Securities fraud and corporate board turnover: New evidence from lawsuit outcomes

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ABSTRACT

We examine the relationship between outcomes of securities fraud class action lawsuits (SFCAs) and corporate board turnover rates. Our results indicate that turnover rates for board members are higher when a firm settles a lawsuit than when a suit is dismissed. Outside director turnover is most sensitive to SFCA outcomes, perhaps reflecting reputational effects. Results demonstrate that involvement in securities fraud is costly for corporate board members.

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Securities Fraud and Corporate Board Turnover: New Evidence from Lawsuit Outcomes

Introduction

What are the consequences of securities fraud for corporate board members? Most public corporations indemnify board members. Board members rarely pay fines or contribute to settlements out-of-pocket (Black, Cheffins and Klausner (2006)).[1] However, the alignment of the interests of board members with those of shareholders requires that board members bear costs from lax monitoring of management or their implication in the underlying wrongdoing. Despite the attention focused on securities fraud in the wake of the corporate scandals of the past decade, relatively little research has addressed the consequences of securities fraud for corporate directors.

Although directors rarely participate in financial settlements, there may be other costs that directors experience as a result of service on the board of a firm in which a fraud occurs. One cost is the loss of their position on the board of directors of the firm that is named as the defendant in a lawsuit. Board service is a source of income for outside directors. Service on the board of directors of a public company carries with it considerable prestige and may be a source of business connections for an outside director. CEO's typically hold a seat on the board. Other senior managers may also hold directorships. For members of the board that are also employees of the firm, loss of a position on the board of directors typically accompanies dismissal from a top management position.

The primary purpose of this paper is to investigate whether the seriousness of the fraud alleged in a securities fraud lawsuit is related to turnover rates among corporate board members of firms subject to a securities fraud class action (SFCA). If the control systems of a firm impose costs on errant board members, board turnover should be higher when a more serious fraud is discovered than when the underlying wrongdoing was less serious or when there is no wrongdoing at all. One difficulty in this line of research is that whether a fraud actually occurred or not is not directly observable. However, lawsuit outcomes are observable, and settlement amounts and orders dismissing lawsuits can be obtained from court records. A substantial percentage of SFCAs are dismissed.[2] Most of the remainder are settled, and trials are rare. We use this largely-overlooked aspect of private securities law enforcement to build testable hypotheses linking the seriousness of the allegations of fraud to board turnover. Lawsuit outcomes provide useful information concerning the seriousness of the underlying wrongdoing if courts screen out weak cases, granting a defendant's

[1] Two notable exceptions are the Enron and Worldcom settlements. In the Enron matter, ten outside directors personally contributed $13 million to the settlement. In Worldcom, ten former outside directors contributed $18 million to the settlement.

[2] NERA Economic Consulting reports that approximately 40 percent of SFCAs are dismissed (National Economic Research Associates (2007)).

motion to dismiss if a lawsuit does not meet certain pleading requirements. However, in instances in which the underlying wrongdoing is more serious, plaintiffs should be better able to construct a case that will survive a defendant's motion for dismissal. Similarly, among lawsuits that are not dismissed and are eventually settled, the size of the settlement may also reflect the seriousness of wrongdoing.

If lawsuit outcomes reflect the seriousness of the underlying wrongdoing, we expect that lawsuit outcomes would also be correlated with corporate board turnover. However, if case outcomes are unrelated to the strength of the case and are primarily driven by the plaintiff attorneys' ability to extract rents, we should not expect to detect any systematic relationship between SFCA outcome and board turnover. We test our competing hypotheses on the seriousness of allegations by estimating the *difference* in board turnover propensity between firms that are involved in securities fraud lawsuits that are dismissed and those that are not dismissed. We later extend this strategy of measuring seriousness by estimating the relationship between turnover rates and settlement amounts. Our results have a bearing on the large literature on the efficacy of private enforcement of securities laws.[3]

Our main findings are as follows. First, we find that board turnover rates (specifically, the probability that a board member will leave the board within several years) are significantly related to indicators of the seriousness of SFCA allegations. Turnover rates are higher when a lawsuit is settled than when it is dismissed. These effects for outside and inside directors are both statistically significant and economically meaningful, with the probability of departure increased by 14.0% for outsiders and 15.1% for insiders. Although the estimated impact on CEOs is not precisely estimated, their point estimate has a similar magnitude. These findings are consistent with our hypothesis that lawsuit outcomes contain important information about the seriousness of allegations.

Second, our finding that lawsuit settlements and settlement amounts have a significantly larger impact on board turnover, relative to lawsuits that are dismissed, have important implications for future research on the effects of managerial opportunism on corporate accounting, investment and financing choices. Researchers have used securities lawsuits to identify periods in which management caused or knew that the value of a firm's equity was inflated.[4] Conditioning on lawsuit outcomes can provide additional precision in these studies of this sort. Plaintiffs in a SFCA must provide evidence of scienter—that the defendants acted with the knowledge that their conduct was wrong or illegal—to survive a motion to dismiss. One should not expect changes in the aftermath of frivolous

[3] For instance, Porta, Lopez-De-Silanes and Shleifer (2006) find that private enforcement of securities laws facilitates financial market development.

[4] Research utilizing SFCAs to identify periods in which managers knew or caused equity values to be inflated include McTier and Wald (2011)'s study of accounting and investment choices when equity is overvalued, DuCharme, Malatesta and Sefcik (2004) examination of equity issuance and Gong, Louis and Sun (2008) examination of stock-for-stock acquisition decisions.

lawsuits, and any research design utilizing lawsuits as a proxy for managerial opportunism should control for information from lawsuit outcomes.

Third, we find that the observed differences in board turnover rates between settled and dismissed lawsuits remain statistically significant even after we control for abnormal stock returns at the end of the class period. The class period is the period of time during which plaintiffs allege that the price of a security was distorted by fraud. The end of the class period is typically the date on which plaintiffs allege that the true state of the firm was revealed to the marketplace. This finding is consistent with lawsuit outcomes producing valuable information about the extent or wrongdoing, leading to board turnover, that is not publicly available at this event date. This is not surprising, as information on wrongdoing is often slow to emerge, sometimes as a consequence of deliberate legal strategy. As expected, abnormal stock returns at the end of the class period are poor predictors of the outcome of a lawsuit.

Finally, our research design provides a workable methodology for two important empirical issues that are relevant to this line of enquiry: (i) the direction of causality and (ii) benchmarking the control group. For both issues, we provide some innovative ways to circumvent the problems. First, while we find that SFCA outcomes drive director turnover, our result needs to be cognizant of and control for Helland and Sykuta's (2014) finding that board structure may be correlated with SFCA outcomes. We explicitly control for this issue by using a new empirical methodology, Lewbel's special regressor technique, designed to estimate binary outcomes where one or more of the key factors may be binary and endogenous in nature. Our key findings are unchanged after controlling for the possibility of endogeneity.

Much of the previous work on agency costs and fraud relies on the use of matching samples of non-lawsuit control firms. But many of the important predictors of a lawsuit, such as the strength of internal controls, the information content of disclosure policies or the strength of corporate governance, are difficult to quantify. These non-quantifiable firm characteristics may often be correlated with board turnover propensities. Our methodology circumvents some of these issues by evaluating the differential impact of the lawsuit outcome on corporate board turnover. All the firms in our sample have one common characteristic: they have all been sued for alleged fraud via a SFCA. Our estimates highlight the differential impacts of these lawsuits when they have been dismissed versus they were settled. This allows us to reduce the impact of those important but non-measurable firm characteristics that might be important to a firm being sued.

The remainder of the paper proceeds as follows. Section I presents an overview of the literature on the connection between securities fraud and corporate board turnover and contains a more detailed discussion of our hypotheses. Section II discusses the construction of our data and our

modeling approach. Section III provides our findings on board turnover and case outcomes. We then consider the implications of our director-level analysis for the firms in our sample in Section IV, which provides evidence on how corporate board structure changes based on resolution of a securities fraud lawsuit. Section V concludes.

I. Fraud and Corporate Board Turnover

A. Board Turnover and Securities Fraud

Securities laws are intended to promote the informational integrity of capital markets. In the United States, federal and state securities laws provide investors the opportunity to file a lawsuit in the event that they believe that a firm has issued fraudulent or misleading disclosures. The primary federal antifraud provision is the SEC's Rule 10b-5. Rule 10b-5 prohibits the use of any instrumentality of interstate commerce "to make any untrue statement of a material fact or to omit to state a material fact necessary to make the statements made, in light of the circumstances under which they were made, not misleading." Courts have interpreted the law to provide investors that bought or sold securities issued by the firm with a private right of action pursuant to Rule 10b-5.

To the extent that fraud represents a divergence in interests between managers and investors, we expect to see a variety of adjustments to strengthen corporate governance structure following a legal action. Two forms of such adjustments may directly affect corporate board turnover. First, the CEO of the firm and other high-ranking officials may be dismissed or pressured to resign. Pressure to relinquish their position on the board may also be applied to outside directors who were lax in monitoring. We examine the relationship between inside and outside director turnover propensity and indicators of the seriousness of the alleged wrongdoing.

Second, if the fraudulent activities were a result of the divergence between the interests of managers and investors, we expect that SFCAs may prompt a firm to strengthen its governance structures to reduce agency costs. Such modifications may take the form of the placement of additional outside directors on the board. Accordingly, we examine the relationship between indicators of the strength of allegations in a lawsuit and subsequent changes in corporate governance structure after a lawsuit has been filed.

A number of prior studies have examined turnover rates of top executives and directors of firms that allegedly issued fraudulent financial disclosures. Their research designs vary. Much of the prior work has utilized a matching sample design whereby firms experiencing a lawsuit are matched with firms that did not. The construction of a matching sample may be problematic. There are numerous outward signs that plaintiff attorneys may utilize to determine whether to file an action including firm characteristics, such as the quality of disclosure or internal controls, that are difficult

to quantify. In our work, we examine only firms that exhibited *ex ante* indications of fraudulent behavior that were serious enough to prompt the filing of a complaint. By conditioning on lawsuit outcome, we are able to separate firms on the basis of the strength of the evidence of fraudulent behavior that is uncovered in the litigation process.

Prior work suggests that securities fraud has a negative impact on CEO careers. Strahan (1998) finds evidence of higher rates of CEO turnover among firms that are named as defendants in a SFCA than among a set of randomly selected firms that experienced a decline in stock price of at least 15 percent that did not experience a lawsuit. Niehaus and Roth (1999) also find higher rates of CEO turnover among lawsuit firms that among industry-matched firms that experienced large stock price drops. A single large stock price drop is only one factor that may be considered by a plaintiff attorney in determining whether to file an action. Our research design sidesteps these complications by selecting only firms that experienced a lawsuit and conditioning on lawsuit outcome as a measure of the seriousness of the underlying wrongdoing. Indeed, we find that the size of the stock price drop at the end of the class period of a SFCA has little predictive power when we condition turnover propensity on both suit outcome and price decline. We also extend the results of Strahan (1998) and Niehaus and Roth (1999) by examining the impact of management entrenchment on the likelihood of CEO dismissal among defendant firms.

Both Strahan (1998) and Niehaus and Roth (1999) examine cases filed in the period before the enactment of the Private Securities Litigation Reform Act (PSLRA) of 1995. The PSLRA instituted a number of procedural reforms intended to reduce the incidence of frivolous litigation. This included increasing the standards of proof required to file an action and placing control of the litigation in the hands of the plaintiff with the largest stake in the outcome, usually an institutional investor. As a result of changes in the law, one would expect SFCAs with higher merit to be filed. As such, results from studies based on data from the pre-PSLRA period may not provide an indication of the relationship between fraud and governance today.

The results of prior work on the impact of fraud on turnover rates of outside directors is less clear. Fich and Shivdasani (2007) report no evidence of abnormally high turnover rates among the outside directors of firms that are named as defendants in a SFCA.[5] Because they do not condition own-firm turnover rates on lawsuit outcome, their sample contains a number of actions that are ultimately dismissed. These SFCAs are likely to involve less serious underlying frauds or no wrongdoing at all. As a result, the inclusion of low-merit actions tends to bias their results against finding a relationship between fraud and turnover. Agrawal, Jaffe and Karpoff (1999) find little evidence of

[5] Fich and Shivdasani (2007) and Helland (2006) examine the effect of lawsuit involvement on the total number of directorships held by outside directors of defendant firms. Their results differ. Fich and Shivdasani (2007) report a decline in outside board seats while Helland (2006) finds an increase in the number of seats on other boards held by outside directors of defendant firms.

change in governance structure after a firm is accused of fraud. They examine a variety of different types of actions, most of which are not securities fraud lawsuits. Our research design examines the differences in turnover rates of outside directors between actions with high merit (i.e., strong indications of actual wrongdoing) versus low merit (i.e., weak indications of actual wrongdoing).

B. Governance Mechanisms and Board Turnover

We also examine the relationship between board turnover propensity and the strength of governance systems. Shleifer and Vishny (1986) show that ownership of a sufficiently large block of shares may provide sufficient incentives for a blockholder to expend resources in monitoring. Here we apply their intuition to the case of disciplinary measures applied to directors when there are indications that a firm may have issued fraudulent or misleading financial disclosures. If the presence of blockholders results in better monitoring and greater application of disciplinary measures, we expect that directors' turnover propensities will be more closely related to the seriousness of wrongdoing when ownership is more concentrated than when ownership is more diffuse.

Our research design is similar to that of Kang and Shivdasani (1995) and Denis, Denis and Sarin (1997). These two studies examine the sensitivity of top management turnover to firm performance as a function of ownership structure. Both sets of authors find that top management turnover propensity is more closely tied to stock price performance when outside blockholders control a larger portion of the shares of the firm. Here we examine the sensitivity of turnover to our measure of the seriousness of the underlying wrongdoing. Our proxy for seriousness is the outcome of the lawsuit. If concentrated equity ownership mitigates agency problems, we expect that turnover will be more sensitive to the outcome of the action among firms with concentrated ownership structures than among firms with diffuse ownership structures. Our measure of external equity ownership concentration is the percentage of shares held in outside blocks of 5% or more.

II. Sample Selection and Methodology

A. Sample and Data Definitions

We examine the consequences of securities fraud for board members of large public companies. Our sample consists of U.S. firms that are either (i) members of the S&P 1500 or (ii) had assets in excess of $500 million (adjusted for inflation to year 2000 dollars) that were named as defendants in a SFCA between January 1, 1996 and December 31, 2003.[6] We limit our analysis to actions filed in 1996 or later to ensure that all actions in the sample are subject to the procedural requirements of the 1995

[6] Because we are interested in the impact of fraud on board members, we eliminate firms that were named as a defendant in a SFCA in the previous three years. The application of this screen minimizes the likelihood that observed turnover would be due to earlier alleged frauds.

PSLRA. We obtain data on case characteristics, filing dates and case outcomes from RiskMetrics, a provider of research on securities disputes to institutional investors, from filings appearing on the website of the Stanford Securities Class Action Clearinghouse and from Lexis/Nexis.

Our sample consists of firms that are named as defendants in a SFCA under the SEC's Rule 10b-5. Rule 10b-5 is the primary antifraud provision in the federal securities laws. We classify actions as settled or dismissed based on the status of the action as of January 2009. Ten actions are dropped because they were still being litigated in January 2009.[7] Table I summarizes the distribution of the actions in our sample by year filed and outcome. Of the 333 actions in our sample, 140 were dismissed and 193 were settled by January 2009. The number of actions in our sample exceeds the number of firms because two firms were involved in actions filed more than three years apart.

We examine turnover events for corporate board members over a four-year period. The timing is based on the dates of annual meetings. We use the index T to designate event time. T=0 is defined as the date of the annual meeting that immediately precedes the filing of the lawsuit, while T=1 is the first annual meeting following the filing of the lawsuit. We focus on annual meeting dates because the annual meeting typically defines the beginning and ending date of the term of a board member. A member is considered to be seated on a board if he or she retains a seat on the board or is elected to the board at an annual meeting. Members that do not stand for reelection or resign on or before the date of the annual meeting are considered to have departed from the board.

We collect board structure data as of the close of each annual meeting from T=0 to T=4.[8] We define directors as insiders or outsiders based on their affiliation with the firm as of date T=0. Inside directors include all directors that are employed by the firm or are former employees. All other directors are considered to be outsiders.

Approximately three years elapse between T=1 and T=4. We examine turnover over a period of at least three years for two reasons. First, the litigation process in the typical SFCA evolves over a number of years. The filing of the action is only the first step. A SFCA typically involves a lengthy period of fact discovery and the resolution of many procedural motions before an action is finally resolved. As a result, it may take some time before the strength of the allegations and likely outcome of the action become apparent to the litigants and the court.

[7] We also repeat our tests with active actions pooled with the set of settled actions and also by pooling active actions with the set of dismissed actions. Neither treatment of the active actions had a material impact on our results.

[8] We examine proxy filings for each annual meeting date from T=−1 to T=4. For some firms, we are unable to locate board composition for meetings at T=1, T=2 or T=3 because they were in the process of reorganization. We replicate all of the analysis in this paper omitting these firms. The omission of firms with missing proxy data in years T=1 through T=3 does not have a material effect on our results. To ensure that board composition data reflects the composition of the board during the time that the alleged wrongdoing occurred, we require that the action be filed no more than a year after the last annual meeting to ensure that governance data collected from the proxy filing for the meeting at T=0 reflects the governance structure of the firm. Otherwise, a firm is dropped from our sample.

Second, some firms in our sample have staggered boards. The choice of a four-year analysis period ensures that the term of every director in the sample will expire on at least one occasion between the SFCA filing date and the end of our analysis period.[9] In the event that a sample firm did not file a proxy for T=4, the firm is dropped from the sample. This restriction eliminates firms that either were liquidated or merged prior to the end of the analysis period.[10]

We control for director-level demographic and ownership characteristics that may affect turnover propensity. We define Age as the age of the director as of T=0 and Tenure as the number of years of board service at T=0.[11] Voting Share is the percentage of votes at the annual meeting that are controlled by a director. Table II contains summary statistics on our director-level variables by type of director. Biographical information is available for 3,164 directors seated on the boards of defendant companies as of the annual meeting at T=0. The sample includes 2,364 outside and 800 inside directors, who may be further divided into CEOs and non-CEOs.[12]

Table III contains sample statistics for firm level data. Among the 193 settled SFCAs, the average settlement was approximately $90 million, or 2.91% of the total assets of the defendant firm prior to the filing of the SFCA.[13] The strength of the allegations put forth by plaintiffs may vary with the type of wrongdoing alleged. We examine complaints, news reports and company disclosures to determine the nature of the allegations.[14] SFCAs are classified into those that involve (i) restatements; (ii) technical violations of GAAP accounting and (iii) other allegations. Prior work has documented higher turnover among board members and top management following the issuance of restatements (Srinivasan (2005); Desai, Hogan and Wilkins (2006); Agrawal and Chadha (2005)). The Restatement indicator variable is set to one if the allegations concern a financial restatement. We construct an indicator variable Other GAAP which is set to one if the complaint alleges a technical violation of GAAP.[15] In general terms, in actions involving restatements or misapplication

[9] Staggered boards typically involve terms of no more than three years. The term of every director serving on the board of sample firms at the time an action is filed expired by the end of our observation period.

[10] As a result our sample does not include some of the more prominent firms involved in securities actions. Neither Enron nor WorldCom are part of our sample, as these firms did not file a proxy for T=4. It may be the case that instances in which the defendant firm is delisted in the period following the SFCA represent more severe disclosure violations. If so, the sample in this study would represent less egregious violations, which would tend to bias our analysis against finding any relationship between SFCA involvement and turnover.

[11] As the relationship between age and turnover propensity is nonlinear, we construct indicator variables for ages 61–65, 66–70, 70+; less than 61 years old at T=0 is the excluded class.

[12] The number of CEOs in our sample is smaller than the number of firms as some firms were conducting a search for a new CEO at T=0. In addition, there is one case in which the firm had co-CEOs. In this instance, both individuals are included in our set of CEOs.

[13] In some cases plaintiffs reach a separate settlement with other defendants such as auditors or underwriters. In such cases we add the amount of the settlements with other defendants to the settlement amount with the defendant corporation.

[14] We obtain complaints from the Stanford Securities Class Actions Clearinghouse. Multiple complaints may be filed in a class action. We collect data on allegations from a consolidated complaint if available. If not, we examine each complaint file and consider an allegation to be part of an action if any one complaint mentions a particular type of allegation.

[15] Our definition of the controls for type of allegation were chosen to capture the specificity of the accounting issues

of GAAP, it is more likely that plaintiffs will be able to provide objective evidence that the firm's financial disclosures were incorrect than in actions involving allegedly false forecasts or failure to disclose a material fact. Actions involving restatements and GAAP violations are more common among settled SFCAs than among dismissed SFCAs.

Large blockholders are generally viewed as having greater incentives to expend efforts to monitor management and the board than individual shareholders (Shleifer and Vishny (1986)). Blockholdings measure the proportion of shares controlled by outside holders of 5% or more of the outstanding shares. Our measure of outside blockholdings includes all shares that are held in 5% blocks by independent parties. The percentage of shares held by 5% outside blockholders is greater for settled actions. Table III also contains sample averages of the composition of the board of directors. Board size and composition are similar for the settled and dismissed cases in our sample.

The turnover propensities of inside and outside directors may also be influenced by the stock price performance of the firm (Warner, Watts and Wruck (1988), Yermack (2004)). We control for performance using the cumulative abnormal return of the defendant firm's equity net of the CRSP Value Weighted index. We form the cumulative abnormal return over a 24-month period ending on the last month before the SFCA was filed. This measure of firm performance appears in all of our specifications of turnover propensity.[16] Firm performance among firms with settled actions is worse than among the firms with dismissed actions. As discussed in greater detail in Section **??**, we also examine the short-term abnormal returns at the end of the class period of a SFCA. The class period is the period during which the plaintiffs allege that fraudulent or misleading disclosures by the defendant firm have caused its securities to be mispriced. Typically, the end-of-class-period date is the date on which plaintiffs allege that the true condition of the firm was revealed to the market. Results for the average abnormal returns in the five-day window centered on the end-of-class-period date appear in Table III.[17] The average abnormal return does not significantly differ between the settled and dismissed SFCAs.

B. Constructing Measures of the Seriousness of Underlying Wrongdoing

We hypothesize that fraud is costly to corporate board members. Actual frauds should be more costly than instances in which indicators of fraud turn out to be weak. As discussed above, court

laid out in the complaint. Restatements provide *prima facie* evidence that there were problems with a firm's financial statement disclosures and an indication that the information restated was material. In contrast, if the complaint only alleges a GAAP violation, it remains to be shown whether the financial statements were in error and whether the information was material.

[16] We also examine other specifications of firm performance including the specification of the performance window as the 24 month period ending on the month that the lawsuit was filed. The alternative specifications did not have a qualitative effect on our parameter estimates.

[17] We considered shorter and longer windows for abnormal returns around the end-of-class-period date; results of using these alternate measures of market reaction did not yield qualitative differences.

records in SFCAs typically remain sealed and few cases go to trial. Whether a fraud actually occurred is not directly observable to the researcher. Therefore, we infer the strength of the allegations of wrongdoing based on the outcome of the action. We construct two variables which should be correlated with the seriousness of the underlying wrongdoing.

The first variable is the outcome of the lawsuit. All else equal, we expect that if there is stronger evidence of actual wrongdoing then it should be easier for plaintiffs to construct a case that will survive a motion to dismiss. Therefore, we expect that actions that are eventually settled would involve more serious frauds than actions that are dismissed. The second variable is the amount of the settlement in the action. All else equal, where there are stronger indications of wrongdoing, defendants should be less willing to seek to resolve the matter through a trial. This places plaintiffs in a stronger bargaining position. Therefore, when there are stronger indications of wrongdoing, the settlement amount should be larger than when there are weaker indications. We examine a measure of settlement size: the amount of the settlement relative to the total assets of the defendant firm prior to the date that the action was filed.

A measure of seriousness based on case outcomes has certain advantages over indicators of wrongdoing commonly used in the literature. The SEC has a high threshold for evidence before it undertakes an action. In contrast, in our sample, we have lawsuits that vary in strength, with weaker lawsuits being dismissed while stronger cases are presumably settled. Another advantage of the use of the outcome of SFCAs as a measure of seriousness of the underlying wrongdoing is that if the lawsuit is not dismissed, it is resolved through a financial settlement, and the amount of the settlement is publicly disclosed. Only in rare instances does the settlement also involve a non-financial component such as a change in governance or disclosure practices. Thus, the size of the settlement may also provide a metric for the seriousness of wrongdoing. In contrast, derivative actions and SEC enforcement actions often involve non-financial as well as financial remedies (Ferris, Jandik, Lawless and Makhija (2007)). The presence of non-financial remedies in derivative and SEC actions makes it difficult to utilize their outcomes to distinguish between cases that were likely to involve more serious violations. However, as we discuss below, our empirical methodology also must take account of potential endogeneity between directors' departures and the case outcome.

A number of caveats concerning our analysis are in order. First, we examine the relationship between indicators of the strength of the allegations and board turnover for SFCA lawsuits in general. Our results cannot be applied to any particular firm or lawsuit. It would be necessary to examine the circumstances and evidence to ascertain the reasons for board departures in any particular case. Second, as we point out, turnover events following a SFCA may also arise as a result of board members' concerns for their reputation of satisfying their fiduciary responsibilities. Board

members of firms involved in a SFCA may voluntarily leave to avoid the stigma of involvement with a firm experiencing a SFCA. Thus, some level of turnover may be due to reputational considerations. These findings on board turnover are consistent with our primary hypothesis that corporate board turnover is affected by disciplinary measures applied to corporate directors.

C. Empirical Methodology

Although the scope of our sample, including only firms who have been faced a SFCA lawsuit, allows us to avoid modeling the likelihood of being sued, it raises issues of endogeneity. Helland and Sykuta (2005) examine several different stages of the litigation process, and find that the progression and potential resolution of a shareholder lawsuit is related to board composition. Given those findings, we must ensure that our 'Suit Settled' measure is not merely reflecting reverse causality from suit outcome to director departure. This is a challenging task in terms of the estimation methodology, as standard control-function techniques for instrumental variables estimation of a model with a binary outcome do not deliver consistent estimates where the endogenous explanatory variables are also binary measures.[18]

To resolve this problem, we have employed Lewbel's 'special regressor' estimation method, which has been specifically devlsed to address this situation. A thorough discussion of the econometric issues is presented in Lewbel, Dong and Yang (2012), and summarized in the online Technical Appendix. In contrast to maximum likelihood estimation methods, we need not make a specific distributional assumption on the error process, which may exhibit heteroskedasticity of unknown form. In Lewbel's method, a 'special regressor' is designated as a component of the model with its coefficient normalized to unity. A special regressor with significant kurtosis is advantageous; in our application, we have used the ratio of the logarithm of shares outstanding to the logarithm of total assets, both evaluated at T=0, as the special regressor.

We have applied the special regressor estimation method in all empirical results, taking the indicator variables related to settlement of the lawsuit and scaled settlement amount in fourth quartile as endogenous. We have employed a set of excluded instruments to provide identification. As Helland and Sykuta's findings suggest, our findings based on the special regressor method, taking account of potential endogeneity of the lawsuit outcome, differ from those derived assuming those variables are predetermined.

For each corporate director in our sample at T=0, we seek to explain whether they remain on the board of directors at T=4 or depart from the board during that four-year period: a binary outcome. To model this outcome, we estimate a binary outcome model using the special regressor

[18] See, for instance, Stata's documentation of the `ivprobit` and `ivlogit` commands.

method at the director level:

$$D = I(X\beta + V + \varepsilon \geq 0)$$

where $I(\cdot)$ is the indicator function, X contains the explanatory variables, V is the special regressor and ε is the error term. The set of explanatory variables includes measures of lawsuit outcome and attributes, director characteristics and a set of firm controls.

Marginal effects from binary outcome models are often reported based on the mean values of the independent variables. These are the so-called marginal effects at the mean or MEM. An alternative estimation procedure is to first compute the marginal effect at each observation and then determine the average marginal effect (or AME) over the set of observations. Cameron and Trivedi (2005) and Bartus (2005) recommend the use of the AME instead of the MEM. Bartus points out that the MEM may result in nonsensical results if the sample mean is at a location that is unreasonable or if the underlying distribution of the independent variables is skewed. Ownership and corporate governance variables often exhibit a skewed distribution. Therefore, in all tabulated results, we present the average marginal effects (AMEs) of each of the explanatory variables by computing the change in each director's predicted probability of departure from the board arising from a one-unit change in the explanatory variable. For an indicator variable Z, the change in predicted probability is computed by comparing the value with Z=0 to the value with Z=1. The change in predicted probability is computed for each director and averaged over observations to produce an estimate of the average marginal effect of the explanatory variable. The average marginal effects in our results are computed from the average index function proposed by Lewbel et al. (2012). Estimated standard errors are computed from 25 bootstrap replications.

We first present two sets of estimated models: for outside directors in Table V, and for inside directors and CEOs, in Table VI. These results provide baseline measures of the importance of case characteristics on the probability of director turnover. Finally, Table VII presents findings regarding changes in board structure for two measures of the seriousness of lawsuits.

III. Director Turnover and the Seriousness of the Underlying Violation

A. Outside and Insider Director Turnover Propensities

We partition our sample of board members into outside board members and inside board members. Outside and inside board members serve different roles. Outside members serve a monitoring and advisory role. Outsiders bring to the board the benefit of employment, experience and information gathered from outside of the firm. Inside board members, both current and former employees of the firm, are more attuned to developments and information generated from within the firm. Inside board members who are current employees of the firm also have responsibility for the oversight and

management of the firm's operations or financial reporting practices and the monitoring of actions of junior-level employees. Overall responsibility for the affairs of the firm is the charge of the CEO who usually holds a seat on the board of directors.

We hypothesize that turnover rates for both outside and inside directors are increasing in the seriousness of the underlying violation. Outside director turnover may be voluntary. An outside director of an firm that is named as a defendant in a SFCA may leave the board in order to preserve the value of her human capital in the market for corporate directors (Fama and Jensen (1983)). Helland (2006) and Fich and Shivdasani (2007) find conflicting evidence concerning the impact of SFCAs on the value of directors' reputations. Outside directors may also depart from the board of a firm named as a defendant in a SFCA out of concern for the additional burdens associated with the lawsuit and the underlying wrongdoing. If there are clear indications of wrongdoing, the board may form a committee of outside directors to conduct an investigation. Time spent on the supervision of internal investigations or dealing with the demands of litigation places an additional burden on outside directors.

Outside director turnover may also be impacted by discipline applied by external monitors such as large blockholders and institutional investors (Denis et al. (1997)). Both the reputation and disciplinary hypotheses imply that turnover rates should be increasing in measures of severity of the underlying violation.

B. Unconditional Measures of Turnover Rates

Table IV presents annual retention rates of inside and outside directors of firms subject to a SFCA. The retention rate is defined as the proportion of directors that were seated on the board at T=0 that remain on the board of directors as of subsequent annual meeting dates. We report the number of directors remaining and retention rates by the outcome of the action. Panel A contains retention rates for outside directors. Of the 2,364 outside directors in our sample that were seated on the board of sample companies as of the annual meeting prior to the filing of the SFCA, 1,358 remained on the board at the fourth annual meeting following the SFCA filing. As of T=4, the retention rate for outside directors in dismissed SFCAs of 61% is significantly higher than the 55% retention rate when the SFCA is settled. We report the p-value of a two-tailed t-test for differences in retention rates between dismissed and settled actions.

Panel B of Table IV reports retention rates for inside directors. Of the 800 inside directors in our sample, 349 remain on the board at T=4. Retention rates differ substantially by the outcome of the SFCA. Retention rates are 13 percentage points lower for inside directors of firms that settle a SFCA than for inside directors of firms in which the SFCA is dismissed: a statistically significant

difference. Retention rates for inside directors who hold the title of CEO are reported in Panel C of Table IV. The difference in unconditional retention rates of CEOs is significantly different at the 1% level. The unconditional CEO retention rate is 16% lower for CEOs of firms with settled SFCAs than for firms in which the SFCA is dismissed.

The results in Table IV indicate that the difference in retention rates for all categories of directors appears first in the period that the action is filed. That is, retention rates between T=0 and T=1 are significantly higher for outside directors, inside directors, and CEOs of firms subject to actions that are dismissed than for firms in which the SFCA is settled. Most SFCAs are not resolved for several years after the action is filed. Among sample actions, the median time to settle an action is 38 months and the median time to dismissal is 20 months. Fewer than 1% of settlements and 7% of dismissals occur within a year of the date a case is filed. Thus, observed turnover between T=0 and T=1 is not a result of the outcome of the legal process. Rather, elevated turnover rates among outside directors between T=0 and T=1 are consistent with the application of disciplinary measures to directors associated with lax monitoring or with directors' concerns over reputational damage and the added burden of the litigation. Elevated turnover rates for inside directors and CEOs between T=0 and T=1 are also consistent with the application of disciplinary measures to managers and insiders who are responsible, by omission or commission, for the underlying wrongdoing. Our finding that the difference in turnover rates appears before the outcome of the legal processes become known is consistent with the findings of Karpoff, Lee and Martin (2008) for public (SEC) enforcement.

C. Turnover Rates and the Seriousness of Wrongdoing: Outside Directors

Following the methodology described in Section II, we estimate the determinants of the likelihood of the departure of outside directors. We use a model of director turnover, or $\Pr[departure]$, where the dependent variable is an indicator for the director departing from the board between T=0 and T=4. The model controls for director-level and firm-level characteristics and several case-specific characteristics: in particular, a measure of the outcome of the lawsuit. We report the average marginal effects (AMEs) from our model of director turnover.[19]

Table V presents our results for outside directors. For comparison, the first column displays a model in which two characteristics of the lawsuit (Restatement of financials and Other GAAP violations) are included without any measure of SFCA outcome. It is evident that cases involving restatements are associated with a higher probability of departure than those involving other allegations of fraud. Among the director-level characteristics, longer board tenure is associated with lower turnover probabilities, while the departure probability is increasing in directors' age.

[19]The number of outside directors reported in these models is smaller than that reported in Table II, as the special regressor method trims and winsorizes the sample.

Turning to the second column, where lawsuit outcome is added to the specification, we find that settled SFCAs are associated with a 14.0% increase in the departure probability, *ceteris paribus*. Given that the average board has approximately seven outside directors at T=0, this corresponds to an additional one outside director departures per board for settled actions. This result contrasts with that of Fich and Shivdasani (2007) who report no abnormal outside director turnover among firms experiencing a SFCA. An important difference between these studies is that we condition on the outcome of the SFCA while Fich and Shivdasani (2007) compare turnover rates for a set of firms subject to SFCAs with baseline turnover rates reported in the literature. Turnover rates are higher among firms with restatements (Srinivasan (2005)). However, the outcome of the lawsuit is also significant. This indicates that while accounting system failures appear to be related to outside director turnover, the factors that give rise to financial reporting problems—whether the reporting failure was a result of fraud—are also important in determining turnover propensities of outside directors.

In column 3, we examine the robustness of our findings using an alternative measure of the seriousness of the allegations: an indicator that the financial settlement amount, scaled by the firm's total assets, was in the top quartile of scaled settlements. This indicator variable assigns all other cases (lower-value settlements as well as dismissed cases) a value of zero. This settlement-based measure is highly significant. Departure rates are 9.4% higher when a SFCA is in the top quartile in terms of settlement amount relative to assets. These results support the hypothesis that a SFCA settled for a trivial amount may have no real effect on corporate board turnover.

D. Turnover Rates and the Seriousness of Wrongdoing: Inside Directors

The first two columns of Table VI contain the average marginal effects for the departure probability of inside directors: directors who are current or former employees of the firm.[20] Current and former employees have greater access to information concerning the inner workings of the organization. They may also have had management or oversight responsibility for the areas within the firm where the alleged wrongdoing may have occurred.[21] Column 1 again reports a model in which lawsuit outcome is omitted. We find that the other two lawsuit characteristics have strong positive effects on the probability of departure. When the lawsuit outcome is added to that specification in column 2, the case characteristics lose significance, and the coefficient for 'Suit Settled' is positive and significant, with a similar magnitude to that for outside directors. However, it should be noted that the correlations of 'Suit Settled' with the restatement and other GAAP indicators are 0.19 and

[20]The number of inside directors reported in these models is smaller than that reported in Table II, as the special regressor method trims and winsorizes the sample.

[21] We do not have a prior expectation on whether lawsuit outcome has a larger effect for insider directors than outside directors. Inside directors have greater access to information and may have direct responsibility for the alleged fraud or supervision. However, inside directors typically have larger ownership interests and more firm-specific human capital than outside directors and therefore have less incentive and ability to sever ties with the firm.

0.05, respectively, so that lawsuit outcome is not merely proxying for those factors.

E. Turnover Rates and the Seriousness of Wrongdoing: CEOs

A SFCA may have a different impact on inside directors depending on their role in the firm. CEOs are typically viewed as having primary responsibility for the management of the affairs of the firm and for monitoring the actions of subordinates. We expect that CEO turnover would be particularly sensitive to the outcome of a SFCA. Other inside directors play either a subordinate or advisory role for the CEO and other board members. We partition our set of inside directors into those holding the title of CEO as of the last annual meeting preceding the filing of the SFCA and other inside directors. Note that the number of CEOs is slightly smaller than the number of firms in our sample. In nine cases, firms were engaged in the search for a CEO at the time that the SFCA was filed.[22] As we have for other types of directors, we define a turnover event as an instance in which the CEO at T=0 no longer serves on the board of directors at T=4. Results for the CEOs in our sample are presented in columns [3] and [4] of Table VI.

In both models, an increase in the CEO's voting share reduces departure probability, as does strong firm performance, although these coefficients cannot be precisely estimated. SFCAs involving restatements of financials are associated with higher probabilities of CEO departure. The case outcome measure has a positive point estimate, but lacks statistical significance. with negative point estimates, are not significantly related to the probability of CEO departure. Positive abnormal returns and the absence of other GAAP violations are more important factors in predicting CEO departure from the board.

F. Robustness of Turnover Findings to Time Period Studied

A potential critique of our empirical methodology is that our measure of director departure begins with T=0, the annual meeting preceding the filing of the SFCA. This meeting date could be almost one year before the filing date, or it could be one day before the filing date. When the latter condition holds, and our baseline measure of board membership is very close to the date at which the suit is filed, one could argue that some turnover related to the alleged fraud may have already taken place. To evaluate the robustness of our findings, we consider an alternate definition of the starting date of the turnover period. Rather than defining the base date as T=0, the date of the annual meeting immediately preceding the filing of the action, we define the base date (T=−1) as the previous annual meeting. We then examine turnover propensities between T=−1 and T=4 by fitting the models reported in Tables V and VI to that longer period.[23] The use of the longer observation period starting with T=−1 did not have a qualitative impact on our results. Therefore,

[22] The number of CEOs directors reported in these models is smaller than that reported in Table II, as the special regressor method trims and winsorizes the sample.

[23] These results are omitted for brevity, but are available on request from the authors.

we feel confident that defining the baseline measure at T=0 adequately captures lawsuit-related turnover.

IV. Change in Board Structure

Prior work on corporate litigation has provided mixed results on whether firms take measures *ex post* to improve corporate governance. Agarwal et al. (1999) find little evidence of a change in governance structures following accusations of fraud. In contrast, Ferris et al. (2007) find that the firms named as defendants in derivative lawsuits increase the proportion of board seats held by outsiders. They also find that firms that settle actions increase the level of board independence relative to firms whose actions are dismissed. Desai, Hogan and Wilkins (2005) find that firms involved in SEC investigations increase the proportion of outside directors on their board of directors relative to a control sample.

We examine two indicators of movement towards improved governance: board independence and board size. The level of board independence has been associated with the strength of corporate governance (Weisbach (1988); Rosenstein and Wyatt (1990), Byrd and Hickman (1992)). Smaller board size has also been associated with stronger oversight and improved decision making (Yermack (1996)). To the extent that the commission of a fraud represents a failure of the corporate governance mechanism, we expect that in instances where there are stronger indications that a serious fraud has occurred, firms would take greater measures to strengthen corporate governance. This may take the form of increased board independence or a reduction in board size.

We evaluate changes in board structure using two measures of the seriousness of the underlying wrongdoing. In Panel A of Table VII, we partition the sample by SFCA outcome. In Panel B we partition the sample into cases that resulted in large settlements and all other cases, settled or dismissed. We define a large settlement as a settlement in the top quartile in terms of settlement amount relative to the total assets of the firm (Scaled Settlement in Q4). We measure changes in board composition between T=0 and T=4.[24] In addition to differences within each group of cases, we also test for differences in the amount of the change in board composition between firms with more and less serious wrongdoing.

The results indicate that there is little connection between case outcome and the change in board size in the years following a lawsuit. These findings contrast with those of Ferris et al. (2007) who find a larger decrease in board size among firms in which a derivative action is terminated against

[24] The differences between the two samples are not driven by broader changes in corporate governance practices such as the enactment of Sarbanes–Oxley restrictions. The timing of the initiation of settled suits in our sample is not significantly different from the timing of the initiation of the dismissed suits. The average date of the initiation of the sample lawsuits that are settled or ongoing differs from the average date of initiation of dismissed suits by only 90 days.

management than when it is terminated in favor of management. The average board size in Panel A decreases slightly among firms with both settled and dismissed SFCAs. Panel B indicates that firms that experience more serious frauds, in terms of the scaled settlement amount, increase board size by an inconsequential amount, while other firms decrease board size between T=0 and T=4. The first set of p-values tests for significant changes over time, while the second p-value tests the hypothesis that the change among settled (large scaled settlement) lawsuit firms is the same as the change among dismissed (other) firms. These changes in board size are generally not distinguishable from one another along either the time dimension or across SFCA outcomes.

Turning to board independence, gauged by the percentage of the board comprised of outside directors, we see marked changes. For both settled and dismissed cases, the percentage increases by over five points between T=0 and T=4. The difference is even larger for large-scaled-settlement cases, rising from 69% to almost 78%. These increases over time are statistically significant for all four categories of firms in Panels A and B. The increase for large-scaled-settlement cases is statistically distinguishable (at the 10% level) from that for other firms, representing a stronger movement towards greater board independence among firms in which there are stronger indications of serious wrongdoing. This is consistent with the hypothesis that, following the discovery of fraud, firms undertake measures to improve the functioning of corporate governance mechanisms. Our results on board independence are consistent with the findings of Ferris et al. (2007) and Desai et al. (2005) for derivative actions and SEC enforcement actions.

Finally, we consider the percentage of directors who are new: those seated at T=4 who were not members of the board at T=0. There is a sizable and statistically significant difference between that statistic for settled-SFCA firms (49%) and for dismissed-SFCA firms (40%). The difference is even more striking when we compare, in Panel B, the statistic for large-scaled-settlement firms (60%) and all other firms (43%). This aspect of the change in board composition, reflecting the departure rates of outside and inside directors over the four-year time span modeled above, supports the hypothesis that the outcome of SFCAs has important effects on director turnover. In the most egregious cases of fraud, companies have brought in substantially more 'new blood' over the years following the lawsuit and its costly resolution.

V. Conclusions

Whether the strength of allegations in securities fraud lawsuits is associated with any observable change in corporate governance has been the subject of considerable controversy. Critics argue that the outcomes of SFCAs are unrelated to the seriousness of the wrongdoing and these lawsuits primarily serve as rent extraction mechanisms for plaintiffs' attorneys. An examination of the role of the strength of allegations of wrongdoing on corporate governance faces serious hurdles. The

merit of such a lawsuit is not directly observable, very few lawsuits are resolved through trial, and the court records remain sealed.

We provide an innovative approach to examine the impact of fraud on corporate board turnover. We argue that the outcome of a securities fraud lawsuit is an indicator of the seriousness of the alleged wrongdoing. We hypothesize that lawsuits that are settled for monetary damages will be associated with larger changes in corporate governance than lawsuits that are dismissed. We evaluate the change in corporate governance by examining the turnover among members of the board of directors in the period following the filing of a SFCA, using an innovative econometric approach to deal with issues of endogeneity.

The turnover rates for board members are higher when a lawsuit is settled relative to those that are dismissed. These effects for outside and inside directors are both statistically significant and economically meaningful, with the probability of departure increased by 14.0% for outsiders and 15.1% for insiders. Although the estimated impact on CEOs is not precisely estimated, their point estimate has a similar magnitude. These results support the view that firms act to impose sanctions on those individuals associated with fraudulent activities.

Our findings have important implications for future research in this area. We find that indicators of the *strength* of allegations—both the outcome of the lawsuit and the scaled settlement amount, if settled—are important determinants of corporate board turnover. We also find that market reactions to the revelation of the information about wrongdoing are poor predictors for the outcome of the lawsuit. The importance of lawsuit outcome suggests that studying firms facing SFCAs without controlling for lawsuit outcomes will dilute the true scope of the association between class action lawsuits and corporate board turnover.

References

Agrawal, A. and Chadha, S. (2005), 'Corporate governance and accounting scandals', *Journal of Law & Economics* **48**(2), 371–406.

Agrawal, A., Jaffe, J. F. and Karpoff, J. M. (1999), 'Management turnover and governance changes following the revelation of fraud', *Journal of Law & Economics* **42**(1), 309–342.

Bartus, T. (2005), 'Estimation of marginal effects using margeff', *Stata Journal* **5**(3), 309–329.

Benish, M. D. (1999), 'Incentives and penalties related to earnings overstatments that violate GAAP', *The Accounting Review* **74**(4), 425–457.

Black, B., Cheffins, B. and Klausner, M. (2006), 'Outside director liability', *Stanford Law Review* **58**(4), 1055–1160.

Blundell, R. W. and Powell, J. L. (2004), 'Endogeneity in Semiparametric Binary Response Models', *Review of Economic Studies* **71**(3), 655–679.

Byrd, J. W. and Hickman, K. A. (1992), 'Do outside directors monitor managers? Evidence from tender offer bids', *Journal of Financial Economics* **32**(2), 195–221.

Cameron, C. and Trivedi, P. (2005), *Microeconometrics: Methods and Applications*, Cambridge University Press, Cambridge.

Dechow, P. M., Sloan, R. G. and Sweeney, A. P. (1996), 'Causes and consequences of earnings manipulation: An analysis of firms subject of enforcement actions by the SEC', *Contemporary Accounting Research* **13**(1), 1–36.

Denis, D. J., Denis, D. K. and Sarin, A. (1997), 'Ownership structure and top executive turnover', *Journal of Financial Economics* **45**(2), 193–221.

Desai, H. A., Hogan, C. and Wilkins, M. (2005), 'Restoring trust after fraud: Does corporate governance matter?', *The Accounting Review* **80**(2), 539–561.

Desai, H. A., Hogan, C. and Wilkins, M. (2006), 'The reputational penalty for aggressive accounting: Earnings restatements and management turnover', *The Accounting Review* **81**(1), 83–112.

DuCharme, L. L., Malatesta, P. H. and Sefcik, S. E. (2004), 'Earnings management, stock issues, and shareholder law suits', *Journal of Financial Economics* **71**(1), 27–49.

Fama, E. F. and Jensen, M. C. (1983), 'Separation of ownership and control', *Journal of Law & Economics* **26**(2), 301–325.

Ferris, S. P., Jandik, T., Lawless, R. M. and Makhija, A. (2007), 'Derivative lawsuits as a corporate governance mechanism: Empirical evidence on board changes surrounding filings', *Journal of Financial and Quantitative Analysis* **42**(01), 143–165.

Fich, E. M. and Shivdasani, A. (2007), 'Financial fraud, director reputation, and shareholder wealth', *Journal of Financial Economics* **86**(2), 306–336.

Gong, G., Louis, H. and Sun, A. X. (2008), 'Earnings management, lawsuits, and stock-for-stock acquirers' market performance', *Journal of Accounting and Economics* **46**(1), 62–77.

Helland, E. (2006), 'Reputational penalties and the merits of class-action securities litigation', *Journal of Law & Economics* **49**(2), 365–395.

Helland, E. and Sykuta, M. (2005), 'Who's monitoring the monitor? Do outside directors protect shareholders' interests?', *Financial Review* **40**, 155–172.

Kang, J.-K. and Shivdasani, A. (1995), 'Firm performance, corporate governance, and top executive turnover in Japan', *Journal of Financial Economics* **38**(1), 29–58.

Karpoff, J. M., Lee, D. S. and Martin, G. S. (2008), 'The consequences to managers for financial misrepresentation', *Journal of Financial Economics* **88**(2), 193–215.

Lewbel, A. (2000), 'Semiparametric qualitative response model estimation with unknown heteroscedasticity or instrumental variables', *Journal of Econometrics* **97**(1), 145–177.

Lewbel, A., Dong, Y. and Yang, T. (2012), 'Viewpoint: Comparing features of convenient estimators for binary choice models with endogenous regressors', *Canadian Journal of Economics* **45**(3), 809–829.

McTier, B. C. and Wald, J. K. (2011), 'The causes and consequences of securities class action litigation', *Journal of Corporate Finance* (in press).

National Economic Research Associates (2007), Recent trends in shareholder class actions, Technical report, NERA.

Niehaus, G. and Roth, G. (1999), 'Insider trading, equity issues and CEO turnover in firms subject to securities class actions', *Financial Management* **28**(4), 52–72.

Porta, R. L., Lopez-De-Silanes, F. and Shleifer, A. (2006), 'What works in securities laws?', *Journal of Finance* **61**(1), 1–32.

Rosenstein, S. and Wyatt, J. G. (1990), 'Outside directors, board independence, and shareholder wealth', *Journal of Financial Economics* **26**(2), 175–191.

Shleifer, A. and Vishny, R. W. (1986), 'Large shareholders and corporate control', *Journal of Political Economy* **94**(3), 461–488.

Srinivasan, S. (2005), 'Consequences of financial reporting failure for outside directors: Evidence from accounting restatements and audit committee members', *Journal of Accounting Research* **43**(2), 291–334.

Strahan, P. (1998), Securities class actions, corporate governance and managerial agency problems, Research Paper 9816, Federal Reserve Bank of New York.

Warner, J. B., Watts, R. L. and Wruck, K. H. (1988), 'Stock prices and top management changes', *Journal of Financial Economics* **20**(1-2), 461–492.

Weisbach, M. S. (1988), 'Outside directors and CEO turnover', *Journal of Financial Economics* **20**(1-2), 431–460.

Yermack, D. (1996), 'Higher market valuation of companies with a small board of directors', *Journal of Financial Economics* **40**(2), 185–211.

Yermack, D. (2004), 'Remuneration, retention, and reputation incentives for outside directors', *Journal of Finance* **59**(5), 2281–2308.

Table I: **Securities Fraud Class Actions**

This table reports the year filed and the outcome of the 333 securities class actions in our sample. Actions are classified as settled or dismissed based on the status of the action as of January 2009.

	Outcome		
Year Filed	Dismissed	Settled	Total
	No.	No.	No.
1996	4	3	7
1997	8	27	35
1998	12	25	37
1999	24	29	53
2000	20	26	46
2001	19	23	42
2002	32	47	79
2003	21	13	34
Total	140	193	333

Table II: **Director-Level Variables**

This table reports sample means of the characteristics of outside directors, inside directors and CEOs of the 333 sample firms. Date T=0 is the date of the last annual meeting prior to the date that the lawsuit was filed. Demographic characteristics, voting strength and audit committee membership status were obtained from the proxy filing for the annual meeting at T=0. Inside directors are directors that are employees or former employees of the firm. All other directors are classified as outside directors. *Departed* is an indicator variable which is set to 1 if a director does not serve on the board through T=4, the fourth annual meeting after the suit is filed, and 0 if the director continues to serve on the board at T=4. Variable *age* is the age of the director as reported in the last proxy prior to the date the action was filed. Variable *board tenure* is the length of a director's board service in years as of the last proxy before the action is filed. Variable *voting share* is the percentage of votes controlled by a director relative to the total number of votes eligible to be cast at the annual meeting.

Variable	Outside Directors	Inside Directors	CEOs	Non-CEO Insiders	
	[1]	[2]	[3]	[4]	N
Observations (N)	2364	800	325	475	3164
Outcome					
Departed (0/1)	0.426	0.564	0.538	0.581	3164
Demographics					
Age (Years)	59.074	53.326	52.403	53.958	3164
Board Tenure (Years)	6.552	9.011	8.895	9.091	3164
Voting Share (%)	0.630	3.093	4.251	2.302	3164

Table III: **Firm-Level Variables**

This table reports sample means of characteristics of the firms that are defendants in a class action lawsuit for violation of SEC Rule 10(b)-5. Actions are classified as settled or dismissed based on the status of the action as of January 2009. Variable *settlement amount* is the dollar amount of settlements in the 193 actions resulting in a settlement. Variable *total assets* is the total assets of the firm at the end of the last fiscal year prior to the filing of the action. Variable *settlement amount as a % of total assets* is *settlement amount* divided by *total assets*. Variable *restatement* is 1 if the action concerns a restatement and 0 otherwise. Variable *other GAAP* is 1 if the action involves a technical violation of GAAP accounting and 0 otherwise. Variable *institutional holdings* is the percent of common shares held by institutions unaffiliated with the firm. Variable *board seats* is the total number of directors elected or continuing to serve on the board as of the annual meeting immediately preceding the date the action was filed. Variables *insider seats* and *outsider seats* are the number of inside and outside directors elected or continuing to serve on the board as of the annual meeting preceding the date the action was filed. Variable *two-year firm performance* is the cumulative abnormal return on equity, net of the return on the CRSP value-weighted index, in the two years ending in the month before the action was filed. Variable *abnormal returns ECP [-2,+2]* is the abnormal return, net of the CRSP value-weighted index with dividend reinvestment, in a five-day window centered on the date of the end of the class period. P-values represent a two-tailed test for differences in sample means between dismissed and settled actions.

Variable	Dismissed Actions	Settled Actions	All Actions	P-value: Difference in Sample Means	
				t-test	Mann–Whitney
	[1]	[2]	[3]	[4]	[5]
Number of Actions	140	193	333		
Settlement Amount (million $)		89.536			
Settlement Amount as % of Total Assets		2.906			
Total Assets (billion $)	26.438	14.539	19.542	0.200	0.401
Allegations					
Restatement (0/1)	0.143	0.306	0.237	0.001	0.000
Other GAAP (0/1)	0.393	0.575	0.498	0.001	0.001
Ownership Structure					
Institutional Holdings (%)	64.582	59.717	61.735	0.038	0.016
Board Structure					
Board Seats	9.643	9.399	9.502	0.485	0.259
Insider Seats	2.457	2.363	2.402	0.526	0.333
Outsider Seats	7.186	7.036	7.099	0.663	0.306
Performance and Market Reaction					
Two-Year Firm Performance	0.141	-0.073	0.017	0.031	0.006
Abnormal Returns ECP [-2,+2]	-0.228	-0.241	-0.235	0.590	0.370

Table IV: **Outside and Inside Director Retention Rates**

Retention rates for outside directors, inside directors and CEOs. Date T=0 is the date of the annual meeting that immediately precedes the filing of the SFCA. Retention rate is defined as the proportion of directors seated on the board of the firm as of the annual meeting immediately preceding the filing of the action that continue to serve on the board at year T. N at T=0 is the number of directors of a given type elected to or continuing to serve on the board at the annual meeting immediately preceding the date the action was filed. N at T=1 through T=4 is the number of those directors that continue to serve on the board. P-values represent a two-sided test for a difference in retention rates between dismissed and settled actions.

Panel A: Outside Directors

	Dismissed Actions		Settled Actions		p-value
Year	Number Directors	Retention Rate	Number Directors	Retention Rate	
0	1006	100.00	1358	100.00	
1	892	88.67	1135	83.58	0.000
2	776	77.14	964	70.99	0.001
3	681	67.69	840	61.86	0.003
4	615	61.13	743	54.71	0.002

Panel B: Inside Directors

	Dismissed Actions		Settled Actions		p-value
Year	Number of Directors	Retention Rate	Number of Directors	Retention Rate	
0	344	100.00	456	100.00	
1	292	84.88	319	69.96	0.000
2	229	66.57	247	54.17	0.000
3	202	58.72	207	45.39	0.000
4	175	50.87	174	38.16	0.000

Panel C: CEOs

	Dismissed Actions		Settled Actions		p-value
Year	Number	Retention Rate	Number	Retention Rate	
0	135	100.00	190	100.00	
1	118	87.41	129	67.89	0.000
2	99	73.33	105	55.26	0.001
3	89	65.93	86	45.26	0.000
4	75	55.56	75	39.47	0.004

Table V: **Outside Director Turnover Probability: Special Regressor Method**

Special regressor method estimates from a model of the average marginal effects on turnover probability of outside directors between T=0 and T=4. Outside directors include all directors seated on the board as of the last annual meeting preceding the lawsuit who are not employees or former employees. T=0 is the date of the annual meeting that immediately precedes the filing of a lawsuit for alleged violation of SEC Rule 10(b)-5. T=4 is the date of the fourth annual meeting after the suit is filed. The dependent variable, *departed*, is set to 1 if a director does not serve on the board through T=4, and 0 if the director continues to serve on the board at T=4. The *suit settled* variable is set to 1 if a lawsuit is settled and 0 if it is dismissed. The coefficient of the suit settled variable measures the difference in director turnover propensity between settled and dismissed suits. A positive coefficient indicates the marginal impact on director turnover was higher in settled suits relative to suits that were dismissed. The other measure of suit outcome, *scaled settlement amount in Q4*, is a binary variable equal to 1 if the dollar value of the settlement, scaled by the assets of the firm, is in the top quartile and 0 otherwise. Model [1] excludes any measure of suit outcome. All models include a set of year indicators. Cluster-robust standard errors are in parentheses. Superscripts ***, ** and * indicate significance at the 0.01, 0.05 and 0.10 levels.

	No Outcome Measures	Lawsuit Outcome	Large Settlements Relative Size
	[1]	[2]	[3]
Director characteristics:			
Age 61-65 (0/1)	0.006	0.000	0.007
	(0.027)	(0.017)	(0.021)
Age 66-70 (0/1)	0.278	0.052	0.058
	(0.029)***	(0.031)*	(0.025)**
Age >70 (0/1)	0.418	0.069	0.055
	(0.040)***	(0.041)*	(0.038)
Log(Board Tenure)	-0.032	-0.046	-0.050
	(0.015)**	(0.018)**	(0.019)***
Voting Share (%)	0.002	-0.023	-0.022
	(0.003)	(0.008)***	(0.008)***
Firm characteristics:			
Log(Total Assets)	0.016	0.054	0.050
	(0.007)**	(0.018)***	(0.011)***
Firm Performance	-0.022	0.004	-0.008
	(0.014)	(0.010)	(0.012)
Outside Blockholdings	0.000	0.001	0.001
	(0.001)	(0.001)*	(0.001)
Case characteristics:			
Restatement of financials (0/1)	0.069	-0.020	0.004
	(0.027)**	(0.026)	(0.020)
Other GAAP (0/1)	-0.006	0.014	0.024
	(0.025)	(0.021)	(0.020)
Ab.Ret. End Cls Per [-2,+2]	-0.089	-0.020	-0.019
	(0.057)	(0.036)	(0.047)
Suit Settled (0/1)		0.140	
		(0.070)**	
Scaled settlement in Q4 (0/1)			0.094
			(0.054)*
Number of Observations	2078	2078	2016

Table VI: **Inside Director and CEO Turnover Probability: Special Regressor Method**

Special regressor method estimates from a model of the average marginal effects on turnover probability of inside directors and CEOs between T=0 and T=4. Inside directors include all directors seated on the board as of the last annual meeting preceding the lawsuit who are employees or former employees of the firm. Directors classified as CEOs are individuals with the title of CEO seated on the board as of the last annual meeting preceding the filing of a lawsuit. T=0 is the date of the annual meeting that immediately precedes the filing of a lawsuit for alleged violation of SEC Rule 10(b)-5. T=4 is the date of the fourth annual meeting after the suit is filed. The dependent variable, *departed*, is set to 1 if a director does not serve on the board through T=4, and 0 if the director continues to serve on the board at T=4. The *suit settled* variable is set to 1 if a lawsuit is settled and 0 if it is dismissed. The coefficient of the suit settled variable measures the difference in director turnover propensity between settled and dismissed suits. A positive coefficient indicates the marginal impact on director turnover was higher in settled suits relative to suits that were dismissed. Models [1] and [3] exclude any measure of suit outcome. All models include a set of year indicators. Cluster-robust standard errors are in parentheses. Superscripts ***, ** and * indicate significance at the 0.01, 0.05 and 0.10 levels.

	Insiders	Insiders	CEOs	CEOs
	[1]	[2]	[3]	[4]
Director characteristics:				
Age 61-65 (0/1)	-0.001	-0.007	0.028	-0.068
	(0.056)	(0.044)	(0.094)	(0.057)
Age 66-70 (0/1)	-0.041	0.034	0.069	-0.251
	(0.079)	(0.090)	(0.235)	(0.197)
Age >70 (0/1)	0.189	0.107	-0.200	-0.019
	(0.105)*	(0.086)	(0.292)	(0.106)
Log(Board Tenure)	-0.009	-0.014	0.011	-0.003
	(0.023)	(0.019)	(0.038)	(0.022)
Voting Share (%)	-0.013	-0.008	-0.015	-0.011
	(0.003)***	(0.006)	(0.004)***	(0.005)**
Firm characteristics:				
Log(Total Assets)	0.013	0.047	0.014	0.043
	(0.011)	(0.023)**	(0.017)	(0.025)*
Firm Performance	-0.052	-0.002	-0.043	-0.026
	(0.022)**	(0.022)	(0.030)	(0.019)
Outside Blockholdings	-0.000	0.001	-0.003	-0.004
	(0.001)	(0.001)	(0.002)*	(0.002)**
Case characteristics:				
Restatement of financials (0/1)	0.167	-0.001	0.269	0.010
	(0.044)***	(0.039)	(0.067)***	(0.068)
Other GAAP (0/1)	0.096	0.000	0.088	-0.088
	(0.042)**	(0.040)	(0.064)	(0.035)**
Ab.Ret. End Cls Per [-2,+2]	0.028	0.079	-0.044	0.173
	(0.089)	(0.062)	(0.147)	(0.081)**
Suit Settled (0/1)		0.151		0.169
		(0.080)*		(0.145)
Number of Observations	735	735	301	301

Table VII: **Change in Board Structure**

Mean values of board structure variables as of T=0, the annual meeting preceding the filing of the lawsuit, and T=4, the fourth annual meeting following the filing of the lawsuit. Panel A partitions the sample of SFCAs into those that are settled and those that are dismissed. Panel B partitions the sample of SFCAs into those settled actions for which the ratio of settlement amount to total assets is in the top quartile of all actions. The change in number of directors and percentage of outside directors is the difference in the mean value of these two board structure variables between T=0 and T=4. P-value is the significance of a two sided t-test for difference in the mean values of board structure variables between T=0 and T=4. *P-value of equal change* is the significance of a test for differences in the difference between T=0 and T=4 between the two sample partitions in Panels A and B.

	T=0	T=4	Change	P-value: Change=0	P-value: Equal change
Panel A					
Number of Directors					
Settled	9.399	9.130	-0.269	0.094	0.917
Dismissed	9.643	9.400	-0.243	0.218	
Percentage of Outside Directors					
Settled	72.859	78.416	5.557	0.000	0.735
Dismissed	73.927	79.056	5.129	0.000	
Percentage of New Directors					
Settled		48.908	9.460	0.000	
Dismissed		39.449			
Panel B					
Number of Directors					
Q4 Scaled Settlement	8.020	8.102	0.082	0.773	0.201
Other	9.757	9.440	-0.317	0.021	
Percentage of Outside Directors					
Q4 Scaled Settlement	69.353	78.010	8.657	0.000	0.054
Other	73.990	78.802	4.811	0.000	
Percentage of New Directors					
Q4 Scaled Settlement		59.160	16.683	0.000	
Other		42.476			

Technical Appendix (for online publication)

Researchers often want to estimate a binomial response, or binary choice, model where one or more explanatory variables are endogenous or mismeasured. A linear 2SLS model, equivalent to a linear probability model with instrumental variables, is often employed, ignoring the binary outcome. Several alternative approaches exist:

- linear probability model (LPM) with instruments
- maximum likelihood estimation
- control function based estimation
- 'special regressor' methods

Each of these estimators has advantages and disadvantages. We focus on a particular disadvantage of the LPM, and propose a straightforward alternative based on 'special regressor' methods Lewbel (2000), Lewbel et al. (2012). We also propose the average index function (AIF), an alternative to the average structural function (ASF; Blundell and Powell (2004)), for calculating marginal effects.

We define D as an observed binary variable: the outcome to be explained. Let X be a vector of observed regressors, and β a corresponding coefficient vector, with ε an unobserved error. In a treatment model, X would include a binary treatment indicator T. In general, X could be divided into X^e, possibly correlated with ε, and X^0, which are exogenous.

A binary choice or 'threshold crossing' model estimated by maximum likelihood is

$$D = I(X\beta + \varepsilon \geq 0)$$

where $I(\cdot)$ is the indicator function. This latent variable approach is that employed in a binomial probit or logit model, with Normal or logistic errors, respectively. Although estimation provides point and interval estimates of β, the choice probabilities and marginal effects are of interest: that is, $\Pr[D = 1|X]$ and $\partial \Pr[D = 1|X]/\partial X$.

Linear probability models

In contrast to the threshold crossing latent variable approach of a binomial probit or logit model, the linear probability model (LPM) assumes that

$$D = X\beta + \varepsilon$$

so that the estimated coefficients $\hat{\beta}$ are themselves the marginal effects. With all exogenous regressors, $E(D|X) = \Pr[D = 1|X] = X\beta$.

If some elements of X (possibly including treatment indicators) are endogenous or mismeasured, they will be correlated with ε. In that case, an instrumental variables approach is called for, and we can estimate the LPM with 2SLS or IV-GMM, given an appropriate set of instruments Z.

As the LPM with exogenous explanatory variables is based on standard regression, the zero conditional mean assumption $E(\varepsilon|X) = 0$ applies. In the presence of endogeneity or measurement error, the corresponding assumption $E(\varepsilon|Z) = 0$ applies, with Z the set of instruments, including the exogenous elements of X.

An obvious flaw in the LPM is that the error ε cannot be independent of *any* regressors, even exogenous regressors, unless X consists of a single binary regressor. This arises because for any given X, ε must equal either $1 - X\beta$ or $-X\beta$, which are functions of all elements of X.

The other, well recognized, flaw in the LPM is that its fitted values are not constrained to lie in the unit interval, so that predicted probabilities below zero or above one are commonly encountered. Any regressor that can take on a large range of values will inevitably cause the LPM's predictions to breach these bounds.

Maximum likelihood estimators

A maximum likelihood estimator of a binary outcome with possibly endogenous regressors can be implemented for the model

$$\begin{aligned} D &= I(X^e\beta_e + X^0\beta_0 + \varepsilon \geq 0) \\ X^e &= G(Z, \theta, e) \end{aligned}$$

which for a single binary endogenous regressor, $G(\cdot)$ probit, and ε and e jointly Normal, is the model estimated by Stata's `biprobit` command.

Like the LPM, maximum likelihood allows endogenous regressors in X^e to be continuous, discrete, limited, etc. as long as a model for $G(\cdot)$ can be fully specified, along with the fully parameterized joint distribution of (ε, e).

Control function estimators

Control function estimators first estimate the model of endogenous regressors as a function of instruments, like the 'first stage' of 2SLS, then use the errors from this model as an additional regressor in the main model. This approach is more general than maximum likelihood as the first stage function can be semiparametric or nonparametric, and the joint distribution of (ε, e) need not be fully parameterized.

To formalize the approach, consider a model $D = M(X, \beta, \varepsilon)$, and assume there are functions G, h and a well-behaved error U such that $X^e = G(Z, e), \varepsilon = h(e, U)$, and $U \perp (X, e)$.

We first estimate $G(\cdot)$: the endogenous regressors as functions of instruments Z, and derive fitted values of the errors e. Then we have

$$D = M(X, \beta, h(e, u)) = \widetilde{M}(X, e, \beta, U)$$

where the error term of the $\widetilde{M}$ model is U, which is suitably independent of (X, e). This model no longer has an endogeneity problem, and can be estimated via straightforward methods.

Given the threshold crossing model

$$\begin{aligned} D &= I(X^e\beta_e + X^0\beta_0 + \varepsilon \geq 0) \\ X^e &= Z\alpha + e \end{aligned}$$

with (ε, e) jointly normal, we can first linearly regress X^e on Z, with residuals being estimates of e. This then yields an ordinary probit model

$$D = I(X^e\beta_e + X^0\beta_0 + \lambda e + U \geq 0)$$

which is the model estimated by Stata's `ivprobit` command. Despite its name, `ivprobit` is a control function estimator, not an IV estimator.

A substantial limitation of control function methods in this context is that they generally require the endogenous regressors X^e to be continuous, rather than binary, discrete, or censored. For instance, a binary endogenous regressor will violate the assumptions necessary to derive estimates of

the 'first stage' error term e. The errors in the 'first stage' regression cannot be normally distributed and independent of the regressors.

In this context, control function estimators—like maximum likelihood estimators—of binary outcome models require that the first stage model be correctly specified. This is an important limitation of these approaches. A 2SLS approach will lose efficiency if an appropriate instrument is not included, but a ML or control function estimator will generally become inconsistent.

Special regressor estimators

Special regressor estimators were first proposed by Lewbel (2000). Their implementation are fully described in Lewbel et al. (2012). They assume that the model includes a particular regressor, V, with certain properties. It is exogenous (that is, $E(\varepsilon|V) = 0$) and appears as an additive term in the model. It is continuously distributed and has a large support. Any normally distributed regressor would satisfy this condition.

A third condition, preferable but not strictly necessary, is that V have a thick-tailed distribution. A regressor with greater kurtosis will be more useful as a special regressor.

The binary choice special regressor proposed by Lewbel (2000) has the 'threshold crossing' form

$$D = I(X^e\beta_e + X^0\beta_0 + V + \varepsilon \geq 0)$$

or, equivalently,

$$D = I(X\beta + V + \varepsilon \geq 0)$$

This is the same basic form for D as in the ML or control function (CF) approach. Note, however, that the special regressor V has been separated from the other exogenous regressors, and its coefficient normalized to unity: a harmless normalization.

Given a special regressor V, the only other requirements are those applicable to linear 2SLS: to handle endogeneity, the set of instruments Z must satisfy $E(\varepsilon|Z) = 0$, and $E(Z'X)$ must have full rank.

The main drawback of this method is that the special regressor V must be conditionally independent of ε. Even if it is exogenous, it could fail to satisfy this assumption because of the way in which V might affect other endogenous regressors. Also, V must be continuously distributed after conditioning on the other regressors, so that a term like V^2 could not be included as an additional regressor.

Apart from these restrictions on V, the special regressor (SR) method has none of the drawbacks of the three models discussed earlier:

- Unlike the LPM, the SR predictions stay 'in bounds' and is consistent with other threshold crossing models.
- Unlike ML and CF methods, the SR model does not require correct specification of the 'first stage' model: any valid set of instruments may be used, with only efficiency at stake.
- Unlike ML, the SR method has a linear form, not requiring iterative search.
- Unlike CF, the SR method can be used when endogenous regressors X^e are discrete or limited; unlike ML, there is a single estimation method, regardless of the characteristics of X^e.
- Unlike ML, the SR method permits unknown heteroskedasticity in the model errors.

The special regressor method imposes far fewer assumptions on the distribution of errors, particularly the errors e in the 'first stage' equations for X^e, than do CF or ML estimation methods. Therefore, SR estimators will be less efficient than these alternatives when the alternatives are consistent. SR estimators may be expected to have larger standard errors and lower precision than other methods, *when those methods are valid*. However, if a special regressor V can be found, the SR method will be valid under much more general conditions than the ML and CF methods.

The average index function (AIF)

Consider the original estimation problem

$$D = I(X\beta + \varepsilon \geq 0)$$

where with generality one of the elements of X may be a special regressor V, with coefficient one. If ε is independent of X, the *propensity score* or *choice probability* is $\Pr[D = 1|X] = E(D|X) = E(D|X\beta) = F_{-\varepsilon}(X\beta) = \Pr(-\varepsilon \leq X\beta)$, with $F_{-\varepsilon}(\cdot)$ the probability distribution function of $-\varepsilon$. In the case of independent errors, these measures are identical.

When some regressors are endogenous, or generally when the assumption $X \perp \varepsilon$ is violated (e.g., by heteroskedasticity), these expressions may differ from one another. Blundell and Powell (2004) propose using the average structural function (ASF) to summarize choice probabilities: $F_{-\varepsilon}(X\beta)$, even though ε is no longer independent of X. In this case, $F_{-\varepsilon|X}(X\beta|X)$ should be computed: a formidable task.

Lewbel et al. (2012) propose using the measure $E(D|X\beta)$, which they call the *average index function* (AIF), to summarize choice probabilities. Like the ASF, the AIF is based on the estimated index, and equals the propensity score when $\varepsilon \perp X$. However, when this assumption is violated (by endogeneity or heteroskedasticity), the AIF is usually easier to estimate via a unidimensional nonparametric regression of D on $X\beta$. The AIF can be considered a middle ground between the propensity score and the ASF, as the former conditions on all covariates using $F_{-\varepsilon|X}$; the ASF conditions on no covariates using $F_{-\varepsilon}$; and the AIF conditions on the *index* of covariates, $F_{-\varepsilon|X\beta}$.

Define the function $M(X\beta) = E(D|X\beta)$, with derivatives m. The marginal effects of the regressors on the choice probabilities, as measured by the AIF, are $\partial E(D|X\beta)/\partial X = m(X\beta)\beta$, so the average marginal effects just equal the average derivatives, $E(m(X\beta + V))\beta$.

For the LPM, the ASF and AIF both equal the fitted values of the linear 2SLS regression of D on X. For the other methods, the AIF choice probabilities can be estimated using a standard unidimensional kernel regression of D on $X\hat{\beta}$: for instance, using the `lpoly` command in Stata, with the `at()` option specifying the observed data points. This will produce the AIF for each observation i, $\widehat{M}_i$.

Employing the derivatives of the kernel function, the individual-level marginal effects $\widehat{m}_i$ may be calculated, and averaged to produce average marginal effects:

$$\overline{m}\hat{\beta} = \frac{1}{n}\sum_{i=1}^{n} \widehat{m}_i\hat{\beta}$$

Estimates of the precision of these average marginal effects are derived by bootstrapping.

Implementation

An implementation of the special regressor method and average index function is available in Stata (version 11 and higher) via the command `ssc describe sspecialreg`.