results for the overall sample, and Panels B and C report results for the subsamples of cases without and with comingled financial fraud charges. Each row summarizes the model's results using a different assumption to calculate p_b and p_c.

Our baseline estimates (in Tables 5 and 6) classify a firm as a bribe-payer if its fitted value from Model 5 in Table 4 exceeds the maximum threshold level for five consecutive years, and selects the threshold level to maximize the area under the ROC curve in Figure 2. In the top row of Panel A of Table 7, we classify a firm as a bribe-payer if its fitted value from Model 5 in Table 4 exceeds the maximum threshold level that generates a sensitivity rate of 100% for any single year of the sample period. This is the threshold level that assures that all 108 bribe-paying firms used in the ROC analysis are classified as bribe-payers. The implied value of p_b is 82.32%, with p_c = 1.91%. In the second row, we assume that a firm is classified as a bribe payer if its fitted value from Model 5 in Table 4 exceeds the maximum threshold level in any single year of the sample period, but let the threshold level be determined by the ROC analysis (to maximize the area under the corresponding ROC curve). The resulting model fit is better, as the area under the ROC curve increases from 0.590 to 0.778, and the implied values of p_b and p_c

are 32.29% and 4.25%. These latter values are not much different from our best-fit estimates reported in Table 5.

Additional rows summarize the results when the decision rule is to classify a firm as a bribe-payer if its fitted value exceeds the threshold level for any 2, 3, 4, or 5 years, or for any 2-5 consecutive years. When applying optimum ROC analysis (i.e., not requiring the sensitivity rate to equal 100%), the estimates of p_b and p_c are stable across these assumptions. The estimate of p_b ranges from 22.85% to 32.29%, while p_c ranges from 4.25% to 6.38%. If we arbitrarily assume low thresholds, the estimate of p_b becomes larger and the estimate of p_c gets smaller. Even if we induce large variation in p_b and p_c, however, the estimated values for the *Ex ante NPV*, *Ex post NPV*, *X*, *C*, and $C_{reputation}$ are not much affected. In all cases, our qualitative conclusions are unaffected.

In the bottom two rows of Panel A we make extreme assumptions that fix $p_b = 1$ (all firms bribe), or that $p_c = 1$ (all bribing firms get caught). Even with such extreme assumptions, our inferences about *Ex ante NPV*, *Ex post NPV*, *X*, *C*, and $C_{reputation}$ are not materially affected. The sole exception to this result is that the *Ex ante NPV* is negative if we assume that $p_c = 100\%$ (i.e., all bribing firms get caught).

Panel B of Table 7 reports on sensitivity tests for the firms in the bribery enforcement sample that do not have comingled fraud charges, and Panel C contains results for the firms with comingled fraud charges. As with the overall sample, we find that even large variations in p_b and p_c do not have substantive impacts on our estimates of the other model parameters. Again, the sole exception occurs when we make the extreme assumption that $p_c = 100\%$ and induce a negative *Ex ante NPV* for the bribe-related project.

We also investigated whether the model calibration differs significantly across time. The number of enforcement actions increased in the early 2000's, so we split the sample into 1978-2003 and 2004-2013 groups. Our inferences are qualitatively identical in each subperiod as for our overall sample. There are some differences in magnitudes, however. Compared to the early cases, later enforcement actions involve bribes paid for more valuable and profitable contracts, as both the ex ante NPV and ex post NPV are higher in the later period.

8.2. Alternate weighting for Type I and Type II errors in the ROC analysis

A potential concern about the ROC analysis is that it assigns equal weight to gains in specificity and sensitivity. From a cost standpoint, however, it is entirely possible that a gain in specificity (which is the decrease in Type II errors from false positives in identifying firms that bribe) could be more or less important than a gain in sensitivity (which is the decrease in Type I errors from false negatives). For example, policymakers might be willing to accept a one percentage point increase in the rate at which firms are falsely accused of bribery (Type II errors) only if doing so decreases the Type I error rate by at least two percentage points. To examine asymmetric benefits in specificity and sensitivity, we recalculate p_b and p_c for every threshold level that results in one fewer firm in our sample being correctly classified as engaging in bribery. We start by setting the sensitivity to 100% (all 108 known-bribers are classified as paying bribes), then to 107/108 = 99.1%, then to 106/108 = 98.1%, and so on. For each threshold level, we calculate the tradeoff between sensitivity and specificity. This allows us to calculate estimates for p_b and p_c for any weighting scheme in the tradeoff between sensitivity and specificity.

The results are reported in Appendix Table A3. Our best estimates for p_b and p_c – in which we assume that gains in sensitivity and specificity are equally important – are highlighted in Row 9 of the table. But suppose we consider gains in the specificity rate to be twice as important as gains in the sensitivity rate (i.e., the marginal cost of a false positive is twice the marginal cost of a false negative, or an error cost ratio of 2:1). Favoring specificity over selectivity implies a higher cutoff value in the ROC analysis that classifies fewer firms as bribe-payers. The weighted optimal tradeoff is indicated by Row 15, and the resulting estimates are p_b = 18.3% and p_c = 7.5%. For an error cost ratio of 4:1, the optimal tradeoff is indicated by Row 49, implying p_b = 4.3% and p_c = 20.6%.

These results indicate that p_b and p_c are somewhat sensitive to alternative assumptions about the relative importance of Type I and Type II errors when classifying firms as bribe-payers. As indicated in Table 7, however, even large deviations in p_b and p_c from our base scenario have small effects on the

other model parameters. That is, our results are qualitatively unaffected by adjustments to the ROC analysis that place different weights on gains in sensitivity and specificity.

9. Conclusion

The enforcement of U.S. anti-bribery laws is controversial. Critics argue that enforcement of the FCPA increases the cost of business for U.S. firms, inefficiently decreases foreign investment, and represents regulatory overreach by the SEC and DOJ. Defenders argue that aggressive anti-bribery enforcement helps to improve business culture and productivity, not only for U.S. firms, but also for other firms around the world. At the center of the debate are questions about the prevalence of bribery, the value to firms of bribing, and the costs to firms that are charged with bribery.

We construct and calibrate a model of bribery and bribery enforcement that addresses these questions. We find that bribes tend to be paid to obtain valuable contracts or concessions that average 3.6% of the firm's equity value and that, when announced, correspond to an abnormal share price increase of 3.3%. While bribe payments are large in absolute terms, they average 16.3% of the value of the underlying contracts, indicating that bribe payers transfer only a minority of the value of the bribe-related contracts.

Firms that are targeted for anti-bribery enforcement face large direct costs in the form of penalties, investigation and legal expenses, and monitoring costs that average 3.3% of market capitalization. Many firms restate their financial statements with an associated further loss of 0.8% of market capitalization. Our best-fit estimates indicate that 22.9% of all Compustat-listed firms with foreign sales engaged in prosecutable bribery at least once during the 1975-2010 period, and the probability that a bribing firm is caught is 6.4%.

A small number of firms that face bribery charges also face comingled charges of financial fraud. These firms tend to pay bribes for particularly valuable contracts and pay larger direct costs when they are caught. Their largest distinction, however, is that fraud-related bribe-payers lose substantial reputation – that is, they face higher future costs or lower revenues as their counterparties change the terms with which

they do business with the firm – that averages 18.8% of firm equity value. Largely because of this large reputation cost, the ex post NPV of bribery that is associated with financial fraud is negative, -25.2%.

The majority of firms that are caught bribing do not also face charges of financial fraud. These firms face total costs from the bribery enforcement action that average 2.4% of market capitalization. This cost is sufficiently low such that the ex post NPV of the bribe-related activity is non-negative. A significant reason these firms' total costs are relatively low is that their reputation loss is negligible.

These findings indicate that, in its impact on firm reputation, bribery is more like an environmental violation and less like consumer fraud. That is, firms do not suffer large reputational losses when they are caught bribing. When the bribe is accompanied by financial fraud, in contrast, the reputational loss tends to be large. This evidence implies that, on average, bribery charges do not by themselves "… lead to irreparable economic hardship and reputational damage that may adversely affect the overall stability and competitiveness of any business," as is claimed by critics of anti-bribery enforcement activities.[24] At times, firms that are targeted by bribery enforcement actions experience large direct costs, especially in the form of large regulatory fines and penalties. On average, however, the bribery charges do not harm the firm's business relationships with its customers, suppliers, or investors. That is, the firm's counterparties tend to care if the firm's financial statements are misrepresented. But they do not, in general, alter their willingness to do business with the firm when it is caught bribing.

We do not address the question of whether public policy should seek to discourage bribery, as is discussed by Rose-Ackerman (2010), Shleifer and Vishny (1993), and others. But our results indicate that the current enforcement regime imposes insufficient expected penalties to offset firms' economic incentive to bribe. To achieve a sufficiently high level of expected penalties to make bribery unattractive on an ex ante basis, our estimates indicate that the probability of getting caught or the total costs imposed on firms that face anti-bribery enforcement action would have to be increased by 9.2 times over historical levels.

[24] See PricewaterhouseCooper, Anti-Corruption, www.pwc.com.br/en/forensics/anti-corruption.jhtml.

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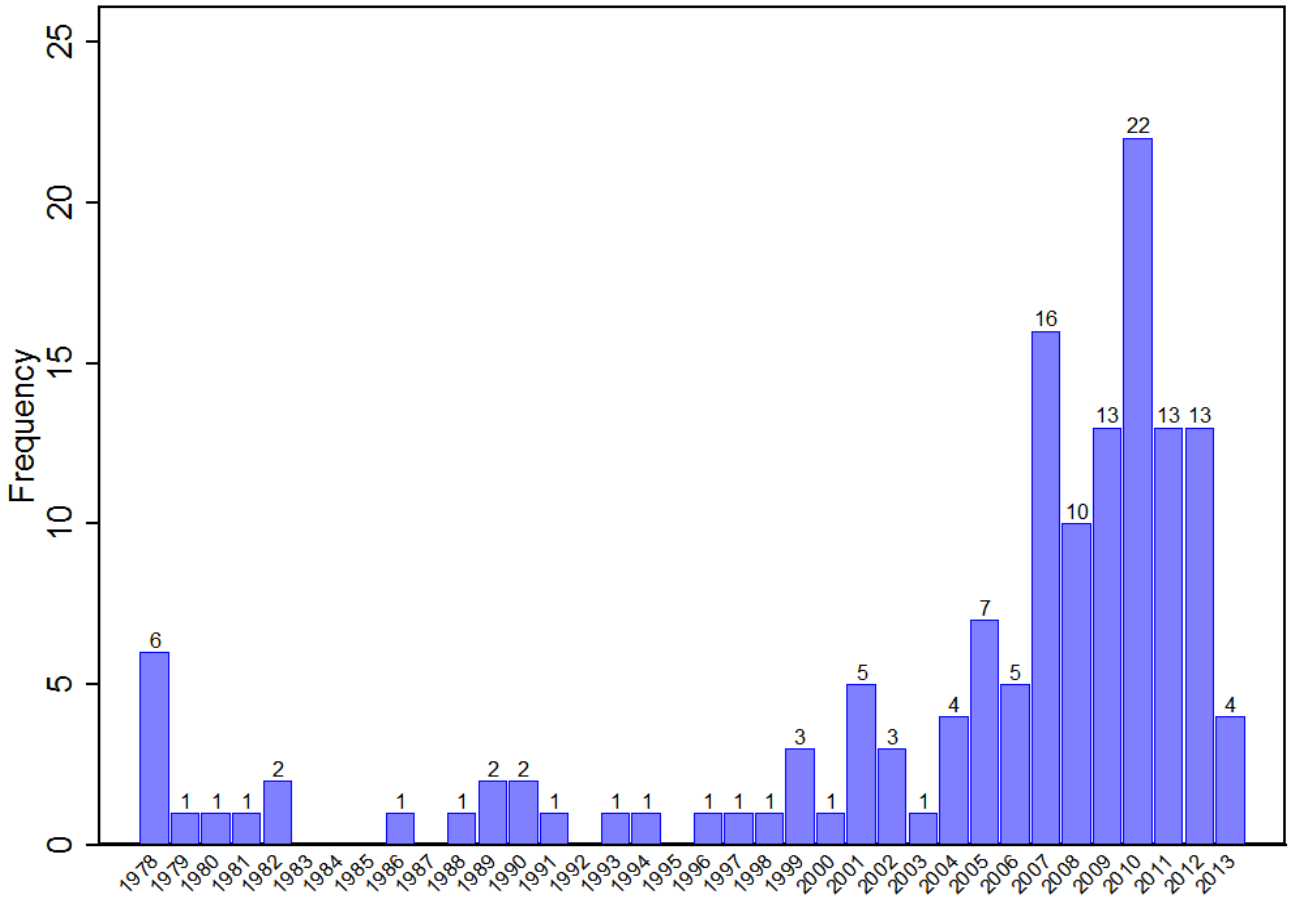

Figure 1. Bribery enforcement actions under the Foreign Corrupt Practices Act
This figure represents the time distribution of all 143 bribery-related enforcement actions initiated by the U.S. Securities and Exchange Commission and/or Department of Justice from 1978 through May 2013 that involved bribery by a publicly traded corporation or its agents. Each enforcement action is placed in the year the enforcement action was initiated.

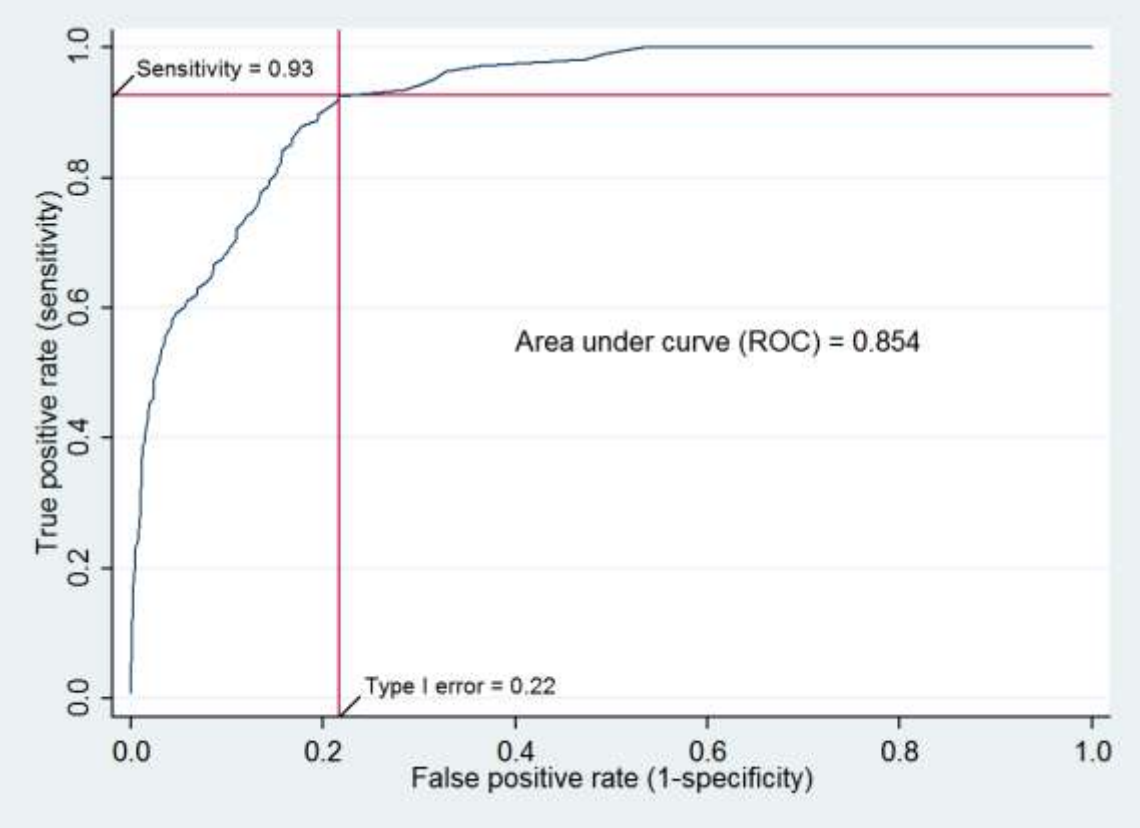

Figure 2. Receiver Operating Characteristic (ROC) curve for the bribery prediction model

The ROC curve illustrates the cutoff value in the prediction model (Model 5 in Table 4) that balances the tradeoff between sensitivity and specificity, where sensitivity measures the rate at which the model identifies true positives and specificity measures the rate at which the model identifies true negatives. A perfect model threshold would locate at the upper left corner of the chart, at which specificity = 1 and sensitivity = 1. The optimal threshold value is the one that results in the largest area under the curve, which is also the average of the sensitivity and specificity rates (= 0.926 + 0.783) / 2 = 0.854.

Table 1. Distribution of bribery-related enforcement actions by industry sector and firm size

Size-based distribution of the publicly traded firms targeted by all 143 enforcement actions for foreign bribery initiated by the SEC and/or DOJ from 1978 through May 2013 partitioned by Transparency International's (TI) industry sectors and size-based deciles. Transparency International's *Bribe Payers Index Industry Sector Score* is based on survey responses and measures the perceived likelihood that firms in the industry pay bribes to obtain or retain business in foreign countries. The *Sector Score* is scaled from 0-10, with higher scores indicating a lower perceived likelihood that firms in the industry bribe. The average *Sector Score* is 6.6. *Firms in the sector* is the number of firms in the Compustat database in each industry sector from 1977 to 2012. Equity *Size-based deciles* are calculated using market capitalization from Compustat in the last fiscal year before the initial public revelation of the bribery. A Pearson's chi-squared test of independence between sectors and sized-based deciles is rejected with $\chi^2 = 191.57$ and p-value < 0.001. Tests of proportional frequencies between size-based deciles is rejected with $\chi^2 = 77.73$ and p-value < 0.001 while tests on the equality of proportions between total firms and enforcement actions within each decile are rejected in the 10th decile ($z = 12.64$, $p < 0.001$) only. Tests of proportional frequencies between industry sectors is rejected with $\chi^2 = 219.93$ and p-value < 0.001 while tests on the equality of proportions between total firms and enforcement actions within an industry are rejected in the Heavy manufacturing ($z = -4.24$, $p < 0.001$) industry only.

	Bribe Payers	Firms in the industry sector		No. of bribery actions			Sized-based deciles:							
	Index		% of		% of	Ratio of	Larger firms							Smaller firms
Industry sector	Sector Score	Count	all firms	Count	all actions	actions to #firms	10	9	8	7	6	5	4	3 – 1
Agriculture	7.1	87	0.4%	4	2.8%	4.60%	1	1	1		1			
Light manufacturing	7.1	594	2.6%	1	0.7%	0.17%	1							
Civilian aerospace	7.0	70	0.3%	0	0.0%	0.00%								
Information technology	7.0	3,046	13.2%	10	7.0%	0.33%	6	1			1	2		
Banking and finance	6.9	4,131	17.9%	5	3.5%	0.12%	5							
Forestry	6.9	71	0.3%	0	0.0%	0.00%								
Consumer services	6.8	1,851	8.0%	1	0.7%	0.05%								1
Telecommunications	6.7	688	3.0%	5	3.5%	0.73%	2	1	1					1
Transportation and storage	6.7	512	2.2%	6	4.2%	1.17%		3		1	1			1
Fisheries	6.6	0	0.0%	0	0.0%	0.00%								
Arms, defense and military	6.6	93	0.4%	8	5.6%	8.60%	5	1		2				
Heavy manufacturing	6.5	3,594	15.6%	53	37.1%	1.47%	30	9	6	4	2	1	1	
Pharmaceutical and healthcare	6.4	1,965	8.5%	20	14.0%	1.02%	12	2	1	2	1	1		1
Power generation and transmission	6.4	151	0.7%	0	0.0%	0.00%								
Mining	6.3	2,069	9.0%	0	0.0%	0.00%								
Oil and gas	6.2	2,001	8.7%	19	13.3%	0.95%	12	2	1	2	1	1		
Real estate, property, legal & business services	6.1	1,367	5.9%	3	2.1%	0.22%	1		1					1
Utilities	6.1	203	0.9%	0	0.0%	0.00%								
Public works contracts & construction	5.3	531	2.3%	8	5.6%	1.51%	5			1		1	1	
Total		23,024	100%	143	100%	0.62%	80	20	11	12	7	6	2	5

Table 2. Abnormal returns for FCPA bribe related contract and enforcement announcements

This table reports on the market-adjusted stock returns of the targeted companies for key dates on which information was publicly revealed about the contract award, bribery, related misconduct, and the enforcement activities surrounding enforcement actions under the Foreign Corrupt Practices Act from 1978 through May 2013. Market returns are measured using the CRSP value weighted index. Panel A reports on one-day market-adjusted returns for announcement dates of the contract awards that subsequently were revealed to have involved bribery payments for 62 enforcement actions for which we identify such contract award announcements. (EDGAR, Lexis-Nexis and Factiva were used to search for contract award announcement dates that were matched to the contracts described in the enforcement actions.) Panel B reports on one day and cumulative one day market-adjusted returns for 140 of the 143 sample firms for which returns are available for dates on which the bribery and related enforcement activity were revealed. Enforcement-related events include announcements of the initial trigger event as identified by the SEC and DOJ, announcements of an informal inquiry and formal investigation, receipt of a Wells Notice, earnings restatements, related private lawsuits, and SEC and DOJ enforcement releases. The compound cumulative market-adjusted return is the geometric sum of all one-day market-adjusted returns for all relevant event dates. In each panel, we report means and medians for all firms and for the subset of firms that have comingled charges of financial fraud and firms that did not. Asterisks next to means represent statistical significance based on parametric t-tests and, for differences, mean-comparison tests assuming unequal variances. Asterisks next to medians represent statistical significance based on sign rank tests and Wilcoxon rank-sum test for differences. ***, **, * indicate significance at the 0.001, 0.01, and 0.1 levels.

	All bribery actions	Actions without financial fraud	Actions with financial fraud	Difference
Panel A – Contract announcement abnormal returns				
Initial revelation date				
N	62	57	5	
Mean	3.34%***	2.94%***	7.84%	-4.90%
Median	2.23%***	2.25%***	1.14%*	1.12%
Panel B – Enforcement announcement abnormal returns				
Initial revelation date				
N	140	127	13	
Mean	-3.07%***	-1.72%**	-16.25%**	14.54%*
Median	-0.53%***	-0.34%***	-11.99%**	11.65%***
Compound cumulative abnormal return				
N	140	127	13	
Events	767	575	192	
Mean	-5.44%***	-2.61%*	-33.06%**	30.45%**
Median	-1.69%***	-1.52%***	-21.29%**	19.77%***

Table 3. Summary measures of bribe amounts, penalties, and direct costs to firms

Panel A – Bribe amounts and penalties

This panel reports summary statistics on bribery violation periods, market capitalization, bribe amounts and monetary penalties imposed on 140 firms with sufficient data that were targeted for bribery-related enforcement action by the SEC and DOJ from 1978 through May 2013. The violation period is the length of the period in which the bribery activity occurred, as identified in SEC and DOJ enforcement releases. Market capitalization is measured at the close of trading the day before the initial revelation of the misconduct. The size of the bribe is identified in SEC and DOJ enforcement releases. The Winsorized (at 98%) ratio of the bribe to market capitalization changes two outlier values of 49.46% and 36.40% to 12.62%, which is the third highest estimate from all enforcement actions. Total monetary penalties include fines and penalties assessed by regulators on the firm, and related private class and derivative action settlements. Penalty amounts may change for 37 enforcement actions for which proceedings were ongoing as of May 31, 2013. Asterisks next to the mean and median in the Difference column represent the statistical significance of a mean-comparison test assuming unequal variances and a Wilcoxon rank sum test, where ***, **, * indicate significance at the 0.001, 0.01, and 0.1 levels.

		All bribery actions (140)	Actions without financial fraud charges (127)	Actions with financial fraud charges (13)	Difference
Period of violation (years)	Mean	5.36	5.34	5.58	-0.24
	Median	5.00	4.50	5.49	-0.99
Market capitalization ($mm)	Mean	25,597.92	26,581.14	15,992.58	10,588.56
	Median	5,373.06	5,637.40	492.42	5,144.98 *
Size of bribe ($mm)	Mean	23.43	22.13	36.11	-13.98
	Median	1.05	0.98	4.29	-3.31
% of market cap	Mean	1.00%	0.36%	7.27%	-6.91%
	Median	0.03%	0.02%	0.68%	-0.66% **
Winsorized % of market cap	Mean	0.58%	0.36%	2.75%	-2.39% *
	Median	0.03%	0.02%	0.68%	-0.66% **
Total firm monetary penalties ($mm)	Mean	93.51	48.10	537.10	-489.00
	Median	5.53	5.86	0.53	5.33
% of market cap	Mean	1.56%	1.06%	6.44%	-5.38%
	Median	0.08%	0.07%	0.73%	-.066%

Table 3. Characteristics of FCPA bribery enforcement actions (continued)

Panel B – Summaries of empirically observable bribery and cost measures used to calibrate the bribery model

This panel reports the mean and median values of the measures used to calibrate the bribery model presented in Section 3 of the paper. *Bribe/Market cap* is the Winsorized mean value from Panel A of the size of the bribe payments divided by the market capitalization of the firm measured at the close of trading the day before the initial revelation of the misconduct, and is used to measure the bribe amount *B* in the model. Total direct costs (C_{direct}) equals the sum of fine and penalties, investigation expense, and monitoring expense. *Fines and penalties* are the total fines and disgorgement levied upon the firm by regulatory agencies, plus class action settlements paid by the firm (net of D&O insurance proceeds), divided by the firm's market capitalization. The *Investigation expense and Monitoring expense* are the observed values where available and otherwise the predicted values from the models described in Appendix A and Table A1. The *Restatement effect* is the sum of the one-day market-adjusted stock returns on days during the enforcement action on which the firm announced earnings restatements. The difference column reports the difference in the means and medians between the actions with and without financial fraud charges. Significance levels are based on a t-test (for differences, we assume unequal variances between groups), and a Wilcoxon rank sum test, where ***, **, * indicate significance at the 0.001, 0.01, and 0.1 levels.

	All bribery actions (N=140)		**Actions without financial fraud charges (N=127)**		**Actions with financial fraud charges (N=13)**		**Difference**	
	Mean	**Median**	**Mean**	**Median**	**Mean**	**Median**	**Mean**	**Median**
Bribe/Market cap	0.58% ***	0.03% ***	0.36% **	0.02% ***	2.75% *	0.68% ***	-2.39% *	-0.66% **
Direct costs:								
Fines and penalties	1.56% **	0.08% ***	1.06% ***	0.07% ***	6.44%	0.73% **	-5.38%	-0.66%
Investigation expense	1.53% ***	0.95% ***	1.41% ***	0.90% ***	2.71% ***	2.28% ***	-1.30% *	-1.38% **
Monitoring expense	0.18% **	0.00% ***	0.18% **	0.00% ***	0.16%	0.00%	0.02%	0.00%
Total direct costs	3.27% ***	1.21% ***	2.66% ***	1.15% ***	9.31% *	4.46% ***	-6.66%	-3.31% ***
Restatement correction	0.78% *	0.00%	0.52%	0.00%	3.30% *	0.00%	-2.78%	0.00%

Table 4. Estimating the likelihood of a bribe occurring in a firm-year

This table presents the results of logit models used to predict the likelihood that a firm pays a bribe in a given firm-year. Data are drawn from all firms identified by Compustat as having foreign sales during at least one five-year period from 1975 through 2010, which corresponds to the years in which the bribes occurred according to regulatory enforcement actions under the Foreign Corrupt Practices Act from 1978 through May 2013. The dependent variable equals one for each fiscal firm-year in which a bribe occurred and zero otherwise. *Log(market cap $mm)* is the natural logarithm of market capitalization in millions of dollars. *Net margin* is net income divided by total sales. *Return on assets* is net income divided by total assets. *Leverage ratio* is total liabilities divided by total assets. *Market-to-book ratio* is the market value of equity plus total assets less shareholders' equity, divided by total assets. *R&D-to-sales ratio* is the ratio of research & development expense divided by total sales, or zero if missing. *Herfindahl Index* is calculated as the sum of the square of firms' industry market shares of total sales using 4-digit SIC Codes to define industries. *Distance to markets* is the log-transformed weighted average distance from the firms' headquarters to the centroid of the geographic segment reported in Compustat, weighted by the proportion of segment sales to total sales. *Geographic segments* is the log-transformed number of reported geographic segments of sales. *BPI Industry Sector Score* is Transparency International's 2011 Bribe Payers Index for the firm's industry sector determined by mapping the firms' SICs from Compustat into Transparency International's industry sectors. The *Sector Score* is scaled from 0-10, where a maximum score of 10 corresponds to the view that companies in that sector never bribe and a 0 corresponds to the view that they always bribe. *WGI Control of Corruption* is the geographic segment sales-weighted average of World Bank's Worldwide Governance Indicators Control of Corruption index, which captures perceptions of the extent to which public power is exercised for private gain, including both petty and grand forms of corruption, as well as "capture" of the state by elites and private interests. It ranges from approximately -2.5 to 2.5 and increases with the perception of corruption-free governance. *Miles & Snow "Defender" strategy flag* is a dichotomous variable that takes the value of one if the firm's business strategy places it in the "Defender" category based upon the method of calculation used in Bentley, Omer and Sharp (2013) and zero otherwise. *% Foreign sales* is the percent of foreign sales outside the United States. *Distance to regulator* is the distance in miles from the firms' headquarters to the closest regulator involved in the enforcement action. *Intangibles-to-total assets* is the ratio of intangible assets to total assets. Gross margin, return on assets, leverage ratio, market-to-book ratio, R&D-to-sales ratio and intangibles-to-total-assets ratios are Winsorized at the 0.01 and 0.99 percentiles. p-values for tests of significance based on firm clustered robust standard errors are reported below the coefficients, where ***, **, * indicate significance at the 0.001, 0.01, and 0.1 levels.

Table 4. Estimating the likelihood of a bribe occurring in a firm-year (continued)

	(1)	(2)	(3)	(4)	(5)
Log(Market cap $mm)	0.3995***	0.4022***	0.4050***	0.4032***	0.4016***
	0.000	0.000	0.000	0.000	0.000
Gross margin	0.8206*	0.8200*	0.8333*	0.8313*	0.8191*
	0.013	0.013	0.012	0.012	0.013
Return on assets	-1.0779*	-1.1015*	-1.1311*	-1.1347*	-1.1038*
	0.091	0.079	0.068	0.066	0.064
Leverage ratio	0.7122*	0.6994*	0.6772	0.6791	0.6918*
	0.084	0.093	0.111	0.110	0.099
Market-to-book ratio	-0.0443	-0.0460	-0.0468	-0.0465	-0.0468
	0.446	0.420	0.412	0.416	0.414
R&D-to-sales ratio	0.0752*	0.0759*	0.0774*	0.0763*	0.0767*
	0.027	0.027	0.031	0.033	0.033
Distance to markets	0.3036	0.3098	0.2864	0.2771	0.2804
	0.181	0.168	0.229	0.238	0.227
# Geographic segments	0.7517***	0.7616***	0.7664***	0.7508***	0.7551***
	0.000	0.000	0.000	0.000	0.000
BPI Industry Sector Score	-0.9186**	-0.9181**	-0.9224**	-0.9186**	-0.9175**
	0.003	0.003	0.003	0.003	0.003
WGI Control of Corruption	-0.4169*	-0.4206*	-0.4167*	-0.4182*	-0.4183*
	0.019	0.018	0.017	0.016	0.016
Defender strategy flag	-1.4996*	-1.5088*	-1.5066*	-1.5055*	-1.5068*
	0.038	0.037	0.037	0.038	0.038
Herfindahl Index (4-digit sic)	0.1072	0.1388	0.1351	0.1383	
	0.836	0.787	0.792	0.786	
% Foreign sales	-0.0610	-0.0622	-0.0502		
	0.541	0.534	0.608		
Distance to regulator	0.0221	0.0207			
	0.729	0.743			
Intangibles-to-total assets	0.3399				
	0.533				
Constant	-5.4500*	-5.4867*	-5.2181	-5.1715	-5.1764
	0.074	0.071	0.115	0.118	0.118
Observations	92,866	92,866	92,866	92,866	92,866
Firms	6,857	6,857	6,857	6,857	6,857
Pseudo R^2	0.163	0.162	0.162	0.162	0.162
Log-likelihood	-2,644.49	-2,645.24	-2,645.63	-2,646.14	-2,646.31
χ^2	268.89	201.41	200.20	197.82	187.33
p-value	0.000	0.000	0.000	0.000	0.000

Table 5. Contingency analysis used to estimate probabilities of committing a bribe (p_b) and getting caught (p_c)

Panel A is a 2 x 2 contingency table that categorizes the firms in Compustat that have foreign sales in any five-year period from 1975 through 2010 along two dimensions: whether the firm committed bribery at least once during the period ("Did not bribe" or "Bribed"), and whether the firm faced enforcement action for bribery ("Not caught" of "Caught"). Firms are classified as having bribed if their fitted values using Model (5) from Table 4 exceed the optimal probability threshold cutoff as determined by the ROC analysis shown in Figure 2 for at least once five-year consecutive period. The resulting estimate of the probability that a firm in the sample committed prosecutable bribery at least once during the sample period (p_b) equals 1,567/6,857 = 22.9%, and our estimate of the probability that a bribing firm is caught (p_c) equals 100/1,567 = 6.4%. Panel B reports several model statistics.

Panel A – 2 x 2 contingency table

	Not caught	**Caught**	**Total**
Did not bribe	5,282	8	5,290
Bribed	1,467	100	1,567
Total	6,749	108	6,857

Panel B – ROC model summary

Total number of firms:	6,857
Total enforcement actions	108
Threshold cutoff value	0.004952
ROC	0.854
Sensitivity	92.59%
Specificity	78.26%
Probability of bribing (p_b)	22.85%
Probability of getting caught (p_c)	6.38%

Table 6. Bribery model calibration

This table presents the model calibration results using inputs derived from the empirical models and summary measures reported in Tables 4 through 7. Results are presented for the overall sample and a subsample of 62 firms with observable contract award announcement returns (used to estimate ΔV_1). Within each sample, results are presented also for firms that have comingled charges of financial fraud and firms that do not have comingled fraud charges.

			Full sample (n = 140)			Enforcement actions with contract award date returns (n = 62)		
Model parameter	**Description**	**Source**	**All**	**Without fraud**	**With fraud**	**All**	**Without fraud**	**With fraud**
	Directly measured inputs:							
B	Bribe/Market cap	Table 3B	0.58%	0.36%	2.75%	0.51%	0.30%	2.95%
ΔV_1	%Δ market cap of contracts	Table 2	3.34%	2.94%	7.84%	3.34%	2.94%	7.84%
ΔV_2	%Δ market cap of enforcement	Table 2	-5.44%	-2.61%	-33.06%	-7.96%	-3.15%	-54.91%
C_{direct}	Direct cost/Market cap	Table 3B	3.27%	2.66%	9.31%	3.98%	2.83%	17.08%
$C_{restate}$	Restatement effect	Table 3B	0.78%	0.52%	3.30%	0.89%	0.53%	5.04%
	Estimated parameters:							
p_b	Probability of bribing	Table 5	22.85%	22.85%	22.85%	22.85%	22.85%	22.85%
p_c	Probability of getting caught	Table 5	6.38%	6.38%	6.38%	6.38%	6.38%	6.38%
	Analytically derived parameters:							
Ex ante NPV	$= X - B - p_cC$	Eq. (3)	2.64%	2.55%	4.17%	2.57%	2.56%	2.94%
Ex post NPV	$= X - B - C$	Eq. (4)	-2.10%	0.33%	-25.22%	-4.62%	-0.21%	-47.07%
X	$= \Delta V_1 + p_b(B + p_cC)$	Eq. (5)	3.55%	3.06%	8.93%	3.57%	3.05%	9.29%
C	$= X - B - (\Delta V_1 + \Delta V_2)$	Eq. (6)	5.07%	2.37%	31.40%	7.68%	2.96%	53.41%
$C_{reputation}$	$= C - (C_{direct} + C_{restate})$	Eq. (7)	1.02%	-0.81%	18.79%	2.81%	-0.40%	31.29%

Table 7. Sensitivity analysis for p_b and p_c

This table reports on alternate assumptions that yield different measures of the probability of bribery (p_b) and the probability of getting caught (p_c). Each row reports the implied model parameters for a different assumption used to generate estimates for pb and pc. For example, the first row reports results assuming that (i) a firm is classified as a bribing firm if its fitted value from Model 5 in Table 4 exceeds the threshold value in any year of the analysis, and (ii) the threshold value is set to establish a sensitivity (true positive) rate of 100%. The second row makes assumption (i) but allows the ROC analysis to establish the threshold value. The bottom two rows report results assuming that (a) all firms engage in bribery, p_b = 100%, implying p_c = 108 / 6,857 = 1.58%; and (b) all firms get caught p_c = 100%, implying p_b = 108 / 6,857 = 1.58%. Panel A presents the effects using all 140 firms with sufficient return data. Panel B present results for the 127 enforcement actions without comingled charges of financial fraud, and Panel C reports results for the 13 enforcement actions with comingled charges of financial fraud.

Panel A – All Enforcement Actions

Protocol	Cutoff	ROC	Sensitivity	p_b	p_c	*Ex ante NPV*	*Ex post NPV*	*X*	*C*	*Reputation loss*
Any year > cutoff	0.001060	0.590	100.00%	82.32%	1.91%	3.22%	-2.10%	3.90%	5.42%	1.37%
(optimal ROC level)	0.006502	0.778	87.04%	32.29%	4.25%	2.80%	-2.10%	3.60%	5.12%	1.07%
Any 2 years > cutoff	0.001063	0.628	100.00%	74.87%	2.10%	3.14%	-2.10%	3.95%	5.47%	1.42%
(optimal ROC level)	0.006502	0.801	87.04%	27.81%	4.93%	2.74%	-2.10%	3.57%	5.09%	1.04%
Any 3 years > cutoff	0.001063	0.661	100.00%	68.40%	2.30%	3.12%	-2.10%	3.82%	5.34%	1.29%
(optimal ROC level)	0.006251	0.817	87.96%	25.55%	5.42%	2.70%	-2.10%	3.56%	5.08%	1.03%
Any 4 years > cutoff	0.001063	0.688	100.00%	63.06%	2.50%	3.08%	-2.10%	3.79%	5.31%	1.26%
(optimal ROC level)	0.005675	0.830	89.91%	24.95%	5.67%	2.69%	-2.10%	3.56%	5.08%	1.03%
Any 5 years > cutoff	0.001063	0.718	100.00%	57.17%	2.76%	3.03%	-2.10%	3.75%	5.27%	1.22%
(optimal ROC level)	0.004952	0.845	92.59%	24.13%	5.90%	2.67%	-2.10%	3.55%	5.07%	1.02%
2 Consecutive years > cutoff	0.001063	0.635	100.00%	73.43%	2.14%	3.16%	-2.10%	3.85%	5.37%	1.32%
(optimal ROC level)	0.005675	0.805	89.81%	29.78%	4.75%	2.76%	-2.10%	3.58%	5.10%	1.05%
3 Consecutive years > cutoff	0.001063	0.672	100.00%	66.05%	2.38%	3.10%	-2.10%	3.81%	5.33%	1.28%
(optimal ROC level)	0.005675	0.826	89.81%	25.61%	5.52%	1.70%	-2.10%	3.56%	5.08%	1.03%
4 Consecutive years > cutoff	0.001063	0.701	100.00%	60.48%	2.60%	3.06%	-2.10%	3.77%	5.29%	1.24%
(optimal ROC level)	0.004952	0.839	92.59%	25.84%	5.64%	2.70%	-2.10%	3.56%	5.08%	1.03%
5 Consecutive years > cutoff	0.001063	0.734	100.00%	54.03%	2.91%	3.00%	-2.10%	3.74%	5.26%	1.21%
(optimal ROC level)	0.004952	0.854	92.59%	22.85%	6.38%	2.64%	-2.10%	3.55%	5.07%	1.02%
All firms bribe			1.58%	100.00%	1.58%	3.34%	-2.10%	4.01%	5.53%	1.48%
All firms get caught			100.00%	1.58%	100.00%	-2.10%	-2.10%	3.43%	4.95%	0.90%

Table 7. Sensitivity analysis for p_b and p_c (continued)

Panel B – Enforcement actions without financial fraud

Protocol	Cutoff	ROC	Sensitivity	p_b	p_c	*Ex-ante NPV*	*Ex post NPV*	*X*	*C*	*Reputation loss*
Any year > cutoff	0.001060	0.590	100.00%	82.32%	1.91%	2.87%	0.33%	3.28%	2.59%	-0.59%
(optimal ROC level)	0.006502	0.778	87.04%	32.29%	4.25%	2.63%	0.33%	3.09%	2.40%	-0.78%
Any 2 years > cutoff	0.001063	0.628	100.00%	74.87%	2.10%	2.84%	0.33%	3.25%	2.56%	-0.62%
(optimal ROC level)	0.006502	0.801	87.04%	27.81%	4.93%	2.60%	0.33%	3.07%	2.38%	-0.80%
Any 3 years > cutoff	0.001063	0.661	100.00%	68.40%	2.30%	2.81%	0.33%	3.23%	2.54%	-0.64%
(optimal ROC level)	0.006251	0.817	87.96%	25.55%	5.42%	2.58%	0.33%	3.06%	2.37%	-0.81%
Any 4 years > cutoff	0.001063	0.688	100.00%	63.06%	2.50%	2.78%	0.33%	3.21%	2.52%	-0.66%
(optimal ROC level)	0.005675	0.830	89.91%	24.95%	5.67%	2.57%	0.33%	3.06%	2.37%	-0.81%
Any 5 years > cutoff	0.001063	0.718	100.00%	57.17%	2.76%	2.76%	0.33%	3.19%	2.50%	-0.68%
(optimal ROC level)	0.004952	0.845	92.59%	24.13%	5.90%	2.56%	0.33%	3.06%	2.37%	-0.81%
2 Consecutive years > cutoff	0.001063	0.635	100.00%	73.43%	2.14%	2.83%	0.33%	3.24%	2.55%	-0.63%
(optimal ROC level)	0.005675	0.805	89.81%	29.78%	4.75%	2.61%	0.33%	3.08%	2.39%	-0.79%
3 Consecutive years > cutoff	0.001063	0.672	100.00%	66.05%	2.38%	2.80%	0.33%	3.22%	2.53%	-0.65%
(optimal ROC level)	0.005675	0.826	89.81%	25.61%	5.52%	2.57%	0.33%	3.07%	2.38%	-0.80%
4 Consecutive years > cutoff	0.001063	0.701	100.00%	60.48%	2.60%	2.77%	0.33%	3.20%	2.51%	-0.67%
(optimal ROC level)	0.004952	0.839	92.59%	25.84%	5.64%	2.57%	0.33%	3.07%	2.38%	-0.80%
5 Consecutive years > cutoff	0.001063	0.734	100.00%	54.03%	2.91%	2.74%	0.33%	3.17%	2.48%	-0.70%
(optimal ROC level)	0.004952	0.854	92.59%	22.85%	6.38%	2.55%	0.33%	3.06%	2.37%	-0.81%
All firms bribe			1.58%	100.00%	1.58%	2.94%	0.33%	3.34%	2.65%	-0.53%
All firms get caught			100.00%	1.58%	100.00%	0.33%	0.33%	2.98%	2.29%	-0.89%

Table 7. Sensitivity analysis for p_b and p_c (continued)

Panel C – Enforcement actions with financial fraud

Protocol	Cutoff	ROC	Sensitivity	p_b	p_c	*Ex-ante NPV*	*Ex post NPV*	*X*	*C*	*Reputation loss*
Any year > cutoff	0.001060	0.590	100.00%	82.32%	1.91%	7.24%	-25.22%	10.62%	33.09%	20.48%
(optimal ROC level)	0.006502	0.778	87.04%	32.29%	4.25%	5.07%	-25.22%	9.16%	31.63%	19.02%
Any 2 years > cutoff	0.001063	0.628	100.00%	74.87%	2.10%	3.88%	-25.22%	7.92%	30.39%	17.78%
(optimal ROC level)	0.006502	0.801	87.04%	27.81%	4.93%	3.68%	-25.22%	7.93%	34.00%	17.79%
Any 3 years > cutoff	0.001063	0.661	100.00%	68.40%	2.30%	4.46%	-25.22%	7.91%	30.38%	17.77%
(optimal ROC level)	0.006251	0.817	87.96%	25.55%	5.42%	3.53%	-25.22%	7.93%	30.40%	17.79%
Any 4 years > cutoff	0.001063	0.688	100.00%	63.06%	2.50%	4.40%	-25.22%	7.91%	30.38%	17.77%
(optimal ROC level)	0.005675	0.830	89.91%	24.95%	5.67%	3.46%	-25.22%	7.93%	30.40%	17.79%
Any 5 years > cutoff	0.001063	0.718	100.00%	57.17%	2.76%	4.33%	-25.22%	7.92%	30.39%	17.78%
(optimal ROC level)	0.004952	0.845	92.59%	24.13%	5.90%	3.39%	-25.22%	7.94%	30.41%	17.80%
2 Consecutive years > cutoff	0.001063	0.635	100.00%	73.43%	2.14%	4.51%	-25.22%	7.91%	30.38%	17.77%
(optimal ROC level)	0.005675	0.805	89.81%	29.78%	4.75%	3.73%	-25.22%	7.93%	30.40%	17.79%
3 Consecutive years > cutoff	0.001063	0.672	100.00%	66.05%	2.38%	4.44%	-25.22%	7.91%	30.38%	17.77%
(optimal ROC level)	0.005675	0.826	89.81%	25.61%	5.52%	3.50%	-25.22%	7.93%	30.40%	17.79%
4 Consecutive years > cutoff	0.001063	0.701	100.00%	60.48%	2.60%	4.37%	-25.22%	7.91%	30.38%	17.77%
(optimal ROC level)	0.004952	0.839	92.59%	25.84%	5.64%	3.47%	-25.22%	7.93%	30.40%	17.79%
5 Consecutive years > cutoff	0.001063	0.734	100.00%	54.03%	2.91%	4.28%	-25.22%	7.92%	30.39%	17.78%
(optimal ROC level)	0.004952	0.854	92.59%	22.85%	6.38%	3.25%	-25.22%	7.94%	30.41%	17.80%
All firms bribe			1.58%	100.00%	1.58%	7.84%	-25.22%	11.12%	33.59%	20.98%
All firms get caught			100.00%	1.58%	100.00%	-25.22%	-25.22%	8.37%	30.84%	18.23%

Appendix A: Countries in which bribes were paid

Appendix Table A1 reports on frequencies of bribe payments in 117 countries identified in the 143 enforcement actions for foreign bribery initiated from 1978 through May 2013 against publicly traded firms, which constitutes our sample. N represents the number of different enforcement action in which each country is named. The total across countries (434) exceeds the total enforcement actions (143) because many actions involve charges of bribery in more than one country. As an example, Dimon, Inc. (now known as Alliance One International, Inc.) paid more than $3 million in bribes to Kyrgyzstan government officials and more than $1.2 million to government officials of the Thailand Tobacco Monopoly to obtain sales contracts. These different bribes were grouped into a single enforcement action that targeted Dimon, Inc.

The table also reports two measures of the culture of bribery in each country. The first is Transparency International's 2011 Corruption Perceptions Index (CPI). The CPI is measured for 178 countries on a scale of 1 (most corrupt) to 10 (least corrupt) and is based on a survey of country analysts and business people. For example, China's CPI of 3.6 ranks it the 71st highest in perceived corruption. Singapore's CPI of 9.2 reflects a perception that it is the least corrupt country among the 117 countries in the sample. The second measure reported in Appendix Table A1 is the 2011 World Governance Indicators Control of Corruption (COC) indicator. The COC captures perceptions of the extent to which public power is exercised for private gain, including both petty and grand forms of corruption, as well as capture of the state by elites and private interests, and ranges from approximately -2.5 (weak) to 2.5 (strong) governance performance. The COC ranks The Netherlands, Luxembourg, and Norway as the least corrupt among the countries that appear in our sample. Reported with each measure is our rank of the country's score from 1 (most corrupt) to 117 (least corrupt). Bribes were paid in three countries that are not included in the TI or WGI indicators, so we assign values from related countries. Antigua and Turks & Caicos each received the UK index values because they were part of the British Commonwealth at the time of the bribe. Cook Islands received New Zealand's index values and rankings because it is an associated state of New Zealand.

Bribe payments associated with FCPA-related enforcement actions tend to occur in countries with a reputation for corruption. For example, the mean CPI for all countries named in bribery enforcement actions is 3.9, which is slightly lower than the mean CPI for all countries of 4.2. Weighting by the number of times each country appears in the sample, the weighted mean CPI is 3.5 for countries connected with bribery enforcement actions.

Appendix Table A1. Countries in which bribes were paid

		Transparency International		World Governance Indicators	
Country	**N**	**CPI**	**Rank**	**COC**	**Rank**
China	28	3.6	71	-0.7	40
Nigeria	27	2.4	24	-1.1	12
Iraq	24	1.8	5	-1.2	9
Indonesia	16	3.0	54	-0.7	39
Saudi Arabia	13	4.4	83	-0.3	63
India	12	3.1	57	-0.6	48
Mexico	12	3.0	49	-0.4	60
Brazil	11	3.8	72	0.2	83
Argentina	10	3.0	52	-0.4	55
Egypt	10	2.9	43	-0.7	38
Greece	8	3.4	66	-0.2	73
Russia	8	2.4	23	-1.1	17
Thailand	8	3.4	64	-0.4	58
Iran	7	2.7	39	-0.9	26
Kazakhstan	7	2.7	38	-1.0	19
United Arab Emirates	7	6.8	103	1.1	101
Venezuela	7	1.9	6	-1.2	8
Angola	6	2.0	8	-1.4	4
Malaysia	6	4.3	81	0.0	76
Poland	6	5.5	96	0.5	92
Turkey	6	4.2	80	0.1	81
Cote D'Ivoire	5	2.2	15	-1.1	16
Ecuador	5	2.7	34	-0.8	29
Italy	5	3.9	74	0.0	75
Korea (South)	5	5.4	95	0.5	90
Bangladesh	4	2.7	35	-1.0	20
Colombia	4	3.4	68	-0.3	62
France	4	7.0	104	1.5	107
Gabon	4	3.0	50	-0.8	33
Niger	4	2.5	29	-0.7	42
Romania	4	3.6	70	-0.2	70
Taiwan	4	6.1	100	0.9	97
Vietnam	4	2.9	44	-0.6	43
Algeria	3	2.9	47	-0.6	49
Azerbaijan	3	2.4	18	-1.1	13
Bahrain	3	5.1	93	0.2	85
Chile	3	7.2	107	1.6	110
Croatia	3	4.0	78	0.0	78
Czech Republic	3	4.4	82	0.3	88
Israel	3	5.8	98	0.7	94
Montenegro	3	4.0	76	-0.2	68
Nicaragua	3	2.5	28	-0.8	35
Oman	3	4.8	89	0.1	80
Pakistan	3	2.5	26	-1.0	20
Panama	3	3.3	61	-0.4	61
Philippines	3	2.6	33	-0.8	32
Qatar	3	7.2	106	1.0	99
Serbia	3	3.3	62	-0.2	69
Uzbekistan	3	1.6	3	-1.3	5
Benin	2	3.0	48	-0.7	41
Bolivia	2	2.8	42	-0.5	52
Bulgaria	2	3.3	63	-0.2	72

Appendix Table A1. Countries in which bribes were paid (continued)

		Transparency International		World Governance Indicators	
Country	**N**	**CPI**	**Rank**	**COC**	**Rank**
Canada	2	8.7	114	2.0	113
Congo Republic	2	2.2	13	-1.1	15
Costa Rica	2	4.8	88	0.6	93
FYR Macedonia	2	3.9	75	0.0	74
Germany	2	8.0	112	1.7	112
Ghana	2	3.9	73	0.1	82
Honduras	2	2.6	32	-0.8	30
Hungary	2	4.6	85	0.3	89
Kuwait	2	4.6	86	0.1	79
Liberia	2	3.2	59	-0.4	53
Libya	2	2.0	9	-1.3	6
Luxembourg	2	8.5	113	2.2	115
Mali	2	2.8	41	-0.6	46
Mauritania	2	2.4	21	-0.6	47
Netherlands	2	8.9	115	2.2	115
Portugal	2	6.1	99	1.1	102
Senegal	2	2.9	45	-0.6	44
Singapore	2	9.2	117	2.1	114
Spain	2	6.2	101	1.1	100
Syria	2	2.6	30	-1.0	24
Trinidad and Tobago	2	3.2	58	-0.3	64
Turkmenistan	2	1.6	2	-1.5	3
Uganda	2	2.4	22	-0.9	28
Yemen	2	2.1	10	-1.2	10
Antigua	1	4.9	90	1.3	104
Austria	1	7.8	110	1.4	105
Belarus	1	2.4	20	-0.7	36
Belgium	1	7.5	108	1.6	111
Bosnia and Herzegovina	1	3.2	60	-0.3	66
Brunei	1	5.2	94	0.8	96
Burkina Faso	1	3.0	56	-0.4	57
Cape Verde	1	5.5	97	0.8	95
Cyprus	1	6.3	102	1.0	98
Dominican Republic	1	2.6	31	-0.8	31
Equatorial Guinea	1	1.9	7	-1.5	2
Gambia	1	3.5	69	-0.5	51
Guatemala	1	2.7	40	-0.5	50
Guinea	1	2.1	11	-1.2	11
Guinea-Bissau	1	2.2	14	-1.1	18
Haiti	1	1.8	4	-1.3	7
Japan	1	8.0	111	1.5	106
Jordan	1	4.5	84	0.0	77
Kenya	1	2.2	16	-0.9	25
Kyrgyzstan	1	2.1	12	-1.1	14
Latvia	1	4.2	79	0.2	84
Lebanon	1	2.5	27	-0.9	26
Lithuania	1	4.8	87	0.3	86
Madagascar	1	3.0	55	-0.3	64
Malawi	1	3.0	53	-0.4	56
Moldova	1	2.9	46	-0.6	44
Mongolia	1	2.7	36	-0.7	37
Morocco	1	3.4	67	-0.3	67
Mozambique	1	2.7	37	-0.4	54
Myanmar	1	1.5	1	-1.7	1
Norway	1	9.0	116	2.2	115
Peru	1	3.4	65	-0.2	70
Rwanda	1	5.0	92	0.5	90
Sao Tome and Principe	1	3.0	51	-0.4	59
Sierra Leone	1	2.5	25	-0.8	33
Slovakia	1	4.0	77	0.3	86
Togo	1	2.4	19	-1.0	22
Turks and Caicos Islands	1	4.9	90	1.5	108
Ukraine	1	2.3	17	-1.0	23
United Kingdom	1	7.8	109	1.5	108
Uruguay	1	7.0	105	1.3	103
Average (total)	(117)	3.9		-0.1	
Weighted average (total)	(434)	3.5		-0.4	

Appendix B: Estimation of investigation costs

This appendix reports on the procedure for estimating firms' internal investigations costs and legal expenses prompted by allegations of foreign bribery. Only some firms report these expenses because the expenses frequently do not meet the materiality requirements of 10-Q and 10-K periodic reports. A few firms have reported investigation and legal expenses in response to media requests or analyst questions regarding an ongoing investigation. We are able to identify these expenses for 48 of the 143 firms in our sample by examining all available periodic reports from the beginning of the violation period through the end of the fiscal year following the concluding regulatory proceeding and searching Lexis-Nexis and Factiva for any press announcements related to the phrase "FCPA investigation expense" and its derivatives. These expenses are summarized in Panel A of Table A1. The mean investigation expense is $64.78 million with a median of $9.78 million. These self-reported expenses undoubtedly reflect reporting biases. For example, the expenses may include allocated expenses that are not directly related to the firm's bribery-related legal expenses, such as ongoing FCPA education initiatives. The reported expenses also may underreport the costs of managers' time in dealing with the bribery charges. It is also is not clear whether the subset of firms that report their direct legal expenses have higher or lower expenses compared to firms that do not report these expenses. Nonetheless, the numbers from these firms provide a rough estimate of their legal expenses due to their bribery-related charges. Among these 48 firms, the mean reported legal expense equals 1.53% of the firm's market capitalization, the median is 0.87% and the range is from 0.01% to 13.63%. Removing the outlier of 13.63%, firms incur legal and investigation costs related to its bribery investigation that average 1.15% of the firm's market capitalization.

Panel B of Table A1 reports the results of an OLS regression of these firms' investigation costs using data from these 48 enforcement actions. We finalized our selection of predictor variables after consulting with all three insurance companies that provide guidance or underwrite insurance policies that cover the costs of investigations for foreign bribery under either the FCPA or the U.K. Bribery Act. As

mentioned in the paper, one of these three companies has adopted our model as an input in pricing its foreign bribery insurance products.

The model indicates that the investigation cost is negatively related to natural logarithm of market capitalization and the average TI Corruption Perception Index of the countries in which the bribes occurred (smaller values relate to greater corruption). The investigation cost is positively related to the natural logarithm of the total size of the bribes paid, the fraction of the firm's sales that are attributable to the bribe payments, and the natural logarithm of the number of countries involved in the bribery investigation. The investigation cost is not significantly related to the number of unique charges brought by regulators or the TI Bribe Payer Industry Sector Score. The model R-squared is 46.8%.

We use censored predicted estimates from the regression to predict the investigation costs for all firms in the sample and report the results in Panel C of Table A1. The predicted values for all 143 enforcement actions are slightly larger than those observed for the 48 firms with hard data. In the last line of Panel C we report the estimates used in our economic model. These estimates use actual values for the 48 firms with reported amounts, and fitted values for the remaining 95 firms for which we cannot find reported expenses. The mean of the predicted investigation expense is 1.53% of market capitalization, the median is 0.95%, and the range is 0.01% to 13.63%. The mean estimated investigation expense is equal to the mean for the 48 observed values, while the median is 8 basis points higher. Whether we use the subset of firms for which we have direct data, or include estimates from all other firms, the results in Table A1 indicate that, on average, firms that are targeted for bribery enforcement actions spend in the neighborhood of 1.5% of market capitalization on internal investigation and legal expenses when they face enforcement action for foreign bribery.

Appendix Table A2. Estimates of internal investigation expenses incurred by firms for bribery violations

Panel A reports summary measures of the total investigation costs for 48 firms in the bribery sample that report on investigation costs in 10-K or other reports filed with the SEC, or through a public release. Panel B reports on a cross sectional OLS regression using data from these 48 firms in which the dependent variable is the investigation cost as a percent of the firm's market capitalization, with p-values based on robust standard errors. Panel C presents summary measures of the investigation costs using three different scenarios: (i) actual values using the 48 firms with data on investigation costs, (ii) actual values for the 48 firms supplemented by forecast investigation costs for the other 95 sample firms using the model reported in Panel B, and (iii) actual values for the 48 firms with known investigation costs supplemented by forecast investigation costs for the other 92 sample firms that have returns data available to calculate other model parameters

Panel A – Investigation cost as a percent of market capitalization for 48 firms with data ($mil)

	N	Mean	Median	Minimum	Maximum
Market capitalization	48	16,167.87	1,347.59	11.17	146,793.30
Investigation cost	48	64.78	9.78	0.38	1,200.00
% of market capitalization	48	1.53%	0.87%	0.01%	13.63%

Panel B – OLS regression estimates of investigation cost using data from 48 firms with reported values

Parameter	Estimate	Prob > |t|
Intercept	-0.0033	0.909
Log(market capitalization)	-0.0060	0.002
Log(bribe amount)	0.0025	0.032
% sales influenced to total sales	0.0659	0.009
Log(number of countries involved)	0.0040	0.037
Number of unique charges	0.0007	0.380
TI Bribe Payer Industry Sector Score	0.0058	0.187
TI Corruption Perception Index	-0.0033	0.056
N	48	
F (7, 40)	8.08	0.000
R-squared	46.82	

Panel C – Average investigation cost using forecasted values for firms without directly reported values

Investigation cost	N	Mean	Median	Min	Max
Actual %	48	1.53%	0.87%	0.01%	13.63%
Predicted %	143	1.55%	0.93%	0.01%	13.63%
Predicted %	140	1.53%	0.95%	0.01%	13.63%

Appendix Table A3: Sensitivity of p_b and p_c to alternate weights on gains in sensitivity and specificity

This table reports the implied values for the probability that a Compustat-listed firm with foreign sales engaged in a program of prosecutable bribery for five consecutive years at least once during the 1975-2010 period (p_b) and the probability that such a firm is caught and faces enforcement action under the Foreign Corrupt Practices Act (p_c). Each row corresponds to a different cutoff value, using Model 5 in Table 4, that accurately classifies the stated fraction of known bribe-paying firms (the Sensitivity) and the associated values for p_b and p_c. For example, the yellow-highlighted row (Row 9) indicates that the minimum cutoff value for accurately classifying 92.6% of the 108 known bribe-paying firms used to estimate Model 5 is 0.0050. Applying this cutoff value, the implied value of p_b = 22.85% and p_c = 6.38%. Increasing the cutoff value and decreasing the model sensitivity can be optimal if gains from specificity are valued more than gains in sensitivity. For example, setting the gains in specificity at 2 times the value of the marginal gain in sensitivity results in the outcome summarized by Row 15, with an implied value for p_b = 18.26% and p_c = 7.51%.

		ROC						
Row	Cutoff value	Area	Std Err	Sensitivity	Specificity	p_b	p_c	
1	0.0011	0.734	0.0030	1.000	0.467	54.03%	2.91%	
2	0.0013	0.750	0.0055	0.991	0.509	49.91%	3.13%	
3	0.0014	0.756	0.0072	0.981	0.531	47.73%	3.24%	
4	0.0023	0.803	0.0085	0.972	0.634	37.55%	4.08%	
5	0.0026	0.813	0.0096	0.963	0.663	34.69%	4.37%	
6	0.0029	0.821	0.0105	0.954	0.688	32.19%	4.67%	
7	0.0031	0.820	0.0114	0.944	0.696	31.46%	4.73%	
8	0.0032	0.818	0.0122	0.935	0.701	30.89%	4.77%	
9	0.0050	0.854	0.0129	0.926	0.783	22.85%	6.38%	<= Error cost ratio = 1/1
10	0.0052	0.853	0.0136	0.917	0.789	22.21%	6.50%	
11	0.0054	0.851	0.0142	0.907	0.795	21.57%	6.63%	
12	0.0057	0.851	0.0148	0.898	0.805	20.65%	6.85%	
13	0.0058	0.848	0.0154	0.889	0.808	20.30%	6.90%	
14	0.0063	0.850	0.0159	0.880	0.821	18.97%	7.30%	
15	0.0065	0.849	0.0164	0.870	0.828	18.26%	7.51%	<= Error cost ratio = 2/1
16	0.0066	0.847	0.0169	0.861	0.832	17.86%	7.59%	
17	0.0067	0.843	0.0173	0.852	0.835	17.62%	7.62%	
18	0.0069	0.841	0.0177	0.843	0.839	17.15%	7.74%	
19	0.0070	0.837	0.0182	0.833	0.841	16.99%	7.73%	
20	0.0073	0.835	0.0185	0.824	0.845	16.51%	7.86%	
21	0.0073	0.831	0.0189	0.815	0.847	16.36%	7.84%	
22	0.0074	0.828	0.0193	0.806	0.850	16.04%	7.91%	
23	0.0076	0.825	0.0196	0.796	0.854	15.63%	8.02%	
24	0.0078	0.823	0.0199	0.787	0.860	15.04%	8.24%	
25	0.0082	0.822	0.0202	0.778	0.865	14.47%	8.47%	
26	0.0085	0.818	0.0205	0.769	0.868	14.19%	8.53%	
27	0.0087	0.816	0.0208	0.759	0.873	13.74%	8.70%	
28	0.0089	0.812	0.0210	0.750	0.875	13.52%	8.74%	
29	0.0094	0.810	0.0213	0.741	0.879	13.08%	8.92%	
30	0.0097	0.808	0.0215	0.731	0.885	12.51%	9.21%	
31	0.0101	0.806	0.0217	0.722	0.891	11.91%	9.55%	
32	0.0102	0.802	0.0219	0.713	0.892	11.75%	9.55%	
33	0.0102	0.798	0.0222	0.704	0.892	11.74%	9.44%	
34	0.0104	0.794	0.0223	0.694	0.893	11.58%	9.45%	
35	0.0111	0.793	0.0225	0.685	0.901	10.85%	9.95%	

36	0.0116	0.791	0.0227	0.676	0.907	10.22%	10.41%	
37	0.0124	0.790	0.0229	0.667	0.914	9.52%	11.03%	
38	0.0127	0.786	0.0230	0.657	0.915	9.36%	11.06%	
39	0.0127	0.782	0.0231	0.648	0.916	9.33%	10.94%	
40	0.0138	0.782	0.0233	0.639	0.924	8.46%	11.90%	
41	0.0146	0.781	0.0234	0.630	0.932	7.73%	12.83%	
42	0.0147	0.776	0.0235	0.620	0.932	7.67%	12.74%	
43	0.0169	0.777	0.0236	0.611	0.942	6.68%	14.41%	
44	0.0173	0.773	0.0237	0.602	0.944	6.43%	14.74%	
45	0.0194	0.772	0.0238	0.593	0.952	5.63%	16.58%	
46	0.0202	0.770	0.0239	0.583	0.956	5.25%	17.50%	
47	0.0202	0.765	0.0239	0.574	0.956	5.24%	17.27%	
48	0.0222	0.763	0.0240	0.565	0.961	4.70%	18.94%	
49	0.0238	0.761	0.0240	0.556	0.966	4.26%	20.55%	<= Error cost = 3/1 and 4/1
50	0.0238	0.756	0.0241	0.546	0.966	4.24%	20.27%	
51	0.0253	0.752	0.0241	0.537	0.968	4.01%	21.09%	
52	0.0256	0.748	0.0242	0.528	0.969	3.91%	21.27%	
53	0.0265	0.744	0.0242	0.519	0.970	3.73%	21.88%	
54	0.0274	0.741	0.0242	0.509	0.973	3.46%	23.21%	<= Error cost = 5/1, 6/1, 7/1
55	0.0287	0.738	0.0242	0.500	0.975	3.22%	24.43%	and 8/1
56	0.0289	0.733	0.0242	0.491	0.976	3.18%	24.31%	
57	0.0295	0.729	0.0242	0.481	0.976	3.09%	24.53%	
58	0.0296	0.724	0.0241	0.472	0.976	3.08%	24.17%	
59	0.0303	0.720	0.0241	0.463	0.977	3.03%	24.04%	
60	0.0335	0.717	0.0241	0.454	0.980	2.67%	26.78%	<= Error cost = 9/1 and
61	0.0347	0.713	0.0240	0.444	0.982	2.48%	28.24%	10/1
62	0.0355	0.709	0.0240	0.435	0.982	2.42%	28.31%	
63	0.0357	0.704	0.0239	0.426	0.983	2.36%	28.40%	
64	0.0370	0.700	0.0238	0.417	0.984	2.26%	29.03%	
65	0.0376	0.696	0.0238	0.407	0.984	2.17%	29.53%	
66	0.0386	0.692	0.0237	0.398	0.985	2.09%	30.07%	
67	0.0428	0.688	0.0236	0.389	0.987	1.90%	32.31%	
68	0.0456	0.684	0.0235	0.380	0.988	1.81%	33.06%	
69	0.0460	0.679	0.0234	0.370	0.988	1.75%	33.33%	
70	0.0465	0.675	0.0232	0.361	0.989	1.69%	33.62%	
71	0.0466	0.670	0.0231	0.352	0.989	1.68%	33.04%	
72	0.0469	0.666	0.0229	0.343	0.989	1.65%	32.74%	
73	0.0473	0.661	0.0228	0.333	0.989	1.62%	32.43%	
74	0.0494	0.657	0.0226	0.324	0.990	1.53%	33.33%	
75	0.0499	0.652	0.0225	0.315	0.990	1.49%	33.33%	
76	0.0511	0.648	0.0223	0.306	0.990	1.44%	33.33%	
77	0.0517	0.643	0.0221	0.296	0.990	1.43%	32.65%	
78	0.0518	0.639	0.0219	0.287	0.990	1.41%	31.96%	
79	0.0521	0.634	0.0217	0.278	0.990	1.40%	31.25%	
80	0.0522	0.629	0.0214	0.269	0.990	1.39%	30.53%	

81	0.0524	0.625	0.0212	0.259	0.990	1.37%	29.79%	
82	0.0588	0.621	0.0209	0.250	0.993	1.12%	35.06%	
83	0.0624	0.617	0.0207	0.241	0.994	1.01%	37.68%	
84	0.0733	0.614	0.0204	0.231	0.996	0.80%	45.45%	
85	0.0735	0.609	0.0201	0.222	0.996	0.79%	44.44%	
86	0.0753	0.604	0.0198	0.213	0.996	0.76%	44.23%	
87	0.0755	0.600	0.0195	0.204	0.996	0.74%	43.14%	
88	0.0787	0.595	0.0191	0.194	0.996	0.70%	43.75%	
89	0.0845	0.591	0.0188	0.185	0.997	0.61%	47.62%	
90	0.0900	0.587	0.0184	0.176	0.997	0.54%	51.35%	
91	0.0923	0.582	0.0180	0.167	0.997	0.53%	50.00%	
92	0.0975	0.578	0.0176	0.157	0.998	0.47%	53.13%	
93	0.1002	0.573	0.0172	0.148	0.998	0.44%	53.33%	
94	0.1033	0.568	0.0167	0.139	0.998	0.41%	53.57%	
95	0.1059	0.564	0.0162	0.130	0.998	0.38%	53.85%	
96	0.1116	0.559	0.0157	0.120	0.999	0.34%	56.52%	
97	0.1126	0.555	0.0152	0.111	0.999	0.29%	60.00%	
98	0.1138	0.550	0.0146	0.102	0.999	0.28%	57.89%	
99	0.1142	0.546	0.0140	0.093	0.999	0.26%	55.56%	
100	0.1151	0.541	0.0134	0.083	0.999	0.25%	52.94%	
101	0.1196	0.537	0.0127	0.074	0.999	0.22%	53.33%	
102	0.1242	0.532	0.0119	0.065	0.999	0.18%	58.33%	
103	0.1342	0.527	0.0111	0.056	0.999	0.15%	60.00%	
104	0.1433	0.523	0.0102	0.046	1.000	0.10%	71.43%	
105	0.1631	0.518	0.0091	0.037	1.000	0.07%	80.00%	
106	0.2085	0.514	0.0079	0.028	1.000	0.04%	100.0%	<= Error cost = 100/1
107	0.2389	0.509	0.0065	0.019	1.000	0.03%	100.0%	
108	0.2446	0.505	0.0046	0.009	1.000	0.01%	100.00 %	