Booms, Busts, and Fraud

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Firms sometimes commit fraud by altering publicly reported information to be more favorable, and investors can monitor firms to obtain more accurate information. We study equilibrium fraud and monitoring decisions. Fraud is most likely to occur in relatively good times, and the link between fraud and good times becomes stronger as monitoring costs decrease. Nevertheless, improving business conditions may sometimes diminish fraud. We provide an explanation for why fraud peaks towards the end of a boom and is then revealed in the ensuing bust. We also show that fraud can increase if firms make more information available to the public. (*JEL* E320, G300, G380)

Booms and busts are a common feature of market economies. Almost as common is the belief that a boom encourages and conceals financial fraud and misrepresentation by firms, which are then revealed by the ensuing bust. Examples in the last century include the 1920s [Galbraith (1955)], the "go-go" market of the 1960s and early 1970s [Labaton (2002), Schilit (2002)], and the use of junk bonds and LBOs in the 1980s [Kaplan and Stein (1993)]. Most recently, the long boom of the 1990s has been followed, first by recession, then by revelations of financial chicanery at many of America's largest companies.

Despite this widespread belief, there is considerable disagreement as to why this pattern occurs and what should be done about it. Some argue that

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We would like to thank an anonymous referee for very helpful comments. We are also indebted to Ulf Axelson, Markus Brunnermeier, Sudipto Dasgupta, Eitan Goldman, Charlie Hadlock, Andrew Hertzberg, Simi Kedia, Tom Nohel, Oguzhan Ozbas, Javier Suarez, and seminar participants at Columbia University, Duke University, Göteborg University, McGill University, Michigan State University, the University of Alberta, the University of Iowa, the University of Minnesota, the University of Pennsylvania, the 2005 American Finance Association meeting in Philadelphia, the 15th Annual Conference on Financial Economics and Accounting at USC, the JFI conference "Corporate Governance: Present and Future" at Washington University St. Louis, the CEPR/SITE conference "Understanding Financial Architecture: On the Economics and Politics of Corporate Governance" at Stockholm School of Economics, the conference "People and Money: The Human Factor in Financial Decision-Making" at DePaul University, the RFS-IU conference "The Causes and Consequences of Recent Financial Market Bubbles", and the 2005 HKUST Finance Symposium for helpful comments. Address correspondence to Paul Povel, Department of Finance, 3-259 Carlson School of Management, University of Minnesota, 321 19th Avenue South, Minneapolis, MN 55455, or e-mail: povel@umn.edu..

doi:10.1093/rfs/hhm012 Advance Access publication January 29, 2007

tougher regulation is needed, forcing firms to disclose more information and to restructure their governance procedures.[1] Others argue that, during booms, investors are excessively optimistic and do not scrutinize the firms they finance as carefully as they should.[2]

In this article, we take a closer look at these arguments, using a simple model of financing and investment. We show that, even when investors are perfectly rational, firms' incentives to commit fraud are highest in relatively good times. Nevertheless, tougher regulation may sometimes have unintended consequences; in particular, making disclosure of firm results more precise can actually increase incentives to commit fraud.

In our model, investors receive financing requests from firms that may have attractive (“good”) or unattractive (“bad”) investment opportunities. When deciding whether to finance a firm, investors can either base their decision on publicly available (but noisy) information about the firm's investment opportunity, or they may invest time and money in monitoring a firm to learn its true situation. Managers of firms with poor prospects may decide to commit fraud; such fraud is costly to them, but it makes the publicly available information look better than it should be, and this may induce an investor to provide funds without monitoring.

Our model highlights two key determinants of a firm's fraud decision. The first is investors' prior beliefs about the state of the economy, measured by the proportion of “good” firms among firms seeking financing.[3] When investors' priors reflect low or average numbers of good firms, there is little or no fraud. Intuitively, even if a firm's public information is positive, enough uncertainty remains that investors find it worthwhile to monitor the firm carefully, and so fraud has little upside. When priors are fairly optimistic, however, investors do not monitor a firm with positive public information carefully, because this merely confirms their view that the firm is very likely to be good, but they do monitor firms with negative public information. Here, incentives for fraud are high.

Of course, it is possible that investors' prior beliefs are so optimistic that investors do not even monitor firms with negative public information. In this case, investors think that the negative information is likely to reflect a basically good firm having bad luck rather than a bad firm per se. Paradoxically, incentives for

[1] Thus, the 1930s saw the establishment of the Securities and Exchange Commission (SEC), and a stiffened regulation of financial institutions and markets; in the early 1990s, antitakeover legislation was enacted; and the most recent crisis led to the Sarbanes–Oxley Act.

[2] For example, the Economist (2002) suggests: “The remedy is disclosure, honest accounting, nonexecutive directors empowered to do their job—and, as always, skeptical shareholders looking out for their own interests. Without doubt, the last of these is the most important of all. Alas, it is beyond the reach of regulators and legislators. . . . The most important lesson of this bust, like every bust, is: buyer beware.”

[3] As noted at the end of Section 2, we obtain similar results if the state is measured instead by the return that firms earn when investments are successful.

fraud are low, because fraud is not necessary for bad firms to get funding.[4]

These predictions are consistent with some stylized facts from the most recent boom. Internet firms were undoubtedly the "hottest" sector during the 1990s, getting huge inflows of money from investors who were increasingly willing to finance early and untested business ideas. The telecommunications industry also attracted large inflows, yet here, investors seemed more critical, studying the financial information more carefully and staying clear of firms that were tainted by negative news. Thus, although investors were certainly optimistic about both sectors, they seem to have been more optimistic about the Internet than telecoms. Consistent with our model's predictions, little fraudulent reporting was uncovered among Internet firms, whereas a large number of prominent cases of fraud were from telecom firms: WorldCom, Qwest, Nortel, Global Crossing, and Lucent.

We also highlight the role of investors' costs of monitoring firms. Although intuition suggests that lowering such costs would reduce fraud, we show that this is not always the case. In fact, reduced monitoring costs can actually lead to more fraud, not less: this happens if investors have relatively optimistic priors, so that their monitoring focuses on firms with negative public information.[5] Moreover, the correlation of fraud incentives with good prior beliefs actually increases as monitoring costs fall. Intuitively, lower monitoring costs increase the range of priors over which investors are always vigilant, regardless of public information; thus, priors have to be especially good before investors lower their guard at all and fraud begins to pay. Again, the boom of the 1990s is consistent with these results. Throughout the 1990s, improved computing and communication technologies greatly reduced investors' costs of examining firms' prospects, yet at the end of the decade—a period of very high investor expectations—a wave of frauds occurred.

In reality, neither firms nor investors are perfectly informed about the state of the economy. Instead, they form beliefs given the recent history, for example, the financing patterns, and how many firms were profitable or failed. As a consequence, these beliefs adapt to changes in the fundamentals of an economy, but only with a lag. For example, at the end of a prolonged boom, firms and investors may take a while to realize that the tide has turned, that is, that the proportion of good firms has decreased, and

[4] This hump-shaped relation between investors' prior beliefs and the probability of fraud occurs even if monitoring is prohibitively costly. However, as noted below, the possibility of monitoring shifts the region where fraud occurs to better priors. In other words, the association between fraud and good times is linked to investors' ability to monitor.

[5] In this case, fraud gives bad firms a chance to leave the pool of firms with negative public information, which are monitored intensively, and join the pool of firms with good public information, which are more likely to be financed without monitoring.

that consequently, their fraud, monitoring, and financing decisions should change.

This delayed response to a changing environment affects the pattern of fraud over the business cycle. In particular, fraud peaks at the end of a boom, when the economy goes into a tailspin. This argument is based on the different roles played by the true (but unobservable) state of the economy and the state as perceived by firms and investors. Again, the true state may deteriorate abruptly at the end of a boom, while firms and investors believe that the boom is continuing. Given these beliefs, bad firms decide to commit fraud (to attract funding), and investors decide not to invest too many resources in monitoring firms with positive public information (because, given their optimistic beliefs, the benefits of such monitoring seem small). Both firms and investors expect that it is likely that a small number of firms will turn out to have been financed even though their type was bad, and that only a small number of firms will have received funding only because they committed fraud. These expectations, however, are based on the perceived state of the economy, which is much better than the true state. And the true state determines how many firms are bad and end up committing fraud. Thus, both firms and investors will be "surprised" by a large number of poorly performing firms, and investigations may reveal that a surprisingly large number of firms committed fraud to improve their financial situation.[6]

Such a dynamic setup may explain the pattern observed in many boom-bust cycles, that fraud peaks towards the end of a boom, often reaching surprising levels. Some have argued that this pattern is a sign of overoptimism on the side of investors, who are either naive or careless when deciding how to invest their funds. Even though this may be a driving force behind these patterns, our analysis suggests that they may equally well be generated by perfectly rational agents, who make self-interested decisions about whether to commit fraud or whether to monitor. In fact, the two ideas go hand in hand: If investors are inclined to waves of excessive optimism and pessimism, this will further exacerbate the effects that we just discussed. However, limited rationality is not a necessary factor to explain the patterns that we observe.

In sum, our model with rational behavior can reproduce many features of the boom-bust-fraud pattern, explaining (among other things) why long booms often seem to end in a wave of failures and fraud. Although we do not claim that investors are always perfectly rational, the fact that rationality does not rule out this pattern suggests limits to the "buyer beware" school of policy response. Moreover, our most critical result—that fraud incentives are highest in good (but not exceptionally

[6] A surprisingly high incidence of fraud may actually slow the learning process, since fraud artificially makes publicly available information look more positive than it really is.

good) states of the economy—actually requires a certain amount of "buyer beware" behavior: specifically, investors must be able to monitor and must decide whether to monitor in a rational fashion.

This adds a new perspective to the debate on how regulation can optimally deter fraud. Investors can use publicly available information to make their investment decisions, and they can also monitor, that is, analyze firms and investment opportunities in more detail. At first glance, forcing firms to disclose more information to the public might reduce the incidence of fraud; similarly, reducing the costs of monitoring by giving investors more rights and more power might help fight fraud. As we show, however, these arguments are incomplete, and such policy changes may backfire. We have already seen that lower monitoring costs sometimes lead to more fraud. Increased disclosure may have the same effect. Suppose that improved disclosure makes investors trust public information more, so that they are more likely to fund firms with positive information and deny funding to firms with negative information; then bad firms are more likely to resort to fraud so that they can produce such positive public information. To be effective against fraud, disclosure standards must directly make fraud more difficult.[7]

The plan of the rest of the article is as follows. We discuss the relevant literature next. In Section 1 we introduce our model and key assumptions. In Section 2 we analyze the behavior of investors and firms in a setting where all agents know the underlying distribution of good and bad firms in the economy. In Section 3 we show how our results are affected by changes in the underlying parameters and how these can motivate actual behavior by firms and investors. We also show how agents' beliefs can be grounded in a framework in which the underlying state of the economy is unknown, leading to "surprising" volumes of fraud in certain circumstances. In Section 4 we extend our model to deal with good firms' incentives to commit fraud, and in Section 5 we conclude. All proofs are in the Appendix.

Literature Review

Several recent articles in the finance literature also focus on managerial incentives to commit fraud. Bebchuk and Bar-Gill (2002) present a model in which firms may commit fraud so as to obtain better terms when issuing shares to raise funds for further investments; this incentive to commit fraud increases if managers can sell some of their own shares in the short run or if accounting and legal rules are lax. Goldman and Slezak (2006) present a model in which optimal managerial pay-for-performance

[7] This is not to say that improved disclosure has no beneficial effects. We discuss the impact of improved disclosure in more detail in Section 3.

contracts balance incentives to exert effort against incentives to commit fraud; increased regulatory penalties for fraud can sometimes increase the equilibrium incidence of fraud, and rules that reduce auditor incentives to collude with managers decrease the incidence of fraud but paradoxically reduce firm value. Subrahmanyam (2005) presents a model in which more intelligent managers are better both at running firms and at committing successful (undetected) fraud; as a result, investors may prefer more intelligent managers and a higher incidence of fraud in exchange for higher average performance. Noe (2003) analyzes a different type of fraud, in which a firm's manager "tunnels" value from the firm into her own pocket. He focuses on providing the manager with incentives to perform rather than steal the funds that she has raised. Unlike our article, these four articles do not examine how changes in economic conditions affect manager's incentives to commit fraud and investor's incentives to monitor managers, which is our primary focus.[8]

Closer to our article is that of Hertzberg (2003). It examines a setting in which investors are more likely to give short-term incentives to firm managers in good times. Since short-term incentives exacerbate financial misreporting, such misreporting tends to be correlated with good times. Although this article can explain a link between good times and fraud, it relies critically on the dynamic link between compensation contracts and business prospects. Since the recent move to link executive compensation to shareholder performance began in the recession of the early 1990s, this cannot be a complete explanation for the links between booms and fraud. Moreover, his model does not explain the relative absence of misreporting in the Internet sector as compared with the telecom sector during the late 1990s. Thus, Hertzberg's model is complementary to ours.

There are a number of studies in the accounting literature that focus on fraud incentives in the relationships between firms and their auditors. Some of these examine incentives to underreport earnings in order to hide managerial perquisite consumption; see for example Morton (1993). Closer to our focus are articles that examine the incentive to *over-report*; examples include Newman and Noel (1989), Shibano (1990), and Caplan (1999). Empirical work on SEC enforcement actions aimed at violations of Generally Accepted Accounting Principles (GAAP) suggests that over-reporting aimed at boosting share prices and improving access to additional capital is in fact the more frequent source of firmwide financial misrepresentation.[9] Unlike our article, these auditing articles

[8] Goldman and Slezak (2006) do show that an influx of naive, overly optimistic investors into the stock market increases the equilibrium incidence of fraud. Again, our model shows that such fluctuations can occur even when all investors are perfectly rational.

[9] For example, Feroz et al. (1991) find that fraud usually takes the form of earnings overstatement, and that news of an SEC enforcement action depresses stock price. Dechow et al. (1996) find that firms that commit fraud tend to have higher *ex-ante* needs for additional funds.

on over-reporting focus on the impact of control systems and auditor incentives; they do not examine how fraud incentives change with overall business conditions. A further distinction is that auditors are typically penalized for failing to detect fraud. By focusing on the incentives of investors, we emphasize the fact that investors are not concerned with finding fraud per se, but rather with finding good investment opportunities. As already noted, this can lead to counterintuitive results when investors rationally focus their scrutiny on low signals rather than high ones.

Although ours is the first article that we are aware of that ties fraudulent behavior by firms to changing investor actions over the business cycle, there are a number of articles that are related to the tenor of our analysis. For example, a growing body of work examines "credit cycles"—the idea that banks and other credit suppliers engage in behavior that exacerbates business cycle effects, making credit even tighter in recessions, and looser in expansions, than pure demand-side effects would suggest. Among these, the closest to our article is that of Ruckes (2004), which models how competing bank lenders' incentives to screen potential borrowers exacerbate cyclical variations in credit standards. Dow, Gorton, and Krishnamurthy (2005) study how the impact of managerial empire-building incentives changes over the business cycle, and how this affects asset prices. None of these articles address borrower incentives to commit fraud, which is our key focus.

Our discussion of the dynamic implications of our model is related to Persons and Warther's (1997) model of booms and busts in the adoption of financial innovations. In their model, individual firms decide whether to adopt a new financial technique based on the information that earlier adopters' experience noisily reveals. They show that such waves of adoption always end on a sour note, in the sense that the most recent adopters always lose money. *Ex post*, the information that ends the wave is always negative, but the timing of the end is *ex ante* random, and the latest adopters were behaving rationally on the basis of the information available at the time. Although Persons and Warther focus on social learning about a static innovation rather than investor monitoring in the face of potential fraud, the result that busts may be surprising yet still rational has some similarities to our discussion.

Finally, our work contrasts with the growing literature that examines how bounded rationality can cause market overreactions. The critical difference is that our model relies on rational behavior throughout. As noted earlier, to the extent that deviations from rationality do lead investors' priors to overreact to recent information, they will exacerbate the effects we describe. Similarly, we assume that firms are run by self-interested rational managers who act opportunistically if doing so is beneficial for them. Noe and Rebello (1994) present a model in which ethical and unethical managers coexist, but where "ethical" managers are unable to act opportunistically. The likelihood that a manager is ethical

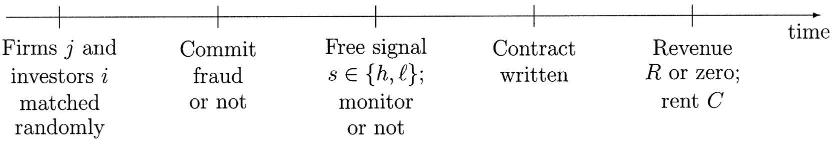

Figure 1
Time line.

depends on past opportunity losses to behaving in an ethical fashion; in some cases, this leads to cyclical behavior in the proportion of ethical and unethical managers.

1. Basic Model and Assumptions

In this section we lay out the basic model that provides the framework for analyzing the incidence of fraud in Section 2. The economy consists of equal numbers of firm managers and investors, each of whom lives for one period. The sequence of events is summarized in Figure 1.

1.1 Firms and managers

Each manager controls a firm that requires an investment of I units of cash at the start of the period. At the end of the period, the firm returns a random contractible cash flow that equals $R > I$ with probability θ_i and zero with probability $1 - \theta_i$, where $i \in \{g, b\}$ is the firm's type. We assume that $0 \leq \theta_b < \theta_g < 1$. We also assume that

$$N_g = \theta_g R - I > 0 \quad N_b = -(\theta_b R - I) > 0; \tag{1}$$

that is, g firms are positive net present value investments ("good"), whereas b firms are negative net present value investments ("bad"). Note that N_b is the *absolute value* of the expected loss from investing in a bad firm.

In addition to generating contractible cash flows, a funded firm generates C in noncontractible control benefits which the manager consumes.[10] This implies that, all else equal, a manager prefers to get her project funded, regardless of her firm's type.

Managers know their own firm's type, but outsiders can discover this only by monitoring the firm at a cost, as we discuss below. The prior probability that any given firm is good is given by μ, where $\mu \in (0, 1)$. This prior is common knowledge. For the moment, we take this prior as

[10] This could represent nonpecuniary benefits of control or pecuniary benefits that have to be given to the manager in order to elicit reasonable efforts [see for example Diamond (1993)]. Moskowitz and Vissing-Jorgensen (2002) give empirical evidence that is consistent with large nonpecuniary benefits; Fee and Hadlock (2004) give evidence on the net pecuniary benefits that CEOs lose if they are dismissed and forced to seek employment elsewhere.

exogenously given; in Section 3 we discuss how this can be embedded in a multi-period framework.[11]

1.2 Investors

Investors are each endowed with I units of the generic good. At the beginning of the period, each investor is randomly matched with a manager and her firm. After being matched, the investor receives a free but noisy signal of the firm's type, and may then decide whether or not to expend additional effort and learn the firm's type more precisely. On the basis of any information that she has, the investor then can make a take-it-or-leave-it investment offer to the manager. The manager does not have time to approach another investor, so if the investor does not make her an offer, the manager cannot get funding for her firm.[12]

Our assumptions of random matching and take-it-or-leave-it offers are made for simplicity; altering them would not change the essentials of our analysis. For simplicity, we also assume that investors cannot pay off bad firms to reveal their type; in practice, doing so is likely to be prohibitively expensive since a large number of incompetent managers would start firms and apply to investors for the sole purpose of receiving that payment.

Thus, in equilibrium, if the investor does fund the firm, she receives all of the contractible cash flows that it produces. Nevertheless, since the manager receives control benefits C if the firm is funded and nothing if the firm is not funded, she will take any offer that she is given.

1.3 Signals, fraud, and monitoring

As just mentioned, right after managers and investors are matched, each investor receives a free but noisy signal of the type of the manager's firm. This signal should be thought of as a financial report or a related public news release by the firm. We assume that this signal takes on one of two values, h (" high") and ℓ ("low"). We also assume that, in the absence of fraud, the signal is positively correlated with the firm's true type:

$$\Pr\{h|g\} = \gamma > \frac{1}{2} > \beta = \Pr\{h|b, no\ fraud\}.$$

The free signal is subject to manipulation by the manager ("fraud"). The manager decides whether or not to commit fraud right after she and the investor are matched. Fraud costs the manager an amount f, where f reflects both any effort involved in committing fraud and the

[11] An earlier version of this article also discussed the possibility of entry and exit of firms, depending on the state of the economy μ. Allowing for entry and exit does not change the results qualitatively.

[12] We abstract from the possibility that firms may be competing for scarce funding and may therefore be rationed. This seems reasonable if better states of the economy (higher values of μ) imply a larger availability of funds (investment increases with μ).

chance that the manager is later caught and punished.[13] Fraud increases the probability that a bad firm generates a high signal by $\delta < \gamma - \beta$; that is, $\Pr\{h|b, fraud\} = \beta + \delta < \gamma$. Thus, fraud reduces the free signal's correlation with the firm's type, but the free signal remains somewhat informative.[14] Fraud is beneficial to the manager to the extent it increases the manager's chance of collecting control benefits C. It follows that fraud will never be attractive unless the cost of fraud f is less than the maximum possible benefit, that is, $f < \delta C$. Henceforth, we assume that this condition holds.

In practical terms, fraud should be thought of as deliberate misstatement of the firm's results, either through altered financial reports or a misleading news release. Such an effort increases the odds that a casual glance at the firm's results will lead investors to think that the firm is in good shape—in terms of our model, it increases the probability that the public signal is high.

For simplicity, we assume that only bad firms commit fraud. As we discuss in Section 4, allowing good firms to commit fraud leaves most of our results qualitatively unchanged, so long as bad firms have relatively more to gain from fraud.

Suppose that the bad firm commits fraud with probability ϕ. Let $\widehat{\mu}_s(\phi)$ be the investor's posterior probability that the firm is good after she sees the free signal s. Applying Bayes' Rule, we have

$$\begin{aligned}\widehat{\mu}_h(\phi) = \Pr[g|h] &= \frac{\Pr\{g\}\Pr\{h|g\}}{\Pr\{g\}\Pr\{h|g\} + \Pr\{b\}\Pr\{h|b\}} \\ &= \frac{\mu}{\mu + (1-\mu)\frac{\beta+\phi\delta}{\gamma}} \\ \widehat{\mu}_\ell(\phi) = \Pr[g|\ell] &= \frac{\Pr\{g\}\Pr\{\ell|g\}}{\Pr\{g\}\Pr\{\ell|g\} + \Pr\{b\}\Pr\{\ell|b\}} \\ &= \frac{\mu}{\mu + (1-\mu)\frac{1-\beta-\phi\delta}{1-\gamma}}.\end{aligned}$$

Notice that $\forall\phi \in (0, 1)$,

$$\widehat{\mu}_\ell(0) < \widehat{\mu}_\ell(\phi) < \widehat{\mu}_\ell(1) < \mu < \widehat{\mu}_h(1) < \widehat{\mu}_h(\phi) < \widehat{\mu}_h(0). \qquad (2)$$

As expected, the posterior probability that the firm is good is higher after observing a high signal than it is after observing a low signal, and fraud

[13] An earlier version of this article discussed the case in which the probability of being caught committing fraud (and punished) depended on the probability of being funded. This does not change our results qualitatively.

[14] Allowing δ to exceed $\gamma - \beta$ would have little effect on our qualitative results; bad firms would never commit fraud with certainty, but comparative statics would be unchanged.

makes the signal less precise, that is, the posterior approaches the prior as either δ or ϕ increases.

After receiving the free signal, the investor can choose to investigate the firm further ("monitor"). Monitoring has an effort cost of $m > 0$ and perfectly reveals the firm's type. Once more, the assumption that monitoring is perfect is not essential; the key point is that monitoring gives more precise information about the firm's type, and that fraud distorts the information from monitoring relatively less than it distorts the free signal.

1.4 An alternative interpretation

Although our model assumes that firms are seeking initial financing, it extends easily to the case of firms that are already in business. Suppose that firms have risky ongoing operations or investment opportunities that can be good or bad. If a manager remains in charge, she receives control rents; if she is fired or constrained from pursuing additional investment, she loses these rents. A firm's investor (say, a large shareholder) can either allow the manager to remain in charge, or else fire or otherwise constrain the manager to avoid wasting the firm's resources. Finally, the investor can either make her decision on the basis of her prior beliefs about the firm's type or else monitor the firm more closely before making her decision. It is easy to see that this alternative interpretation uses essentially the same model that we have already presented.

2. Investor and Firm Behavior

In this section, we analyze the equilibrium actions of the firm's manager (henceforth, "firm") and of the investor. As we will see, the incidence of fraud is hump-shaped, first increasing in the prior probability that firms are good, then decreasing. When this prior probability is below the point at which fraud reaches its peak, fraud increases as monitoring decreases; when the prior is above this peak, fraud and monitoring decrease together. Most importantly, whenever monitoring is feasible, the peak in fraud occurs for good priors—those for which the average net present value of a firm's project is positive—and this peak shifts toward higher priors as monitoring costs decrease. In this sense, fraud is associated with "good times."

Our analysis proceeds via backwards induction. We begin with the investor's problem once she has observed the free signal; then we examine the firm's decision on whether to commit fraud before the free signal is sent. We conclude by characterizing the equilibrium levels of fraud and monitoring as functions of the prior probability that firms are good.

2.1 The investor's *ex-post* problem

After receiving the free signal s, the investor has three possible actions: she can choose not to invest (action "N"); she can monitor and then invest if the firm is good (action "M");[15] or she can invest without further monitoring (action "U" for unmonitored). Defining V_A as the expected payoff to action A, the actions' expected payoffs are as follows.

$$V_N = 0$$
$$V_M = \widehat{\mu} N_g - m$$
$$V_U = \widehat{\mu} N_g - (1 - \widehat{\mu})\, N_b$$

It is immediately clear that the investor's decision depends only on the net present values N_g and $-N_b$ of the two types of firms, the cost of monitoring m, and the investor's posterior belief on the probability $\widehat{\mu}$ that the firm is good. For expositional ease, we define the following threshold probabilities: If $\widehat{\mu} = \frac{m}{N_g} \equiv \mu_1(m)$ then $V_N = V_M$; if $\widehat{\mu} = \frac{N_b}{N_b+N_g} \equiv \mu_2$ then $V_N = V_U$; and if $\widehat{\mu} = 1 - \frac{m}{N_b} \equiv \mu_3(m)$ then $V_M = V_U$. The next proposition describes the parameter regions in which the various actions are optimal.

Proposition 1. *Suppose that, after observing the free signal, the investor believes that the firm is good with probability $\widehat{\mu}$. The investor's optimal action is as follows:*

1. *Do not invest if $\widehat{\mu} < \min\{\mu_1(m), \mu_2\}$.*
2. *Invest without monitoring if $\widehat{\mu} \geq \max\left\{\mu_2, \mu_3(m)\right\}$.*
3. *Monitor and invest if the firm is good if $\mu_1 < \widehat{\mu} \leq \mu_3(m)$ and $m < \frac{N_b N_g}{N_b+N_g} \equiv \overline{m}$.*

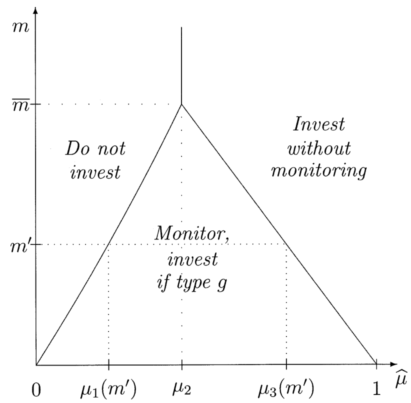

Figure 2
Posterior probabilities and optimal investor decisions..

[15] Note that, given (1), it never pays to invest in a bad firm.

Figure 2 displays key elements of the investor's decision problem. Given the realization of the free signal, the investor updates her beliefs about the firm's type. Together, the posterior $\widehat{\mu}$ and the cost of monitoring m determine the optimal decision. If the cost of monitoring is above $\overline{m}$, then $\min\{\mu_1(m), \mu_2\} = \max\{\mu_2, \mu_3(m)\} = \mu_2$ and monitoring is always dominated either by not investing at all or by unmonitored financing. Here, the investor provides unmonitored finance if and only if the posterior is above the threshold μ_2, which determines where the investor is indifferent between not investing and providing unmonitored financing.

For monitoring costs below $\overline{m}$, it is possible that the expected benefit from monitoring (avoiding investing in bad firms and losing N_b) may exceed the cost of monitoring m. If $\widehat{\mu}$ is such that $m = \widehat{\mu} N_g$ (the upward sloping line in Figure 2), we have $V_N = V_M$, and the investor is indifferent between monitored finance and not investing. For example, if $m = m'$, the threshold for $\widehat{\mu}$ is $\mu_1\left(m'\right)$. If $\widehat{\mu}$ is such that $m = (1 - \widehat{\mu})\, N_b$ (the downward-sloping line), we have $V_M = V_U$, and the investor is indifferent between monitored finance and unmonitored finance. For the example $m = m'$, this defines the threshold $\mu_3\left(m'\right)$. It follows that monitoring is optimal for intermediate posteriors, and the range of posteriors for which it is optimal increases as the cost of monitoring m decreases.

Note that the investor's decision depends only on the posterior $\widehat{\mu}$, and not on *how* she forms this posterior; different combinations of the prior μ and the probability of fraud ϕ that lead to the same posterior $\widehat{\mu}$ lead to the same action.

2.2 The manager's decision to commit fraud

Having solved the investor's problem, we now examine the bad firm's decision on whether to commit fraud. This decision depends on the cost of fraud versus the expected benefit of fraud, which in turn depends on the investor's response as described in Proposition 1. Since monitoring detects bad firms, the firm benefits from fraud only if fraud increases the firm's probability of receiving unmonitored funding. This requires two conditions: (i) after a high signal, the investor's posterior leads her to provide unmonitored funding with positive probability, and (ii) after a low signal, the investor's posterior leads her to provide unmonitored funding with strictly lower probability than in the high-signal case. On the other hand, as mentioned in the previous section, in equilibrium, fraud makes the signal less precise; this lessens the difference in impact between high and low signals, reducing the gains from fraud.

In equilibrium, the incidence of fraud must be consistent with incentives. Thus, if the manager's expected benefit strictly exceeds the cost f, she undertakes fraud with certainty ($\phi = 1$). If the benefit equals the cost, she is willing to commit fraud with positive probability ($0 \leq \phi \leq 1$). Otherwise, she does not commit fraud at all.

We first describe five different "regimes" which characterize the equilibrium; which regime is relevant depends on the prior μ and on the cost of monitoring m. Define

$$\mu_{UF} = \max\left\{\mu_3(m), \mu_2\right\}.$$

From Proposition 1, μ_{UF} is the posterior at which the investor is indifferent between investing without monitoring and some other action. As noted above, unmonitored investment is critical to fraud. If the posterior is always above μ_{UF}, there is no point to committing fraud; bad firms always get funding regardless of the signals they send. Similarly, if the posterior is always below μ_{UF}, there is also no point to committing fraud; because firms never get funding without being monitored, bad firms cannot get funding regardless of the signals they send. Thus μ_{UF} is the key to equilibrium behavior, as we now show.

The regimes are defined as follows (the names are motivated by the results of Proposition 2 below).

(i) The *Fund-Everything* regime: $\left(1 + \frac{1-\mu_{UF}}{\mu_{UF}} \frac{1-\gamma}{1-\beta}\right)^{-1} \leq \mu < 1.$

(ii) The *Optimistic* regime:
$\left(1 + \frac{1-\mu_{UF}}{\mu_{UF}} \frac{1-\gamma}{1-\beta-\delta}\right)^{-1} \leq \mu < \left(1 + \frac{1-\mu_{UF}}{\mu_{UF}} \frac{1-\gamma}{1-\beta}\right)^{-1}.$

(iii) The *Trust-Signals* regime:
$\left(1 + \frac{1-\mu_{UF}}{\mu_{UF}} \frac{\gamma}{\beta+\delta}\right)^{-1} \leq \mu < \left(1 + \frac{1-\mu_{UF}}{\mu_{UF}} \frac{1-\gamma}{1-\beta-\delta}\right)^{-1}.$

(iv) The *Skeptical* regime:
$\left(1 + \frac{1-\mu_{UF}}{\mu_{UF}} \frac{\gamma}{\beta}\right)^{-1} \leq \mu < \left(1 + \frac{1-\mu_{UF}}{\mu_{UF}} \frac{\gamma}{\beta+\delta}\right)^{-1}.$

(v) The *No-Trust* regime: $0 < \mu < \left(1 + \frac{1-\mu_{UF}}{\mu_{UF}} \frac{\gamma}{\beta}\right)^{-1}.$

There are two cases. In one case, monitoring is prohibitively costly, i.e. $m > \overline{m}$; in the other, $m \leq \overline{m}$, and the investor may monitor in equilibrium. We begin with the case where monitoring is possible.

Proposition 2. *Assume that the monitoring cost* $m \leq \overline{m} = \frac{N_b N_g}{N_b + N_g}$. *Denote by* λ_s *the probability of monitoring with a signal* s, *by* κ_s *the probability of unmonitored finance with a signal* s, *and by* ϕ *the bad firm's probability of committing fraud. The equilibrium decisions are as follows:*

(i) Fund-Everything regime. The investor never monitors ($\lambda_h = \lambda_\ell = 0$), *all firms are funded regardless of the signal* ($\kappa_h = \kappa_\ell = 1$), *and there is no fraud* ($\phi = 0$).

(ii) Optimistic regime. High-signal firms are always funded without monitoring ($\lambda_h = 0$ *and* $\kappa_h = 1$). *Low-signal firms are funded*

without monitoring with probability $\kappa_\ell = 1 - \frac{f}{\delta C}$ *and are monitored otherwise* ($\lambda_\ell = \frac{f}{\delta C}$). *Bad firms commit fraud with probability* $\phi = \frac{1}{\delta}\left(1 - \beta - \frac{\mu}{1-\mu}\frac{m}{N_b - m}(1-\gamma)\right)$.

(iii) *Trust-Signals regime. High-signal firms are always funded without monitoring* ($\lambda_h = 0$ *and* $\kappa_h = 1$). *Low-signal firms are never funded without monitoring* ($\kappa_\ell = 0$). *Bad firms always commit fraud* ($\phi = 1$).

(iv) *Skeptical regime. High-signal firms are funded without monitoring with probability* $\kappa_h = \frac{f}{\delta C}$ *and are monitored otherwise* ($\lambda_h = 1 - \frac{f}{\delta C}$). *Low-signal firms are never funded without monitoring* ($\kappa_\ell = 0$). *Bad firms commit fraud with probability* $\phi = \frac{1}{\delta}\left(\frac{\mu}{1-\mu}\frac{m}{N_b - m}\gamma - \beta\right)$.

(v) *No-Trust regime. Firms are never funded without being monitored* ($\kappa_h = \kappa_\ell = 0$) *and there is no fraud* ($\phi = 0$).

Figure 3 shows which (μ, m) pairs fall into each regime, both for the case where monitoring is feasible, as described in the preceding proposition, and for the case where monitoring is prohibitively expensive, as described in Proposition 3 below. The darker shaded region consists of all (μ, m) pairs for which bad firms find it optimal to commit fraud with certainty.

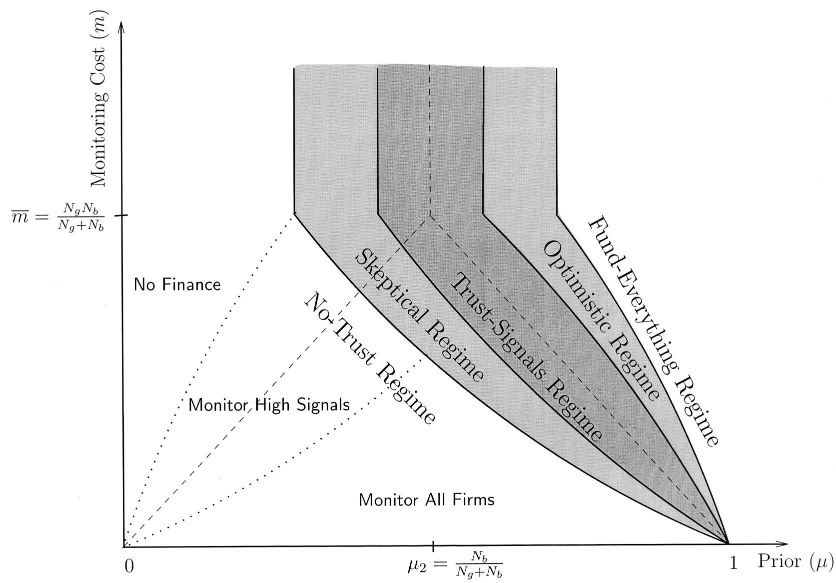

Figure 3
Five Regimes.

In the lighter shaded regions, bad firms commit fraud with probability strictly between 0 and 1. In the unshaded regions, there is no fraud at all.

Figure 3 is related to Figure 2, which shows the details of the investor's *ex-post* decision problem; the dashed lines in Figure 3 correspond to the solid lines in Figure 2. From the figure, it is clear that fraud takes place in a region centered on $\mu_{UF} = \max\{\mu_3(m), \mu_2\}$, the posterior belief at which the investor is just indifferent to providing unmonitored finance. Intuitively, if the prior is close to this indifference point, the prior uncertainty over whether the firm should receive unmonitored finance or not is greatest. This means that the signal's outcome has the greatest effect on whether the investor provides unmonitored finance or not: a high signal is most likely to lead to a different outcome from a low signal, which is when incentives for fraud are highest.

Analytically, the results in Proposition 2 follow from the regime definitions that precede the proposition; these are given in terms of the prior μ and μ_{UF}. (Note that in the case of Proposition 2, μ_{UF} equals $\mu_3(m)$; that is, when the investor is indifferent to providing unmonitored finance, her relevant choice is between monitoring and not monitoring.) The expressions for the boundaries of the regimes are derived from critical values of $\widehat{\mu}_s(\phi)$, which again is the investor's posterior belief that the firm is good after seeing the free signal s and assuming that the bad firm commits fraud with probability ϕ.

As an example, in the *Fund-Everything* regime, the prior μ is so high that even a low signal is very likely to have come from a good firm. Specifically, we have $\mu_{UF} = \mu_3(m) \leq \widehat{\mu}_\ell(0)$: even after seeing a low signal, and even if bad firms commit fraud with probability 0, the investor is willing to extend unmonitored finance to the firm. Using the definition of $\widehat{\mu}_\ell(0)$ and rearranging yields the condition given in the definition. Since all firms receive unmonitored finance regardless of the public signal, there is no benefit from committing fraud in this regime.

In the *Optimistic* regime, either the prior μ or the cost of monitoring m is somewhat lower, so that $\widehat{\mu}_\ell(0) < \mu_3(m) < \widehat{\mu}_\ell(1)$. Here, a high signal still leaves the investor choosing to fund the firm without monitoring, but a low signal is bad enough that the investor prefers to monitor with some probability.[16] In this regime, monitoring actually encourages fraud, since bad firms that produce a low signal may be monitored and denied funding.

In the *Trust-Signals* regime, $\widehat{\mu}_\ell(1) < \mu_3(m) < \widehat{\mu}_h(1)$. Here, only high signals receive unmonitored finance; low signals are either monitored or

[16] More precisely, if there were no chance of fraud in equilibrium, the investor would strictly prefer to monitor after a low signal; if there were fraud with certainty, the investor would strictly prefer to not monitor; thus, in equilibrium, the investor monitors with probability between 0 and 1.

rejected.[17] Either way, bad firms have no chance of being financed if they produce a low signal, so their incentive to commit fraud is higher than it would be in the *Optimistic* regime. In this regime, bad firms commit fraud with certainty.

With lower values of μ or m, we enter the *Skeptical* regime, where $\widehat{\mu}_h(1) < \mu_3(m) < \widehat{\mu}_h(0)$. The priors in this regime are low enough that the investor finds it optimal to monitor even high signals with positive probability. Because the bad firm may not get financing even if it manages to obtain a high signal, the gains from fraud are lower than those in the *Trust-Signals* regime. Thus, bad firms commit fraud with probability strictly less than 1.

Finally, for very low values of μ, we have $\widehat{\mu}_h(0) < \mu_3(m)$. In this *No-Trust* regime, the investor's prior is so low that all firms are either monitored or rejected, regardless of the signal. Since there is no unmonitored finance, there is no gain to committing fraud, and so there is no fraud in equilibrium.

Next, we turn to the case where monitoring costs are so high that monitoring never pays (that is, $m > \overline{m}$). The regimes described in Proposition 2 extend to this case in a natural way (see Figure 3):

Proposition 3. *Assume that the monitoring cost $m > \overline{m} = \frac{N_b N_g}{N_b + N_g}$, so that the investor never monitors. Denote by κ_s the probability of unmonitored finance with a signal s, and by ϕ the bad firm's probability of committing fraud. The equilibrium decisions are as follows:*

- *(i) Fund-Everything regime. All firms are funded regardless of the signal ($\kappa_h = \kappa_\ell = 1$), and there is no fraud ($\phi = 0$).*
- *(ii) Optimistic regime. High-signal firms are always funded ($\kappa_h = 1$). Low-signal firms are funded with probability $\kappa_\ell = 1 - \frac{f}{\delta C}$ and denied funding otherwise. Bad firms commit fraud with probability $\phi = \frac{1}{\delta}\left(1 - \beta - \frac{\mu}{1-\mu}\frac{N_g}{N_b}(1-\gamma)\right)$.*
- *(iii) Trust-Signals regime. High-signal firms are always funded ($\kappa_h = 1$). Low-signal firms are never funded ($\kappa_\ell = 0$). Bad firms always commit fraud ($\phi = 1$).*
- *(iv) Skeptical regime: High-signal firms are funded without monitoring with probability $\kappa_h = \frac{f}{\delta C}$ and denied funding otherwise. Low-signal firms are never funded ($\kappa_\ell = 0$). Bad firms commit fraud with probability $\phi = \frac{1}{\delta}\left(\frac{\mu}{1-\mu}\frac{N_g}{N_b}\gamma - \beta\right)$.*
- *(v) No-Trust regime: firms are never funded ($\kappa_h = \kappa_\ell = 0$) and there is no fraud ($\phi = 0$).*

If $m > \overline{m}$, monitoring is prohibitively expensive, and the investor either rejects the firm or provides unmonitored financing. The five regimes are

[17] The choice depends on whether or not $\widehat{\mu}_\ell(0)$ exceeds $\mu_1(m)$.

analogous to those in Proposition 2. One key difference is that if a regime calls for monitoring when $m \leq \overline{m}$, it calls for denying funding when $m > \overline{m}$. Another key difference is that when $m > \overline{m}$, the critical level μ_{UF} equals μ_2, which does not depend on the monitoring cost m. As a result, the boundaries of the five regimes are constant in m, as can be seen from Figure 3. We will return to the implications of this shortly.

Our next result is a straightforward consequence of Propositions 2 and 3.

Proposition 4. *Both the probability of fraud ϕ conditional on the firm being bad, and the ex-ante probability of fraud $(1-\mu)\phi$ are hump-shaped in the prior μ. There is no fraud for the highest and lowest levels of μ, the Fund-Everything and No-Trust regimes. In the Skeptical regime the probabilities of fraud are increasing in μ, while in the Optimistic regime they are decreasing. In the Trust-Signals regime, the conditional probability is constant, while the ex ante probability is decreasing in μ.*

Figure 4 shows the conditional and *ex-ante* probabilities of fraud. The graphs consist of five parts, corresponding to the five regimes described above. In the *Skeptical* regime, the probabilities increase with μ. High-signal firms are monitored or denied funding with positive probability, low-signal firms with certainty. Thus the investor is indifferent between monitoring (or denying funding to) high-signal firms and funding them without any further information. All else equal, an increase in the prior μ makes the investor strictly unwilling to monitor (or deny funding to) high-signal firms—but then the bad firm would prefer to commit fraud with certainty, worsening the pool of high-signal firms and destroying equilibrium. In equilibrium, the probability of fraud must increase so as to restore balance.

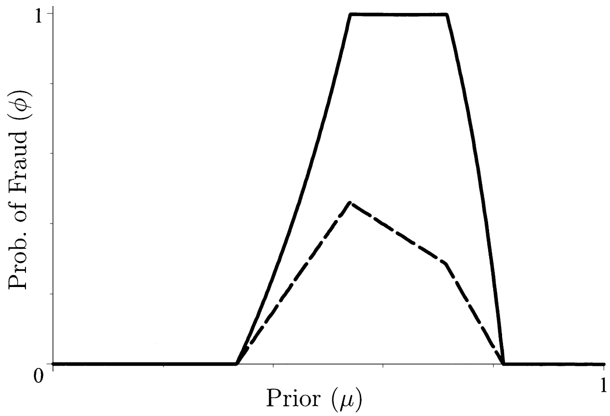

Figure 4
Fraud probability: *ex-ante* (dashed line) and conditional (solid line).

In the *Optimistic* regime, the probability of fraud *decreases* with μ. The investor strictly prefers to fund high-signal firms, and is indifferent between monitoring (or denying funding to) low-signal firms and funding them without further information. Here, an increase in the prior makes the investor strictly prefer to fund low-signal firms without monitoring—but then bad firms would have no reason to commit fraud, worsening the pool of low-signal firms and destroying equilibrium. In equilibrium, the probability of fraud decreases so as to restore balance.

The preceding discussion accounts for the results on the bad firms' conditional probability of fraud ϕ. The results on the *ex-ante* probability of fraud $(1-\mu)\phi$ follow immediately.

The last issue we consider in this section has to do with where fraud is most likely—that is, where the "hump" has its peak. As we discussed following Proposition 2, the region in (μ, m) space where fraud incentives are highest centers around the line given by $\mu = \mu_{UF}$. When monitoring costs exceed $\overline{m}$, so that monitoring is not feasible, this is a vertical line at μ_2, the prior at which the investor is indifferent between not financing the firm and extending unmonitored financing. But this indifference means that the *ex ante* expected net present value of a firm is zero. Thus, when monitoring is not feasible, fraud is most prevalent in "so-so" times.

Matters are very different when monitoring costs are low enough that monitoring is sometimes feasible. In this case, μ_{UF} equals $\mu_3(m)$, which is a downward-sloping line. This means that when monitoring costs fall, the region where fraud is highest shifts towards higher and higher priors. In other words, an association between fraud and "good times" depends on investors being able to monitor, and this association is stronger as monitoring costs are lower.

Finally, although our analysis focuses on how fraud changes as the prior probability that a firm is good changes, we obtain similar results if this prior is held fixed and instead the return of a successful firm, R, changes. It is easy to show that when R is so low that a good firm's net present value N_g is only slightly positive (and so a bad firm's *negative* net present value N_b is large), investors will be cautious even after a high signal. As R increases, eventually investors begin to fund high-signal firms without monitoring, at which point fraud starts to occur; further increases in R lead to the same hump-shaped pattern of fraud that we have already described.[18] Thus, even if one defines "bad times" and "good times"in

[18] Briefly, an increase in R decreases μ_2 and $\mu_3(m)$, and thus μ_{UF} as well. From the definitions of the five regimes preceding Proposition 2, the boundaries of the regimes are all increasing in μ_{UF}. Thus, an increase in R shifts all regimes to the left in (μ, m) space, which means that for a fixed prior μ, the regime "improves."For example, if initially the equilibrium is *No-Trust*, increasing R leads first to the *Skeptical* regime, then to the *Trust-Signals* regime, and so forth.

terms of the expected return to any given firm rather than the relative numbers of good and bad firms, our predictions still hold.

3. Determinants of Fraud

Having established the properties of equilibria in the various regimes, we now turn to the question of how various parameters affect the incidence of fraud. We show that, while certain results are constant across regimes, others depend heavily on whether the regime is *Skeptical* or *Optimistic*. In particular, the *Skeptical* regime is the more intuitive case; here, monitoring discourages fraud, and other parameter effects are as one would expect. By contrast, the *Optimistic* regime is counterintuitive; here, monitoring *encourages* fraud, and several parameter effects are the reverse of what one would expect. We discuss the practical implications of these results. Finally, we discuss how our model's implications are affected by dynamic considerations.

We begin with the comparative statics of the *Skeptical* regime.

Proposition 5. *In the Skeptical regime,*

(i) The equilibrium probability that bad firms commit fraud (ϕ) is increasing in the prior μ, weakly increasing in the cost of monitoring m, and decreasing in the efficacy of fraud δ.

(ii) If the monitoring cost is low ($m \leq \overline{m}$), then the equilibrium probability that high-signal firms are monitored (λ_h) is decreasing in the cost of fraud f and increasing in both the efficacy of fraud δ and in the level of private benefits C. If the monitoring cost is high ($m > \overline{m}$), then the equilibrium probability that high-signal firms are denied funding is decreasing in the cost of fraud f and increasing in both the efficacy of fraud δ and in the level of private benefits C.

The intuition for part (i) of the proposition follows from the effects of parameter changes on the investor's incentives to monitor the pool of firms that generate high signals. An increase in the prior probability that firms are good improves the pool, lowering the investor's incentives to monitor or deny funding. This allows the probability that bad firms commit fraud (ϕ) to increase until equilibrium is restored. An increase in the efficacy of fraud has the opposite effect. Finally, if monitoring costs are sufficiently low ($m \leq \overline{m}$), an increase in the cost of monitoring directly lowers the investor's monitoring incentives, again allowing the probability of fraud to increase. (If $m > \overline{m}$, the investor never monitors, so changes in m have no effect on the probability of fraud.)

The intuition for part (ii) of the proposition is straightforward. The probability of monitoring or funding denial is determined by the bad firm's incentive condition—the point at which it is indifferent between committing fraud and not committing fraud. If the cost of fraud increases, then fraud is less attractive, and less intensive monitoring or less frequent funding denial suffices to deter fraud to the point of indifference. Higher private benefits make getting funded more attractive. Because generating a high signal is the only way that a bad firm has a chance of getting funded, fraud is more attractive, and again more intensive monitoring or funding denial is needed. Finally, if fraud is more effective, the pool of high-signal firms worsens, all else equal, and more intensive monitoring or funding denial is needed to restore balance.

As noted above, the *Skeptical* regime is the intuitive case. The investor's decision about partial monitoring or funding denial focuses on firms with high signals, and fraud gives a bad firm a higher chance of entering this pool and getting funding. This leads to a direct link between the intensity of monitoring or funding denial and fraud incentives. By contrast, the *Optimistic* case is less intuitive. Here, partial monitoring or funding denial focuses on firms with low signals, and fraud gives a bad firm a higher chance of *exiting* this pool by generating a high signal and getting automatic funding. Thus, the link between the intensity of monitoring and fraud incentives is now less direct. This can be seen in the following proposition.

Proposition 6. *In the Optimistic regime,*

- *(i) The equilibrium probability that bad firms commit fraud (ϕ) is decreasing in the prior μ and the efficacy of fraud δ, and weakly decreasing in the cost of monitoring m.*
- *(ii) If the monitoring cost is low ($m \leq \overline{m}$), then the equilibrium probability that low-signal firms are monitored (λ_ℓ) is increasing in the cost of fraud f and decreasing in both the efficacy of fraud δ and in the level of private benefits C. If the monitoring cost is high ($m > \overline{m}$), then the equilibrium probability that low-signal firms are denied funding is increasing in the cost of fraud f and decreasing in both the efficacy of fraud δ and the level of private benefits C.*

As before, part (i) of the proposition follows from the effects of parameter changes on the investor's incentives to tighten funding (i.e., monitor or deny funding, depending on whether or not $m \leq \overline{m}$) for the pool of firms with low signals. An increase in the prior probability that a firm is good increases the fraction of low-signal firms that are good, reducing the investor's incentives to tighten funding. Since a reduction in monitoring or funding denial makes fraud less attractive (bad firms are more likely to be funded even if they get a low signal), the probability of fraud falls until incentives are restored. An increase in the probability that bad firms can generate high signals through fraud (δ) also increases the fraction of low-signal firms that are good, discouraging fraud. Finally, if monitoring costs are sufficiently low ($m \leq \overline{m}$), an increase in the cost of monitoring directly lowers the investor's monitoring incentives, discouraging fraud.

Part (ii) follows from the effects of parameter changes on the bad firm's incentives to commit fraud. The difference is that now, more intensive monitoring or more frequent funding denial decreases the probability that a bad firm with a low signal gets funded, and so tighter funding *encourages* bad firms to commit fraud so as to improve their odds of generating high signals. When fraud is more costly, fraud is less attractive, so more of the low-signal firms are in fact bad firms, and tighter funding is required to restore equilibrium. Conversely, since more effective fraud or higher private control benefits increase the quality of the pool of low-signal firms, looser funding is required to restore equilibrium.

Thus far, we have not addressed the impact of changes in the base signal's precision (i.e., the signal's precision in the absence of fraud). The following proposition shows that an increase in this precision always tends to increase the incidence of fraud.

Proposition 7. *Suppose that the precision of the base signal improves, so that the probability that good firms send high signals (γ) increases, or the base probability that bad firms send high signals (β) decreases, or both.*

(i) In both the Skeptical and the Optimistic regimes, the equilibrium probability that bad firms commit fraud (ϕ) increases.
(ii) The regimes in which fraud occurs expand, encompassing more prior beliefs μ. Specifically, the maximal fraud (Trust-Signals) regime expands, beginning at a lower μ and ending at a higher μ. The Skeptical regime also begins at a lower prior μ, and the Optimistic regime ends at a higher prior μ.

These results follow from the effect of improved signal precision on investor behavior and thus on bad firms' incentives to commit fraud. An increase in the probability that good firms generate high signals improves the pool of firms that have high signals and worsens the pool of firms that have low signals. A decrease in the base probability that bad firms generate low signals has similar effects. All else equal, such a change decreases investors' incentives to monitor or deny funding to high-signal firms and increases their incentives to monitor or deny funding to low-signal firms. This in turn tends to increase bad firms' incentives to commit fraud. Intuitively, a more precise signal means that the bad firm has more chance of generating a bad signal and then losing funding, but more chance of getting funding if it does generate a high signal; this gives it more incentive to try to commit fraud, " noising up" the signal.

In the *Trust-Signals* regime, the change in investor incentives does not affect behavior; investors already fund all high-signal firms and never fund low-signal firms without monitoring, so the fraud incentives of bad firms are already maximized (probability of fraud ϕ equals 1). By contrast, in the *Skeptical* regime, the probability that high-signal firms are funded without monitoring increases; this makes generating a high signal through fraud strictly more attractive, and the probability that bad firms commit fraud increases until equilibrium is restored. Similarly, in the *Optimistic* regime, the probability that low-signal firms are given funding without monitoring decreases; this too makes generating a high signal through fraud strictly more attractive. This explains the results in part (i) of the proposition.

The results in part (ii) follow similar logic. At the outer boundaries of the fraud regimes, improved signal precision introduces a difference in investors' willingness to extend unmonitored funding to high-signal firms versus low-signal firms, creating an incentive for fraud where none previously existed. Similarly, within the *Skeptical* and *Optimistic* regimes, the increase in incentives for fraud expands the set of priors for which these incentives are maximized, expanding the *Trust-Signals* regime. The upshot is that improved signal precision increases both the set of economic conditions under which fraud occurs and the probability with which it occurs.[19]

Of course, our results on signal precision obtain in a very simple setting. In a more complex model, improving signal precision might also make some types of fraud harder to commit, increasing the cost of fraud f. If so, then for some firms or managers, fraud might now be prohibitively costly.

3.1 Implications for the incidence of fraud

Our model predicts that the incidence of fraud is nonmonotonic in μ, the proportion of good firms peaking for high (but not too high) values of μ. We may observe different values of μ across different industries at a given time, or different values over time as a consequence of business cycles.

Consider the Internet and telecoms sectors in the late 1990s. Internet or "dot-com" firms were viewed as "can't miss" opportunities, because of a widespread conviction that much conventional business would migrate to the Internet in a relatively short period of time. Investors were willing to finance many start-ups with untested business models, and to keep providing funds. By contrast, the telecoms sector, though viewed very positively, was not the subject of such strong optimism in the 1990s.[20] There have been few accusations of fraud directed at the Internet firms, but numerous large telecoms firms (including WorldCom, Qwest,

[19] Although our focus is on how increased signal precision increases the incidence of fraud (ϕ), it is worth noting that, overall, bad firms may be more or less likely to get funded. Within a given regime, an increase in γ weakly increases the overall probability that a bad firm is funded, whereas a decrease in β weakly decreases this. If the increase in precision causes a regime shift, however, matters are more complex, because the probability κ_s that a firm with signal s gets unmonitored funding shifts discontinuously.

[20] During the 1990s, telecom firms raised hundreds of billions of dollars for investment, based on optimistic projections of future demand for their services. For discussion of their financing and the frauds which subsequently came to light, see Morgenson (2000, 2002).

Global Crossing, Nortel, and Lucent) have been accused of fraudulent or misleading accounting. This difference is consistent with our model: Internet firms may have fallen into or close to the *Fund-Everything* regime, in which case there was no need to commit fraud, whereas the telecoms may have fallen into the lower *Optimistic* regime, in which case fraud should have been expected.

The nonmonotonicity of fraud with respect to μ is just one example of how many parameter changes have opposite effects depending on whether the fraud regime is *Skeptical* or *Optimistic*. The reason for this is that investors do not monitor to detect fraud *per se*; instead, their goal is to find good investment opportunities and avoid bad ones. In the *Skeptical* regime, investors strictly prefer to be "tough" with low-signal firms (monitor or deny funding), but they are somewhat "looser" with high-signal firms. As a result, changes in parameters affect investors' behavior with high-signal firms but not with low-signal firms. The opposite is true in the *Optimistic* regime: now, investors strictly prefer to fund high-signal firms, but they apply somewhat tougher standards to low-signal firms. In this case, changes in parameters affect investors' behavior with low-signal firms but not with high-signal firms, and so the effects of many parameter changes switch sign. In particular, a change that causes investors to loosen standards for low firms reduces fraud because bad firms see less need for it—why commit fraud when you can get funded without it?

As another example of this nonmonotonicity, consider the impact of a change in the cost of monitoring. Consider again the 1990s. Arguably, as information technology improved, it became easier for analysts and others to "kick the tires". Recall that as the cost of monitoring m decreases, the region where fraud occurs shifts towards better prior beliefs—if during the boom these monitoring efforts were concentrated on firms that were known as poor performers, then perversely, this may have increased the prevalence of fraud.

The comparative statics for other parameters of our model are more intuitive. In particular, the probability of fraud increases with the quality of the free signal (cf. Propositions 5 and 6). If the informativeness of the free signal increases (higher γ, lower β), bad firms have a stronger incentive to add noise to it (by committing fraud); and if fraud is more effective (higher δ), a bad firm can compensate by committing fraud with a lower probability (to achieve the same expected effect).

This has implications for the use of disclosure requirements, and their use as a tool to combat fraud. During the 1990s, the trend was for annual reports to include more and more details, partly in response to stricter demands from the Financial Accounting Standards Board (FASB). In the absence of fraud or misrepresentation, investors could now do a better job of assessing a firm's situation—and so a number of firms began to game the system, in many cases crossing the line into fraud. Thus, tougher disclosure laws may have the perverse effect of increasing fraud.[21] Our results suggest that, to be effective against fraud, disclosure laws must directly make fraud more difficult.

3.2 Implications for investment across the business cycle

We now examine how the possibility of fraud affects the behavior of investors and, in turn, which types of firms get funding. As we will see, these effects depend heavily on the nature of the fraud regime, but in a certain sense the effect of fraud is to amplify the impact of business conditions on firm funding.

First, we note that if fraud is impossible, there are only three regimes: *No Trust*, *Trust Signals*, and *Fund Everything*. Intuitively, once fraud is ruled out, firms no longer have any choice variable to randomize over, so the mixed strategy equilibria—*Skeptical* and *Optimistic*—disappear. A more technical way of seeing this is to take the definitions of the regimes given before Proposition 2 and let the efficacy of fraud δ go to zero. It also follows that the boundaries of the *No-Trust* and *Fund-Everything* regimes are precisely as before, whereas the *Trust Signals* regime expands to take in the two regions in which mixed strategies prevail if fraud is possible. Briefly, removing the possibility of fraud means that investors can now fully rely on a firm's signal without concern that bad firms will try to change the quality of that signal. As a result, even if investors would choose a mixed strategy in the presence of fraud, when fraud is ruled out they choose to fund all high signal firms without monitoring.

Since fraud has no impact in the *No Trust* and *Fund-Everything* regimes, we focus our attention on the impact of fraud on investment in the other regimes. Suppose first that monitoring is not feasible ($m \geq \overline{m}$). With no fraud, we are in a *Trust-Signals* regime where high-signal firms are funded and low-signal firms are not. If the possibility of fraud leads to the *Skeptical* regime, high-signal firms are less likely to be funded, and low-signal firms are still not funded. This unambiguously decreases the number of good firms that get funded. However, it is possible that the number of bad firms that get funded increases; this occurs when $\frac{f}{\delta C}(\beta + \delta) > \beta$, which requires that the increased chance that bad firms generate high signals outweighs the decreased chance that high signals are funded. If the possibility of fraud causes the regime to remain *Trust Signals*, high-signal firms are funded whereas low-signal firms are not. It follows that the number of bad firms funded increases whereas the number of good firms funded does not change. Finally, in the *Optimistic* regime, high signals are funded and low signals now have a chance of being funded. As a result, the number of good firms and bad firms that are funded both increase. Thus, in this case,

[21] Furthermore, as noted above, increased precision does not necessarily reduce the overall probability with which a bad firm is funded, so the overall effect of tougher disclosure on funding efficiency can be mixed.

one can unambiguously say that business cycle effects are amplified: fraud makes investors more stringent in the *Skeptical* regime (despite which more bad firms may be funded), no more stringent in the *Trust Signals* regime, and less stringent in the *Optimistic* regime. Also, as one would expect, more bad firms relative to good firms are funded when there is fraud.

Suppose instead that monitoring is feasible ($m < \overline{m}$). The effects just mentioned continue to hold, but now there is a complicating effect: fraud affects the probability of monitoring, which affects good and bad firms differently—good firms receive funding if monitored whereas bad firms do not. If the possibility of fraud leads to the *Skeptical* regime, again, the number of bad firms funded may increase, but now the number of good firms funded does not decrease—though more good firms are now monitored. If fraud leads to the *Trust-Signals* regime, more bad firms are funded, but the monitoring of low signals may increase because the pool of low signals is of higher quality when there is fraud. If such monitoring increases, more good firms are monitored and funded. Finally, if fraud leads to the *Optimistic* regime, more bad firms are funded, and weakly more good firms are funded; again, the last occurs when the probability of monitoring low signals increases. In summary, once monitoring is feasible, the impact of fraud may be to increase monitoring efforts; if so, this actually helps the good firms get funded. Nevertheless, it remains the case that fraud means that bad firms are more likely to get funded when conditions are good.

3.3 Dynamic considerations

Until now, we have assumed that investors and firms know the prior distribution of firm types without uncertainty. In practice, such priors are likely to be uncertain, since the "true" state of the economy can only be known *ex post*, if at all. Moreover, the true state of the economy is dynamic, which can complicate the inference problems of investors and managers. As suggested in the introduction, these considerations can exacerbate the links between fraud, booms, and busts.

To model these issues in a simple way, we assume that there are two possible true states of the economy, one in which there are relatively many good firms (fraction μ_u of all firms) and one in which there are relatively few good firms (fraction μ_d of all firms, with $\mu_d < \mu_u$). Furthermore, we assume that μ_u falls into the *Fund-Everything* regime, and μ_d falls into the *No-Trust* regime. The true state cannot be observed, and all agents share common beliefs: the probability that the state is μ_u is p_0. It follows that the overall prior that any given firm is good is $\mu = p_0\mu_u + (1 - p_0)\mu_d$.

First suppose that p_0 is low. In this case, the *ex ante* prior μ is low, corresponding to either the *No-Trust* or (low) *Skeptical* regime. Bad firms are unlikely to commit fraud in this case, since even high-signal firms are usually monitored before they are financed. If, *ex post*, the true state of the economy proves to be μ_d, there will be slightly more bad firms than expected, but the overall incidence of fraud will still be low or nonexistent. If, instead, the true state proves to be μ_u, there will be even fewer cases of fraud, funded projects will be relatively successful, and investors' conservatism may seem overblown, as more monitored projects than expected will prove to be good.

Now suppose p_0 is high, so that the *ex ante* prior μ falls within the *Trust-Signals* or *Optimistic* regime. Although bad firms will be committing fraud, if the true state later proves to be μ_u, there will not be many bad firms, and the actual incidence of fraud will be somewhat lower than expected. By contrast, if the true state proves to be μ_d, the numbers of bad firms and fraud cases will be much higher than expected.

If the prior is higher still, of course, the equilibrium will fall into the upper end of the *Optimistic* regime or even the *Fund-Everything* regime. In this case, fraud will be low or nonexistent, even if the state proves to be μ_d, but in this last case many more funded projects than expected will perform poorly.

All of this has taken p_0 as given. In reality, p_0 will arise from investors getting signals from various firms and from some "actual" realizations (e.g., realized cash flows in our model). Note that the presence of fraud slows down updating in both directions: both high and low signals become noisier. Thus, priors will be slower to shift in the "middle," where bad firms are likely to commit fraud. If beliefs begin with a p_0 so high that the regime is *Fund-Everything*, and then some bad realizations of the free signal shift p_0 and thus μ into the *Optimistic* or *Trust-Signals* regime, further updating will be slowed.

If there were no change in the underlying state, then, over time, investor beliefs would find their way to the true state. A more realistic assumption is that there is always some chance that the underlying state governing the returns on new projects can shift—some chance of transitioning from μ_d to μ_u, and another chance of transitioning the other way. If by some chance beliefs do find their way close to one or the other extreme, there will always be some chance that the beliefs are "very wrong" because of a transition. Of course, these transition probabilities limit how high or low p_0 can go, but there is still a chance that beliefs will be heavily weighted towards one extreme or the other, in which case "surprises" of the sort already discussed will still be possible. In particular, once p_0 and thus μ are in the *Optimistic* regime, a period of slow updating from "free" signals (interim results) could be followed either by a reassuring string of high cash flows or a spate of low cash flows that suddenly reveal that the economy is in recession—followed in the last instance by a wave of revelations of fraud.

In short, the agents in an economy may be "surprised" by changes in the economy's fundamentals. Although this notion is not especially surprising, it has strong implications for the incidence and prevalence of fraud across the business cycle. As noted, when times are bad—in terms of our model, in the *No-Trust* or *Skeptical* regimes—positive surprises will lead to lower amounts of fraud than expected. The opposite is true when times are good; now surprises lead to higher-than-expected fraud.

It is also important to note that, in the last case, even fraudulent firms are surprised by the extent of fraud. Although they have private information that they are in bad shape, which is a *somewhat* negative signal for the economy as a whole, this is not the same as knowing that many firms are in bad shape. In a more complex model, this can lead to negative spillovers as firms with weak prospects who see others post high results feel more pressure to do so themselves, precisely because neither they nor investors know whether the others are committing fraud. Something of this sort seems to have happened in the case of WorldCom, whose fraudulent reporting in the 1990s increased the pressure on its rivals [Schiesel (2002)].

4. Fraud Committed by Good Firms

We have assumed that good firms cannot commit fraud. We now discuss this assumption, and what results we would obtain if we relax it. The motivation for the assumption is that investors may discover whether a firm committed fraud. In our model, the detection of fraud itself is of no consequence, since investors will not finance a firm anyway if they know its type is bad. But in a more realistic and more complex model, committing fraud may well be taken as a sign that the firm's management may misbehave in future, and an investor may reject a good firm if there is evidence that the firm committed fraud. This may deter the managers of good firms from committing fraud, in particular if they are easily replaced once their firm is up and running.

On the other hand, even if firms commit the type of fraud that is the focus of our analysis, that does not necessarily imply that investors will worry about future misbehavior. In our model, fraud makes firms look more attractive to investors, but it does not fool investors who monitor before providing funds. Fraud committed by good firms improves the odds that a firm with a high signal is actually a good firm. If it is hard to tell apart good and bad firms, investors may therefore tolerate fraud by good firms: after all, investors care only about making good investments and avoiding bad investments. If investors do not object to fraud committed by good firms, then it is reasonable to expect that other agents in the economy will not object, either. For example, the media may show little interest in such cases, because they do not make spectacular headlines; and regulators and enforcement agencies may show little interest too, because no harm was done.[22]

Nevertheless, it is interesting to explore the consequences of allowing for good-firm fraud. We now provide a sketch of the analysis, which provides three insights about the role of good-firm fraud. First, good and bad firms commit fraud for different reasons: good firms may commit fraud to increase their chances of being monitored instead of being rejected; while bad firms commit fraud to *reduce* their chances of being monitored. Second, good-firm fraud makes the signal more informative and therefore leads to better investment decisions, while bad-firm fraud has the opposite effect. Third, good-firm fraud tends to happen when the economy is in poorer shape than it is when bad-firm fraud is more likely to happen.

To analyze a good firm's incentive to commit fraud, we need to extend our model. Assume that good firms can commit fraud at a cost f', and that fraud increases the probability of a high signal from γ to $\gamma + \delta' < 1$. Given that $\gamma > \beta$, it is reasonable to assume that fraud is less effective for the good firms, that is, $\delta' < \delta$. Also, we assume that $\frac{\delta'}{1-\gamma} < \frac{\delta}{1-\beta}$, which implies that the costless signal is more informative if there is no fraud at all than it is if both types commit fraud with certainty. Finally, we assume that $f' < \delta' C$, since otherwise a good firm would never commit fraud. It can easily be verified that given a signal h or ℓ, the conditional probability of facing a good firm is

$$\widehat{\mu}_h(\phi', \phi) = \frac{\mu(\gamma + \phi'\delta')}{\mu(\gamma + \phi'\delta') + (1 - \mu)(\beta + \phi\delta)}$$

$$\widehat{\mu}_\ell(\phi', \phi) = \frac{\mu(1 - \gamma - \phi'\delta')}{\mu(1 - \gamma - \phi'\delta') + (1 - \mu)(1 - \beta - \phi\delta)},$$

where ϕ' is the probability with which the good firm commits fraud. Notice that $\widehat{\mu}_h(\phi', \phi)$ is increasing in ϕ' and decreasing in ϕ, while $\widehat{\mu}_\ell(\phi', \phi)$ is decreasing in ϕ' and increasing in ϕ (good-firm fraud improves the quality of the costless signal, while bad-firm fraud worsens it).

The two firm types' incentives for committing fraud are not the same. While both may commit fraud to obtain unmonitored funding instead of being rejected, a good firm may also commit fraud in order to induce the investor to monitor (instead of rejecting), which a bad firm would not want; also, a bad firm may commit fraud to induce the investor to provide unmonitored funding instead of monitoring, whereas a good firm is indifferent between the two. Hence, we focus on the case of lower monitoring costs m in what follows, since monitoring affects the two types

[22] The same may be true even if outsiders are unable to observe the firm's type. In this case, they may only punish fraud at firms that subsequently fail, under the same reasoning as above—why punish fraud that has not harmed anyone? Since good firms are less likely to fail than bad firms, good firms again will be less likely to be punished for fraud.

of firm differently and is more likely to happen if m is low. Considering lower values of m also simplifies the analysis considerably, since the various motives for committing fraud can be separated.

Lemma 1. *Define $\overline{\overline{m}}$ implicitly as the value of m which satisfies both $m = N_g \widehat{\mu}_\ell(1,0)$ and $m = N_b\left(1 - \widehat{\mu}_h(1,0)\right)$. If $m < \overline{\overline{m}}$, then in equilibrium, either only bad firms commit fraud, or only good firms commit fraud, or there is no fraud at all.*

If $m < \overline{\overline{m}}$, then the incentives to commit fraud are driven uniquely by the desire to be monitored or not, which is when good and bad firms differ most in their incentives to commit fraud. The two functions that define $\overline{\overline{m}}$ describe pairs (μ, m) for which the investor is indifferent between two alternatives, assuming that only good firms commit fraud ($\phi' = 1$ and $\phi = 0$). The equation $m = N_g \widehat{\mu}_\ell(1,0)$ is equivalent to $\widehat{\mu}_\ell(1,0) = \mu_1(m)$, that is, the investor is indifferent between rejecting and monitoring a firm with a low signal; since $\widehat{\mu}_h(1,0) > \widehat{\mu}_\ell(1,0)$, a firm with a high signal will certainly not be rejected. And $m = N_b\left(1 - \widehat{\mu}_h(1,0)\right)$ is equivalent to $\widehat{\mu}_h(1,0) = \mu_3(m)$, that is, the investor is indifferent between monitoring a firm with a high signal and funding it without monitoring; since $\widehat{\mu}_h(1,0) > \widehat{\mu}_\ell(1,0)$, a firm with a low signal will certainly not be funded without monitoring. It is readily verified that $m = N_g \widehat{\mu}_\ell(1,0)$ is upward sloping and that $m = N_b\left(1 - \widehat{\mu}_h(1,0)\right)$ is downward sloping. If $N_g \widehat{\mu}_\ell(1,0) < m < \overline{\overline{m}}$, the good firm may commit fraud, but the bad firm certainly does not commit fraud (it does not benefit from being monitored, the only alternative outcome to being rejected). And if $N_b\left(1 - \widehat{\mu}_h(1,0)\right) < m < \overline{\overline{m}}$, the bad firm may commit fraud, but the good firm certainly does not commit fraud (it is indifferent between being monitored and obtaining funds without being monitored). Hence, for all pairs (μ, m) below both curves, there is no fraud at all. In sum, good firms commit fraud only if the state of the economy is low enough, and bad firms only if it is high enough.

The next question is under what circumstances good firms will commit fraud. For notational convenience define

$$\overline{\mu}_{GF}(m) = \frac{m(1-\beta)}{m(1-\beta) + \left(1 - \gamma - \delta'\right)\left(N_g - m\right)}$$

$$\underline{\mu}_{GF}(m) = \frac{m\beta}{m\beta + \left(\gamma + \delta'\right)\left(N_g - m\right)},$$

where $\underline{\mu}_{GF}(m)$ is the value of μ such that the investor (assuming that only good firms commit fraud) is indifferent between rejecting and monitoring a firm with a high signal and similarly $\overline{\mu}_{GF}(m)$ is the indifference value of μ conditional on a low signal. For all $m < \overline{\overline{m}}$, if $\mu > \overline{\mu}_{GF}(m)$, the good firm does not commit fraud in equilibrium, so our earlier analysis is not affected if we allow for good-firm fraud. In other words, our earlier analysis carries over to this more general model. Analyzing the good firm's decision is simplified by the fact that good-firm fraud happens only if $\mu \leq \overline{\mu}_{GF}(m)$, that is, if there is certainly no bad-firm fraud.

Proposition 8. *Assume $m < \overline{\overline{m}}$. Then*

(i) if $\mu < \underline{\mu}_{GF}(m)$, the good firm does not commit fraud;
(ii) if $\underline{\mu}_{GF}(m) < \mu < \overline{\mu}_{GF}(m)$, the good firm commits fraud; and
(iii) if $\mu > \overline{\mu}_{GF}(m)$, the good firm does not commit fraud.

For low levels of μ, the investor rejects all firms even if they obtain a high signal, and there is no benefit from committing fraud [case (i)]. For high enough levels of μ, the investor monitors even if a low signal is realized, so a good firm will be financed with certainty and thus gets no benefit from committing fraud [case (iii)]. It is only for intermediate values of μ that the good firm benefits from committing fraud: if the investor monitors only high-signal firms, then fraud helps the good firm because it increases the chances of producing a high signal [(case (ii)], being monitored, and therefore financed.

These results demonstrate that the incentives for committing fraud are very different for the two types of firms. While both may commit fraud in order to improve their chances of obtaining funding without monitoring instead of being rejected, their motives differ when monitoring is involved. Bad firms commit fraud only to increase their chances of obtaining unmonitored funding, instead of being monitored or rejected. Good firms commit fraud to attract attention and be monitored, if the chances of being rejected are sufficiently high. This is quite intuitive, and it provides a reason why investors should not be worried if they discover that a good firm committed fraud to make itself look more attractive to investors. It is also consistent with the result that good-firm fraud tends to happen when the economy is in poorer shape than it is when bad-firm fraud is more likely to happen. Bad-firm fraud happens to noise up the costless signal and to convince investors to fund without monitoring; this happens only in the better states of the economy. In contrast, good firms commit fraud in order to be monitored instead of being rejected, which investors consider as alternatives only in poor states of the economy.

5. Conclusion

We have presented a simple model in which firms commit fraud in order to get funds from investors. Despite its simplicity, the model can motivate several patterns of behavior that are observed in practice and that may seem hard to explain, for example, the high incidence of fraud towards the end of the most recent stock market boom, and the prevalence of fraud in certain industries and its near absence in others.

Our model shows which factors determine whether firms commit fraud or not. One such factor is how carefully investors can be expected to scrutinize the firms in which they may invest. The extent of monitoring, in turn, depends on investors' expectations about the state of the economy, and their expectations about firms' fraud decisions. Our analysis reveals that the incidence of fraud does not always respond as expected to changes in circumstances. While it is natural to assume that improved business conditions lead to less fraud, and reduced costs of monitoring also lead to less fraud, the opposite may be true. Similarly, improvements in the informativeness of publicly available information may have counterintuitive effects, since they may increase the incidence of fraud.

These results were derived using a model with firms seeking funds for their investments, and investors who may trust noisy information or pay for superior information about the firms. The same information structure arises in completely different settings, and our results will apply in these settings, too. For example, labor markets for skilled workers face a similar information problem: employers may trust information that is easily available, such as a worker's resume, or they can make their own costly inquiries; and workers seeking jobs may embellish the details listed on their resume in order to get a better job. Other examples include the used car and the housing markets: buyers may trust their own eyes and experience, or they may hire professional help to discover fatal flaws of what is being offered for sale; and sellers may find that a fresh coat of paint can cover up signs of damage, fooling inexperienced buyers into thinking that they are being offered a house or car of high quality.

Coming back to fraud and investment, our results have implications for public policy: legislators and the media alike have called for new or changed regulation aimed at preventing future waves of fraud. The Sarbanes–Oxley Act was introduced to improve the public disclosure of financial information; the consequence may well be that investors monitor less (instead relying more on the publicly available information), and more firms commit fraud. In other words, the effectiveness of the new constraints that were imposed on businesses to prevent fraud may be more limited than expected, and they may even have unintended consequences. At the same time, our analysis suggests that it is pointless to blame investors for the abuses by arguing that they were careless or naive when making their decisions. Such judgments are easy with the benefit of hindsight; but given the information that was available to investors at the time, it may have been fully rational for them to trust publicly available information in many cases, instead of carefully monitoring firms that requested funds.

Appendix

Proof of Proposition 1. Investing without monitoring dominates not investing iff $V_U > V_N \iff \widehat{\mu} N_g - (1-\widehat{\mu}) N_b > 0 \iff \widehat{\mu} > \frac{N_b}{N_b+N_g}$. Monitoring and investing in the good firm dominates not investing iff $V_M > V_N \iff \widehat{\mu} N_g - m > 0 \iff \widehat{\mu} > \frac{m}{N_g}$. Investing without monitoring dominates monitoring and investing in the good firm iff $V_U > V_M \iff \widehat{\mu} N_g - (1-\widehat{\mu}) N_b > \widehat{\mu} N_g - m \iff \widehat{\mu} > 1 - \frac{m}{N_b}$. Threshold for m: monitoring is dominated if $\widehat{\mu} \leq \frac{m}{N_g}$ and $\widehat{\mu} \geq 1 - \frac{m}{N_b}$; combine $\widehat{\mu} = \frac{m}{N_g}$ and $\widehat{\mu} = 1 - \frac{m}{N_b}$, which yields $1 - \frac{m}{N_b} = \frac{m}{N_g}$, and the definition of $\overline{m}$. ■

Proof of Proposition 2. The cutoffs for the five regimes can equivalently be defined using cutoffs for the posterior beliefs. Recall from Equation (2) that

$$\widehat{\mu}_\ell (0) < \widehat{\mu}_\ell (1) < \widehat{\mu}_h (1) < \widehat{\mu}_h (0).$$

These four cutoffs in the interval [0, 1] define the five regimes, depending on the location of $\mu_3 (m)$ in relation to the four cutoffs (for example, the *Fund-Everything* regime has $\widehat{\mu}_\ell (0) > \mu_3 (m)$).

- The proofs for the *Fund-Everything* and *No-Trust* regimes are straightforward.
- The *Optimistic* regime: $\phi \in (0, 1]$ such that $\mu_3 (m) < \widehat{\mu}_\ell (\phi)$ cannot be an equilibrium. If it was, ℓ signals would not be monitored, so there would be no benefit from committing fraud, i.e. $\phi = 0$. Similarly, $\phi \in [0, 1)$ such that $\mu_3 (m) > \widehat{\mu}_\ell (\phi)$ cannot be an equilibrium. If it was, ℓ signals would be either monitored or rejected, while h signals receive unmonitored financing; so there would be an incentive to increase ϕ. So in equilibrium, the bad firm chooses $\phi \in (0, 1)$ such that with a signal ℓ,

$$V_U = V_M \iff \widehat{\mu}_\ell (\phi) = \mu_3 (m) \iff \phi = \frac{1}{\delta} \left(1 - \beta - (1-\gamma) \frac{\mu}{1-\mu} \frac{m}{N_b - m} \right). \tag{A1}$$

Next, $\kappa_h < 1$ cannot be an equilibrium, since $\mu_3 (m) < \widehat{\mu}_h (\phi)\ \forall \phi$. Therefore, $\kappa_h = 1$ and $\lambda_h = 0$.
$\kappa_\ell = 1$ cannot be an equilibrium. If it was, there would be no incentive for bad firms to commit fraud, and therefore firms with a signal ℓ should not receive unmonitored financing. Similarly, $\kappa_\ell + \lambda_\ell < 1$ cannot be an equilibrium. If it was, ℓ signals would be rejected with positive probability. But that is not optimal for the investor since $\widehat{\mu}_\ell (\phi) = \mu_3 > \mu_1$, i.e. she strictly prefers monitoring an ℓ signal to rejecting it. Next, $\lambda_\ell = 1$, $\kappa_\ell = 0$ cannot be an equilibrium. If it was, bad firms would commit fraud with certainty. So in equilibrium, the investor chooses λ_ℓ and κ_ℓ such that $\lambda_\ell \in (0, 1)$, $\lambda_\ell + \kappa_\ell = 1$, and

$$(\beta + \delta) C + (1 - \beta - \delta) \kappa_\ell C - f = \beta C + (1-\beta) \kappa_\ell C \iff \kappa_\ell = 1 - \frac{f}{\delta C}.$$

- The *Trust-Signals* regime: $\widehat{\mu}_\ell (0) < \widehat{\mu}_\ell (1) < \mu_3 (m) < \widehat{\mu}_h (1) < \widehat{\mu}_h (0)$, so ℓ signals are rejected or monitored while h signals are financed without monitoring. By assumption, $\delta C > f$, so it pays for a bad firm to increase ϕ up to one. Signals ℓ are monitored iff

$$\widehat{\mu}_\ell (1) \geq \mu_1 (m) \iff \frac{\mu}{\mu + (1-\mu) \frac{1-\beta-\delta}{1-\gamma}} \geq \frac{m}{N_g} \iff \mu \geq \frac{\frac{m}{N_g} \frac{1-\beta-\delta}{1-\gamma}}{1 + \frac{\gamma-\beta-\delta}{1-\gamma} \frac{m}{N_g}}.$$

- The *Skeptical* regime: $\phi \in (0, 1]$ such that $\mu_3 (m) > \widehat{\mu}_h (\phi)$ cannot be an equilibrium. If it was, all firms would be either monitored or rejected, and there would be no benefit from committing fraud. Similarly, $\phi \in [0, 1)$ such that $\mu_3 (m) < \widehat{\mu}_h (\phi)$ cannot be an equilibrium. If it was, h signals would receive unmonitored financing, while ℓ signals would be either monitored or rejected, giving bad firms an incentive to increase ϕ. So in equilibrium, the bad firm chooses ϕ such that with a signal h,

$$V_U = V_M \iff \widehat{\mu}_h(\phi) = \mu_3(m) \iff \phi = \frac{1}{\delta}\left(\frac{\mu}{1-\mu}\frac{m}{N_b - m}\gamma - \beta\right). \qquad \text{(A2)}$$

If ϕ is such that $\widehat{\mu}_h(\phi) = \mu_3(m)$, the investor is indifferent between monitored and unmonitored finance for h signals, and she prefers either option to rejecting an h signal; therefore $\lambda_h + \kappa_h = 1$. The investor mixes between monitored and unmonitored finance for h signals, such that a bad firm is indifferent between committing fraud and not:

$$(\beta + \delta)\kappa_h C - f = \beta C \kappa_h \iff \kappa_h = \frac{f}{\delta C}.$$

So $\lambda_h = 1 - \kappa_h = 1 - \frac{f}{\delta C}$. Finally, $\kappa_\ell > 0$ cannot be an equilibrium. If it was, then $\widehat{\mu}_\ell(\phi) \geq \mu_3(m) = \widehat{\mu}_h(\phi)$, contradiction. So bad firms with an ℓ signal cannot expect to get financing at all. In equilibrium, ℓ signals are monitored iff

$$\widehat{\mu}_\ell(\phi) \geq \mu_1(m) \iff \mu \geq \frac{\frac{m}{N_g}}{1 - \gamma\left(1 - \frac{N_b}{N_g}\frac{m}{N_b - m}\right)}.$$

(and rejected otherwise). ■

Proof of Proposition 3.

- The proofs for the *Fund-Everything*, *Trust-Signals* and *No-Trust* regimes are straightforward.
- The *Optimistic* regime: $\kappa_h = 1$ since $\mu_2 < \widehat{\mu}_h(1) < \widehat{\mu}_h(0)$. Next, $\phi = 0$ cannot be an equilibrium. The investor would not finance with a signal ℓ, since $\widehat{\mu}_\ell(0) < \mu_2$. But then a bad would firm prefer to increase ϕ above zero, since $\delta C > f$. Similarly, $\phi = 1$ cannot be an equilibrium. The investor would finance with any signal, so there would be no need to invest f. Next, $\kappa_\ell = 0$ cannot be an equilibrium. All bad firms would commit fraud with certainty, and the investor should then provide unmonitored finance for either signal, since $\mu_2 < \widehat{\mu}_\ell(1)$. Finally, $\kappa_\ell = 1$ cannot be an equilibrium. Bad firms would not commit fraud, and the investor should then reject ℓ signals, since $\widehat{\mu}_\ell(0) < \mu_2$. So the equilibrium must be in mixed strategies for both players. The bad firm chooses ϕ such that with a signal ℓ,

$$\begin{aligned} V_U = V_N \quad &\iff \widehat{\mu}_\ell(\phi) N_g - \left(1 - \widehat{\mu}_\ell(\phi)\right) N_b = 0 \\ &\iff \phi = \tfrac{1}{\delta}\left(1 - \beta - (1-\gamma)\tfrac{\mu}{1-\mu}\tfrac{N_g}{N_b}\right). \end{aligned}$$

  The investor chooses κ_ℓ such that

$$(\beta + \delta) C + (1 - \beta - \delta)\kappa_\ell C - f = \beta C + (1 - \beta)\kappa_\ell C \iff \kappa_\ell = 1 - \frac{f}{\delta C}.$$

- The *Skeptical* regime: $\phi = 0$ can not be an equilibrium. The investor would not finance with a signal ℓ, since $\widehat{\mu}_\ell(0) < \mu_2$. But then a bad would firm prefer to increase ϕ above zero, since $\delta C > f$. Similarly, $\phi = 1$ can not be an equilibrium. If it was, the investor would not finance any firm, so there would be no need to commit fraud. Next, $\kappa_h = 0$ cannot be an equilibrium. No firm would be financed, and therefore bad firms would not commit fraud; but then the investor should finance all h signals, since $\mu_2 < \widehat{\mu}_h(0)$. Finally, $\kappa_h = 1$ cannot be an equilibrium. Bad firms would have an incentive to commit fraud with probability 1; but then the investor should reject all signals, since $\widehat{\mu}_h(1) < \mu_2$. So the equilibrium must be in mixed strategies for both players. The bad firm chooses ϕ such that with a signal h,

$$V_U = V_N \iff \widehat{\mu}_h(\phi) N_g - (1 - \widehat{\mu}_h(\phi)) N_b = 0 \iff \phi = \frac{1}{\delta}\left(\frac{\mu\gamma}{1-\mu}\frac{N_g}{N_b} - \beta\right).$$

The investor chooses κ_ℓ such that

$$(\beta + \delta)\kappa_h C - f = \beta\kappa_h C \iff \kappa_h = \frac{f}{\delta C}. \tag{A3}$$

■

Proof of Proposition 4.

The conditional probabilities are derived in Proposition 2. The *ex-ante* probability of fraud is calculated as $(1-\mu)\phi$ in each regime. ■

Proof of Proposition 5.

Follows immediately from Equation (A2). ■

Proof of Proposition 6.

Follows immediately from Equation (A1). ■

Proof of Proposition 7.

Part (i) follows immediately from Equations (A1) and (A2). Part (ii) follows from an inspection of the regime boundaries as defined in Section 4.2 (immediately before Proposition 2). ■

Proof of Lemma 1.

Consider cases $m < N_g\widehat{\mu}_\ell(1,0)$. Rearrange as $\widehat{\mu}_\ell(1,0) > \frac{m}{N_g}$, which is equivalent to $\widehat{\mu}_\ell(1,0) > \mu_1(m)$. Since $\widehat{\mu}_\ell(\phi',\phi)$ is decreasing in ϕ' and increasing in ϕ, this implies that $\widehat{\mu}_\ell(\phi',\phi) > \mu_1(m)\ \forall\phi',\phi$, i.e., the investor prefers to monitor a firm with a signal ℓ rather than rejecting it. Since $\widehat{\mu}_h(\phi',\phi) > \widehat{\mu}_\ell(\phi',\phi)\ \forall\phi',\phi$, a firm with a signal h will be either monitored or funded without monitoring. So the good firm has no incentive to commit fraud.

Now consider $m < N_b(1 - \widehat{\mu}_h(1,0))$. Rearrange as $\widehat{\mu}_h(1,0) < 1 - \frac{m}{N_b}$, which is equivalent to $\widehat{\mu}_h(1,0) < \mu_3(m)$. Since $\widehat{\mu}_h(\phi',\phi)$ is increasing in ϕ' and decreasing in ϕ, this implies that $\widehat{\mu}_h(\phi',\phi) < \mu_3(m)\ \forall\phi',\phi$, i.e., the investor prefers to monitor a firm with a high signal rather than funding it without monitoring. Since $\widehat{\mu}_h(\phi',\phi) > \widehat{\mu}_\ell(\phi',\phi)\ \forall\phi',\phi$, a firm with a signal ℓ will be either monitored or rejected. So the bad firm has no incentive to commit fraud. ■

Proof of Proposition 8.

(i) This condition is equivalent to $\widehat{\mu}_h(1,0) < \mu_1(m)$, which implies that $\widehat{\mu}_h(\phi',\phi) < \mu_1(m)$ $\forall\phi',\phi$, so even if the good firm commits fraud, the investor rejects all firms; hence, the good firm will not commit fraud in equilibrium. (ii) This condition is equivalent to $\widehat{\mu}_\ell(1,0) < \mu_1(m) < \widehat{\mu}_h(1,0)$, so high signals are monitored and low signals are rejected. The good firm commits fraud if $(\gamma + \delta')C - f' > \gamma C$, which is satisfied given our assumption that $f' < \delta' C$. (iii) Follows from Lemma 1. ■

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