The Economics of Fraudulent Accounting*

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Abstract

We study the consequences of earnings management for the allocation of resources among firms, and we argue that fraudulent accounting has important economic consequences. We first build a model where the costs of earnings management are endogenous, and we show that, in equilibrium, bad managers hire and invest too much, distorting the allocation of real resources. We test the predictions of the multidimensional signalling model using new historical and firm-level data. We first show that periods of high stock market valuations are systematically followed by large increases in reported frauds. We then show that, during periods of suspicious accounting, insiders sell their stocks, while misreporting firms hire and invest like the firms whose income they are trying to match. When they are caught, they shed labor and capital and improve their true productivity. In the aggregate, our model seems able to account for the recent period of jobless and investment-less growth.

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Introduction

Fraudulent accounting by management has been costly for shareholders. The market adjusted return over the three-days surrounding the announcement of a restatement to financial statements is associated with an average return of –10% (See GAO (2002)). Though the losses to shareholders are large and apparent, the impact of fraudulent accounting on the wider economy is not well understood. It is not known, for instance, whether earnings management lowers economic efficiency, or whether it simply redistributes income from shareholders to insiders. In this paper, we examine the economic consequences of fraudulent accounting, with a particular focus on the dynamics of employment and investment.

The dramatic case of Enron's restatement illustrates our point. On November 8, 2001, Enron announced that it would restate its earnings for the period 1997 through 2001. This restatement recorded a $1.2 billion reduction to shareholders equity. The stock price of Enron declined from more than $30 to less than $1 between October 16, 2001 and November 28, 2001. Accompanying these large losses was a striking pattern of growth and demise. During the period when Enron was misreporting, it grew faster than any other firm in its industry. The book value of Enron's assets nearly tripled, from $23.5 billion in 1997 to $65.5 billion in 2000. Tobin's Q increased from 1.32 to 1.8 over this period. At its peak, Enron employed more than 20,000 employees worldwide. This period of misreporting was also characterized by substantial stock sales by Enron insiders (See **Figure 1**). After its restatement Enron shrank rapidly. Today, about 500 employees remain and Enron's creditors expect to receive about one-fifth of the estimated $63 billion they are owed.

In this paper, we report that Enron's story is typical – if somewhat extreme – of fraudulent accounting in periods of high financial valuations. We study the problem of a manager whose productivity is private information, and who makes hiring and investment decisions. We point out that, when these decisions are observable, bad managers who want to hide their poor quality must not only manage their earnings to show high profits, but must also hire and invest like good managers. In equilibrium, they hire and invest too much, distorting the allocation of real resources. In short, it is not sufficient to merely misreport performance. Poor quality firms also have to mimic higher quality firms in their investment and hiring decisions. Prior and concurrent theoretical work (see Narayanan (1985), Stein (1989), Guttman, Kadan, and Kandel (2004), Goldman and Slezak (2003) and Povel, Singh, and Winton (2004)) assume exogenous costs of earnings management. In our model, we show that real costs of earnings management can arise endogenously because earnings management distorts the hiring and investment decisions of firms.

Our main contribution is then to test the predictions of the model using newly collected data. The first prediction is that, as long as managerial rewards are tied to the perceived performance of companies, the incidence of fraudulent accounting will be higher when price-earnings ratios are high. We use historical data on actions by the Securities and Exchange Commission (SEC), from 1936 to 2003, to capture the incidence of fraudulent accounting. We find that periods with high price-earnings ratios, proxied by the ratio of stock market valuation to GDP, are followed by significant increases in civil injunctive actions and administrative proceedings by the SEC.

Second, the model predicts that fraudulent firms hire and invest at a higher rate during the fraudulent period. Upon being caught, fraudulent firms will shed labor and capital, and improve their real productivity. We use a sample of firms that announce restating their financial statements over the period 1997 to June 2002 to proxy for allegedly fraudulent accounting. We find that during misreported periods, restating firms hire at rates that are significantly higher than firms matched on age, size and industry. The growth rate of employment is significantly lower than matched firms after the restated period. The growth rate of property, plants and equipment is also significantly higher during the restated period and significantly lower after the restated period, relative to matched firms. A similar dynamic is observed with book value of assets and reported sales. On the other hand, real labor productivity tends to improve after the restatement, which suggests that restatements are not capturing unobserved negative technology shocks.

Further, we find that the higher growth rates of employment and investment observed in restating firms are not random. Rather, the growth rates of restating firms are similar to those of firms in the same reported income group. In other words, if reported earnings of a fraudulent firm places it in the top 10% of all comparable firms, then it will mimic the employment and investment growth rate of this group.

Finally, we find that restated periods are accompanied by significantly higher insider sales, as predicted by the model. Matching our sample of firms with those covered under EXECUCOMP, we find that during the restated period, CEOs exercise and realize a significantly higher fraction of total value realizable from options. The value realized from exercises is not significantly different from matched firms before or after the restated period. These results add to the evidence in recent research that shows that managers with large stock option portfolios are more likely to manipulate earnings (See Bergstresser and Philippon (2002), Burns and Kedia (2004)), and that they succeed in manipulating stock prices and in making money on concurrent insider trading (See Beneish and Vargus (2002) and Bartov and Mohanram (2004)). This pattern of insider exercises also suggests that alternate theories, like managerial optimism, do not explain the observed dynamics of investment and employment.

After the restatement is announced, the firms shrink quickly. The macroeconomic consequences are easily visible: the publicly traded firms that restated their earnings in 2000 and 2001 lost between 250,000 and 600,000 jobs between 2000 and 2002. Moreover, in industries where there are a lot of restatements, even firms that did not have to restate experience slower growth in investment and employment, together with strong labor productivity growth. Our paper is the first to show that the existence of earnings management can explain periods of 'jobless' and 'investment-less' growth.

The paper also contributes to a large body of existing work on earnings management. In their review of the literature, Healy and Wahlen (1999) argue that "prior research has focused almost exclusively on understanding whether earnings management exists and why." They also point to a crucial question that the academic research has left unanswered: What is the effect of earnings management on the allocation of resources? To the best of our knowledge, our paper is the first to address this issue.

The rest of the paper is organized as follows. Section 1 discusses the model, Section 2 examines, with historical data, the relationship between stock market valuation and the incidence of fraudulent accounting. Section 3 uses firm level data to examine the dynamics of employment and investment for fraudulent firms. Section 4 examines industry dynamics, and Section 5 concludes.

1 Model

We now present a model of earnings manipulation. We first describe the case where the underlying cash flows are exogenous. This case has been the main focus of the literature so far. However it is not very useful to think about the real effects of fraudulent accounting. We then show that real inefficiencies arise from the *interaction* of endogenous hiring and investment decisions, and the opportunity to manipulate earnings.

1.1 Exogenous Fundamental Earnings

The model has two periods $t = 1, 2$ and a large number of firms whose fundamental earnings (x) are constant over time and depend on the quality of their managers. There are two types of managers. Half are bad $(x = x_L)$ and half are good $(x = x_H)$. The type of the manager is known only to the manager. Realized earnings (y) are equal to fundamental earnings plus discretionary accruals (a) :

$$\begin{aligned} y_1 &= x + a \ , \\ y_2 &= \varepsilon (x - a) \ , \ E[\varepsilon \mid x, a] = 1. \end{aligned}$$

Each firm has one share, and all earnings are paid out as dividends. Hence, each stock holder receives y_t in period t. We assume that the earnings in period 2 are randomly distributed around a mean of $E[y_2 \mid x, a] = x - a$. Managers know x, and they own $\alpha \in (0, 1)$ shares that they *have to sell between the two periods*. The appendix shows how to extend the model to allow for endogenous trading. If they manage their earnings, managers are caught and punish with some probability, and we let γ be the expected punishment.

Let λ be the fraction of bad managers who manipulate (strategy m) and $1 - \lambda$ the fraction of bad managers who report honestly (strategy o). Let $\hat{\lambda}$ be the market belief about λ. We focus throughout on equilibria where good managers report honestly. The set of equilibria depends in general on the details of the information structure[1], and on the functional form for the punishment technology (γ)[2]. In this respect, our setup is clearly special, but it is not arbitrary. One of the clearest results in the literature on earnings

[1] See Guttman, Kadan, and Kandel (2004)

[2] It is easy to construct examples where good managers also manipulate. It is also possible that they succeed in separating from the bad types, if, for instance, the probability of detection increases with the amount of manipulation.

management is that stock prices react strongly to announcements of earnings restatements. Therefore, pooling does occur in the real world. We do not pretend to show theoretically that this should be expected, but rather, we focus on pooling equilibria because they appear empirically relevant.

Let ϕ be the desired price-earnings ratio[3], which depends on the riskiness of the firms (ε), and on the risk aversion of investors. We introduce risk aversion to be able to study the comparative statics with respect to ϕ while keeping the risk free rate normalized to 0. Assuming efficient financial markets, the market value of the firm will be:

$$V\left(y_1, \hat{\lambda}\right) = \phi E\left[y_2 \mid y_1\right] = \left\{ \begin{array}{c} V_L = \phi x_L \text{ if } y_1 = x_L \\ V_H\left(\hat{\lambda}\right) \text{ if } y_1 = x_H \end{array} \right\} ,$$

where

$$V_H\left(\hat{\lambda}\right) = \phi \frac{\hat{\lambda}\left(x_L - a\right) + x_H}{\hat{\lambda} + 1} ,$$

and

$$a = x_H - x_L .$$

The expected utilities of managers under strategies o and m are

$$U^o = \alpha V_L \ ; \ U^m = \alpha V_H - \gamma .$$

Definition 1 *An equilibrium is a market belief* $\hat{\lambda}$ *such that bad managers choose* $\max\left(U^o, U^m\right)$ *and* $\lambda = \hat{\lambda}$.

Condition 1: $\alpha\phi\left(x_H - x_L\right) > \gamma$

Under condition 1, $\hat{\lambda} = 0$ is not an equilibrium. On the other hand, $\hat{\lambda} = 1$ is not an equilibrium either, since $V_H(1) = \phi x_L = V_L$ and therefore $U^m < U^o$ when $\hat{\lambda} = 1$. The equilibrium condition $U^o = U^m$ implies that $\hat{\lambda}$ must lie strictly between 0 and 1

$$\frac{1 + \hat{\lambda}}{1 - \hat{\lambda}} = \frac{\alpha\phi}{\gamma}\left(x_H - x_L\right) . \tag{1}$$

Equation (1) has all the intuitive properties one would expect. Earnings management increases with the amount of stocks owned by the manager, and with the difference between the fundamental values of good and bad managers.

[3] Remember that earnings are equal to dividends.

1.2 Endogenous Factor Demand

Our main focus in this paper in on the allocation of resources among firms. To study this question, we extend the model to incorporate production decisions by the managers. By assumption, when fundamental earnings are exogenous, earnings manipulation does not affect the efficiency of the economy. To overcome this problem, the literature has typically introduced ad-hoc costs of manipulation. Here we show that this assumption is unnecessary: inefficiencies arise automatically when the hiring and investment decisions are endogenous (and observable), because the need to mimic the good types distort all the observable actions of the bad types.

Suppose that the production technology is Leontief with scale θ that is private information of the manager. Assume for simplicity that labor is the only factor of production, supplied at price w. Profits are given by

$$x = \min(n, \theta) - wn \ .$$

Assume that $w < 1$, and that $\theta \in \{1, 1+\Delta\}$ for bad and good managers respectively. The first best level of employment is always

$$n^*(\theta) = \theta = \left\{ \begin{array}{c} 1 \text{ for bad managers} \\ 1+\Delta \text{ for good managers} \end{array} \right\} ,$$

but since n is observable, bad managers who manipulate have to hire just like good ones, therefore

$$n^m = 1 + \Delta \ .$$

So we have the following true profits:

$$\begin{aligned} x_H^* &= (1-w)(1+\Delta) \ , \\ x_L^* &= 1 - w \ , \\ x_L^m &= 1 - w(1+\Delta) \ . \end{aligned}$$

Discretionary accruals have to make up not only for the fundamental difference in quality $\Delta(1-w)$, but also for the inefficient allocation of resources Δw :

$$a = x_H^* - x_L^m = \Delta \ .$$

Making n observable creates misallocations and real costs. Unlike previous models (Stein (1989)), we do not need to assume that manipulating accruals is costly in and of itself. The market value of a firm reporting high earnings is

$$V_H\left(\hat{\lambda}\right) = \phi \frac{\hat{\lambda}\left(x_L^* - a\right) + x_H^*}{1 + \hat{\lambda}} \ ,$$

and the equilibrium condition

$$\begin{aligned} U^o &= U^m \Leftrightarrow \alpha\left(V_H - V_L\right) = \gamma \\ \gamma &= \frac{\alpha\phi}{1+\hat{\lambda}}\left(x_H^* - x_L^* - \hat{\lambda} a\right) \ , \end{aligned}$$

leads to

$$\frac{1+\hat{\lambda}}{1-\hat{\lambda}-w} = \frac{\alpha\phi\Delta}{\gamma} \ .$$

Proposition 1 *The fraction $\hat{\lambda}$ of managers who manipulate their earnings increases with the price-earnings ratio ϕ, and with the number of shares owned by managers α, and decreases with the cost of manipulation γ.*

The only critical assumption we have made is that good managers should optimally hire more than bad managers, an assumption that seems highly plausible. The Leontief technology makes the formula easier to read, but the results generalize to any production function that is super-modular in (n, θ).[4]

Bergstresser and Philippon (2002) and Burns and Kedia (2004), among others, have already confirmed the comparative statics with respect to α. In the empirical analysis below, we want to focus on the other predictions of the model:

1. Fraudulent accounting is more likely when price-earnings ratios are high.

2. The fraudulent firms mimic the hiring and investment decisions of successful firms.

[4] An example is when managers influence the productivity of their companies and output is $y = \theta f(n)$ for some increasing function $f(.)$. A case that would not deliver the same result is $y = \theta + f(n)$ because it makes optimal employment independent of the type of the manager. The evidence supports the super-modular case, since, for instance, managers of large companies are paid more than managers of small companies.

3. Insider trading is higher during fraudulent periods (see the straightforward extension in the appendix).

A direct implication of prediction 2 is that fraudulent firms end up larger than predicted by their technology. Hence, one would expect to see these firms shrink after they are caught.

2 Historical Evidence from SEC Actions

The model predicts that fraudulent accounting is more likely when the price-earnings ratio is high. We look at historical data to see if it is indeed true that high market valuations, i.e., high P/E ratios, are followed by a high incidence of fraudulent accounting.

We use data on Securities and Exchange Commission (SEC) actions, from 1936 to 2003, to capture the incidence of fraudulent accounting. The SEC classifies its actions into several categories. We use the longest available series, that combines civil injunctive actions and administrative proceedings initiated in each year (ACT_t). Civil judicial actions usually involve securities fraud. Administrative proceedings involve allegations that a firm or individual has violated GAAP or that an individual has caused a firm or other individuals to act unlawfully. We use the logarithm of the market value of listed securities (V_t) over GDP (Y_t) as our proxy for the desired price-earnings ratio, because P/E ratios are not available before 1951[5]. However, the number of publicly traded companies in the US has increased over time. This causes an upward trend in the ratio of market capitalization to GDP, as well as in the number of SEC actions. To control for this common trend we define the intensity of SEC actions as the residuals of the following regression

$$\log\left(ACT_{t-1} + ACT_t + ACT_{t+1}\right) = \alpha + \beta \log\left(N_t^{Public\ Firms}\right) + \varepsilon_t^{SEC} \ ,$$

where $N_t^{Public\ Firms}$is the number of publicly listed firms obtained from CRSP. Similarly, ϕ_t is defined as the residual of the regression

$$log\left(\frac{V_t}{Y_t}\right) = \alpha + \beta \log\left(N_t^{Public\ Firms}\right) + \phi_t$$

[5] In the post 1951 sample, using actual P/E ratios gives very similar results. Note however, that P/E ratios are constructed with the earnings reported by firms, and, as the model makes clear, these need not be the correct earnings. In this case, using GDP (or any other measure based on NIPA data) is conceptually better. The issue of course is that the fraction of listed companies has increased over time, hence the trend in $\frac{V}{Y}$.

Figure 2 plots the intensity of SEC actions $\left(\varepsilon_t^{SEC}\right)$ and the detrended ratio of market capitalization over GDP (ϕ_t) from 1936 to 2003. ε_t^{SEC} and ϕ_t are positively correlated at medium run frequencies. To confirm the visual impression, we ran the simple regression (standard errors are below the coefficients):

$$\varepsilon_t^{SEC} = \underset{(0.088)}{0.77} \times \phi_t + u_t, \; R^2 = 52.6\%$$

As predicted by the model, there is a tight correlation between SEC actions and market valuations in historical data. This shows that the link between market valuations and fraudulent activity is not exclusively an experience of the late 1990s.

An important issue here is that SEC actions are endogenous. An increase in the number of SEC actions can come from an increase in frauds, an increase in scrutiny, or both. One would naturally expect the SEC to increase its investigations when frauds go up. In this case, the number of SEC actions would over estimate the true increase in fraud. However, this does not affect our interpretation of the evidence. It simply means that we may need to scale down our estimated elasticity of fraud cases to market valuations.[6] On the other hand, there are good reasons to believe that the number of reported SEC cases might under-estimate the true incidence of fraud. The SEC has limited resources and cannot expand quickly. Therefore, in the short run, we would expect the detection technology to exhibit decreasing returns to scale. Consequently, the number of SEC actions would increase less than one for one with the number of frauds. Overall, we acknowledge that the bias could go either way, and we refrain from drawing quantitative conclusions from the time series evidence.

3 Firm Level Evidence from the 1990's

In this section, we use firm level data to test the other predictions of the model. Firm level data allow for more direct tests of the hypothesis presented above.

3.1 Data

To capture alleged fraudulent accounting, we use the list of firms that restated their earnings in the late 1990's. This list was compiled by the General Accounting Office (GAO) in 2002

[6] This is similar, for instance, to the issues of unobserved labor effort and capacity utilization in the business cycle literature.

(GAO (2002)). The GAO "identified 919 financial restatements by 845 public companies from January 1, 1997 to June 30, 2002, that involved accounting irregularities resulting in material misstatements of financial results." These financial restatements occur when a company, either voluntarily or prompted by auditors or regulators, revises public financial information that was previously reported. [7] 645 of these companies were publicly traded. The distribution of announcements per year shows a clear upward trend (see **Table 1**). The number of identified restatements rose from 92 in 1997 to 225 in 2001. "The proportion of listed companies on NYSE, Amex and NASDAQ identified as restating their financial reports tripled from 0.89% in 1997 to 2.5% percent in 2001. From January 1997 through June 2002, about 10% of all listed companies announced at least one restatement." Moreover, later restatements involved larger firms: the average market capitalization of restating companies quadrupled between 1997 and 2002, from $500 million to $4 billion, while the average size of listed companies increased only about 60% over the same period.

GAO also reports the reasons for the restatements. Errors in revenue recognitions account for roughly 40% of the cases while those due to improper cost accounting explain 16%. Issues with loans, like write-offs, reserves, and bad loans account for 14% of the cases. Issues with assets and inventories, like goodwill, write downs, and valuation account for another 9% of restatements. The remaining 20% of cases are linked to R&D, M&A, securities (Enron for instance), reclassifications of debt payments and related party transactions. It is useful to keep in mind that only 16% of the restatements can be formally attributed to external parties' actions like the SEC or independent auditors. Further, many firms do not mention in their reports the real reason for their restatements, unless they are somehow forced to do so (see GAO for details). Restatements are not fully anticipated by the market: the market-adjusted return over the three trading days surrounding the initial announcement is -10%. For the 575 restatements for which 6 months of data were available around the announcement, the 6 month abnormal holding period return was -18%.

We match the GAO data to COMPUSTAT through company name. Out of the 645 publicly traded companies, 560 firms were covered by COMPUSTAT. For 528 firms, we were able to obtain the beginning and end dates of the restated period, in addition to the

[7] These announcements exclude stock splits, changes in accounting principles, and other restatements that were not made to correct mistakes in the application of accounting standards.

date on which the restatement was announced. The period for which the financial data was eventually restated is referred to as the restated period, or the fraudulent period. This restated period, over which the fraud was allegedly committed, lasts for an average of 5 quarters (See **Table 1**). It takes an average of 2 quarters from the end of the restated period to the announcement of the restatement.

Table 1 also displays the summary statistics for the other variables of interest. The growth rates reported are the log differentials in the variable of interest. To capture hiring decisions we calculate the growth rate of employment (COMPUSTAT Data Item 29). The average annual growth in the number of employees for non-restating COMPUSTAT firms, over the period 1991 to 2003, was 4%. To capture investment decisions of firms we look at the growth rate of property plant and equipment (COMPUSTAT Data Item 73). The average growth in property, plant, and equipment for non-restating COMPUSTAT firms was 7% per year. This is not different from the growth of 8% observed in the PP&E for restating firms over the whole period. The second measure of investment activity that we examine is the ratio of capital expenditures (COMPUSTAT Data Item 30) to property plant and equipment. There continues to be no difference between restating and non-restating firms with this measure over the whole sample.

The unconditional dynamics of restating and non-restating firms are also remarkably similar with respect to the growth rate of market values, book assets and sales We use sales per employee to measure firm productivity. The growth rate of sales per employee is 5% for both restating and non-restating firms. To capture insider trading activity, we get data on CEO option exercises from EXECUCOMP. Option exercises are captured by the ratio of the value realized from option exercises normalized by the total value realizable from options. The total value realizable from options is the sum of the value realized from option exercises and the value of exercisable options. We find no difference in the unconditional value of this ratio between restating and non-restating firms. We also examine differences in the value realized from option exercises, i.e., log(1+value realized). The value realized from option exercises appears to be somewhat higher for restating firms. There is also a difference in the likelihood of acquisition activity. The acquisition dummy, that takes the value one if the reported sales for the firm reflect an acquisition, has a higher average for restating firms. Overall, **table 1** shows that the unconditional dynamics of restating and non-restating firms are quite similar. We now show that the conditional dynamics are remarkably different.

3.2 Earnings Restatements, Firm Dynamics and Insider Trading

We want to compare the dynamics of hiring and investment for restating firms around the restated period. Before conducting more advanced econometric tests, a clear picture of the raw data can be obtained by looking at the dynamics of firms that announced a restatement in 2000 (111 firms) and 2001(120 firms).

The number of people employed in these 231 restating firms over the period 1997 to 2002 is displayed in **figure 3**. The left panel of the figure compares the 231 restating firms to aggregate non-farm payrolls obtained from the Bureau of Labor Statistics (BLS). Employment in restating firms went up by 0.5 million (+25%) between 1997 and 1999, and down by 0.6 million between 2000 and 2002. Over the same period, non-farm payrolls went up by 6.7% and then down by 1.5%. The relative increases and decreases in employment for restating firms are clearly much larger than for the economy as a whole. A potential concern in this analysis is that some firms drop out of the sample after the announcement of the restatement. In the left panel, we implicitly assign zero employees to firms that drop out. This may happen due to delisting or bankruptcy. For e.g., complete data for Enron is available only till 2000. To the extent that some firms drop out of the sample, but continue operating (unlike Enron), we may over-estimate the true dynamics. To address this issue we construct a constant sample of firms for which we have complete data over this period. This constant sample comprises 74 firms that restate in 2000 and 96 firms that restate in 2001. The right panel of **figure 3** compares the employment in these restating firms to a constant sample of all non-restating firms in COMPUSTAT. Restating firms grew more rapidly than non-restating firms from 1997 to 1999 and declined much faster afterwards. The right panel also gives a sense of the coverage of our data set: a bit less than a third of total non-farm payrolls.[8] Clearly, the truth lies somewhere in between the left and the right panel. If most restating firms are like Enron, then the left panel is the better approximation. If most restating firms continue operating with a reduced ,but still significant, number of

[8] But a much larger share of output (more than 1/2) since only large firms with relatively high labor productivity are included.

employees, then the right panel is more appropriate.

Figure 4 compares the growth of market and book values of restating and non-restating firms. For this we use the unbalanced sample of firms since firms dropping out of the sample is less of an issue with year-to-year growth rates. As can be seen in the left panel, the total market value for restating firms grew at a faster rate than non-restating firms till 1999 and a slower rate afterwards A similar picture emerges with respect to growth in the book value of assets. Restating firms grew faster than non-restating firms before the announcement, and more slowly afterwards.

The pictures provides a clear pattern of rapid growth and decline for restating firms. We now turn to more formal econometric tests to substantiate this evidence. We first create a control group of non-restating firms that are matched in age, industry and initial size. For every restating firm, we choose all non-restating firms that appear in COMPUSTAT in the same year as the restating firm, or in 1991 for the firms already present at the beginning of our sample. We then select non-restating firms that operate in the same industry (defined as two-digit SIC code), and that are in the same initial book asset quintile. We exclude observations in government, health and education sectors and firms which have less than three observations for asset and sales growth over this time period. We adjust variables of interest by substracting the mean of this control group.

$$\hat{g}_{it} = g_{it} - \bar{g}_{C(i)t}$$

where $C(i)$ is the control group for firm i. We then estimate

$$\hat{g}_{it} = \beta^{before} 1_{t<\tau(i)} + \beta^{during} 1_{t\in\tau(i)} + \beta^{after} 1_{t>\tau(i)} + u_{it} \quad , t = 1991..2003$$

Where $\tau(i)$ is the restated period for firm i ($\tau(i) = \varnothing$ for firms that do not restate). The coefficients β^{during} will show if the restating firms grew faster than comparable firms in their industry during the suspicious period or the period in which they were misreporting. The coefficients β^{before} and β^{after} will show if they grew differently before and after the suspicious period. In these comparisons, the null hypothesis is that $\beta = 0$. We can also compare β over time to see if the dynamics of restating firms changed significantly around the restated period. In this case, the null hypothesis is that $\beta^{before} = \beta^{during}$, for instance.

The results are presented in **table 2**. The growth of employment in fraudulent firms is 5% higher during the fraudulent period. As predicted by the model the growth of employment is significantly lower in the period after restatement. It appears that restating firms were growing rapidly in the years prior to the restated period. These firms most likely misreported in order to continue portraying themselves as high growth firms. A similar dynamic is seen with investment activity. The growth rate of investment, i.e., PP&E is about 5% higher during the restated period and 6% lower after the restated period. The same pattern is seen when we examine capital expenditures normalized by PP&E.

Growth in book value of assets, sales and the market value of the firms are all significantly higher for restating firms during the restated period and lower after the restated period. In addition, the null hypothesis that β^{during} is the same as β^{after} can be rejected at less than 1% level for all variables. We can safely conclude that growth rates of assets, employees, capital and market values were higher during the restated periods than after, as predicted by the model. Interestingly, the growth rates of reported sales per employee is not significantly different across firms and over time. As the period after the restatement is not associated with lower productivity, it is unlikely that restatements were the result of negative TFP shocks. Moreover, the sales in the restated period were inflated by fraudulent accounting, so that true sales per employee certainly increased after the restatement.

Lastly, we examine the prediction of the model that insider trading will be higher during the restated period. As mentioned above, we use the 1) value realized from option exercises normalized by the total value realizable from options exercises, and 2) the log of the proceeds from options exercises. Data on option exercises of CEOs is obtained from EXECUCOMP. Since EXECUCOMP covers only S&P 1500 firms, only 179 restating firms have available data on value of option exercises in EXECUCOMP. For this subset of firms, we find that CEOs of restating firms exercise more stock options during the restated period relative to comparable firms, and relative to what they did before or after the restated period. The proceeds from option exercises are also larger. However, one must keep in mind that the proceeds are mechanically correlated with the stock price and the number of options exercised. Taken together, these findings provide strong support for the model of section 1

There are two main alternative interpretations that we wish to discuss. First, one might argue that earnings restatement do not reflect genuine frauds, but rather excessive optimism by the manager. This might explain the relatively higher growth rates before the restatement, and relatively lower growth rates afterwards. However, this interpretation is inconsistent with the manager selling the stock of his or her company.[9] Second, one could argue that negative productivity shocks ex-post caused some firms to be caught, while other firms with positive shocks escaped. We have argued, however, that restating firms enjoy higher, not lower, true labor productivity growth following the restated period. Moreover, these shocks were not randomly distributed across firms, since restating firms were growing faster than their industry peers prior to the restatements. Our findings therefore rule out these two alternative interpretations: that frauds are caused by excess managerial optimism, or that they are caused by random, ex-post TFP shocks.

Our results are consistent with the following interpretation: managers of growth firms discovered a drop in their real growth opportunities, and decided to hide it for a while by managing earnings. Our model explains why these firms decided to continue expanding so much despite knowing that they were likely to shrink even faster in the near future.

The multidimensional signalling model, presented above, not only predicts that restating firms should grow faster (slower) than non-restating firms during (after) the restated period but also that the growth rate of fraudulent firms should be consistent with their reported earnings. If the reported earnings of a particular fraudulent firm places it in the top 25% of its industry/size/age group, then this firm should try to mimic the growth rates of the firms in this same group. To test for the consistency of the mimicking strategy, we define the *earnings* group of firm i at time t as

$$\theta_{it} = \{ j \mid j \in C(i), \ \tau(j) = \varnothing, \ e_{jt} \in [.9 \times e_{it}, 1.1 \times e_{it}] \}$$

where e_{it} is pretax income over assets. The earnings group θ_{it} includes non-restating firms in the control group of firm i with earnings that lie within 90% to 110% of the earnings of firm i in year t. The model predicts that the restating firm will mimic the growth rate of this earnings group. To test for this, we estimate the following simple model

$$\hat{g}_{it} = \beta E[\hat{g}_{jt} \mid j \in \theta_{it}] + u_{it}$$

Table 3 presents the results. As predicted by the model, we find that we cannot reject the null that $\beta = 1$ for all our relevant variables. The estimated β is 1.03 for growth in

[9] Ofek and Yermack (2000), looking at US executives, document that nearly all executive stock option exercises are followed by share sales.

employees and it is 1.1 for the growth in capital. These results support the consistency of the mimicking strategy and provide evidence in favor of our theory.

3.3 Industry Dynamics

The dynamics of restating firms, that make them grow faster than comparable firms in the restated period and slower afterwards, is also likely to impact other non-restating firms in the industry. Some non-restating firms surely engaged in earnings management, but probably to a lesser extent than firms that eventually had to restate. In this case, our control group is not valid and our results under-estimate the true impact of earnings management. It also implies that investors may draw negative inferences about all firms that belong to an industry where many accounting frauds have been revealed, even if some of the firms were actually honest. This suggests that the announcement of a restatement has negative implications for other non-restating firms in the industry. On the other hand, there are equilibrium reasons to expect that non-restating firms may benefit from the announcements of restatements by their competitors. If they did not themselves manage their earnings, and if investors do not become suspicious of them, non-restating firms should expand in response to the negative shocks affecting other firms in their industry.

We investigate the effect on other non-restating firms in the industry by estimating

$$g_{jt} = \beta \bar{R}_{I(j),t-1} + \gamma \log\left(age_{jt}\right) + \alpha_t + \alpha_{I(j)} + u_{jt} \quad , t = 1991..2003 \tag{2}$$

for a sample of non-restating firms, i.e., where $\tau(j) = \varnothing$, at least between January 1997 and June 2002. $\bar{R}_{I(j),t-1}$ is the fraction of firms in industry $I(j)$ that restated at time $t-1$. We also include year dummies (α_t) and 2-digit industry dummies $\left(\alpha_{I(j)}\right)$. We estimate this for all the relevant growth variables studied earlier. The results are in **table 4**. Non-restating firms grow more slowly when they belong to an industry that had a lot of announced restatements in the preceding years. The effect is clear and strong for growth in employees and capital. Growth rate of book assets, sales and market value are also lower when the industry is characterized by a higher incidence of restatements (the slower growth in market values is not significant, consistent with the market correctly anticipating the average effect of restatements).

Interestingly, sales per employee grow significantly faster following a wave of restatements. In other words, fraudulent industries are characterized by high labor productivity growth together with negative employment and investment growth, even for firms that did not have to restate their earnings. The fact that sales per employee increases, while hiring and investment decline is not consistent with the interpretation of restatements as negative TFP shocks.[10]

The impact of these industry dynamics on overall employment is large. The predicted drop in employment can be obtained by multiplying the estimated β in the above regression with the average number of restating firms in the preceding year, i.e., average $\bar{R}_{t-1}$ across all industries. **Figure 5** plots the predicted drop in employment implied by the evolution of the average $\bar{R}_{t-1}$, and shows that it is at least as large as the one we have observed between 1999 and 2002.[11]

3.4 Predicting Accounting Fraud: The Role of Governance

We have shown that all the predictions of the model find strong support in the data. Our final effort is to understand the ex-ante factors that make fraudulent accounting more or less likely. We run predictive logit regressions in the cross-section of firms present in our sample in 2002

$$P\left(fraud_{i,02}\right) = F\left(\gamma' X_{i,97} + \alpha_{I(i)}\right) \ ,$$

where $fraud_{02}$ is a dummy variable for any restatement between 1997 and 2002, $F(.)$ is the logistic function, $\alpha_{I(i)}$ is a set of 2-digits industry dummies, and $X_{i,97}$ includes age, assets and Tobin's Q in 1997, as well as governance variables. The governance variables come from the Institutional Investor Research Center (IRRC). IRRC follows 24 governance provisions that appear beneficial to management, and which may be harmful to shareholders. Gompers, Ishii, and Metrick (2003) have used all 24 provisions to construct an index of bad governance, and have shown that the index is negatively correlated with Tobin's Q. Recently, Bebchuk, Cohen, and Ferrell (2004) have argued that staggered boards, limits

[10] We have used sales per employee, not TFP, because comparisons of the value of book assets across firms is subject to large measurement errors. However, our results are unchanged if we construct a measure of TFP using both labor and capital.

[11] But general equilibrium feed-backs imply that our coefficient from the cross-section of industries will over-estimate the true aggregate effect. The cross-sectional estimate is obtained for given factor prices (labor, capital, intermediate inputs). In the aggregate, a drop in labor demand, for instance, would drive down the wage, and mitigate the actual drop in employment.

to shareholder bylaw amendments, super-majority requirements, poison pills and golden parachutes account for most of the correlation.

In our data set, 1207 firms have IRRC data available in 1997. **Table 5** shows that firms with bad governance in 1997 were more likely to restate between 1997 and 2002 than comparable firms in the same industry. Among the individual provisions, we find that classified boards, poison pills and limits to amend the corporate charter are significant. Of course, we do not want to infer causality from these reduced form regressions, since one could imagine that good firms, or honest managers, would be more likely to choose good governance provisions, and at the same time would be less likely to commit frauds. We simply hope that these results will stimulate future research in this area.

4 Conclusion

Earnings management distorts the allocation of resources in the economy, especially in periods of high financial valuations. When hiring and investment decisions are observable, bad managers hire and invest too much in order to mimic good managers. When they are caught and forced to restate, their firms shrink quickly We find strong support for these theoretical predictions in historical and firm level data. Restating firms grow at significantly higher rates during the period where they misreport relative to age, size, and industry matched firms. Growth in restating firms is significantly slower than matched firms in the years after the restatement. We also find that the relationship between fraudulent accounting and market valuations is not confined to the late 1990's, but has been consistent over the past 70 years.

The observed dynamic of hiring and investment seen in restating firms breaks the link between labor productivity and labor demands. The period after the restatement is characterized by strong labor productivity growth, while labor and capital demands fall. Thus, waves of earnings management are followed by periods of jobless growth and low investment. [12]

[12] See Clementi and Philippon (2004) for a dynamic partial equilibrium model. Philippon (2004) studies imperfect governance in a standard real business cycle model, calibrated to the US economy.

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Appendix

A A Brief Review of the Literature on Earnings Management

In this section, we discuss previous research on earnings management, following Dechow, Kothari, and Watts (1998). Economists write models about cash flows. In practice, investors look at earnings. Why? Because earnings forecast future cash flows. Consider a firm, and assume that sales follow a random walk

$$s_t = s_{t-1} + \varepsilon_t \ .$$

Earnings (assuming a constant profit rate π) are

$$e_t = \pi s_t \ ,$$

and we assume that accounts receivable (rec_t) and payable (pay_t) are constant fractions of sales and total costs

$$rec_t = \alpha s_t \ , \text{and } pay_t = \beta \left(1 - \pi\right) s_t \ .$$

In this simplified setup, cash flows are simply given by

$$\begin{aligned} c_t &\equiv e_t + \Delta pay_t - \Delta rec_t \\ &= \pi s_t + \left[\beta\left(1-\pi\right) - \alpha\right] \varepsilon_t \ , \end{aligned}$$

so we see that

$$E_t\left[c_{t+1}\right] = \pi s_t = e_t \ .$$

To forecast future cash flows, and therefore to compute the value of the firm, earnings are the place to start. The value of the firm at the end of period t is

$$V_t = \frac{e_t}{r} \ ,$$

where r is the risk adjusted discount rate. Dechow, Kothari, and Watts (1998) expand this model to take into account other important features of accruals, such as depreciation, and show that, empirically, accruals are indeed the better predictors of future cash flows.

What we would like the reader to take away from this brief discussion is that earnings forecast cash flows, and that, to a first order, investors are right to focus on earnings when assessing the value of a firm. The problem, however, is that earnings can be manipulated. For instance, accruals, defined in our example as $\Delta rec_t - \Delta pay_t$, cannot be verified. Investors need to trust a manager who claims high earnings coming from large future receivables. Unfortunately, there are documented cases of earnings management.

1. Firms avoid negative numbers. There is a higher than expected frequency of firms with slightly positive earnings changes. Burgstahler and Dichev (1997), and see Guttman, Kadan, and Kandel (2004) for a model.

2. Who manipulates earnings? Bergstresser and Philippon (2002) and Burns and Kedia (2004) show that managers with a lot of stock options are more likely to engage in earnings management.

3. Accruals are mispriced. Sloan (1996) documents the presence of negative excess returns after large positive accruals. In fact, excess returns follow high accruals *that coincide with insider selling the stock*, as shown by Beneish and Vargus (2002)

B Extension of the Model to Endogenous Trading Decision

In this section, we briefly show how the model extends to the case where trading is an endogenous decision for (at least some) managers. A fraction δ of the managers are hit by liquidity shocks and have to trade. The remaining $1-\delta$ decides to trade or not, based on their private information. Managers who are not hit by a liquidity shock consume at the end of period 2.

Claim: *Good managers do not trade unless they have to, and bad managers who have manipulated always trade.*

The proof is straightforward. Good managers are better off waiting since they would have to sell below the market price. Bad managers who manipulated their earnings at $t=1$ are better off trading since their manipulation will be found out at time $t=2$.

$$\begin{aligned} V_H\left(\hat{\lambda}, trade\right) &= \phi \frac{\hat{\lambda}\left(x_L - a\right) + \delta x_H}{\hat{\lambda} + \delta} \ , \\ V_H\left(notrade\right) &= \phi x_H \ , \end{aligned}$$

The equilibrium condition becomes

$$\frac{\delta + \hat{\lambda}}{\delta - \hat{\lambda}} = \frac{\alpha\phi}{\gamma}\left(x_H - x_L\right) \ .$$

Under condition 1, the fraction of bad firms that inflate earnings is strictly between 0 and 1, and is increasing in $\frac{\alpha\phi}{\gamma}\left(x_H - x_L\right)$ and in δ. Comparing this formula to the one in section 1, we can see that endogenous trading reduces the incentives to manipulate because of the price impact. Like in the noise trading literature, a higher δ induces more insider trading by decreasing the price impact.

Table 1 : Descriptive Statistics

	Variable	Obs	Mean	Std. Dev.	Min	Max
Non Restating Firms	Value Realized / Exercisable Value	11833	0.18	0.29	0	1
	Log(1+Value Realized)	15298	2.37	3.44	0.00	13.47
	Market Value (growth rate)	71203	0.05	0.42	-1	1
	Book Assets (growth rate)	81916	0.08	0.34	-1.00	1.00
	Number of Employees (growth rate)	71017	0.04	0.30	-1.00	1.00
	Sales (growth rate)	81916	0.10	0.35	-1.00	1.00
	Sales per Employee (growth rate)	71017	0.05	0.32	-2.00	2.00
	Prop. Plant & Equip. (growth rate)	77899	0.07	0.36	-1.00	1.00
	Cap. Exp./ PPE	82342	0.30	0.27	-1.00	1.00
	Acquisition Dummy	96160	0.17	0.37	0.00	1.00
Restating Firms	Value Realized / Exercisable Value	1258	0.18	0.29	0	1
	Log(1+Value Realized)	1574	2.82	3.61	0.00	11.92
	Market Value (growth rate)	4668	0.06	0.45	-1	1
	Book Assets (growth rate)	4866	0.09	0.35	-1.00	1.00
	Number of Employees (growth rate)	4562	0.06	0.32	-1.00	1.00
	Sales (growth rate)	4866	0.11	0.35	-1.00	1.00
	Sales per Employee (growth rate)	4562	0.05	0.31	-2.00	2.00
	Prop. Plant & Equip. (growth rate)	4716	0.08	0.38	-1.00	1.00
	Cap. Exp./ PPE	4954	0.33	0.26	-0.61	1.00
	Acquisition Dummy	5476	0.23	0.42	0.00	1.00
	Reported Length of Restated Period (quarters)	528	4.73	3.74	1	20
	Delay between End of Restated Period and Announcement (quarters)	528	2.21	2.21	0	22
	Distribution of Announcements by Year	year	Freq.	Percent		
		1997	62	11.07		
		1998	62	11.07		
		1999	112	20.00		
		2000	123	21.96		
		2001	132	23.57		
		2002	69	12.32		
		Total	560	100		

Note: Value Realized / Exercisable Value is (Value Realized from Options Exercised) / (Value Realized from Options Exercised + Value of Exercisable Options)

Table 2 : Dynamics of Restating Firms. Before, during and after restated periods. All dependent variables except Acquisition are relative to control group, matched by size, age, and industry. The acquisition logit regression includes sector/year dummies.

Sample	EXECUCOMP		COMPUSTAT							
Dependent Variable	Value Realized/ Exercisable	Log(1+Value Realized)	Market Value (growth rate)	Book Assets (growth rate)	Number of Employees (growth rate)	Sales (growth rate)	Sales per Employee (growth rate)	Prop. Plant & Equip. (growth rate)	Cap. Exp./ PPE	Acquisition Dummy
	ols	ols	ols	ols	ols	ols	ols	ols	ols	logit
Before	**-0.002**	**0.352**	**0.054**	**0.064**	**0.047**	**0.05**	**0.002**	**0.054**	**0.025**	**0.376**
	-0.16	2.66	6.61	9.05	6.77	7.01	0.34	6.44	3.44	5.62
During	**0.052**	**0.619**	**-0.003**	**0.037**	**0.045**	**0.035**	**-0.004**	**0.053**	**0.037**	**0.652**
	2.36	2.58	-0.18	2.91	3.79	2.87	-0.46	4.01	4.04	7.46
After	**-0.003**	**-0.369**	**-0.052**	**-0.069**	**-0.044**	**-0.042**	**0.004**	**-0.063**	**-0.014**	**0.006**
	-0.22	-2.41	-5.75	-7.09	-5.29	-4.62	0.6	-6.39	-2.04	0.07
p-values										
Before=During	*0.0319*	*0.3296*	*0.0014*	*0.0578*	*0.892*	*0.2373*	*0.5897*	*0.9793*	*0.1944*	*0.0037*
During=After	*0.038*	*0.0005*	*0.0074*	*0*	*0*	*0*	*0.4938*	*0*	*0*	*0*
Before=After	*0.9411*	*0.0004*	*0*	*0*	*0*	*0*	*0.7863*	*0*	*0*	*0.0003*
R2	0.005	0.012	0.015	0.038	0.025	0.02	0	0.029	0.012	
N	1258	1574	4668	4866	4562	4866	4562	4716	4954	101636

Source: GAO and Compustat, sample period 1991-2003. **Coefficients** in bold, t-statistics below coefficients. Standard errors are robust and corrected for firm level clustering. All variables are relative to mean for control group matched by size/age/industry. We use 22 industries, and we exclude Real Estate, Health, Education and Entertainment. Value Realized / Exercisable is (Value Realized from Options Exercised) / (Value Realized from Options Exercised + Value of Remaining Exercisable Options)

Table 3: The Dynamics of Firms During the Restated Period. The dependent variables are the excess growth rates of fraudulent firms during the restated periods. The RHS variables are the excess growth rates of firms with similar income over assets. The multidimensional signalling model predicts slope coefficients of one.

Mean of Firms of Firms with Similar Income/Assets	Dependent Variable				
	Book Assets (growth rate)	Number of Employees (growth rate)	Sales (growth rate)	Sales per Employee (growth rate)	Prop. Plant & Equip. (growth rate)
	ols	ols	ols	ols	ols
Book Assets (growth rate)	**1.132**				
	6.32				
Number of Employees (growth rate)		**1.031**			
		6.91			
Sales (growth rate)			**0.849**		
			3.8		
Sales per Employee (growth rate)				**0.95**	
				4.76	
Prop. Plant & Equip. (growth rate)					**1.144**
					5.69
p-value of test that slope is 1	*0.46*	*0.8337*	*0.4988*	*0.8019*	*0.473*
R2	0.048	0.063	0.021	0.03	0.043
N	808	842	777	842	813

Note: Source: GAO and Compustat, sample period 1991-2003. Coefficients in bold, t-statistics below coefficients. Standard errors are robust and corrected for firm level clustering. All variables are relative to mean for control group matched by size/age/industry. We use 22 industries, and we exclude Real Estate, Health,

Table 4 : Dynamics of Non-Restating Firms

Dependend Variable	Market Value (growth rate)	Book Assets (growth rate)	Number of Employees (growth rate)	Sales (growth rate)	Sales per Employee (growth rate)	Prop. Plant & Equip. (growth rate)	Cap. Exp./ PPE	Acquisition Dummy
	ols	*ols*	*ols*	*ols*	*ols*	*ols*	*ols*	*logit*
Average Number of Restatements in Industry in Previous Year	**-0.278**	**-1.379**	**-1.016**	**-0.858**	**0.416**	**-2.26**	**-0.811**	**2.792**
	-1.37	-8.08	-6.66	-4.95	3.04	-11.7	-6.34	1.96
log(Age)	**0.014**	**-0.041**	**-0.047**	**-0.062**	**-0.014**	**-0.062**	**-0.065**	**-0.094**
	7.91	-25.99	-31.45	-40.11	-11.46	-35.96	-43.26	-5.5
Year Dummies	yes	yes	yes	yes	yes	yes	yes	yes
Industry Dummies	yes	yes	yes	yes	yes	yes	yes	yes
N	71203	81916	71017	81916	71017	77899	82342	96160
r2	0.07	0.04	0.042	0.051	0.008	0.053	0.176	

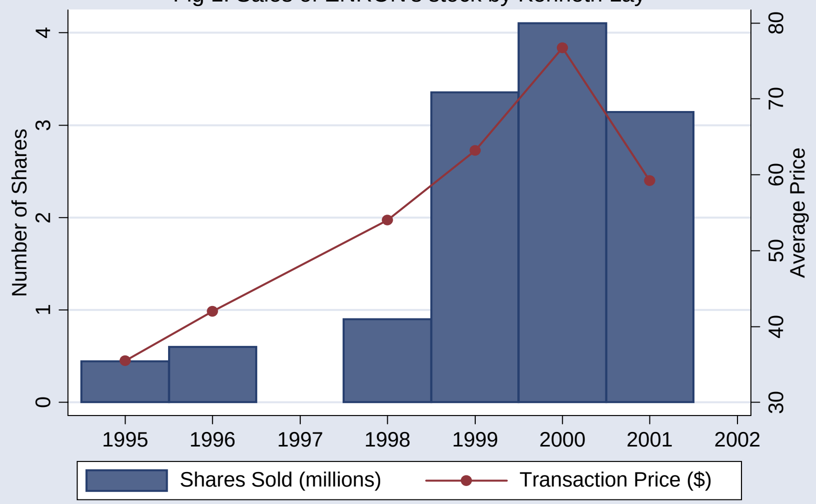
Source: GAO and Compustat, sample period 1991-2003. Coefficients in bold, t-statistics below coefficients. Standard errors are robust and corrected for firm level clustering. We use 22 industries. Excluded industries are Real Estate, Health, Education and Entertainment.

Table 5: Predicting Restatement by 2002 using Corporate Governance in 1998.

Independent Variables, all measured in 1998	Dependent Variable is Dummy for Restatement between 1998 and 2002.					
	(i)	(ii)	(iii)	(iv)	(v)	(vi)
Bebchuck et al. index	**0.183**					
	2.61					
Gompers et al. index		**0.085**				
		2.46				
Classified Board			**0.363**			
			1.82			
Poison Pills				**0.364**		
				1.88		
Limits to Amend Corporate Charter					**1.117**	
					2.29	
Golden Parachute						**0.366**
						1.89
Log Tobin's Q	**0.33**	**0.277**	**0.267**	**0.279**	**0.255**	**0.286**
	1.52	1.29	1.26	1.31	1.21	1.35
Log Age	**0.03**	**0.005**	**0.04**	**0.026**	**0.034**	**0.033**
	0.46	0.08	0.63	0.42	0.54	0.52
Log Assets	**0.796**	**0.859**	**0.793**	**0.828**	**0.868**	**0.803**
	1.8	1.9	1.78	1.88	1.95	1.8
Industry Dummies	yes	yes	yes	yes	yes	yes
N	1207	1207	1207	1207	1207	1207

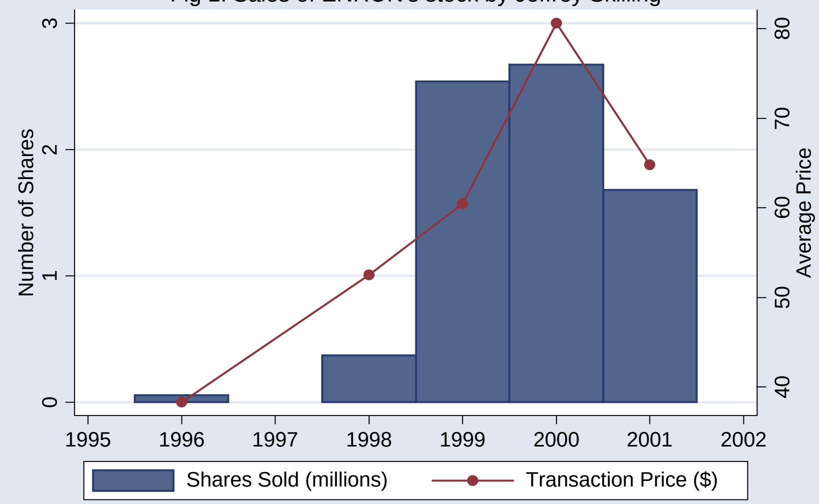
Source: GAO and Compustat, sample period 1997-2002. **Coefficients** in bold, t-statistics below coefficients. Logit Models estimated in cross section in 2002 by Pseudo Maximum Likelihood, with Robust Standard Errors.

Fig 1: Sales of ENRON's stock by Kenneth Lay



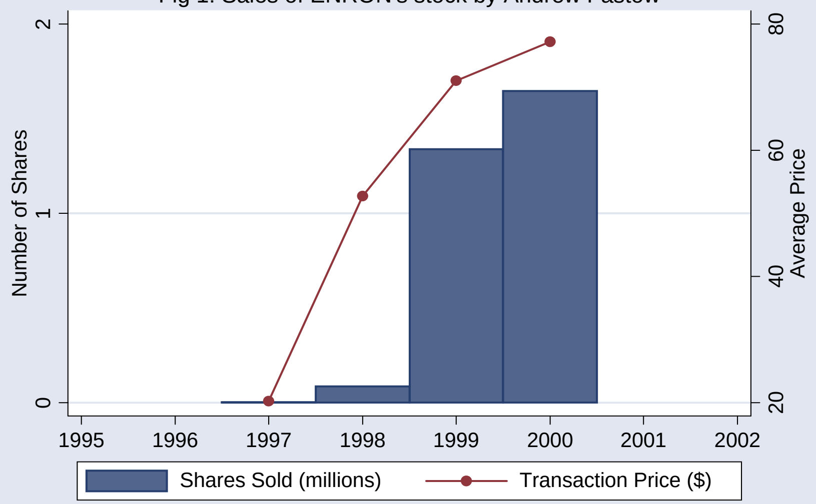
Source: Thomson Financial Insider Filing Data

Fig 1: Sales of ENRON's stock by Jeffrey Skilling



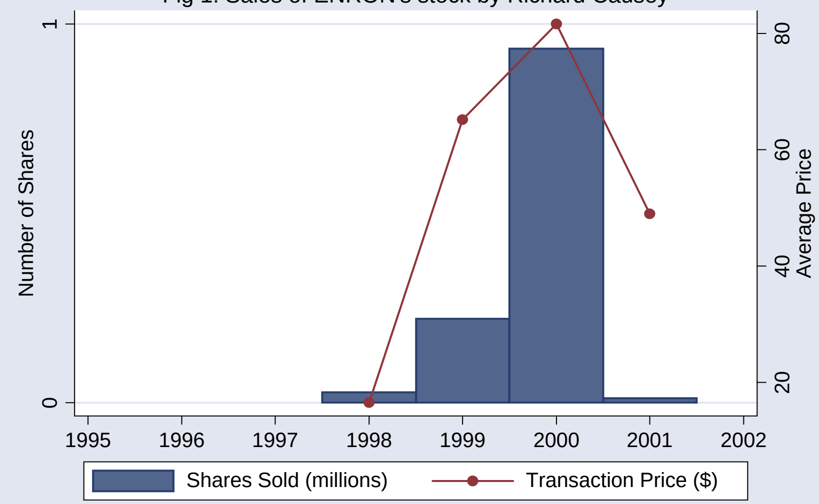
Source: Thomson Financial Insider Filing Data

Fig 1: Sales of ENRON's stock by Andrew Fastow



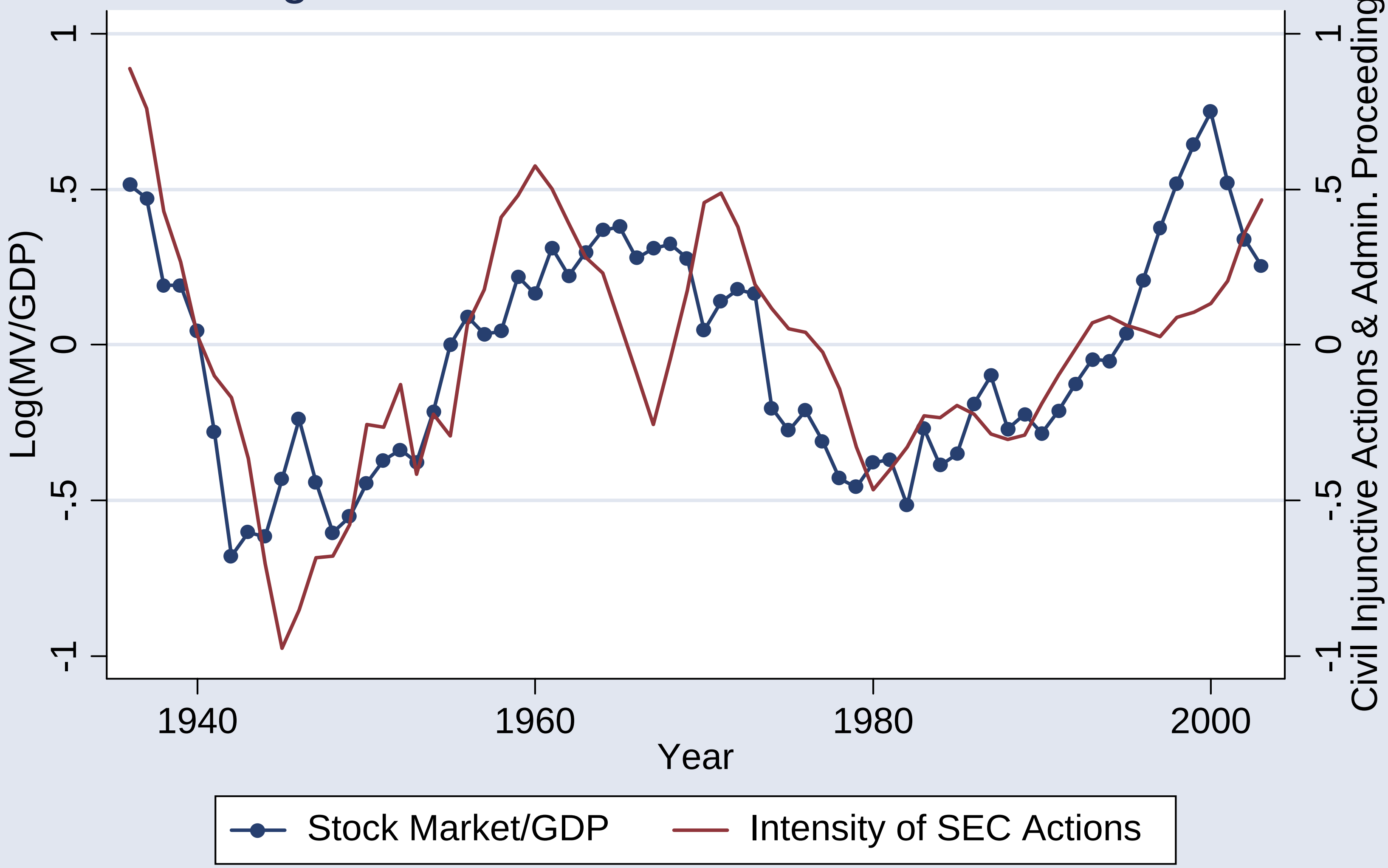
Source: Thomson Financial Insider Filing Data

Fig 1: Sales of ENRON's stock by Richard Causey



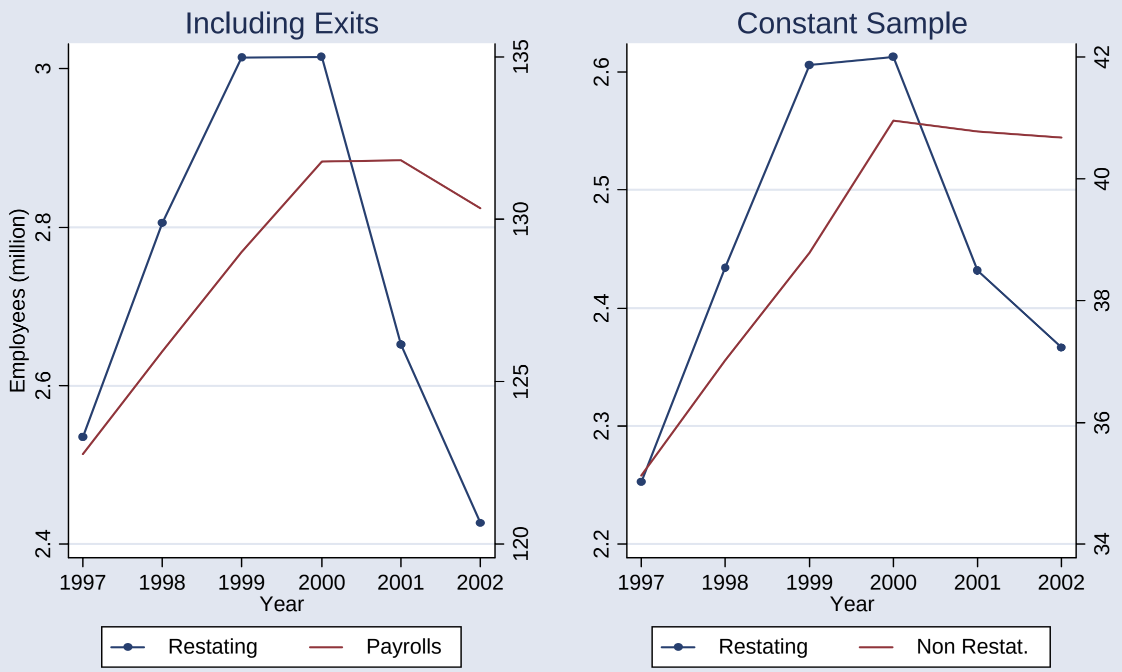
Source: Thomson Financial Insider Filing Data

Fig 2: Market Valuation and SEC Actions



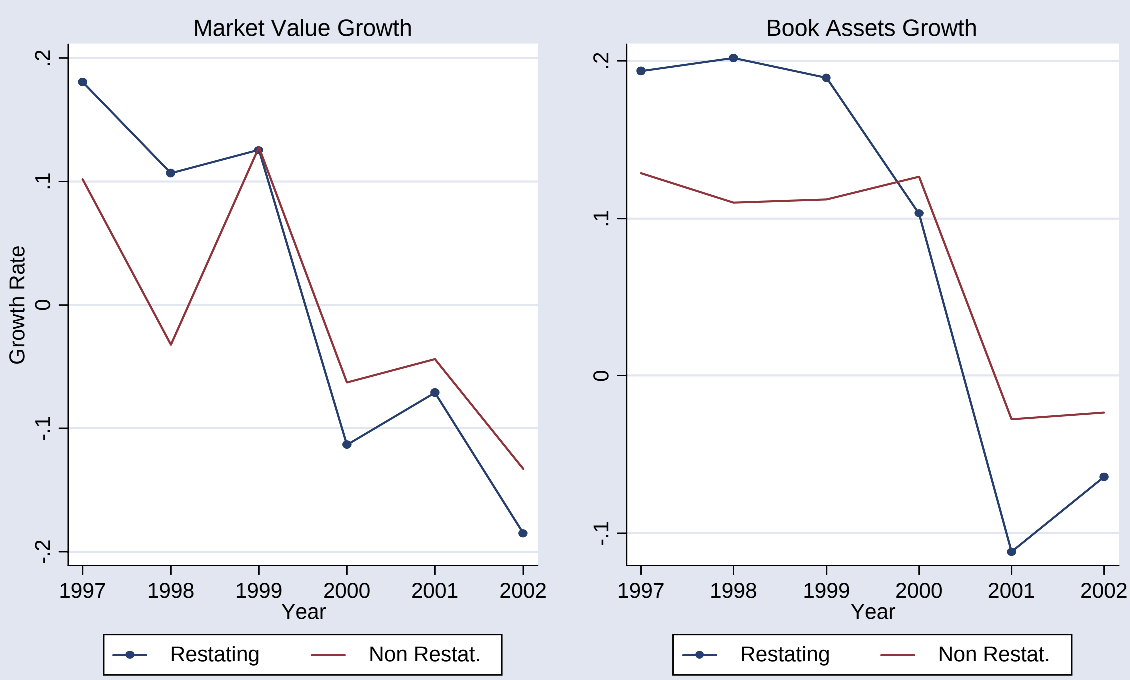
Source: SEC annual reports, CRSP and NIPA.

Fig 3: Employment of Firms Announcing Restatements in 2000-2001



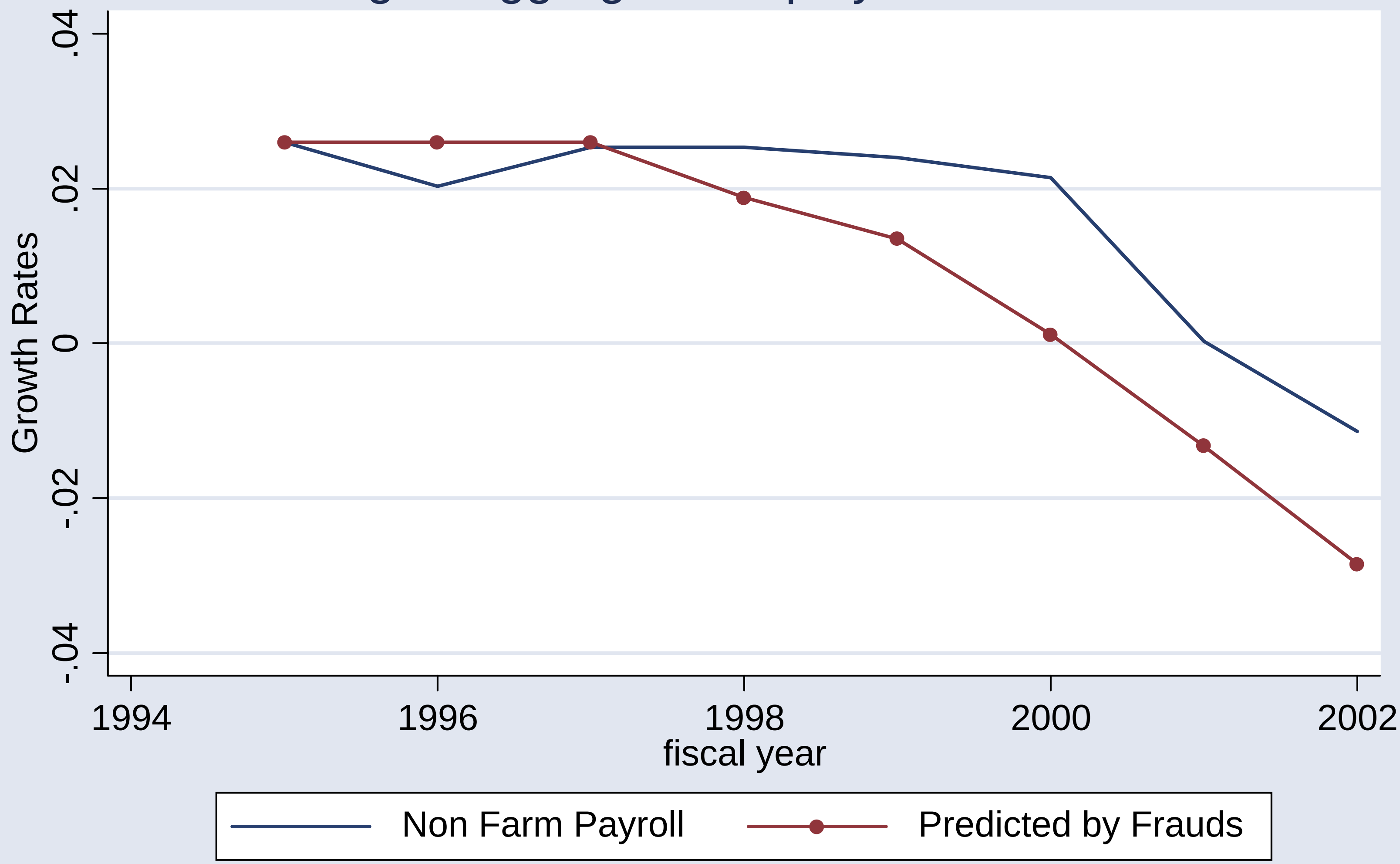
Source: GAO, BLS and COMPUSTAT

Fig 4: Dynamics of Firms Announcing Restatements in 2000-2001



Source: GAO, BLS and COMPUSTAT

Fig 5: Aggregate Employment Growth



Note: predicted series using cross-sectional industry estimates.