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The Macro Impact of Short-Termism

By

Stephen J. Terry

Stanford Institute for Economic Policy Research
Stanford University
Stanford, CA 94305
(650) 725-1874

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Stephen J. Terry*

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Abstract

There is a long concern in economics that investor pressure can induce managerial short-termism, which I examine through the lens of analyst earnings targets. Managers face a tradeoff between short-run profits and long-run investment. This paper starts empirically by showing that firms that just meet earnings targets lower their investment in R&D and intangibles. Firms that just miss their earnings targets cut CEO pay and face drops in stock-market valuation. The paper then builds and structurally estimates a quantitative general equilibrium endogenous growth model with heterogeneous firms, R&D and accounting manipulation choices, and endogenous earnings forecasts. In the model, the short-run pressure to meet earnings forecasts cuts growth because R&D is misallocated across firms, responding too much to short-run profit shocks. This effect cuts growth rates by almost 0.1%, costing the US economy around 6% of output each century. Extending the model to include managerial shirking and empire-building reveals that earnings targets can improve firm value but may still reduce long-run growth and consumer welfare.

Keywords: Short-Termism, Earnings Manipulation, Heterogeneous Agents, Endogenous Growth, Agency Conflicts, Shirking, Empire Building

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1 Introduction

For over a century economists have been concerned that pressure from investors for short-term results can damage the long-run growth of companies. For example, Alfred Marshall famously wrote in 1890 that people act like “children who pick the plums out of their pudding to eat them at once.” This paper examines the macroeconomic growth implications of short-termism through the lens of analyst earnings targets, a particularly prevalent and observable manifestation of short-term pressure today.¹

The benefits from investments in research and development (R&D) or other intangible expenditures may either fail to materialize or appear only much later. Yet the costs of these long-term investments generally must be borne today. In a particularly important example of this tradeoff, R&D must be immediately subtracted or expensed from profits according to the Generally Accepted Accounting Principles (GAAP) governing public firms in the US.² If failure to deliver short-term results has adverse consequences, firms or managers may therefore be willing to sacrifice some long-term value to deliver higher profit now. Economic theory for decades has modeled overall growth and changes in aggregate productivity as the result of long-term investment at the microeconomic level. So a heavy dependence of long-term investment on short-term pressures can be crucial for understanding the process of economic growth in the macroeconomy.³ Furthermore, factors impacting long-term growth disproportionately affect the economy in quantitative terms because of their compounding effects. This paper takes several concrete steps towards empirically documenting and structurally quantifying the costs of short-termism, through the lens of pressure to meet earnings forecasts, on innovative investments, long-term growth, and welfare.

Research analysts at stock brokerages routinely forecast the earnings of public companies. Firms publicly release statements of earnings, an accounting measure of profitability also known as net income or simply profits, at the end of each fiscal quarter and year. The

¹See Marshall (1890) for the quote, as well as Haldane and Davies (2011), Mayer (2012), Markoff (1990), or Michie (2001) for additional perspectives on short-termism. See also Budish et al. (Forthcoming) for a recent empirical treatment of apparent short-termist distortions of long-term investment in cancer drugs.

²See Financial Accounting Standards Board (FASB) rule 730-10-25-1 for the explicit statement of the rule in 2014 US GAAP. By contrast, EU accounting guidelines do allow for discretionary depreciation or amortization of R&D development costs (PricewaterhouseCoopers, 2013).

³See, for example, work by Romer (1990), Aghion and Howitt (1992), Grossman and Helpman (1991), or Acemoglu et al. (2013). Also, note that a recent strand of papers models endogenous growth as the product of idea flows (Perla and Tonetti, 2014; Lucas and Moll, 2011; Alvarez et al., 2008; Sampson, 2014). Since exploiting idea flows remains costly for firms, the tradeoff between growth and performance remains.

financial press as well as equity market participants follow these releases closely during earnings season. Around 90% of the respondents to a broad survey of managers in Dichev et al. (2013) report systematic pressure, internal and external to their firms, to meet earnings benchmarks. Consistent with these reports, Figure I displays the annual distribution of the difference between realized and forecast earnings (forecast errors), scaled by firm assets for a panel of US public firms. A disproportionate number of firm-years report zero or just positive earnings forecast errors, i.e. display profits that just meet or beat analyst forecasts, while the mass of forecast errors is hollowed out just below zero.⁴

Earnings benchmarks and potential concerns about short-termism are not exclusive to public firms. Interestingly, surveys of private and public firm managers reveal quite similar rates of reported earnings pressure.⁵ However, the pressures and incentives surrounding innovation at large public firms, measured directly in this paper, are independently interesting for our broad understanding of innovation in the macroeconomy. Public firms undertake almost two-thirds (67%) of all non-government R&D expenditures in the United States.⁶ A long history of research into apparent real earnings manipulation by public firms also suggests that R&D investments systematically and discontinuously change around earnings benchmarks or targets including analyst forecasts of profits.⁷ More broadly, a literature on investments in technology notes that budgeting deadlines and agency frictions within firms can constrain the ability of organizations to invest in improved productivity, and other work in economic history suggests that the presence of sharp performance targets may contribute to overall inefficiency.⁸

My paper first establishes two empirical facts using a merged database of analyst forecasts

⁴Marinovic et al. (2012) and Hong and Kacperczyk (2010) overview analyst earnings forecasts. Burgstahler and Chuk (2013) emphasizes that the discontinuity in Figure I is robust. The McCrary (2008) sorting test strongly rejects continuity of the distribution at the zero forecast error level. See Garicano et al. (2013), Gourio and Roys (2012), Chetty et al. (2011), Daly et al. (2012), and Allen and Dechow (2013), respectively for evidence of similar bunching in French firm sizes around regulatory thresholds, Danish income around tax kinks, nominal wage changes around zero, and even marathon finish times around focal points.

⁵See Dichev et al. (2013), Table 13.

⁶The R&D statistic reflects the aggregation of R&D expenditures in my baseline sample from Compustat (`xrd`) compared to aggregate research expenditures in 2000 from the NSF Survey of Industrial Research and Development (total private R&D). Note that recent empirical studies by Bernstein (2012), Aghion et al. (2013), or Asker et al. (2014) suggest that the quality and quantity of innovation and investment at publicly traded firms can either be lower than in their private counterparts or hinge crucially upon factors such as institutional ownership with long horizons.

⁷See for example, Bhojraj et al. (2009), Baber et al. (1991), Roychowdhury (2006), or Gunny (2010).

⁸See Liebman and Mahoney (2013) for a study in the US government and Atkin et al. (2014) for an experiment Pakistani manufacturing. See Meng et al. (Forthcoming) for evidence that food procurement quotas across regions may have contributed to the severity of the Great Famine in China.

and firm accounting data. First, firms that just meet or beat analyst forecasts in a particular year exhibit discontinuously lower R&D and broader intangibles investment growth. There is a drop of around 30% in mean R&D and intangibles growth relative to firms that just fail to meet earnings forecasts. Such discontinuities, detected using flexible nonparametric regression discontinuity estimators, are consistent with systematic manipulation of long-term investment to meet analyst forecasts of earnings. Relatedly, a survey of executives at large US public firms in Graham et al. (2005) corroborates the result: almost half of managers reveal that they would reject a positive net present value project if taking the project meant missing analyst forecasts of earnings.⁹ In a second empirical contribution, the paper then applies the same techniques to inspect manager incentives and stock returns. CEOs just failing to deliver profits above consensus analyst expectations face drops of around 7% in total compensation. Earnings pressure is not limited to solely the CEO of a company. The several most highly paid executives in a company face around 5% less total compensation for just failing to meet analyst targets. Furthermore, stock returns are discontinuously lower for firms just failing to meet earnings targets. Firms that just fail to meet earnings targets see around 0.64% lower abnormal cumulative returns in a ten-day window to the earnings release date. The finding of apparent compensation incentives for managers to deliver short-term results, together with capital market pressures, helps to motivate real earnings manipulation but also concurs with a large literature on performance-based incentives and the relationship between earnings announcements and returns.¹⁰

Building off of my empirical findings, the second part of the paper builds a theoretical model linking earnings targets and aggregate growth. The model features managers of heterogeneous firms making R&D investment decisions together with pure paper or accounting manipulation choices subject to both persistent and transitory profitability shocks. R&D expenditures by firms result in random innovation arrival according to a quality ladder structure that aggregates in general equilibrium. Earnings forecasts, endogenously produced by an outside sector of analysts, provide short-term pressure on managers who seek to avoid costs resulting from failure to meet earnings forecasts. The model is agnostic about the

⁹Firms of course can use paper or accounting rather than operational or real decisions to boost earnings above analyst forecasts. Studies such as Burgstahler and Eames (2006) document that discretionary accruals appear to be unusually high for firms just meeting earnings targets.

¹⁰See, for example, Larkin (2014), Oyer (1998), Murphy (1999), Murphy (2001), Matsunaga and Park (2001), Edmans et al. (2013), Jenter and Lewellen (2010), Jenter and Kanaan (Forthcoming), Eisfeldt and Kuhnen (2013), and Asch (1990), Bhojraj et al. (2009), Bartov et al. (2002).

source of these costs for managers, but in practice earnings miss costs may be purely private to the manager due to reputational or career concerns (Dichev et al., 2013), borne by the firm due to higher external finance costs or disrupted communication costs with outsiders (Graham et al., 2005), or even the result of explicit manager compensation policies chosen by firms (Matsunaga and Park, 2001).¹¹

After laying out the model structure, the paper employs numerical solution methods and parametrizes the model using a combination of calibration and structural GMM estimation. Structural estimation here exploits the moments of R&D expenditures, sales, and forecast errors in a panel of firm-level data on thousands of large US public firms to produce a “Baseline” quantitative model economy. My main quantitative results in the paper compare the Baseline environment with a “No Targets” counterfactual economy in which there are no costs or incentives for managers to meet or beat earnings forecasts.

The Baseline model with earnings targets for firms qualitatively reproduces the kinked earnings forecast error distribution in Figure I, with a disproportionate mass of firm-years just above targets and a hollowing out the forecast error distribution below zero. The counterfactual No Targets economy, by contrast, fails to reproduce a kinked distribution. Furthermore, while the No Targets economy produces a smooth distribution of R&D growth across the zero forecast error threshold, the Baseline model leads to a cut in R&D growth for firms just meeting earnings targets, consistent with the empirical evidence from the first portion of the paper. Finally, the counterfactual exercise reveals insights into a body of research in corporate finance studying the release of information contained within earnings releases and surprises (Stein, 1989; MacKinlay, 1997). Firms in the Baseline model with mediocre profitability shocks are able to find the resources, either in long-term investment manipulation or paper obfuscation, to boost earnings above target. Therefore, firms that miss an earnings forecast in equilibrium are far less profitable than firms meeting or beating earnings forecasts, a quantitative difference which is positive but muted by contrast in the No Targets economy. Such considerations may help to explain why firms report increased pressure from outsiders to explain or divulge more information about the prospects of the firm if they miss analyst expectations. The information revelation upon missing an earnings target also naturally helps to motivate the change in stock returns I document empirically for firms just failing to meet earnings targets.

¹¹In my model-based calculations, I choose between these alternatives in a manner which results in conservative estimates of the costs of earnings targets.

Within the model, short-termism can be defined as responsiveness of forward-looking R&D policies to purely transitory or short-term shocks to profitability, even when those shocks contain no information about the profitability of innovation in the long term. The Baseline economy features such short-termism, resulting in lower and more volatile R&D expenditures.¹² Increased volatility impacts the overall efficiency of R&D expenditures for firms even absent any effects on levels, since my theoretical structure includes curvature or diminishing returns to R&D. Just as Barlevy (2004) theoretically links business cycle volatility to reduced growth in the macroeconomy in the presence of diminishing returns to investments, my model implies that firms subject to transitory profitability shocks and choosing more volatile R&D expenditures have fewer innovation arrivals than would result from a smoother long-term investment path.¹³ At the microeconomic level the result is lower firm value on average, an approximately 1% reduction in mean firm value in the Baseline economy relative to the No Targets case. By studying the distortion to long-term investments resulting from earnings targets, I contribute to a literature on structural estimation in dynamic corporate finance which outlines the costs to firms resulting from, for example, financial frictions, CEO firing costs, or agency frictions surrounding cash holding and investment.¹⁴

At the macroeconomic level, the Baseline economy with earnings targets is characterized by lower aggregate growth of around 2.25% per year relative to a growth rate of around 2.31% per year in the No Targets environment. By exhibiting short-termism and responding to purely transitory profitability shocks with their long-term R&D investments, manager earnings pressure causes a sort of research misallocation, whereby the efficiency of aggregate innovation declines.¹⁵ Small changes in permanent growth rates translate into quantitatively large differences in welfare, because these changes are continuously compounded over time. In my model, the removal of earnings targets results in an overall increase in welfare of 0.44%, i.e. consumption in each period would need to be increased by almost half a percent in the Baseline to make the aggregate household as well off as in the No Targets balanced

¹²High R&D sensitivity to profitability echoes empirical work in corporate finance. See, for example, Borisova and Brown (2013), Brown and Petersen (2009), and Mairesse et al. (1999).

¹³For further macroeconomic work on the link between volatility and growth, see for example Ramey and Ramey (1995) or Imbs (2007).

¹⁴See Hennessy and Whited (2007), Taylor (2010), and Nikolov and Whited (2010), respectively. Strebulaev and Whited (2012) provides an overview of structural estimation in dynamic corporate finance.

¹⁵The misallocation from profitability volatility is distinct from but related to the broader literature on misallocation in Hsieh and Klenow (2009), Restuccia and Rogerson (2008), Peters (2013), Asker et al. (2013), or Yang (2014).

growth path.¹⁶ For comparison, recent quantitative estimates of the welfare gains from the elimination of business cycles are around 0.1-1.8%, or the static gains from trade according to recent work could be approximately 2.0-2.5%.¹⁷ Overall, short-termism from earnings targets results in a quantitatively large distortion to long-term growth and the macroeconomy.

The main quantitative contribution of the paper should be interpreted as the delineation of the *costs* of earnings targets as outlined above. However, earnings targets may of course also provide benefits to firms or society, omitted from the baseline cost measurements.¹⁸ For example, earnings forecasts may contribute to more accurate valuation of firms or alleviate financial frictions at otherwise healthy firms. In fact, a series of recent theoretical and empirical papers indicates that alleviation of financial frictions or the liberalization of equity markets can indeed reap efficiency gains from better allocation of resources throughout the macroeconomy.¹⁹ A second source of potential benefits from earnings targets operates within firms through the provision of discipline to managers in the presence of agency conflicts. Compensation schemes which explicitly or implicitly punish managers for failure to meet publicly observable earnings forecasts may lead to firm or social gains. The final portion of the paper analyzes multiple sources of agency conflicts within the existing model of dynamic manager investment used initially to estimate the costs of earnings pressure.

A corporate finance investment literature emphasizes that firms are riddled with agency frictions leading to a wedge between the interests of managers and firms as a whole (Stein, 2003). Two classic forms of agency conflict include unobservable shirking by managers (Edmans et al., 2009; Grossman and Hart, 1983) and empire building motivated by private manager benefits from size or investment (Nikolov and Whited, 2010; Jensen, 1986). When managers can provide low effort, I show that for strong enough shirking motives earnings targets within manager compensation contracts may improve value for firms as well as social welfare. The dynamic distortion to long-term investment, while costly, may be overwhelmed

¹⁶US consumption was around \$11,500 billion in 2013 according to the BEA as of March 2014, so a 0.44% increase in consumption is equivalent to a permanent increase in consumption of around \$51 billion each year. The overall welfare gains decompose into 1.32% dynamic gains from growth rate changes and a static loss of -0.86% due to higher initial investment in R&D.

¹⁷See Krusell et al. (2009) for the welfare consequences of business cycles, Costinot and Rodríguez-Clare (2015) or Melitz and Redding (2013) for the welfare gains from trade. Also, see Hassan and Mertens (2011) for the social cost of “near-rationality” in investment, around 2.4% in consumption-equivalent terms.

¹⁸An interpretation of this sort is the norm for cost calculations in macroeconomics, with the most prominent example being the literature on the costs of business cycles (Lucas, 2003; Barlevy, 2004; Krusell et al., 2009). Gains from the elimination of business cycles may not be achievable if their elimination is costly.

¹⁹See, for example, Midrigan and Xu (2014), Moll (Forthcoming), Buera and Shin (2013), Buera et al. (2011), or Campello et al. (2014).

by the gains to levels obtained from increased discipline. In a second case, when firm agency conflicts are instead characterized by empire-building tendencies for managers, earnings targets may improve firm value by restraining R&D investments. If the social and private returns to R&D differ, however, restraint of R&D through earnings pressure can lead to an exacerbation of underinvestment from the social perspective and an increase in social losses from earnings targets.

So, the model’s implications depend crucially on assumptions about the exact form of agency conflicts within firms. Motivated by this consideration, I focus on qualitative results within my discussion of the benefits of earnings targets, demonstrating possibilities over a broad range of model parametrizations.

Section 2 of the paper describes my data and lays out the empirical results linking earnings forecasts, long-term investment, and CEO incentives. Section 3 describes the quantitative model of earnings pressure and growth, together with my numerical solution and estimation strategy. Section 4 performs the main quantitative analysis estimating the costs of short-termism for firms and the macroeconomy. Section 5 explores potential agency benefits from short-term pressure. Section 6 concludes. Appendixes follow describing the data (Appendix A), theory (Appendix B), and numerical solution method (Appendix C).

2 Data and Empirical Discontinuities

This section empirically investigates the manipulation of long-term investment and incentives for executives surrounding earnings targets for firms. First, after joining analyst forecasts of earnings with the accounting releases of US public firms, my analysis reveals that firms just meeting earnings targets exhibit substantially lower long-term investment growth in R&D as well as broader intangibles. Similarly, CEOs and other executives at firms just failing to meet earnings targets receive discontinuously lower compensation.

This paper draws on data from two main sources. First, I use millions of earnings forecasts at the firm-analyst level from the Institutional Brokers Estimates System (I/B/E/S) database. Actual or realized values of firm “Street” earnings per share accompany the analyst forecasts in I/B/E/S.²⁰ I also use Compustat data drawn from the annual accounting reports of public firms.

²⁰So-called Street earnings, over which firms possess moderate discretion, are the appropriate measure of earnings for my purposes, since Street earnings are more widely followed by financial market participants and observers than the net income measures reported in Compustat (Bradshaw and Sloan, 2002).

Linking the I/B/E/S and Compustat datasets results in a panel of around 25,000 firm-fiscal year observations with consensus analyst forecasts, Street realizations, and basic accounting outcomes. Around 4,000 firms from 1983-2010 are available in the combined unbalanced panel. The sample primarily consists of larger firms, accounting for around 11% of US employment, 67% of all US private R&D expenditures, and total sales of around 31% of US GDP.²¹ See Data Appendix Table A.I for descriptive statistics on the sample. I also incorporate Execucomp data on CEO and executive compensation where possible, as well as Center for Research in Security Prices (CRSP) data on stock returns. Data Appendix A provides further information on the datasets, the sample restrictions imposed, and the construction of individual variables.

If managers face incentives to meet earnings forecasts, then firms should avoid reporting profits just below analyst forecasts if possible, instead taking actions throughout their fiscal year to satisfy expectations. In this section I employ a flexible empirical tool, nonparametric regression discontinuity techniques, to identify exactly this type of earnings manipulation through changes in the distribution of long-term investment as firms just meet forecasts. By the first application of regression discontinuity estimators to my knowledge in this context, I contribute to a literature which treats similar results as *prima facie* evidence of earnings manipulation by firms.²²

Throughout the empirical analysis, my preferred measure of the forecast error for a particular firm j in year t is the realized value of Street earnings Street_{jt} minus the median analyst forecast of firm earnings made from the middle of the same fiscal year Street_{jt}^f scaled by firm assets. This measure of earnings forecast errors is a standard one used in accounting studies (Burgstahler and Eames, 2006; Burgstahler and Chuk, 2013).

Forecast errors serve as the running variable in my regression discontinuity estimation with a cutpoint of zero. The first measure of investment I consider at firms is the tangible investment rate. Since tangible capital expenditures are depreciated from earnings over time rather than immediately expensed as incurred, their impact on current earnings and hence usefulness as a tool for earnings manipulation is diluted. Ex-ante, therefore, I expect little

²¹For these comparisons, US employment is total nonfarm payrolls according to the BLS in 2000 (St. Louis FRED variable PAYEMS), while Compustat employment is the variable `emp`. US R&D expenditures are drawn from the National Science Foundation Survey of Industrial Research and Development in 2000, with R&D for the corresponding year from Compustat variable `xrd`. US nominal GDP in 2000 comes from the BEA (St. Louis FRED variable GDPA), with Compustat gross sales in variable `sale`.

²²See, for example, Roychowdhury (2006), Gunny (2010), Baber et al. (1991), or Burgstahler and Eames (2006).

change in tangible investment rates for firms just meeting earnings targets. By contrast, two measures of long-term investment, R&D expenditures and broader “Intangibles” expenditures are both immediately expensed from earnings in the period incurred.²³ A growing empirical literature within economics and finance concludes that long-term investment expenditures contribute to long-term profitability for firms, to aggregate productivity over the business cycle, and to an improved explanation of stock returns in the cross section of firms.²⁴

The first three columns of Table I above report regression discontinuity estimates of the predicted difference in the tangible investment rate, overall intangible expenditures growth, and R&D growth for firms just meeting their earnings targets in a given year relative to firms failing to meet an earnings target. I compute results using outcomes demeaned by firm then year, controlling for both permanent trend heterogeneity across firms in long-term investments as well as business cycle effects.²⁵ I detect no discontinuity in tangible investment rates. By contrast, R&D growth and overall intangibles growth are both approximately 2.5% lower for firms just meeting an earnings target. The discontinuities are statistically significant and economically meaningful, each representing a cut of around 30% of average annual long-term investment growth.²⁶

Note that I make no direct causal claims from my regression discontinuity results of the form that is typically relied upon in applied microeconomics (Lee and Lemieux, 2010). By contrast, the apparent endogenous “sorting” of firms to the right of the zero forecast error cutpoint, which would typically be considered a threat to identification, lies at the very core of my argument for the economic impacts of earnings targets. In a later section, I build and estimate a quantitative model of R&D investment and earnings forecasts. The model demonstrates that reduced R&D growth around the zero forecast error threshold

²³Intangibles expenditures are equal to selling, general, and administrative (SG&A) expenditures. SG&A, a basic accounting item, enjoys extensive coverage within the Compustat database and include not only R&D expenses but also a range of other nonproduction expenses such as management labor compensation, training expenditures, and advertising costs.

²⁴See for example Eisfeldt and Papanikolaou (2013, 2014), Gourio and Rudanko (2014), McGrattan and Prescott (2014), Hall (2004), Corrado et al. (2009), Corrado et al. (2013), or Corrado et al. (2012).

²⁵Of course this implies that the results from Table I are based upon a two-stage procedure. Table I follows the literature by relying upon straightforward clustering at the firm level in the calculation of standard errors. For robustness, however, Table A.III in Data Appendix A reports the results with no qualitative changes from a block bootstrap procedure taking into account within-firm correlation as well as uncertainty associated with the first-stage demeaning of outcome variables.

²⁶For all the regression discontinuity tests in this section, see Table A.II in Data Appendix A for placebo checks. Data Appendix Figure A.I plots a range of robustness checks with bandwidth choice alternatives to the optimal Imbens and Kalyanaraman (2011) value used in Table I. Placebo checks reveal no significant breaks at alternative cutpoints away from 0, and bandwidth plots reveal robustness.

should be expected in the presence of incentives for managers to meet earnings targets but would otherwise be absent. Such results structurally support the convenient use of regression discontinuity methodology as a detection mechanism in this context.

Pressure to meet earnings targets can represent the product of explicit efforts of the distributed shareholders or boards of firms to provide discipline to CEOs and managers with interests divergent from their own. Therefore, discipline for managers may be evident in observed compensation for the CEO or for the several most highly paid executives in a firm.²⁷ Table I displays estimated discontinuities in pay. CEOs that generate earnings just below analyst forecasts earn approximately 7% less, while the top managers as a whole receive around 5% lower compensation. Discontinuous manager incentives in my sample link to a literature in corporate finance and accounting that documents either discontinuities in manager compensation at earnings benchmarks or interaction between investment responses to earnings targets and CEO equity incentives (Matsunaga and Park, 2001; Edmans et al., 2013). However, just as in the case of long-term investments, my results represent to my knowledge the first application of regression discontinuity methodology to the study of earnings target incentives.

Finally, Table I also documents a discontinuity in abnormal returns. Firms just failing to meet targets have approximately 0.64% lower cumulative abnormal returns in a ten-day window to the earnings release date. This result corroborates literature on the information content within earnings releases as well as on a capital market premium to meeting or beating analyst expectations.²⁸ However, also note that horizon matters for the interaction between earnings targets and outcomes. Changes in long-term investments such as R&D expenditures over the course of the year naturally take time to implement. The results in this paper therefore reflect earnings forecasts made for the full fiscal year from the perspective of the middle of the year, i.e. from a two-quarter horizon. The single exception to this rule is the discontinuity in abnormal returns, which I document using a forecast horizon of one quarter. Following the related discussion of forecast horizons in Bhojraj et al. (2009), I feel that these timing choices strike the appropriate balance between allowing for R&D and investment choices to be implemented, on the one hand, and incorporating a fuller range of information available to capital market participants when examining return patterns on the other hand.

²⁷In this paper, total compensation includes salary, bonuses, and the value of stock option-based pay.

²⁸See, for example, the results contained in Stein (1989), MacKinlay (1997), and Bartov et al. (2002).

Table I: Estimates of Firm Regression Discontinuities in Forecast Errors

	(1)	(2)	(3)	(4)	(5)	(6)
Method	Local Linear	Local Linear	Local Linear	Local Linear	Local Linear	Local Linear
Dependent Variable	Investment Rate	Intangibles Growth	R&D Growth	CEO Pay	Executive Pay	Abnormal Returns
Running Variable	Forecast Error	Forecast Error	Forecast Error	Forecast Error	Forecast Error	Forecast Error
Cutpoint	0	0	0	0	0	0
Discontinuity	0.35 (0.40)	-2.66** (0.95)	-2.57* (1.44)	6.78** (2.68)	4.88*** (1.75)	0.64*** (0.21)
Effects	Firm, Year	Firm, Year	Firm, Year	Firm, Year	Firm, Year	Market-Adjusted
Years	1983-2010	1983-2010	1983-2010	1992-2010	1992-2010	1983-2010
Firms	3969	3969	3969	2349	2382	7794
Observations	23084	23084	23084	17661	114296	48297
Relative to Mean	1.4%	-27.0%	-32.9%	6.78% ^a	4.88% ^a	0.64% ^a

Note: *,**,*** denote 10, 5, 1% significance. The regression discontinuity estimation relies on local linear regressions and a triangular kernel, with bandwidth chosen via the optimal Imbens and Kalyanaraman (2011) approach. Standard errors are clustered at the firm level. The estimates represent the mean predicted differences for firms just meeting earnings forecasts relative to firms just failing to meet forecasts. Earnings forecast errors are Street earnings minus median analyst forecasts from a 2-quarter horizon, scaled by firm assets as a percentage. Investment Rate is the percentage tangible annual investment rate. Intangibles growth is annual percent selling, general, and administrative expenditures growth. R&D growth is annual percent research and development expenditure growth. CEO Pay, Executive Pay are the log of total compensation for the CEO and several most highly compensated executives at a firm, respectively. Abnormal Returns are the cumulative abnormal returns for a firm in a ten-day window to the announcement date, market adjusting using the returns of the S&P 500. For returns analyst forecasts are drawn from a 1-quarter horizon.

^a Executive pay and stock returns are already in normalized form, and these values duplicate discontinuity estimates.

3 Model of Earnings Pressure and Growth

In this section I build a quantitative model of endogenous growth and earnings targets, followed by a discussion of the equilibrium concept and numerical solution method. Finally, I explain my parametrization of the model based on GMM structural estimation using firm-level moments from my Compustat and I/B/E/S sample.

3.1 Baseline Model Structure

Time is discrete, and a representative household subject to no aggregate uncertainty maximizes utility from a flow of aggregate consumption C_t denominated in units of a final good. Period utility takes a standard constant relative risk aversion form with subjective discount rate ρ and intertemporal elasticity of substitution $\frac{1}{\sigma}$. The household purchases shares S_{jt} at price P_{jt} , receives dividends D_{jt} from a fixed continuum of intermediate goods firms $j \in [0, 1]$, and inelastically supplies a fixed amount of labor L to a final goods sector at wage rate w_t . The household problem is

$$\max_{C_t, B_{t+1}, \{S_{jt}\}} \sum_{t=0}^{\infty} \rho^t \frac{C_t^{1-\sigma}}{1-\sigma}$$

$$C_t + B_{t+1} + \int_0^1 P_{jt} S_{jt} dj = R_t B_t + w_t L + \int_0^1 (P_{jt} + D_{jt}) S_{jt-1} dj.$$

The household also makes a savings choice B_{t+1} in a one-period bond with interest rate R_{t+1} . As is standard, in general equilibrium household Euler equations will link growth rates and firm policies to this interest rate. Furthermore, on the balanced growth path which I will consider in this paper, interest rates will be fixed at a value R . The numeraire final good is produced by a competitive, constant returns to scale, and price-taking sector which combines intermediate goods X_{jt} from each firm j , and demands labor in the amount L_t^D to produce output Y_t in each period. The labor share is β , and the final goods technology is

$$Y_t = \frac{L_t^{D\beta}}{(1-\beta)} \int_0^1 [Q_{jt}(a_{jt} + \varepsilon_{jt})]^\beta X_{jt}^{1-\beta} dj.$$

As will be discussed in more detail below, each intermediate goods firm at time t possesses both a quality level Q_{jt} , together with an exogenous profitability shock $a_{jt} + \varepsilon_{jt}$.²⁹ Together, these quantities determine the marginal product of intermediate input X_{jt} in final goods

²⁹The intermediate goods firm profitability shock is the sum of persistent a_{jt} and transitory ε_{jt} .

production. The final goods problem is

$$\max_{\{X_{jt}\}, L_t^D} Y_t - \int_0^1 p_{jt} X_{jt} dj - w_t L_t^D.$$

The form of the final goods sector optimization problem above, which follows Acemoglu and Cao (Forthcoming), yields a standard isoelastic downward-sloping demand curve for variety j , given by

$$X_{jt} = p_{jt}^{-1/\beta} L Q_{jt} (a_{jt} + \varepsilon_{jt}).$$

Each member of the fixed continuum of intermediate goods firms $j \in [0, 1]$ faces idiosyncratic uncertainty.³⁰ Firm j is associated with a manager who in each period determines its monopoly price p_{jt} , R&D investment z_{jt} , and paper or accounting manipulation m_{jt} . Firm j 's long-term quality level Q_{jt} is nonstationary and grows from R&D investments according to a quality ladder structure. Simultaneously, stationary exogenous profitability shocks a_{jt} and ε_{jt} satisfy

$$a_{jt} = (1 - \rho_a) + \rho_a a_{jt-1} + \zeta_{jt}, \quad \zeta_{jt} \sim N(0, \sigma_a^2)$$

$$\varepsilon_{jt} \sim N(0, \sigma_\varepsilon^2).$$

The transitory shock process ε_{jt} buffets firm profitability in each period, while the AR(1) process a_{jt} persists. A number of recent papers apply a similar basic structure, decomposing volatility affecting firm or economy-wide investment choices into persistent and transitory components, and of course transitory-persistent shock breakdowns have a long history in labor economics.³¹ Variable profits $\Pi_v(Q_{jt}, a_{jt}, \varepsilon_{jt}, p_{jt})$ in firm j equal total revenue minus total production costs. Intermediate goods firms can convert final goods output to variety j of intermediate output at constant marginal cost ψ , yielding

$$\Pi_v(Q_{jt}, a_{jt}, \varepsilon_{jt}, p_{jt}) = p_{jt} X_{jt} - \psi X_{jt}.$$

The isoelastic form of the final goods sector's demand for input j implies an optimal constant markup pricing rule for p_{jt} over marginal cost ψ ,³² so that eventually variable profits take

³⁰Throughout the paper, I abstract from entry and exit with a fixed set of intermediate goods firms. This assumption is made more palatable by my structural estimation of the model with data from large public firms with lower exit hazards. However, I abstract from the Schumpeterian interactions between entry and innovation studied in endogenous growth models starting with Aghion and Howitt (1992).

³¹Such papers for firm investments include Aguiar and Gopinath (2007), Franco and Philippon (2007), Roys (2011), and Gourio (2008), while Blundell et al. (2008) and many others consider household persistent and transitory shock decompositions in the presence of a consumption/savings choice.

³²For notational convenience, following Acemoglu and Cao (Forthcoming), I make the assumption that $\psi = 1 - \beta$, leading to a monopoly price of $p_{jt} = \frac{1-\beta}{1-\beta} = 1$.

the following homogenous form in Q_{jt} :

$$\Pi_v(Q_{jt}, a_{jt}, \varepsilon_{jt}, p_{jt}) = \beta Q_{jt}(a_{jt} + \varepsilon_{jt})L.$$

Firm j 's scaled R&D choice z_{jt} leads to a total expenditure of $z_{jt}Q_{jt}$ and results in an innovation with probability $\Phi(z_{jt}) = Az_{jt}^\alpha$. The parameter $\alpha \in (0, 1)$ governs the elasticity of innovation arrival with respect to R&D. Innovations embody a proportional improvement up a quality ladder by amount $\lambda > 1$, so that the level of long-term quality Q_{jt+1} for firm j in period $t + 1$ is

$$Q_{jt+1} = \begin{cases} \lambda Q_{jt}, & \text{with probability } \Phi(z_{jt}) \\ \max(Q_{jt}, \omega Q_{t+1}), & \text{with probability } 1 - \Phi(z_{jt}) \end{cases}.$$

Eventually, if firm j lags and does not innovate for long enough, the firm will receive a diffusion of some small fraction ω of the average quality level Q_{t+1} of the economy as a whole.³³

Managers also make discretionary accounting choices which affect reported earnings. Empirically, paper manipulation by public firms can be accomplished through judicious use of tools such as heavy revenue accrual or recognition into earnings within a fiscal period. Through their accounting discretion, managers may also shift their reported Street earnings from a value which would be determined by strict application of GAAP principles to the more flexible value reported in the financial press. However, activities such as accruals manipulation bear costs for at least two reasons. First, by recognizing revenues now firms constrain their ability to count those revenues towards earnings in future. Second, more discretionary accounting manipulation involves more disruption of manager time, higher auditor expenses, or even higher probability of fraud detection and prosecution.³⁴ In the model, by choosing manipulation level m_{jt} firm j can induce a net paper shift of its reported earnings by $m_{jt}Q_{jt}$ subject to a quadratic cost $\gamma_m m_{jt}^2 Q_{jt}$. Overall earnings Π_{jt}^{Street} reported in the model are defined as variable profits net of R&D expenditures and paper manipulation:

$$\Pi_{jt}^{Street} = \Pi_v(Q_{jt}, a_{jt}, \varepsilon_{jt}, p_{jt}) - z_{jt}Q_{jt} + m_{jt}Q_{jt}.$$

³³The diffusion structure follows Acemoglu and Cao (Forthcoming) and is useful to deliver existence of a stationary distribution of normalized firm-level quality levels Q_{jt} on a balanced growth path for the economy.

³⁴See Dichev et al. (2013) for a survey-based discussion of the costs of earnings manipulation perceived by managers at large firms in the United States. See Bradshaw and Sloan (2002) for a further discussion of the distinction between Street and GAAP earnings in practice. See Zakolyukina (2013) for a structural model of paper accounting manipulation. See Druz et al. (2015) for a discussion of manipulation of earnings conference calls through manager tone.

For individual firms, forecasts of earnings evolve over time based on the rational projections of an outside sector of identical equity analysts. Since earnings Π_{jt}^{Street} are homogeneous in long-term quality Q_{jt} , analysts forecast normalized earnings $\pi_{jt} \equiv \Pi_{jt}^{Street}/Q_{jt}$. Analysts understand the structure of the economy, including the exogenous shock processes and the potential for earnings manipulation by firms. Forecasters possess an information set at time t consisting of lagged normalized earnings π_{jt-1} , consistent with survey evidence in Brown et al. (2014) revealing that large fractions of equity analysts incorporate recent earnings performance into the production of their earnings forecasts.³⁵ Further motivated by empirical evidence suggesting that analysts face career concerns and pressure to produce accurate forecasts of earnings,³⁶ in the model forecasts $\pi_{jt}^f(\pi_{jt-1})$ minimize the following ex-ante expected quadratic loss function:

$$\pi_{jt}^f = \arg \min_{\pi^f} \mathbb{E}_{\pi_{jt-1}} (\pi^f - \pi_{jt})^2.$$

Optimally forecasts in the model therefore satisfy $\pi_{jt}^f(\pi_{jt-1}) = \mathbb{E}(\pi_{jt}|\pi_{jt-1})$, and firm j is aware of its earnings forecast π_{jt}^f when making R&D investment and paper manipulation choices in period t .

The manager of firm j maximizes the expected discounted flow of their personal utility.³⁷

Their decisions solve

$$\max_{\{z_{jt}, m_{jt}, p_{jt}\}_t} \mathbb{E} \left\{ \sum_{t=0}^{\infty} \left(\frac{1}{R} \right)^t D_{jt}^M \right\}.$$

Manager compensation depends on a constant, exogenous share θ_d of ownership in their firm. Given manager choices for R&D, accounting manipulation, and pricing, firm dividends in period t equal variable profits minus R&D expenditures and resource costs of paper manipulation:

$$D_{jt} = \Pi_v(Q_{jt}, a_{jt}, \varepsilon_{jt}, p_{jt}) - z_{jt}Q_{jt} - \gamma_m^2 m_{jt}Q_{jt}.$$

³⁵In practice, analysts may of course use more information for forecasts than lagged earnings alone. However, Numerical Appendix Table C.III demonstrates that within the model a lagged earnings information set results in high forecast accuracy. In particular, only marginal improvements in forecasting performance would result from broader information sets including lagged forecast errors or R&D expenditures.

³⁶See, for example, Hong et al. (2000), Hong and Kubik (2003), or Hong and Kacperczyk (2010). Theoretical frameworks using analyst objective function based on squared-error loss include Marinovic et al. (2012) and Beyer and Guttman (2011).

³⁷Managers discount their flow utility using the interest rate R implied by household decisions. In Theory Appendix B, I provide details of a microfoundation of this discounting structure with overlapping generations of one period-lived managers selling a manager franchise onwards to the next period's manager after choosing firm policies.

Manager flow utility, linear in consumption and other payoffs, is given by

$$D_{jt}^M = \theta_d D_{jt} - \xi \mathbb{I}(\Pi_{jt}^{Street} < \Pi_{jt}^f) Q_{jt}.$$

The first term in D_{jt}^M simply represents the manager's dividend share. The second term contains the impact of firm earnings forecasts on the manager objective and hence firm policies. A manager who fails to deliver earnings which meet or beat analyst expectations suffers a fixed loss governed by the parameter $\xi \geq 0$. In particular, however, when $\xi = 0$ the manager problem results in firm profit maximization. Although in Section 5 I will explicitly examine the potential for other agency frictions such as a manager taste for shirking or empire-building, note that these channels are shut down in my initial framework.

The discontinuous, fixed nature of the miss cost is a natural choice given the kinked forecast error distribution in Figure 1 as well as the evidence for discontinuous manager incentives from Section 2. In principle, earnings miss costs can represent three separate sources of loss for managers

$$\xi = \xi^{manager} + \theta_d \xi^{firm} + (1 - \theta_d) \xi^{pay}.$$

The first potential component of miss costs for managers, $\xi^{manager}$, is purely private and could include career or reputational concerns for managers. Surveyed managers report that such reputational concerns loom large (Dichev et al., 2013). Alternatively, managers may suffer increased effort costs due to higher rates of more negatively focused communications with outsiders upon an earnings miss (Yermack and Li, 2014).³⁸

The second potential component of miss costs, ξ^{firm} , reflects any resource, disruption, or other costs borne by firms rather than directly by managers for failure to meet analyst expectations. Such firm-borne costs still affect managers through their ownership shares θ_d . Surveyed managers report that efforts to avoiding earnings misses are important to maintain a low cost of external finance, to avoid triggering debt covenants, and even to avoid higher likelihood of lawsuits from shareholders (Graham et al., 2005).

The third and final component of miss costs, ξ^{pay} , represents the potential for a firm to explicitly condition manager compensation on meeting earnings targets. In particular, if exogenous compensation includes not only a dividend share but also an amount $\xi^{pay} Q_{jt}$

³⁸Given the focus of my paper on long-term growth rather than fluctuations, I abstract through a constant value of ξ from potential fluctuations in managerial incentives to meet or beat earnings benchmarks over time. However, recent empirical evidence presented by Stein and Wang (2014) suggests that such incentives may vary with the overall level of economic volatility or uncertainty.

clawed back conditional upon a miss, then the net loss to a manager from this channel is given by $(1 - \theta_d)\xi^{pay}$. Empirically, managers failing to meet earnings benchmarks suffer reduced bonuses (Matsunaga and Park, 2001), and the empirical evidence from Section 2 suggests that total compensation is discontinuously lower for managers just failing to meet analyst forecasts.

My structural estimation approach for quantifying a manager’s cost of missing an earnings target, will identify only the combined cost ξ rather than the three individual components $\xi^{manager}$, ξ^{firm} , and ξ^{pay} . When making quantitative statements about the overall cost of earnings targets in Section 4, I conservatively assume that the entirety of the term ξ represents personal costs $\xi^{manager}$. Any changes in firm value or household welfare due to distorted manager policies are therefore due to the policies themselves rather than a direct mechanical contribution from resource costs ξ^{firm} .

3.2 Balanced Growth Path Equilibrium and Numerical Solution

The model outlined above admits a balanced growth path equilibrium at which all model aggregates, including average quality $Q_t = \int_0^1 Q_{jt}dj$, grow at constant rate g . Theory Appendix B outlines the full equilibrium definition, which involves four major optimizing components: 1) optimal household consumption and savings decisions C_t , S_{jt} , and B_{t+1} given the budget constraint, 2) competitive final goods firm optimization over intermediate goods X_{jt} and labor demand L_t^D , 3) intermediate goods firm manager optimization over monopoly pricing p_{jt} , R&D investment z_{jt} , and paper earnings manipulation m_{jt} , and 4) rational analyst forecasts of earnings π_{jt}^f for each firm. An economy-wide resource constraint, labor market clearing, asset market clearing, and aggregation consistency conditions complete the characterization of general equilibrium for the model.

I use numerical techniques to solve the model. Given homogeneity of manager returns in long-term quality, I first normalize their dynamic problem by the average quality level in the economy Q_t . This normalization yields a stationary recursive formulation reported in Theory Appendix B as a function of four state variables: q (normalized endogenous long-term quality), a (exogenous persistent profitability), ε (exogenous transitory profitability), and π^f (endogenous analyst forecasts of earnings). I notationally omit dependence on j or t for clarity, indicating future and lagged values by $'$ and $_{-1}$, respectively. I solve the manager problem using standard numerical dynamic programming techniques (Judd, 1998). I also

rely upon a polynomial approximation to the analyst expectation $\pi^f = \mathbb{E}(\pi|\pi_{-1})$.³⁹ For a given parametrization of the model and solution to the manager's problem, I compute a stationary distribution $\mu(q, a, \varepsilon, \pi^f)$ of firm states.

Model aggregates are a function of the stationary distribution μ . My algorithm for full general equilibrium solution of the model along a balanced growth path, explained in more detail in Numerical Appendix C, involves a hybrid dampened fixed-point and bisection algorithm iterating over the growth rate g , interest rate R , and forecast function $\pi^f(\pi_{-1})$ such that the following three fixed points are satisfied:

1. The constant interest rate R and growth rate g satisfy the household Euler equation:

$$R = \frac{1}{\rho}(1 + g)^\sigma$$

2. An economy-wide growth rate equal to g results from the aggregation of intermediate goods firm R&D investment policies z and the innovation arrival function $\Phi(z)$:

$$1 + g = \frac{Q'}{Q} = \frac{\int \Phi(z)\lambda q d\mu(a, \varepsilon, q, \pi^f) + \int_{q > \omega(1+g)} (1 - \Phi(z))q d\mu(a, \varepsilon, q, \pi^f) + \int_{q \leq \omega(1+g)} (1 - \Phi(z))\omega(1 + g) d\mu(a, \varepsilon, q, \pi^f)}{\int \Phi(z)\lambda q d\mu(a, \varepsilon, q, \pi^f) + \int_{q > \omega(1+g)} (1 - \Phi(z))q d\mu(a, \varepsilon, q, \pi^f) + \int_{q \leq \omega(1+g)} (1 - \Phi(z))\omega(1 + g) d\mu(a, \varepsilon, q, \pi^f)}$$

3. Analyst expectations of earnings are consistent with the equilibrium distribution μ :

$$\pi^f = \mathbb{E}_\mu(\pi|\pi_{-1})$$

3.3 Estimation with Firm-Level Data

Numerical analysis of the baseline model laid out above requires fixing the values of many parameters. For the most part I follow a structural estimation strategy based on GMM using firm-level moments from my joint sample of Compustat and I/B/E/S data. However, before estimating the model I externally calibrate some of the parameters involving common quantities from the macroeconomics or innovation literature. Table II reports the values of these parameters.

The model period is one year. Together, an intertemporal elasticity of substitution of 0.5 or $\sigma = 2$, a subjective discount rate of $\rho = 1/1.02 \approx 0.98$, and a targeted growth rate

³⁹Table C.III in the Numerical Appendix C records forecast accuracy or robustness statistics to alternative forecast systems with higher order approximations in π_{-1} above the baseline implementation (a linear rule), as well as to different information sets including forecast errors and R&D expenditures. In all cases, the higher-order approximations and extended information sets yield little quantitative gain in forecast accuracy.

Table II: Outside Calibration of Common Parameters

Parameter	Explanation	Source, Value
σ	CRRA	Hall (2009), 2.0
ρ	Discount rate	Annual interest rate $\approx 6\%$, 0.98
β	Labor share	NIPA, 0.67
L	Human capital scale	Normalization, 1.0
α	R&D curvature	Bloom et al. (2013), 0.5
λ	Quality step	25% increment, 1.25
θ_d	Manager equity share	Nikolov and Whited (2013), 5.1%

Note: The table displays the notation (first column) as well as an explanation (second column) of each model parameter fixed by outside calibration. The third column lists the source and value of each common parameter.

of near 2% yield annual interest rates of around 6%. A labor share of $\beta = 2/3$ matches standard values in the quantitative macroeconomics literature, and a value of $\lambda = 1.25$ implies long-term quality increases of 25% upon innovation arrival.⁴⁰ I normalize labor supply to $L = 1$, and choose a manager equity share equal to $\theta_d = 5.1\%$ based on the manager compensation data presented in Nikolov and Whited (2013). Based on micro-level estimates of the relationship between R&D expenditures and innovation outcomes in Bloom et al. (2013) I fix the elasticity of innovation arrival to R&D expenditures at $\alpha = 0.5$. Note that robustness checks to alternative values of calibrated parameters, reported in Numerical Appendix C, result in similar qualitative conclusions.

My GMM approach requires selection of informative moments to use for identification of the remaining six parameters of the model, including the persistence and volatilities of profitability shocks (parameters ρ_a , σ_a , and σ_ε), as well as the magnitude of manager miss costs associated with earnings targets ξ , the productivity level for innovation A , and the costs of paper accounting manipulation γ_m . Table III lists the seven selected moments together with their values in the data and model.⁴¹ At the macroeconomic level I target the aggregate

⁴⁰Absent direct information on innovation arrival at firms in my data, I choose to fix this quality step size at the round value of 25%. Note that structural estimates of the quality step size from Peters (2013) or Acemoglu et al. (2013) would suggest values on the order of 7-14% instead. As shown in robustness checks to a lower value of λ in Numerical Appendix C, the effect of λ on my quantitative growth rate counterfactual statements is very limited, while my choice of a higher, round value for λ is conservative for welfare counterfactual statements.

⁴¹Note that the table presents, for ease of reference, the covariance matrix transformed into percentage standard deviations and unit-free correlations, although the underlying GMM estimation is performed using the untransformed covariance matrix. Forecast errors are equal to the percentage difference between the realized Street earnings value and analyst forecasts of earnings within a period. Also, the model and data

Table III: Data and Model Moments

Moment, %	Data	Baseline	No Targets
Aggregate Growth Rate, g	1.98	2.25	2.31
σ (R&D Growth)	30.1	27.7	16.1
σ (Sales Growth)	25.9	22.0	22.0
σ (Fcst. Error)	36.4	24.2	21.8
Corr(R&D Growth, Sales Growth)	0.36	0.41	0.47
Corr(R&D Growth, Fcst. Error)	-0.001	-0.03	0.05
Corr(Sales Growth, Fcst. Error)	0.09	0.29	0.65

Note: The data moments from the covariance matrix of sales growth, R&D growth, and earnings forecast errors above are computed from the estimation sample composing a panel of income statement and earnings forecast data from US firms in Compustat and I/B/E/S, with 4,839 firms and 32,597 firm-years from 1982-2010. σ implies standard deviation, “Corr” implies correlation. The aggregate growth rate is the mean US per capita real GDP annual growth rate. The Baseline moments are computed from the stationary distribution of the estimated baseline model, while the No Targets figures are computed from the counterfactual model stationary distribution with no manager miss cost of missing an earnings target, i.e. $\xi = 0$, holding all other parameters fixed at Baseline levels.

growth rate, while the covariance matrix between sales growth, R&D growth, and forecast errors provides a useful corresponding set of microeconomic moments.

First, I lay out the structure of the GMM estimation algorithm for the vector of parameters $\theta = (\rho_a, \sigma_a, \sigma_\varepsilon, A, \gamma_m, \xi)'$, with further details available in the Data Appendix A. After choosing a weighting matrix W , I estimate $\hat{\theta}$ through numerical minimization of the objective

$$\hat{\theta} = \arg \min_{\theta} [m(\theta) - m(X)]' W [m(\theta) - m(X)],$$

where $m(X)$ and $m(\theta)$ are the vector of moments from the data X and model with parameters θ , respectively.⁴² The moment weighting matrix W I use results in a sum of squared percentage deviations objective, but also, given its importance for an investigation of growth, places additional weight on the aggregate growth rate in the data. With point estimates $\hat{\theta}$ from the numerical minimization in hand, the asymptotic covariance matrix of the estimates follows standard GMM formulas.⁴³

definitions of each growth rate are Davis and Haltiwanger (1992)-style robust and bounded percent growth rates. A percentage growth rate for variable x equals $\% \Delta x_{jt} = 2 \frac{x_{jt} - x_{jt-1}}{x_{jt} + x_{jt-1}}$.

⁴²The numerical minimization is carried out using a standard global stochastic numerical optimization routine called particle swarm optimization which is simple, robust, and broadly comparable to other global stochastic optimization routines such as simulated annealing.

⁴³See for example, the derivations and formulas in Gourieroux and Monfort (1997), but note that the stationary distribution of model state variables is directly computable and doesn't require simulation. Therefore, my approach can be classified as GMM and avoids the need for the variance inflation factor of SMM

With seven moments and six parameters, the estimation algorithm is overidentified GMM. The mapping between moments and estimated parameters in the model is joint and not one-to-one. However, certain moments are particularly influential for the identification of a given parameter. In the absence of a proof of identification, I conduct a formal investigation of this mapping by computing Gentzkow and Shapiro (2014) sensitivity statistics as reported in Appendix Figure C.VI. These sensitivity measures represent the estimated coefficients of a theoretical regression of parameters on model moments over the asymptotic distribution.

I also broadly discuss the estimation mapping here, giving economic intuition. First, the estimate of the innovation productivity parameter A in the model depends heavily upon the data's aggregate growth rate, because higher innovation arrival rates in the model imply higher growth. Identification of the remaining parameters typically places significant weight on the covariance matrix of R&D growth, sales growth, and forecast errors. Forward-looking R&D investments feed into realized forecast errors, and this link implies that the structural estimates of persistent profitability volatility σ_a load particularly upon R&D growth as well as forecast error volatility moments. By contrast, the estimated level of transitory profitability volatility, σ_ε , depends relatively more upon overall sales growth volatility in the data. Estimation of the persistence ρ_a of profitability shocks again links to the behavior of forward looking R&D, placing weight both upon each of the volatility moments in the data but also crucially on the correlation or covariance between sales and R&D growth. Since easier paper manipulation in the model can obscure the passthrough of sales growth to earnings, the cost parameter γ_m for paper manipulation is determined in large part by the observed correlation between sales growth and forecast errors. Finally, we will see below that the primary model manifestation of earnings pressure from miss costs ξ is higher R&D volatility, as firms sometimes react to profitability shocks by cutting R&D to boost earnings above targets. Naturally, therefore the estimated level of ξ depends crucially upon both R&D growth volatility in the data as well as the correlation between forecast errors and R&D growth.

Table IV records the estimated parameters and standard errors based on my combination of aggregate and firm-level data in the baseline model. The persistent portion of profitability is highly autocorrelated, with ρ_a approximately equal to 0.9, and the combination of persistent and transitory volatility, $\sqrt{\sigma_a^2 + \sigma_\varepsilon^2}$, is moderate at around 12% annually.⁴⁴ Profitability

estimation.

⁴⁴Although the profitability processes are defined in levels, a profitability mean of 1 allows us to apply the log approximation to these deviations and interpret them approximately as percentage deviations.

Table IV: GMM Parameter Estimates

Parameter	Explanation	Estimate (SE)
ρ_a	Prof. persistence	0.903 (0.0325)
σ_a	Prof. volatility	0.070 (0.0029)
σ_ε	Transitory shock vol.	0.099 (0.0071)
A	R&D level	0.256 (0.1168)
ξ	Earnings miss disruption	0.001 (0.0006)
γ_m	Manipulation cost	0.290 (0.3679)

Note: The parameter estimates above are computed from an unbalanced panel of income statement and earnings forecast data, with 4,839 firms and 32,597 firm-years from 1982-2010 in the US, together with data on the US per capita real GDP growth rate. The estimation procedure is standard overidentified GMM, with a moment covariance matrix reflecting time series correlation of the aggregate growth rate using a stationary bootstrap and arbitrary time series correlations within firm-level clusters for all microeconomic moments. Optimization was performed using particle swarm optimization, a stochastic global minimization routine. The weighting matrix is chosen so that the GMM objective equals the sum of squared percentage deviations, with 10 times extra weight placed on the aggregate moment. Asymptotics are computed in the number of firms while assuming independence between aggregate and microeconomic moments in the data.

parameters are quite precisely estimated. Comfortingly, the persistence and volatility estimates are comparable to the structural estimates of the parameters of firm-level productivity or profitability processes found in both Gourio and Rudanko (2014) as well as Hennessey and Whited (2007), which are also based on dynamic firm-level problems and Compustat data. Naturally, however, I estimate higher persistence in the profitability shock a_{jt} than found in those studies because I also allow for purely transitory variation ε_{jt} .

The accounting manipulation and R&D productivity parameters γ_m and A are in model units difficult to map directly to observable quantities. However, I can naturally examine the plausibility of the estimated costs $\hat{\xi}$ by expressing them in terms of observables. In the baseline model, managers are indifferent between missing an earnings targets and a loss of around 3.6% of firm revenues on average, with the miss cost statistically distinguishable from zero at the 5% level. Benchmarks for direct comparison with the 3.6% figure are scarce. However, Taylor (2010) structurally estimates a perceived cost to firms of CEO turnover of around 5.9% of firm assets, equal to 8.9% of firm revenues given the mean assets to revenues ratio in my estimation sample. CEO firing events are rare at a 2% rate (Taylor, 2010) relative to earnings misses, which occur at a 44% rate in my GMM estimation sample. My estimated earnings miss costs should therefore naturally be smaller. Additionally, macroeconomics has for decades devoted considerable energy to quantifying the costs of price adjustment at firms, another fixed cost crucial to firm decision making. Zbaracki et al. (2004) provides

estimates of the costs at a large firm associated with a price change and dominated by costs of customer negotiation and communication. These total expenses sum to about 1.2% of firm revenues in each annual price-changing cycle. Given that price changes predictably occur each year within firms, a lower direct estimate of price change costs relative to my structurally estimated costs perceived by managers from earnings misses is reassuring.

Given the overidentified and highly nonlinear structure of the model, I can not in general expect an exact match between model and data moments. However, Table III demonstrates that the Baseline model with incentives to meet earnings forecasts leads to a broadly successful fit to the data moments.⁴⁵ In particular, the Baseline delivers an aggregate growth rate around the 2% level seen in the data, together with substantial variation in sales growth rates as in the data. Note that the Baseline model delivers somewhat less volatile forecast errors than observed in the data, but higher volatility than a model without earnings pressure (moments also reported in Table III). Furthermore, in both the Baseline and the data, forecast errors negatively covary very slightly with R&D growth. In other words, the presence of earnings targets implies that cuts to R&D growth can be driven in the model by a desire to meet or beat earnings forecasts and therefore be correlated with higher forecast errors. By contrast, the model without earnings targets, in which R&D innovations are exclusively motivated by persistent profitability innovations, naturally produces a positive correlation of forecast errors with R&D growth. Furthermore, the presence of earnings targets in the Baseline causes dependence of R&D policies on transitory shocks to profitability, increasing the volatility of R&D growth substantially, while a model without a motive to meet earnings forecasts underpredicts the R&D volatility seen in the data by a large margin. Finally, the paper obfuscation in a model with earnings targets leads to lower correlation between sales growth and forecast errors, closer in line with the data, while a model without earnings targets overpredicts this correlation by a large amount.

4 Estimated Costs of Short-Termism

With estimated model parameters in hand, I now evaluate the impact of earnings targets by comparing my Baseline economy with a counterfactual No Targets economy in which there are no manager costs of missing an earnings forecast. First, I decompose the contrast-

⁴⁵Note, however, that the amount of data used for GMM estimation of the model implies that the J-test of overidentifying restrictions for the model is quite stringent, producing a strong rejection of the model.

ing implications of the Baseline economy and the No Targets model for earnings forecast errors, R&D growth, and profitability. The presence of pressure to meet earnings targets endogenously delivers a kinked forecast error distribution, lower R&D growth for firms just meeting earnings targets, as well as a stark separation of profitability between firms meeting and missing forecasts. Each of these outcomes is absent or muted in the counterfactual No Targets economy. Second, I then move to a discussion of the economic costs of earnings targets. Earnings benchmarks force a distortion to the dynamic long-term investment decisions of firms in the Baseline model. Because of this effect, I find that the Baseline economy exhibits quantitatively meaningful decreases in aggregate growth rates and household welfare, lower and more volatile firm R&D expenditures, and lower firm value on average.

4.1 Earnings Manipulation in the Baseline Model

Within my model, Figure II displays the unconditional distribution of earnings forecasts errors in the Baseline (in red bars) and the counterfactual No Targets (in black bars) economies. Crucially, the model with earnings targets delivers bunching of the forecast error distribution at zero, as managers engage in both real and paper earnings manipulation to reach earnings forecasts, as well as a hollowing out of the distribution of earnings forecast errors below zero.⁴⁶ Both patterns are generally consistent with the empirical kink in forecasts errors evident from Figure I. By contrast, the model without earnings targets displays a smoothly varying distribution of forecast errors.

Figure III displays the conditional mean of percentage R&D growth for firms in the Baseline (in red) and No Targets economy (in black), given different values for forecast errors $\pi - \pi^f$. While R&D growth varies rather smoothly across the zero forecast error benchmark in the No Targets economy, firms which are incentivized to meet earnings forecasts in the Baseline model have R&D growth rates around 1% lower than firms that fail to meet an earnings target. Clearly a finding of reduced R&D growth by firms just meeting earnings targets fits naturally into a world with high-pressure earnings forecasts but is not consistent with a No Targets economy.

A strand of literature within both corporate finance and accounting seeks to understand

⁴⁶The horizontal axis, based on normalization by long-term firm quality Q_{jt} rather than a notion of firm assets, is not directly comparable to the earnings forecast error distribution displayed in Figure I. However, the long-term value and scale of a firm in the model depends heavily upon quality, in a similar fashion to the heavy dependence of scale upon assets in the estimation sample.

the determinants of and information content within earnings releases.⁴⁷ In a theoretical contribution, Stein (1989) suggests that myopic distortions of investment by firms endogenously arise in order to boost short-term earnings of profitability in a signal-jamming equilibrium. An imperfectly informed market expects manipulation and therefore updates its inferences about firms with poor earnings reports particularly harshly. Anecdotally, this intuition is consistent the survey of large US firm managers in Graham et al. (2005), where one participant reported that “if you see one cockroach, you immediately assume that there are hundreds behind the walls, even though you may have no proof that this is the case.”

In the context of my model, Figure IV shows quantitative evidence of exactly this type of selection into meeting earnings targets, with firms that meet forecasts in the Baseline model 146% more profitable on average (as measured by the persistent shock a_{jt}) than firms that miss a target. By contrast, firms in the No Targets economy that miss an earnings target are only 11% less profitable on average than firms that meet their targets. Clearly, in the Baseline model, observers of firms would be justified in inferring quite poor profitability prospects for firms failing to meet an earnings forecast. I view the results in Figure IV as potentially suggestive as to the means by which disruptions to firms or managers from earnings misses could arise. Imperfectly informed analysts, the financial media, or the distributed owners of public firms may react particularly negatively to an earnings miss and demand manager time, attention, or even litigation as they seek to gain more information about the underlying profitability prospects of the firm in question.

The results in Figures II-IV above incorporate measurement error for earnings targets within the model for the purposes of plotting model outcomes against model forecast errors. Why is this useful? Quantitative models with fixed costs and heterogeneity routinely yield a stark sorting of agents across a threshold or into adjustment vs. inaction (Khan and Thomas, 2008; Berger and Vavra, 2014), and my model is no exception. In fact bunching is strong, and a range of forecast errors just below zero never occur in equilibrium if measurement error is ignored. The literature routinely incorporates some some quantitative addition, such as measurement error or maintenance investment depending on the context, in order to allow for a looser sorting of model stationary distributions. Motivated by these concerns, Theory Appendix B lays out my extended model of manager decisions with a decomposition of transitory profitability shocks into two separate components: ε_{jt} (known

⁴⁷See, for example, work by MacKinlay (1997), McNichols (1989), Kasznik and McNichols (2002), or Liu et al. (2009).

to managers when policies are decided) and another component ν_{jt} (unknown to managers when policies are decided). In practice ν_{jt} serves as “target measurement error,” since the exact earnings threshold for meeting forecasts is ex-ante uncertain. However, throughout the rest of the paper in which direct comparison of firm outcomes to forecast errors is not the object of interest, I conservatively discuss results generated by the Baseline model without measurement error, since the impact of earnings pressure on growth and welfare turns out to be slightly lower in this case.⁴⁸

4.2 Costs of Earnings Targets

Earnings pressure systematically changes real or economic outcomes for firms and the economy as a whole. Figure V displays the mean of R&D policy z for the Baseline and No Targets economies conditional upon the value of the transitory shock ε . Without earnings pressure, forward-looking R&D investment in the No Targets economy optimally ignores transitory profitability shocks and is flat as a function of ε . However, by contrast, the Baseline R&D policy z responds to short-term profitability, declining when profits are low in the current period.⁴⁹ Responsiveness of R&D to transitory variation is the primary manifestation of short-termism in my model. Even though a negative transitory profitability shock does not contain information about the payoff to R&D in future, managers on average cut their long-term investment to avoid the disruption associated with missing their earnings forecast in the near term. Overall, earnings targets reduce R&D expenditures z by -0.32% and increase the standard deviation or volatility of R&D expenditures by 23.1%. The sensitivity of R&D to transitory profitability shock represents a type of misallocation of R&D, because long-term investment here deviates from a purely forward-looking optimal policy within the model. Such sensitivity is also consistent with empirical work in Brown and Petersen (2009); Brown et al. (2009) finding a high sensitivity of R&D to cash flows in US public firms.⁵⁰

More R&D volatility resulting from sensitivity to short-term shocks damages the overall efficiency of the innovation process. Table V reports the aggregate growth rate in the Baseline

⁴⁸The interested reader may find analogues to Figures II-IV above, without earnings target measurement error, in Numerical Appendix Figures C.III-C.V. Also, note that for the purposes of generating Figures II-IV, I calibrate the decomposition of known and unknown transitory shock volatilities to attribute approximately half of the total estimated transitory volatility to each source.

⁴⁹In both the Baseline and No Targets economies, of course, higher values of the persistent shock a induce higher levels of R&D expenditures z on average.

⁵⁰See also Schmitz (2014) for a related model of business cycles and R&D in which differences in firm size interact with R&D sensitivity to shocks to generate persistent business cycles.

Table V: Earnings Targets Reduce Growth, Welfare

	%		%
$g^{\hat{\xi}}$	2.25	Δ Welfare	0.44
$g^{\xi=0}$	2.31	Δ Firm Value	1.03
100-yr ΔY	5.82		

Note: The entries above represent the percent difference in the indicated aggregate quantity between the counterfactual $\xi = 0$ and estimated benchmark $\hat{\xi}$ cases. The moments are computed from the stationary distributions μ of the respective economies, and comparisons are across balanced growth paths without a transition path calculation. Δ Welfare represents the percentage consumption equivalent variation of $\xi = 0$ relative to the baseline economy. The change in firm value is the mean partial equilibrium percent change in firm value when $\xi = \hat{\xi} \rightarrow \xi = 0$ for an individual firm, averaged over the stationary distribution of $\hat{\xi}$. The 100-yr change in Y is the percentage difference in output after 100 years from a no targets growth rate rather than a targets growth rate, using identical initial conditions.

model, $g^{\hat{\xi}} = 2.25\%$, which is around 6 basis points lower than growth in the No Targets economy, $g^{\xi=0} = 2.31\%$. These differences are quantitatively larger than they may at first appear, since growth changes lead to compounded differences across economies far into the future. The driving force behind diminished growth in my economy with earnings targets is curvature in the model link $\Phi(z)$ between R&D expenditures and innovation. Given concavity or diminishing returns to R&D in $\Phi(z)$, randomly more volatile R&D causes fewer innovation arrivals on average, even ignoring level changes in R&D expenditures.⁵¹

A negative relationship between volatility and growth, crucial to the quantitative results here, is familiar from the macroeconomics literature. For example, Barlevy (2004) describes the manner in which at the aggregate level, higher volatility of tangible investment caused by business cycles can increase the theoretical cost of business cycles by reducing the aggregate growth rate. The same mechanism appears at the microeconomic level in my Baseline model. Since macroeconomists routinely infer much higher volatility or variation in profitability at the disaggregated level than on aggregate (Bloom et al., 2012), my firm-level link between profit shocks and R&D naturally provides a potent source of changes in the innovative efficiency of the economy as a whole.

To gain a better sense of the quantitative magnitude of the distortion to aggregate growth rates, I also engage in an accounting exercise for aggregate welfare. The second column of Table V displays the consumption equivalent welfare gain to the aggregate household from the removal of earnings targets, ΔW . This welfare gain is the percentage increase

⁵¹This statement is a straightforward implication of Jensen’s inequality together with the concavity of the innovation arrival function $\Phi(z) = Az^\alpha$, where $\alpha \in (0, 1)$.

in consumption in each period (around 0.44%) which would make the Baseline household indifferent to the No Targets consumption stream, comparing directly across balanced growth paths.⁵² Explicit welfare formulas and a set of quantitative robustness checks are reported in Theory Appendix B and Numerical Appendix C.⁵³

Overall, consumption equivalent gains on the order of 0.44% are large. For perspective, recent quantitative estimates of the welfare costs of business cycles range from 0.1-1.8% (Krusell et al., 2009), and measures of the static gains from trade range from 2.0-2.5% (Costinot and Rodríguez-Clare, 2015; Melitz and Redding, 2013). I conclude from the sizable changes in growth and welfare in my model that the dynamic distortion to R&D investment induced at firms by the presence of earnings targets matters for the macroeconomy.

A final quantitative perspective in Table V on earnings target costs comes from the firm level. In the Baseline economy, the change in average firm value which would result in partial equilibrium from the removal of pressure to meet earnings forecasts is around 1%.⁵⁴ For perspective on the size of this firm-level distortion we can turn to work in structural dynamic corporate finance that quantifies the loss in shareholder value from CEO turnover frictions at around 3% (Taylor, 2010), or from manager agency frictions affecting cash holding at around 6% (Nikolov and Whited, 2013).

Distortions to manager R&D policies and the resulting losses in firm value, growth rates, and welfare laid out above represent the costs of pressure to meeting earnings targets. However, earnings targets may provide a range of benefits as well. In principle the benefits could be external to the firm, functioning for example through more precise valuations of companies on the equity market and more socially efficient allocations of capital across firms. Or,

⁵²Recall that to remain conservative I assume that the entirety of the term ξ in the manager payoff is apportioned to personal costs for the manager, implying that these costs should be rebated back to the household in aggregate consumption. If the effect of the miss costs is included as entirely due to firm resource costs or disruptions ξ^{miss} , overall household gains are 0.48% instead.

⁵³The change in growth rates due to the removal of earnings targets is around 0.1% in the version of the model with calibrated target measurement error for firms, with a total change in aggregate welfare of 1.39%. The increase in the effects of targets is due to the increased mass of managers who perceive a possibility of missing an earnings target, given the addition of uncertainty surrounding the target itself. Overall, the dynamic distortion to long-term investment is strengthened, and the Baseline results in the main text should therefore be considered conservative.

⁵⁴This 1% figure is derived from computing average firm value from optimal policies in an environment with $\xi = 0$, or no manager cost from missing earnings targets, with the aggregate growth rates, interest rates, and forecasting in the Baseline economy held fixed. The average is taken with respect to the equilibrium stationary distribution of state variables μ in the Baseline model. For conservatism I assume such costs are private to the manager. If disruption costs are borne as resource costs to the firm, the change in firm value is 1.3%.

by contrast, earnings pressure could yield benefits for firms themselves if agency considerations drive a wedge between the interests of managers and firm owners which is alleviated by earnings discipline.

Consideration of such benefits from earnings targets seems important for two reasons. First, and crucially, the gains from removal of earnings pressure embodied in the No Targets counterfactual considered so far could fail to materialize in practice if policymakers were to take action preventing earnings targets and simultaneously extinguish the benefits from earnings pressure. Second, a significant portion of earnings targets could represent explicit or implicit compensation contracts with some portion of overall pay for managers dependent upon meeting earnings forecasts. In this case, a countervailing benefit from earnings targets for firms might in principle provide a microfoundation for the existence of pressure on managers to meet short-term benchmarks, even if such benchmarks lead to a loss in investment efficiency. In the next section, I build off of the baseline model structure and include two sources of agency frictions in the firm-manager relationship.

5 Agency Benefits from Short-Term Pressure

Empirically, Section 2 demonstrates that CEOs and other executives at large US public firms which just fail to meet an earnings target or forecast receive lower total compensation on average. These results open up a suggestive possibility: pressure to meet earnings forecasts or targets may arise from the efforts of the boards or distributed shareholders of firms to exert discipline on managers. In this section, I consider two forms of agency frictions which may serve to both microfound and to provide countervailing benefits from the distortions to long-term investment induced by earnings targets.

5.1 Manager Shirking and Effort Provision

I first consider the possibility of shirking by managers. In particular, firm owners may be unable to observe whether managers continually exert effort, and compensation contracts can serve as a tool to mitigate the possibility of low effort provision (Grossman and Hart, 1983; Edmans et al., 2009; Beyer et al., 2014). In this framework, managers can in each period choose either to shirk ($s_{jt} = 1$) or to exert normal effort ($s_{jt} = 0$). If managers shirk, then they receive some private benefit governed by the parameter $\lambda_s \geq 0$. Shirking comes at the cost of firm variable profits, with a proportional disruption to firm quality equal to

some fraction $\gamma_s \in (0, 1)$. The remainder of the economic environment is similar to before, where managers now solve

$$\max_{\{z_{jt}, m_{jt}, p_{jt}, s_{jt}\}_t} \mathbb{E} \left\{ \sum_{t=0}^{\infty} \left(\frac{1}{R} \right)^t D_{jt}^M \right\}.$$

Manager payoffs are given by D_{jt}^M where

$$D_{jt}^M = \theta_d D_{jt} - (1 - \theta_d) \xi^{pay} \mathbb{I}(\Pi_{jt}^{Street} < \Pi_{jt}^f) Q_{jt} + \lambda_s s_{jt} Q_{jt}.$$

Manager flow returns reflect two components. First, D_{jt}^M includes an exogenous compensation contract with a fixed dividend share $\theta_d \in (0, 1)$ and clawback by the firm of $\xi^{pay} \mathbb{I}(\Pi_{jt}^{Street} < \Pi_{jt}^f) Q_{jt}$ conditional upon missing an earnings target.⁵⁵ Endogenization of such a contract is beyond the scope of the paper, but I will demonstrate in a quantitative exploration of the extended framework that earnings-target conditional compensation can be value-improving for firms on average. The second component of manager flow returns is a private benefit $\lambda_s s_{jt} Q_{jt}$ accruing to the manager when shirking. In practice shirking might represent increased leisure at the firm's expense or some sort of resource diversion towards managers. The countervailing costs of shirking for the firm enter the expression for dividends, written here net of manager clawback compensation:

$$D_{jt} = \Pi_v(Q_{jt}, a_{jt}, \varepsilon_{jt}, p_{jt})(1 - \gamma_s s_{jt}) - z_{jt} Q_{jt} - \gamma_m^2 m_{jt} Q_{jt}.$$

At this point it is worth exploring the tradeoffs involved for managers considering shirking. In the absence of earnings targets managers weigh a private gain from low effort equal to $\lambda_s Q_{jt}$ versus a firm-wide loss diluted through their equity share of $\theta_d \Pi_v \gamma_s$. However, by conditioning compensation on meeting a publicly available earnings forecast, the owners of the firm can augment the immediate costs of shirking by the net amount $(1 - \theta_d) \xi^{pay} \mathbb{I}(\Pi_{jt}^{Street} < \Pi_{jt}^f) Q_{jt}$. For those firm-years in which shirking would lead to an earnings miss, i.e. in which earnings prospects are near earnings targets ex-ante, the prospect of lost compensation can induce effort provision by managers. Therefore, in an environment with manager shirking, the owners of firms face a fundamental tradeoff between the dynamic distortion to long-term R&D investments from earnings pressure and the level gains which may accrue to the firm from disciplining managers.

⁵⁵By interpreting the miss costs for managers as embedded within compensation I am implicitly attributing the entirety of the estimated $\hat{\xi}$ term from before to the ξ^{pay} term.

I more rigorously investigate the tradeoffs involved through the following experiment. First, I fix ξ^{pay} so that managers perceive a cost to missing equivalent in magnitude to the estimated miss costs $\hat{\xi}$ from the structural estimation exercise above. Then, I vary the strength of the private motive for shirking λ_s .

Figure VI plots four quantities within the model: the baseline mean shirking rate in an economy with earnings targets (top left), the average increase in shirking if manager target compensation were to be removed and ξ^{pay} set to 0 (top right), the average partial equilibrium change in firm value from target removal (bottom left), and the general equilibrium consumption equivalent change in welfare for the representative household from target removal (bottom right). Throughout this exercise, I fix the proportional loss to variable earnings at the firm from shirking at the round figure of $\gamma_s = 7.5\%$. The horizontal axis represents the ratio between the private returns perceived by managers and the average loss from shirking for a given value of λ_s , both normalized by firm quality q .⁵⁶ As the shirking motive grows, managers unsurprisingly shirk more on average. However, there is a hump-shaped pattern to the increase in shirking seen if earnings discipline were to be removed. For very low levels of shirking motive, managers already provide effort almost always, so the presence of pressure only prevents a small increase in shirking. By contrast, for intermediate levels of private value to shirking, managers are close to indifferent between shirking or not, and the presence of earnings pressure can shift a relatively larger portion of managers to provide effort. Finally, if managers have very high private returns to shirking, the lost compensation for managers upon an earnings miss does not dissuade shirking much at all. The hump-shaped pattern to the prevention of shirking feeds into counterfactual changes in firm value and social welfare: for intermediate levels of private shirking benefits, firm value would decrease on average if a firm removed miss costs for managers even though a dynamic investment distortion remains. The reduction in quality levels and hence production induced by shirking if earnings pressure were to be removed also leads to a static loss for the aggregate household, which crucially implies that the presence of earnings targets can be welfare-enhancing if they prevent a substantial amount of costly shirking by managers.

The patterns in Figure VI suggest that discontinuous and short-term incentives for managers may play a useful disciplinary role. Firms as well as the economy as a whole can benefit from imposing earnings miss costs if managers subsequently shirk less overall, even

⁵⁶Further details behind these calculations may be found in Theory Appendix B. Also, as a robustness check, Appendix Figure C.VII plots the analogous results associated with an alternative smaller value of γ_s .

while targets distort the R&D decisions of firms. A disciplinary role may therefore provide a rationale for the existence of earnings targets within firms, since the use of a readily observable performance benchmark can improve firm value on average. Importantly, however, the next section considers an alternative agency justification for earnings targets and demonstrates that the exact nature of the conflict between managers and firms matters for the relationship between the firm and social implications of earnings benchmarks.

5.2 Manager Empire Building

If managers obtain some private benefit from the size or scale of the firm under their control, then overinvestment or empire building may occur. This type of empire building mechanism plays a role in a range of recent quantitative corporate finance studies (Nikolov and Whited, 2010; Glover and Levine, 2014) and conceptually dates to early work in Jensen (1986). If the owners of a firm do not perfectly observe the ex-ante expected profitability of R&D investments, then such overinvestment may be difficult to curtail in practice. However, earnings targets provide a convenient and readily observable benchmark against which manager decisions may be measured. This subsection analyzes a structure in which manager decisions are influenced by empire building and solve

$$\max_{\{z_{jt}, m_{jt}, p_{jt}\}_t} \mathbb{E} \left\{ \sum_{t=0}^{\infty} \left(\frac{1}{R} \right)^t D_{jt}^M \right\}.$$

By contrast with the previous subsection, managers are not motivated by a shirking possibility but instead face personal returns given by

$$D_{jt}^M = \theta_d D_{jt} - (1 - \theta_d) \xi^{pay} \mathbb{I}(\Pi_{jt}^{Street} < \Pi_{jt}^f) Q_{jt} + \lambda_e Q_{jt}.$$

Again, there remains a fixed equity share $\theta_d \in (0, 1)$ of firm dividends, as well as the potential for compensation contracts to impose an earnings miss cost on managers through $\xi^{pay} > 0$. However, the final term $\lambda_e Q_{jt}$ indexes the strength of the empire-building motive for managers, where higher values of λ_e give managers a more potent intrinsic taste for firm scale as determined by long-term quality Q_{jt} . Here, dividends are standard and can be written net of manager clawback compensation as

$$D_{jt} = \Pi_v(Q_{jt}, a_{jt}, \varepsilon_{jt}, p_{jt}) - z_{jt} Q_{jt} - \gamma_m^2 m_{jt} Q_{jt}.$$

Exactly as in the analysis of manager shirking behavior above, I broadly explore the potential impact of earnings targets in the presence of empire building by first fixing ξ^{pay}

to duplicate the magnitude of the earnings miss costs $\hat{\xi}$. Subsequently varying the strength λ_e of the empire motive yields the four panels of results in Figure VII, each of which plots against a horizontal axis equal to the ratio between the manager’s private return to size and their average return to variable profits, both normalized by firm quality q . The top left panel plots the average R&D to sales ratio for the economy with earnings targets. As the private return to empire building grows, the R&D to sales ratio unsurprisingly increases. The top right panel plots the increase in the R&D to sales ratio which would be observed in an economy with target removal, i.e. with ξ^{pay} set to 0. As overinvestment from a firm’s perspective becomes more severe, the scope for earnings targets to provide discipline on managers grows as well. Recall that by imposing miss costs through manager compensation, firms induce a distortion to R&D investment through excess sensitivity to short-term or transitory profitability shocks. For relatively low empire motives, the bottom left panel reveals that firms would in fact gain overall in partial equilibrium from the removal of targets, since they would remove the inefficiency associated with induced short-termism. However, for higher empire building pressures at firms the tradeoff shifts in favor of targets, and firms would lose value on average from their removal because of the resulting overinvestment by managers.

The bottom right panel of Figure VII reveals that for the parametrizations considered here the aggregate household always experiences higher welfare if targets are removed. Intermediate goods firms realize profits and producer surplus from sales to a final goods sector, but managers ignore the consumer surplus accruing to the final goods sector and eventually to the aggregate household. In general this “surplus appropriability problem,” as coined by Jones and Williams (2000), causes firms to undervalue innovation and R&D relative to their social value, leading to inefficiently low growth rates.⁵⁷ Therefore, as shown in Figure VII the presence of earnings targets discipline may increase intermediate goods firm value if it induces lower R&D on average. Simultaneously, however, earnings discipline may lead to a social loss.

Just as in the analysis of manager shirking, the potential benefits of earnings targets in the presence of empire building recorded here should be taken as suggestive. The quantitative strength of the surplus appropriability problem and hence the divergence between firm

⁵⁷The assumption of eventual diffusion of average firm quality to lagging firms, which is not internalized by firm R&D decisions, also leads to a distinct inefficiency in this model. The surplus appropriability mechanism, however, does not rely on diffusion.

and social returns to R&D depends on a markup structure which, while computationally convenient, links to the inverse capital share. Also, other potentially important factors such as the interplay between firm valuations, financial frictions, and earnings forecasts are omitted from the current structure. Therefore, I view a precise quantification of the benefits to firms or society from earnings targets as beyond the scope of the paper, preferring to instead outline that such benefits do exist.

6 Conclusion

Empirically, earnings realizations bunch directly above analyst forecasts. Firms that just meet or beat analyst targets of earnings display discontinuously lower long-term investment growth, while CEOs and other executives just failing to meet benchmarks face lower compensation. Together, these results suggest a pervasive tradeoff in the data between the short-term prospects of firms versus their long-term investments.

This paper builds and structurally estimates a quantitative endogenous growth model with R&D investment by managers subject to idiosyncratic profitability shocks and incentives to meet or beat earnings targets. Discontinuities in earnings forecast error distributions and R&D growth naturally arise, and a counterfactual exercise comparing the baseline model to an economy without earnings pressure on firms reveals that managers choose lower and more volatile R&D when short-term targets are incentivized. Such short-termism, manifested in sensitivity of R&D to purely transitory variation in profitability, leads to quantitatively significant costs for firm value, aggregate growth rates, and household welfare. The estimation of such costs is the primary quantitative contribution of the paper.

Although short-termism distorts long-term investments and imposes costs on firms and the broader economy, the presence of discipline may provide benefits if managers are motivated by agency considerations such as a desire to shirk or to empire build. These benefits might help to motivate the existence of short-term incentives for managers. In particular, for some parametrizations of my model, a compensation contract which conditions manager pay upon meeting observable earnings forecasts leads to higher firm value on average. The final impact on social welfare can still be detrimental however, validating classic concern with short-termism.

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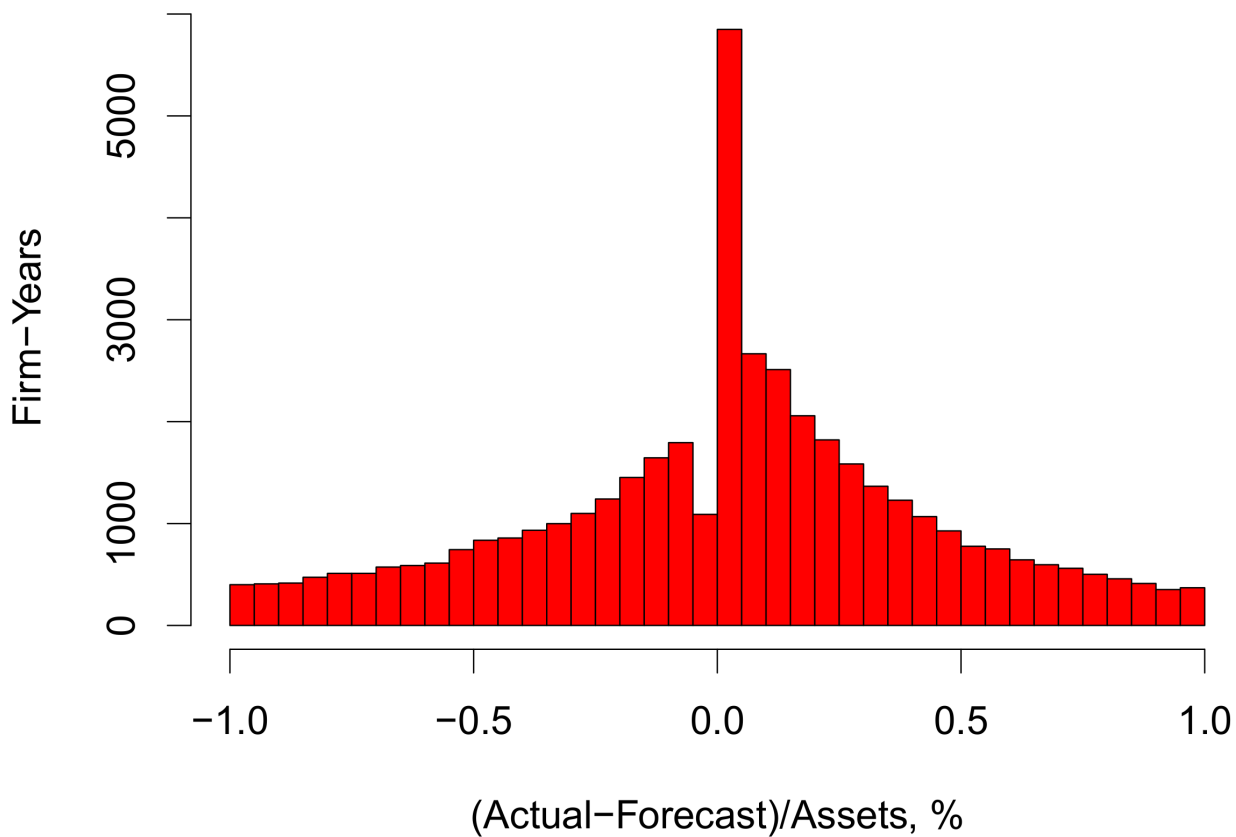


Figure I: There is a Discontinuity in the Earnings Distribution

Note: Earnings forecast errors are Street earnings minus median analyst forecasts from a 2-quarter horizon, scaled by firm assets and expressed as a percentage. The histogram represents a panel of 43,688 firm years, covering 1982-2010 for 7,215 firms. 68% of the sample lies within the bounds plotted above, and 13% of firm years have forecast error in the middle bin. 10% of the sample exhibits exactly zero forecast error. Bin size is 0.05% of firm assets. Discontinuity or sorting is detected in the forecast error distribution at 0 at the 1% level according to the McCrary (2008) statistic.

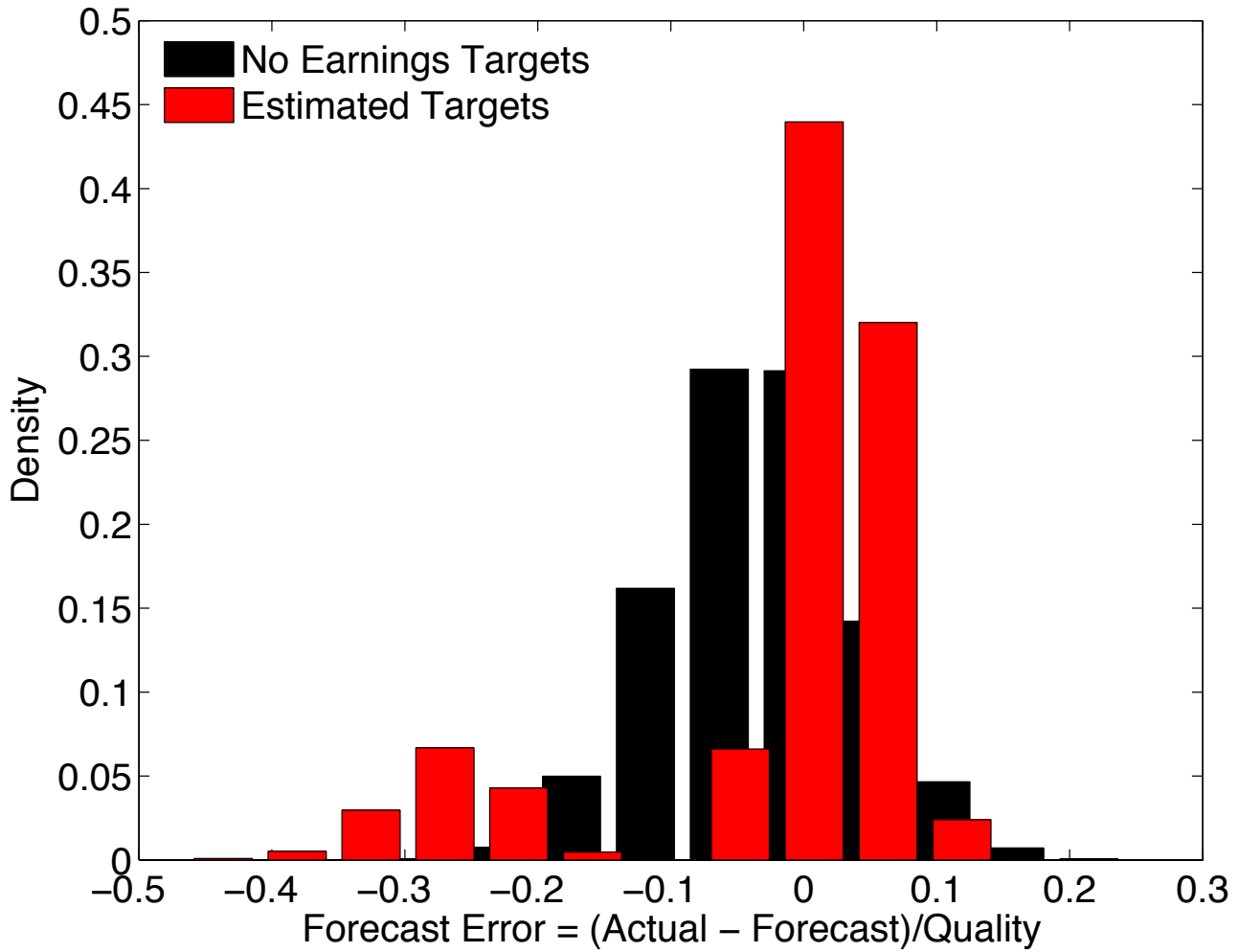


Figure II: Estimated Forecast Error Distribution

Note: The figure above represents the distribution of forecast errors $\pi - \pi^f$ computed from the stationary distribution of the balanced growth path associated with both the estimated earnings miss cost $\hat{\xi}$ (in red) and the counterfactual $\xi = 0$ (in black). The model is a calibrated version of the Baseline including ex-ante measurement error of targets on the part of firms. The model was solved via discretization, policy iteration, and nonstochastic simulation.

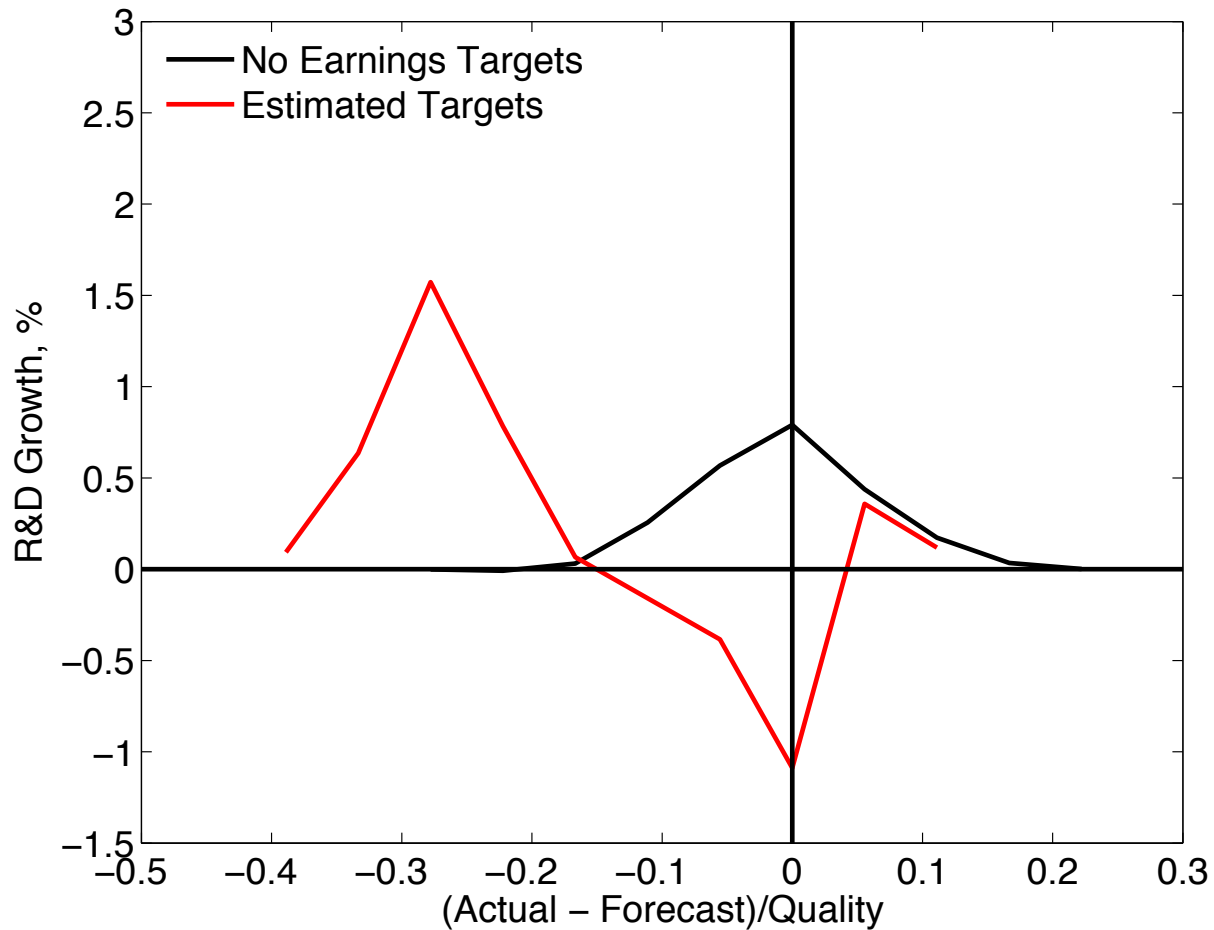


Figure III: R&D Growth versus Forecast Errors

Note: The figure plots the average R&D growth in the estimated benchmark model with miss cost $\hat{\xi}$ (in red) and no miss costs (in black) conditional upon bins of the forecast error $\pi - \pi^f$, computed from the stationary distribution of the balanced growth path. The model is a calibrated version of the Baseline including ex-ante measurement error of targets on the part of firms. The model was solved via discretization, policy iteration, and nonstochastic simulation.

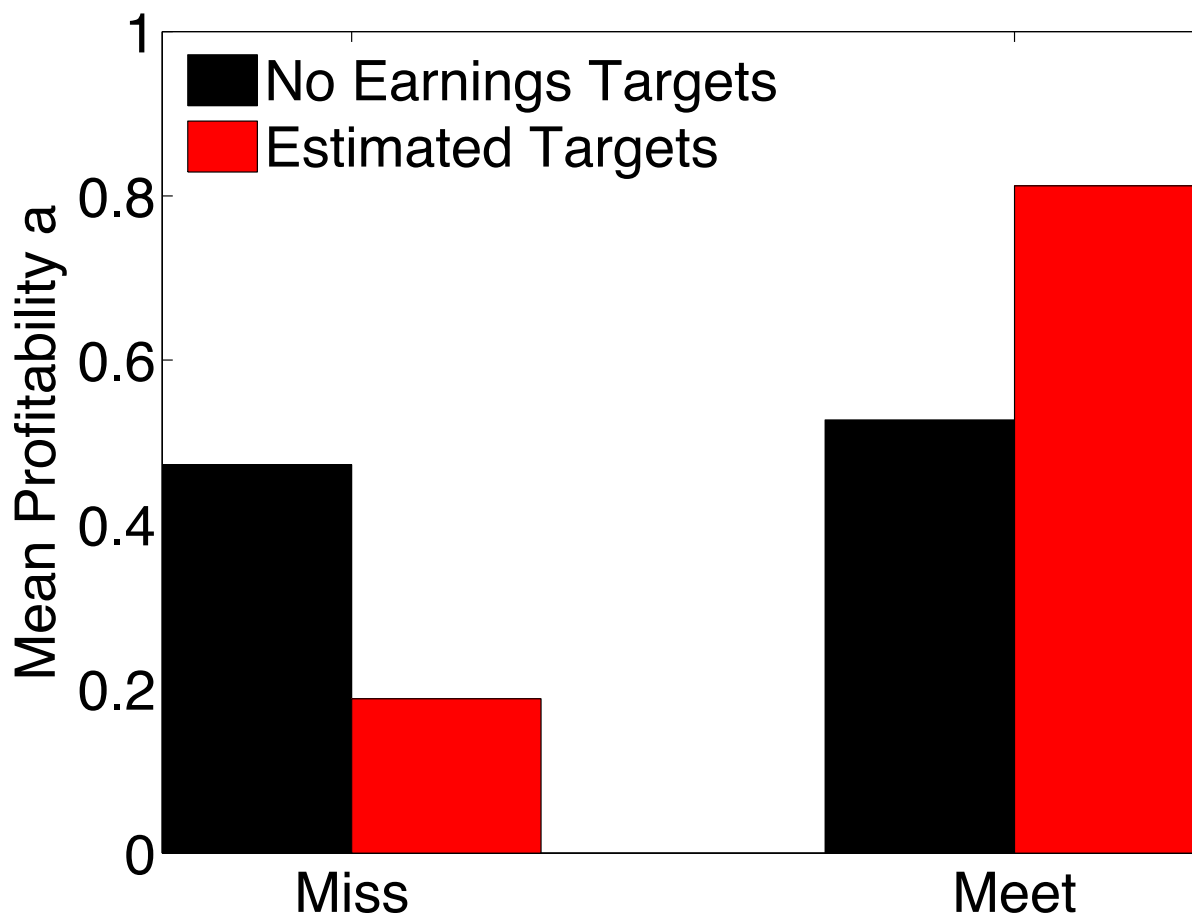


Figure IV: Profitability Sorting into Earnings Misses

Note: The figure above represents the conditional mean of profitability a for firms missing their forecasts ($\pi < \pi^f$), and firms meeting their forecasts ($\pi \geq \pi^f$), computed from the stationary distribution of the balanced growth path associated with both the estimated earnings miss cost $\hat{\xi}$ (in red) and $\xi = 0$ (in black). The difference in mean profitability from missing is -146% in the estimated baseline, compared to -11% for $\xi = 0$. The model is a calibrated version of the Baseline including ex-ante measurement error of targets on the part of firms. The model was solved via discretization, policy iteration, and nonstochastic simulation.

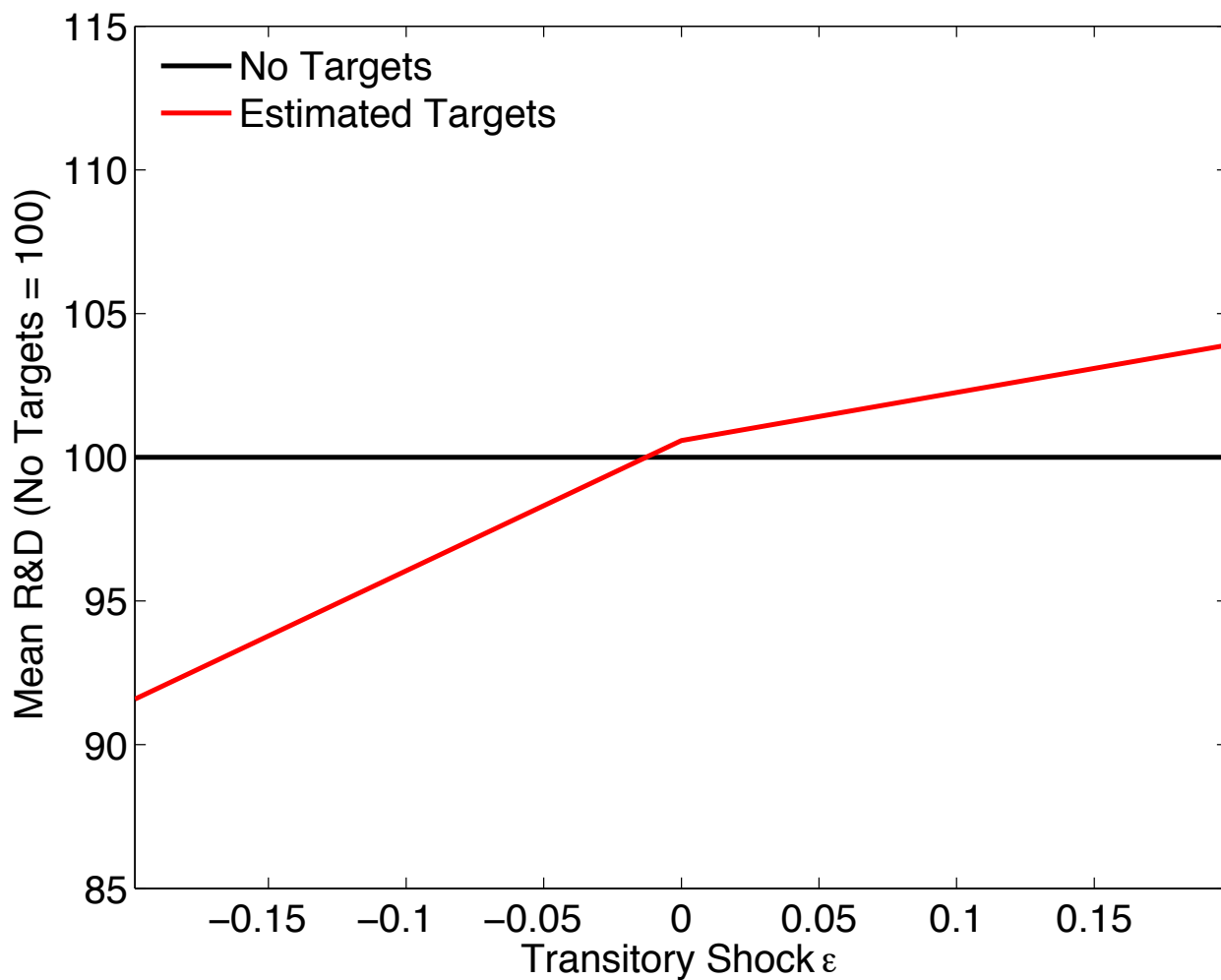


Figure V: R&D Reacts to Short-Term Shocks

Note: The figure plots the mean R&D policy z in the counterfactual No Targets (in black, with $\xi = 0$) and Baseline estimated model (in red, with $\hat{\xi}$) conditional upon the value of the transitory profitability shock ε , computed from the stationary distribution of the balanced growth path. For readability, the constant level of mean R&D z in the No Targets model is normalized to 100. The model was solved via discretization, policy iteration, and nonstochastic simulation.

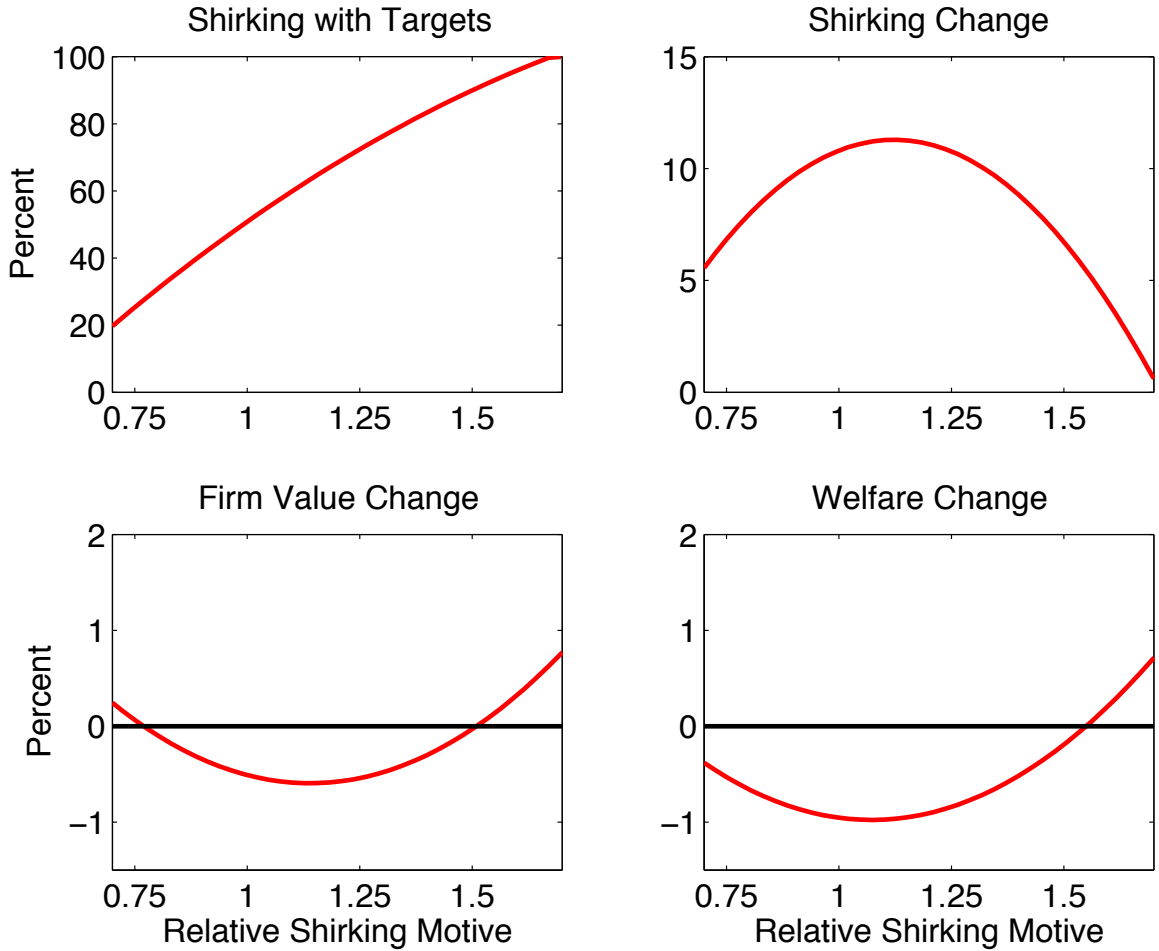


Figure VI: A Levels-Growth Tradeoff with Shirking

Note: Horizontal axis is $r(\lambda_s) = \lambda_s / \mathbb{E}(\theta_d \Pi_v \gamma_s / q)$, where $\gamma_s = 0.075$. The top left panel plots the average shirking level $100\mathbb{E}_\mu s$ with earnings targets, the top right panel plots the percent difference in shirking from target removal, the bottom left panel plots the average PE percent change in firm value from target removal, and the bottom right panel plots the GE total consumption equivalent percent change in social welfare from target removal. Numerical comparative statics have been smoothed using a polynomial approximation.

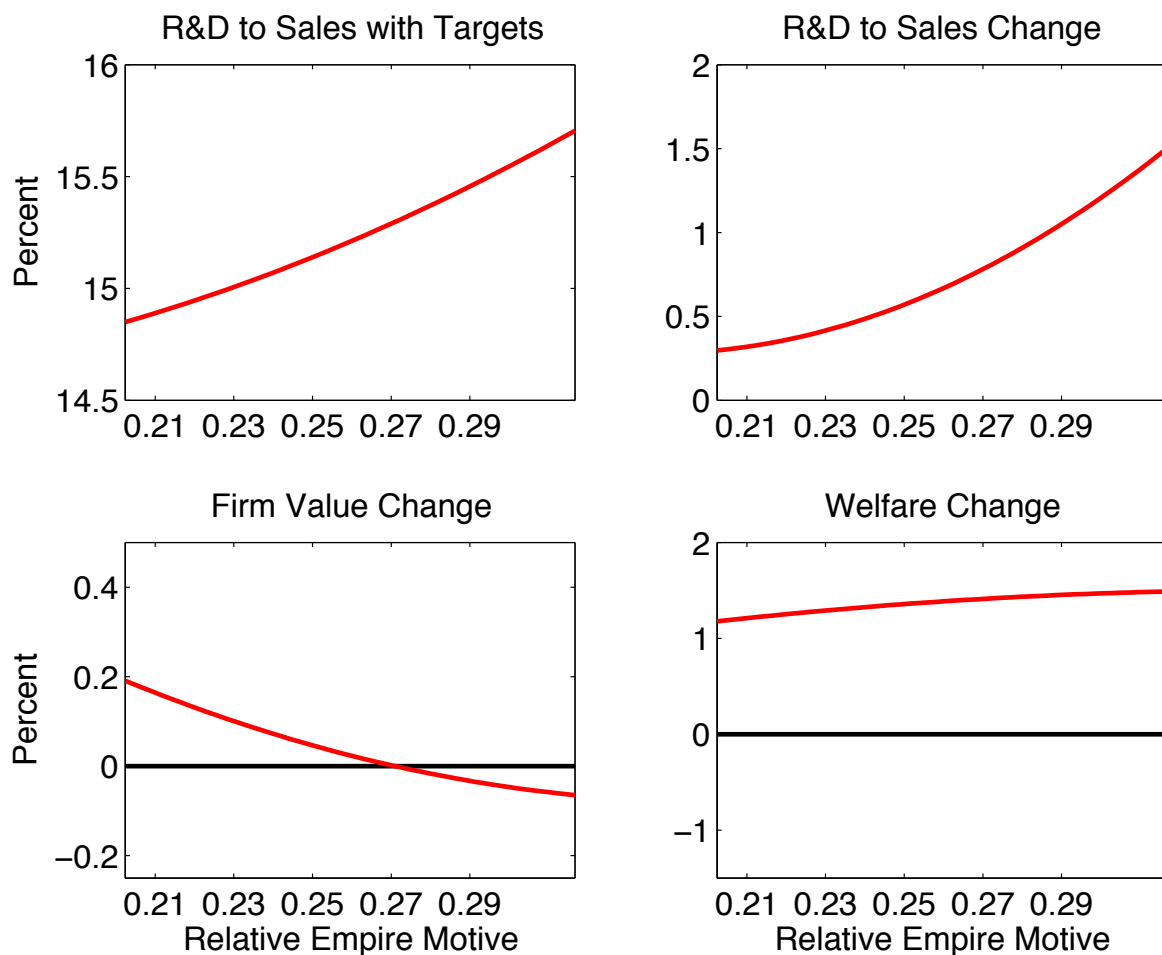


Figure VII: Targets can Restrain Empires

Note: Horizontal axis is $r(\lambda_e) = \lambda_e / \mathbb{E}(\theta_d \Pi_v / q)$. The top left panel plots the average R&D to sales ratio with earnings targets, the top right panel plots the percent difference in the R&D to sales ratio from target removal, the bottom left panel plots the average PE percent change in firm value from target removal, and the bottom right panel plots the GE total consumption equivalent percent change in social welfare from target removal. Numerical comparative statics have been smoothed using a polynomial approximation.

A Data

I combine data from two main sources: 1) the Compustat database for accounting reports from publicly listed US firms, 2) the Institutional Brokers Estimate System (I/B/E/S) database for analyst earnings forecasts and reported earnings for publicly listed US companies. Unless otherwise specified, data is at the firm-fiscal year level. Linking table data from the CRSP database is also required to connect the I/B/E/S and Compustat datasets, and I make use of CRSP data to compute stock returns where applicable. I also make use of the Execucomp database, complementary to Compustat, for executive compensation data.

A.1 Compustat Data

I downloaded Compustat accounting data from the US Fundamentals Annual file in the CRSP/Compustat Merged dataset available through Wharton Research Data Services (WRDS) in January 2014. Allowed linking codes between CRSP and Compustat were “LU” and “LC,” and the following sample restrictions were made:

- Nonmissing total assets `at`, SIC code `sic`, book value of capital `ppent`, GAAP earnings `ib`, operating earnings before depreciation EBITDA `oibdp`, total sales `sale`, value of equity `ceq`, employment `emp`
- Positive levels of assets and book value of capital: `at`, `ppent` > 0
- No utilities or financial firms as classified by SIC code: `sic` not in 6000’s or 4900’s
- Fiscal year between 1974 and 2010, from `datadate` year
- No major mergers flag: `compst` not equal to “AB”
- Only include primary issue securities: `priusa` equal to `liid`

A.2 I/B/E/S Data

I downloaded I/B/E/S earnings forecasts and realized earnings data from WRDS in January 2014. My data construction requires files for (stock-split) adjusted detail history, unadjusted detail history, adjusted detail actuals, unadjusted detail actuals, currency headers, and identification headers. I made the following sample restrictions where applicable:

- Nonmissing I/B/E/S permanent ticker `ticker`, earnings per share (EPS) value of forecast or realization `value`, nonmissing fiscal period end date `pends` or `fpedats`, nonmissing announcement date `anndats`, nonmissing analyst and estimator codes `anals`, `estimator`
- Only US firms, as indicated in all files by `usfirm` = 1
- Only firms reporting in US dollars, with available primary/diluted reporting basis flag and historical CUSIP number, as indicated by the currency and identification header files by `curr`, `pdi`, `cusip`

I/B/E/S makes available forecasts for earnings per share as well as realized “Street” earnings per share on two reporting bases: “adjusted,” in which the entire time series for a security is continuously adjusted for both stock splits and primary/dilution factors, as well as “unadjusted,” in which the originally reported forecasts and actuals are stored. Information is also available as “summary” or “detail” data, with summary files containing consensus forecasts for a firm as well as reported actuals, rounded to 2 digits (i.e. cents of earnings per share) and detail files containing the history of analyst forecast rounded to 4 digits.

As Payne and Thomas (2003) note, the joint presence of stock splits and rounding in the adjusted summary files can lead to a severe loss of information as some earnings hits or misses are misclassified as zeros due to the ex-post adjustments made by I/B/E/S. Because accurate classification of earnings hits or misses is crucial to my research agenda, I base my analysis on the unadjusted detail files. However, this requires that all analyst forecasts from the unadjusted files be readjusted to the reporting basis as of the earnings announcement date, since reporting conventions for some securities may change in between a given analyst forecast and the earnings announcement.

To readjust analyst forecasts to the same basis as announced unadjusted actuals requires the following process:

1. Merge the adjusted detail history files with the unadjusted detail history files, on I/B/E/S variables `ticker`, `fpedats`, `anndats`, `analys`, `estimator`
2. For each unadjusted forecast i of EPS for ticker j in fiscal year t $\hat{EPS}_{ijt}^{\text{unadj}}$ as well as equivalent adjusted forecast $\hat{EPS}_{ijt}^{\text{adj}}$, compute the stock split ratio of forecast i relative to the data download date

$$\text{ratio}_{ijt}^{i,\text{today}} = \frac{\hat{EPS}_{ijt}^{\text{unadj}}}{\hat{EPS}_{ijt}^{\text{adj}}}$$

3. For each unadjusted actual value of EPS for ticker j in fiscal year t EPS_{jt}^{unadj} , as well as equivalent adjusted actual EPS_{jt}^{adj} , compute the stock split ratio of the realized earnings in t relative to the data download date

$$\text{ratio}_{jt}^{t,\text{today}} = \frac{EPS_{jt}^{\text{unadj}}}{EPS_{jt}^{\text{adj}}}$$

4. Based on the two ratios above, compute for each unadjusted forecast i of EPS for ticker j in fiscal year t , the EPS forecast \tilde{EPS}_{ijt} on the same reporting basis as t

$$\tilde{EPS}_{ijt} = \hat{EPS}_{ijt}^{\text{unadj}} \frac{\text{ratio}_{jt}^{t,\text{today}}}{\text{ratio}_{ijt}^{i,\text{today}}}$$

Since they are on the same reporting basis, the analyst forecasts \tilde{EPS}_{ijt} , which have 4 digit precision, can be directly compared to the unadjusted actuals series EPS_{jt}^{unadj} . All forecast statistics are computed from these underlying series.

Note that forecasts are made throughout the fiscal year for a given end of year financial release. Therefore, I must make a choice of horizon at which to compute earnings forecasts.

Table A.I: Descriptive Statistics

	Mean	Median	Standard Deviation
Assets	4007.7	599.7	15977.9
Revenues	3505.3	610.5	11804.5
Employment	15.5	3.3	50.8
Intangibles	730.7	136.7	2301.4
R&D	135.0	14.9	519.9
Street Earnings	245.7	32.9	940.2

Note: Assets, Revenues, Intangibles, R&D, and Street Earnings in millions of dollars. Employment in thousands. Intangibles represents selling, general, and administrative expenditures. R&D represents total research and development expenditures. Statistics computed from the forecast error discontinuity detection sample in the year 2000, covering 920 firms and 217 4-digit SIC industries.

In the baseline analysis, I consider forecasts made from a two-quarter horizon, i.e. from 91 to 180 days before the data release. Given a horizon, I construct, for a given firm and fiscal year combination (`ticker` and `pends` in I/B/E/S), a dataset with realized Street actuals as well as median analyst forecasts of earnings per share within that horizon window $[d_1, d_2]$. More precisely, my forecast for a particular firm-fiscal year of earnings per share with horizon window $[d_1, d_2]$ equals

$$\text{EPS}_{jt}^f = \text{median}\{\tilde{\text{EPS}}_{ijs} | t - s \in [d_1, d_2]\}.$$

A.3 Linking Compustat and I/B/E/S

Linking the Compustat and I/B/E/S data requires all observations from the underlying Compustat data, which are uniquely identified by a combination of permanent security identifier `gvkey` and `datadate`, with I/B/E/S observations of realized EPS and forecast EPS, which are uniquely identified by the permanent ticker `ticker` and forecast period end date variables `pends` and `fpedats`. Following the WRDS recommendation for linking in Moussawi (2006), these sets of identifiers can be linked through the CRSP dataset as follows.

- Download the CRSP linking information with the permanent CRSP identifier `permno` together with historical CUSIP security identifiers `cusip` and first date of use `date`
- For each observation in the Compustat dataset which, as a member of the Compustat/CRSP merged database already contains the CRSP identifying PERMNO value, use the date range in the CRSP linking table to assign an historical CUSIP value
- Match a Compustat accounting observation to an I/B/E/S forecast information and realized earnings observation if they have identical CUSIP, PERMNO, as well as fiscal year end date (defined by year and month)

Table A.II: Regression Discontinuity Placebo Checks

Variable	-0.15% Cutpoint	0.15% Cutpoint
Investment Rate	-0.44 (0.37)	0.44 (0.40)
Intangibles Growth	0.26 (0.55)	-0.55 (0.53)
R&D Growth	0.81 (1.00)	-0.88 (0.93)
CEO Pay	-3.89 (3.29)	0.39 (3.66)
Executive Pay	-3.86 (2.38)	0.61 (2.67)
Abnormal Returns	-0.28 (0.26)	-0.20 (0.22)

Note: The regression discontinuity estimation relies on local linear regressions and a triangular kernel, with bandwidth chosen via the optimal Imbens and Kalyanaraman (2011) approach. Standard errors are clustered at the firm level. The estimates represent the mean predicted differences for firms just meeting earnings forecast cutpoints relative to firms just failing to meet forecast cutpoints, for placebo checks at -0.15% and 0.15% forecast errors. Earnings forecast errors are Street earnings minus median analyst forecasts from a 2-quarter horizon, scaled by firm assets as a percentage. Investment Rate is the percentage tangible annual investment rate. Intangibles growth is annual percent selling, general, and administrative expenditures growth. R&D growth is annual percent research and development expenditure growth. CEO Pay, Executive Pay are the log of total compensation for the CEO and several most highly compensated executives at a firm, respectively. Abnormal Returns are the cumulative abnormal returns for a firm in a ten-day window to the announcement date, market adjusting using the returns of the S&P 500. For returns analyst forecasts are drawn from a 1-quarter horizon.

A.4 Execucomp Data

Data from Execucomp from fiscal years 1992-2010 is integrated with the Compustat panel using the common firm identifier `gvkey` together with the date variable `datadate`. CEO compensation and compensation for other executives are considered, with observations requiring `pceo` equal to “CEO” for the CEO subsample. Total compensation for a given fiscal year is measured as the log total pay `tdc2` from Execucomp.

A.5 CRSP Data

Stock returns data from the Center for Research in Security Prices (CRSP) from fiscal years 1983-2010 is integrated with the Compustat panel using the common firm identifier `permno`. Abnormal returns are equal to the cumulative abnormal return over a ten-day window up to the earnings release date for a particular firm fiscal year, market-adjusting daily returns using the S&P 500 index return and within-firm regressions.

Note that in the discontinuity detection exercises, I wish to focus on behavior near the earnings forecast targets and to remove the influence of observations with an unusually high

number of analyst forecast records (and potentially dramatic changes in firm news between forecast generation and earnings releases). Therefore, before estimating the regression discontinuities reported in the main text I further restrict the sample to remove observations with forecast errors greater than 1% of firm assets in absolute value or with higher than the 99.5 percentile of forecast frequency in the aggregation period. Table A.I reports descriptive statistics on the resulting sample for estimation of the investment regression discontinuities in Section 2 of the paper. Table A.II reports placebo checks for each of the regression discontinuity estimates reported in Section 2. Table A.III reports block bootstrap estimates of the regression discontinuities from Section 2.

A.6 Data Moments and Model Estimation

To compute model moments, I first require positive values of Compustat sales `sale` and selling, general, and administrative (SG&A) expenses `xsga`. Then, I also deflate sales, SG&A, and research and development expenditures `xrd` by the value of the GDP deflator current as of December 2013.⁵⁸ Given real vales for a series x_t , I compute percentage growth rates as

$$\Delta x_t = \begin{cases} 2 \frac{x_t - x_{t-1}}{x_t + x_{t-1}}, & x_t \neq 0 \text{ or } x_{t-1} \neq 0 \\ 0, & x_t = x_{t-1} = 0 \end{cases}.$$

This measure of growth rates as the difference relative to the average follows Davis and Haltiwanger (1992) and has the advantage of being bounded within $[-2, 2]$. Selection out of R&D with zero spending for a particular year results in a bounded rather than missing growth value. Following the construction of growth rates and real series from Compustat data, I use the linking process described above to I/B/E/S to obtain a dataset with merged accounting (from Compustat) and earnings forecast (from I/B/E/S) data.

After the link, unscaled values of Street earnings (Street_{jt}) and forecasts (Street_{jt}^f) can be computed by multiplying either the primary or diluted share count as of the fiscal year end date from Compustat (`cshpri` or `cshfd`, respectively, with choice determined by I/B/E/S dilution flag `pdi`) by the unadjusted earnings per share actual value ($\text{EPS}_{jt}^{\text{unadj}}$) or forecast value (EPS_{jt}^f) from I/B/E/S. Once unscaled forecasts and actual Street earnings values exist, forecast error is defined as actual Street earnings minus forecast earnings: $\text{fe}_{jt} = \text{Street}_{jt} - \text{Street}_{jt}^f$.⁵⁹

⁵⁸The GDP deflator is given by the series `GDPDEF` in the Federal Reserve Bank of St. Louis' online FRED database, accessed at <http://research.stlouisfed.org/fred2/>.

⁵⁹I omit the dependence of forecast errors on horizon, although as noted in the I/B/E/S data subsection, earnings per share forecasts are defined as median analyst expectations within a given horizon window before the data release date.

Table A.III: Bootstrap Estimates of Firm Regression Discontinuities in Forecast Errors

	(1)	(2)	(3)	(4)	(5)	(6)
Method	Local Linear	Local Linear	Local Linear	Local Linear	Local Linear	Local Linear
Dependent Variable	Investment Rate	Intangibles Growth	R&D Growth	CEO Pay	Executive Pay	Abnormal Returns
Running Variable	Forecast Error	Forecast Error	Forecast Error	Forecast Error	Forecast Error	Forecast Error
Cutpoint	0	0	0	0	0	0
Discontinuity	0.40 (0.39)	-2.67*** (0.92)	-2.63* (1.56)	6.89*** (2.59)	4.89*** (1.73)	0.67*** (0.21)
Effects	Firm, Year	Firm, Year	Firm, Year	Firm, Year	Firm, Year	Market-Adjusted
Years	1983-2010	1983-2010	1983-2010	1992-2010	1992-2010	1983-2010
Firms	3969	3969	3969	2349	2382	7794
Observations	23084	23084	23084	17661	114296	48297
Relative to Mean	1.0%	-27.2%	-33.7%	6.89% ^a	4.89% ^a	0.67% ^a

Note: *,**,*** denote 10, 5, 1% significance. The results reflect a block bootstrap procedure. Draws of data blocks were sampled with replacement from the distribution of firms, taking into account within-firm correlation as well as uncertainty surrounding variable demeaning by firm and year and the estimation of the regression discontinuity itself. The point estimates are the mean, and the standard errors are the standard deviation, over 250 bootstrap replications. The regression discontinuity estimation relies on local linear regressions and a triangular kernel, with bandwidth chosen via the optimal Imbens and Kalyanaraman (2011) approach. The estimates represent the mean predicted differences for firms just meeting earnings forecasts relative to firms just failing to meet forecasts. Earnings forecast errors are Street earnings minus median analyst forecasts from a 2-quarter horizon, scaled by firm assets as a percentage. Investment Rate is the percentage tangible annual investment rate. Intangibles growth is annual percent selling, general, and administrative expenditures growth. R&D growth is annual percent research and development expenditure growth. CEO Pay, Executive Pay are the log of total compensation for the CEO and several most highly compensated executives at a firm, respectively. Abnormal Returns are the cumulative abnormal returns for a firm in a ten-day window to the announcement date, market adjusting using the returns of the S&P 500. For returns analyst forecasts are drawn from a 1-quarter horizon.

^a Executive pay and stock returns are already in normalized form, and these values duplicate discontinuity estimates.

Table A.IV: Covariance Matrix of Sales Growth, R&D Growth, Forecast Error

	$\Delta Sales$	$\Delta R\&D$	% Forecast Error
$\Delta Sales$	0.067040655	0.027758656	0.008499934
$\Delta R\&D$	0.027758656	0.09078609	-0.00009675512
% Forecast Error	0.008499934	-0.00009675512	0.1328048

Note: The moments sample is as described in the text above, with 32,597 firm-fiscal year observations in an unbalanced panel with Davis and Haltiwanger (1992) growth rate and forecast error transformations applied to real sales, real R&D expenditures, and Street forecast error series in a merged Compustat and I/B/E/S dataset from 1982-2010.

For correspondence with model moments, I compute percentage forecast errors defined as

$$\hat{f}e_{jt} = \begin{cases} 2 \frac{fe_{jt}}{|\text{Street}_{jt}| + |\text{Street}_{jt}^f|}, & |\text{Street}_{jt}| \neq 0 \text{ or } |\text{Street}_{jt}^f| \neq 0 \\ 0, & |\text{Street}_{jt}| = |\text{Street}_{jt}^f| \neq 0 \end{cases}.$$

This measure of forecast error relative to the average absolute value of actual and forecasted Street earnings has several advantages. First, $\hat{f}e_{jt}$ is bounded in $[-2, 2]$ and can flexibly accommodate zeros in forecast or actual earnings series together with differences in sign. I construct estimation moments from data which includes the following series: sales growth, R&D growth, and percentage forecast errors. To avoid the influence of outliers, I further remove observations more extreme than the 0.5% or 99.5% quantiles for accounting series and observations exactly equal to -2 or 2 for percentage forecast error. As noted in the main text, I consider a total of six micro moments for estimation. The values of the moment covariance matrix, in raw form as utilized in the GMM estimation procedure itself, are reported in Table A.IV.

I now turn to the details of the overidentified GMM structural estimation of $\hat{\theta}$ in the baseline model based on the vector of moments $m(X)$. Recall that the aggregate growth rate is used as a targeted moment in the estimation, together with the micro-level covariance matrix of sales growth, R&D growth, and forecast errors. The growth rate is the average annual growth rate of US per capita GDP from 1961-2010, FRED series USARGDPC.

Under an assumption of independence between micro and macro data samples, the covariance matrix of the joint set of moments $m(X)$ is computed in a two-stage process. First, I compute the variance of the aggregate growth rate g , $\hat{\sigma}_g^2$, taking into account arbitrary stationary time series correlation in my sample of length T using the stationary bootstrap of Politis and Romano (1994).

Second, note that the vector of micro moments can be written as a smooth function of unscaled first and second moments, say $\hat{\mu}$, of sales growth, R&D growth, and forecast errors, so that the estimated covariance matrix of the micro moments, \hat{V} , is immediately implied by an estimate of the covariance matrix of the raw moments, Ω , and the Delta method. I compute $\hat{\Omega}$ with asymptotics in the number of firms N allowing for arbitrary clustering within firms. If each firm j has T_j observations in the sample and the average number of

observations is $\hat{\tau} = \frac{\sum_{j=1}^N T_j}{N}$, then in particular

$$\hat{\mu} = \frac{1}{N} \sum_{j=1}^N \frac{1}{\hat{\tau}} \sum_{t=1}^{T_j} x_{jt}$$

$$\hat{\Omega} = \frac{1}{N} \frac{1}{\hat{\tau}^2} \sum_{j=1}^N \sum_{s=1}^{T_j} \sum_{t=1}^{T_j} (x_{js} - \hat{\mu})(x_{jt} - \hat{\mu})'$$

$$\sqrt{N}(\hat{\mu} - \mu) \rightarrow_d N(0, \Omega),$$

where x_{jt} is the stacked vector of levels and cross-products of R&D growth, sales growth, and forecast errors for firm j in period t .

Under an assumption that $\hat{\gamma} = \sqrt{\frac{T}{N}} \rightarrow \gamma$ asymptotically as $N \rightarrow \infty$, which adjusts for relative sample sizes, together with the assumption of independence between the micro and macro samples, I can write the joint asymptotic covariance matrix of the vector $m(X)$ of the aggregate growth rate and micro moments together as

$$\begin{bmatrix} \hat{\gamma} & 0 \\ 0 & 1 \end{bmatrix} \sqrt{N}(m(X) - m(\theta)) \rightarrow_d N(0, V),$$

where $\hat{V} = \begin{bmatrix} \hat{\sigma}_g^2 & 0 \\ 0 & \hat{V} \end{bmatrix}$.

Given the asymptotic distribution of the moments used in the estimation of the underlying structural parameters θ , the definition of $\hat{\theta}$ as the minimizer of the GMM objective function and standard GMM arguments yield the result that

$$\sqrt{N}(\hat{\theta} - \theta) \rightarrow_d N(0, \Sigma),$$

where the covariance matrix of the estimated parameters is given by

$$\Sigma = \left[\frac{\partial m(\theta)}{\partial \theta'} W \frac{\partial m(\theta)}{\partial \theta} \right]^{-1} \frac{\partial m(\theta)}{\partial \theta'} W \begin{bmatrix} \frac{1}{\gamma} & 0 \\ 0 & 1 \end{bmatrix} V \begin{bmatrix} \frac{1}{\gamma} & 0 \\ 0 & 1 \end{bmatrix} W \frac{\partial m(\theta)}{\partial \theta} \left[\frac{\partial m(\theta)}{\partial \theta'} W \frac{\partial m(\theta)}{\partial \theta} \right]^{-1}.$$

Here, the weighting matrix W is chosen so that the GMM objective is equal to the sum of the squared percentage deviations of model from data moments, with one modification. The aggregate growth rate, of crucial importance economically given my endogenous growth framework, is assigned 10 times more weight than the micro moments. Estimates of $\hat{\theta}$ are computed using particle swarm optimization, a robust and standard global stochastic optimization routine. Given $\hat{\theta}$ and W in hand, an estimate of the Jacobian $\frac{\partial m(\theta)}{\partial \theta'}$ of model moments with respect to parameters is computed using straightforward numerical differentiation averaging over relative step sizes of 0.75%, 1%, and 1.25%.

B Theory

B.1 Model Equilibrium

An equilibrium of the model consists of household consumption and savings policies $C_t, B_{t+1}, \{S_{jt}\}_j$, final goods firm input policies $\{X_{jt}\}_j, L_t^D$, intermediate goods firm manager R&D, pricing, accounting manipulation, shirking, and franchise pricing policies $\{z_{jt}, p_{jt}, m_{jt}, s_{jt}, \chi_{jt}^M\}_j$, intermediate goods firm manager rejection policies $\{r_{jt}\}_j$, analyst earnings forecasts $\{\pi_{jt}^f\}_j$, aggregate final output Y_t , aggregate intermediate goods expenditures X_t , aggregate accounting manipulation expenditures AC_t , aggregate R&D expenditures Z_t , aggregate firm miss costs Ξ_t^{firm} , and lump-sum transfers T_t^{HH}, T_t^M , together with prices $R_{t+1}, \{P_{jt}\}$, and w_t such that the following conditions hold.

Household Optimizes

Taking as given wages w_t , share prices and dividends $\{P_{jt}\}_j, \{D_{jt}\}_j$, and lump-sum transfers T_t^{HH} , the values for household consumption C_t , one-period risk free bond savings B_{t+1} , and share purchases in intermediate goods firms $\{S_{jt}\}$ maximize household utility:

$$\max_{C_t, B_{t+1}, \{S_{jt}\}} \sum_{t=0}^{\infty} \rho^t \frac{C_t^{1-\sigma}}{1-\sigma}$$

$$C_t + B_{t+1} + \int_0^1 P_{jt} S_{jt} dj = R_t B_t + w_t L + \int_0^1 (P_{jt} + D_{jt}) S_{jt-1} dj + T_t^{HH}.$$

Final Goods Sector Optimizes

Taking as given wages w_t and intermediate input prices p_{jt} , the competitive and constant returns to scale final goods sector labor and intermediate input demands $L_t^D, \{X_{jt}\}_j$ maximize profits:

$$\begin{aligned} \max_{\{X_{jt}\}_j, L_t^D} Y_t - \int_0^1 p_{jt} X_{jt} dj - w_t L_t^D \\ Y_t = \frac{(L_t^D)^\beta}{(1-\beta)} \int_0^1 [Q_{jt}(a_{jt} + \varepsilon_{jt})(1 - \gamma_s s_{jt})]^\beta X_{jt}^{1-\beta} dj. \end{aligned}$$

Managers Optimize

Taking as given an exogenous endowment of consumption goods $\bar{C}^M Q_t$, exogenous persistent and transitory profitability shocks $a_{jt-1}, \varepsilon_{jt-1}$, long-term quality level Q_{jt-1} , previous manager R&D and paper manipulation choices z_{jt-1}, m_{jt-1} , next-period earnings forecasts Π_{jt}^f , and the previous manager's take-it-or-leave-it price χ_{jt-1}^M for the managerial franchise, each manager $j \in [0, 1]$ born in period $t-1$ must make the end of period $t-1$ choice $r_{jt-1} \in \{0, 1\}$ to reject ($r_{jt-1} = 1$) or accept ($r_{jt-1} = 0$) the offer of the managerial franchise when seeking to maximize period t expected utility, i.e.

$$r_{jt-1} = \arg \max_r -R_t \chi_{jt-1}^M (1-r) + \bar{C}^M Q_t + T_t^M + (1-r) \mathbb{E}_{t-1} \left(\begin{array}{c} \theta_d D_{jt} - \xi \mathbb{I}(\Pi_{jt} < \Pi_{jt}^f) Q_{jt} \\ + \lambda_e Q_{jt} + \lambda_s s_{jt} Q_{jt} + \chi_{jt}^M (1 - r_{jt}) \end{array} \right).$$

Conditional upon accepting the previous manager's franchise offer ($r_{jt-1} = 0$), in their

second period of life in period t each manager $j \in [0, 1]$ born in period $t - 1$ must make R&D investment, paper manipulation, monopoly pricing, and managerial franchise pricing offer choices z_{jt} , m_{jt} , p_{jt} , and χ_{jt}^M . These decisions take as given the realization of exogenous persistent and transitory profitability shock a_{jt} , ε_{jt} , long-term quality Q_{jt} , current profit forecast Π_{jt}^f , as well as the optimal choice r_{jt} of acceptance or rejection of the managerial franchise by the next-period manager born in period t . The manager seeks to maximize their period t utility, i.e. they solve the problem

$$\max_{z_{jt}, m_{jt}, p_{jt}, s_{jt}, \chi_{jt}^M} \left(\begin{array}{l} -R_t \chi_{jt-1}^M + \bar{C}^M Q_t + T_t^M + \theta_d D_{jt} - \xi \mathbb{I}(\Pi_{jt} < \Pi_{jt}^f) Q_{jt} \\ + \lambda_e Q_{jt} + \lambda_s s_{jt} Q_{jt} + \chi_{jt}^M (1 - r_{jt}) \end{array} \right).$$

From the perspective of the manager, perceived miss costs are a combination $\xi = \xi^{manager} + \theta_d \xi^{firm} + (1 - \theta_d) \xi^{pay}$, and dividends net of manager clawback compensation and firm-borne miss costs are $D_{jt} = (1 - \tau_c) (\Pi_v(Q_{jt}, a_{jt}, \varepsilon_{jt}, p_{jt}) (1 - \gamma_s s_{jt}) - z_{jt} Q_{jt}) - \gamma_m m_{jt}^2 Q_{jt}$.

Intermediate Goods Firm Values

Given exogenous persistent and transitory profitability shocks a_{jt} , ε_{jt} , long-term quality level Q_{jt} , and analyst forecasts Π_{jt}^f , as well as manager-determined intermediate goods firm R&D investments z_{jt} , monopoly prices p_{jt} , shirking decisions s_{jt} , and accounting manipulation choices m_{jt} , the value of intermediate goods firms j at time t is given by the present-discounted value of firm dividends

$$\mathbb{E} \sum_{t=0}^{\infty} \left(\frac{1}{R} \right)^t \left(\begin{array}{l} (1 - \tau_c) (\Pi_v(Q_{jt}, a_{jt}, \varepsilon_{jt}, p_{jt}) (1 - \gamma_s s_{jt}) - z_{jt} Q_{jt}) \\ - \gamma_m m_{jt}^2 Q_{jt} - (\xi^{firm} - \xi^{pay}) \mathbb{I}(\Pi_{jt}^{Street} < \Pi_{jt}^f) Q_{jt} \end{array} \right),$$

$$\Pi_{jt}^{Street} = (1 - \tau_c) (\Pi_v(Q_{jt}, a_{jt}, \varepsilon_{jt}, p_{jt}) (1 - \gamma_s s_{jt}) - z_{jt} Q_{jt}) + m_{jt} Q_{jt}$$

$$Q_{jt+1} = \begin{cases} \lambda Q_{jt}, & \text{with probability } \Phi(z_{jt}) \\ \max(Q_{jt}, \omega Q_{t+1}), & \text{with probability } 1 - \Phi(z_{jt}) \end{cases}, \quad \Phi(z_{jt}) = A z_{jt}^\alpha$$

$$a_{jt} = (1 - \rho_a) + \rho_a a_{jt-1} + \zeta_{jt}, \quad \zeta_{jt} \sim N(0, \sigma_a^2), \quad \varepsilon_{jt} \sim N(0, \sigma_\varepsilon^2)$$

$$\Pi_v(Q_{jt}, a_{jt}, \varepsilon_{jt}, p_{jt}) = p_{jt} X_{jt} - \psi X_{jt}, \quad \psi = 1 - \beta.$$

Analyst Sector Optimizes

Taking as given normalized Street earnings last period $\pi_{jt-1} = \frac{\Pi_{jt-1}^{Street}}{Q_{jt-1}}$, an outside analyst sector forecasts normalized Street earnings π_{jt} today, where the forecast earnings levels $\pi_{jt}^f = \frac{\Pi_{jt}^f}{Q_{jt}}$ must minimize analyst loss as follows

$$\pi_{jt}^f = \arg \min_{\pi^f} \mathbb{E}_{\pi_{jt-1}} (\pi^f - \pi_{jt})^2.$$

Labor and Asset Markets Clear

$$L_t^D = L \text{ (Final Goods Labor Input)}$$

$$B_{t+1} = \int \chi_{jt}^M (1 - r_{jt-1}) dj \text{ (Borrowing for Franchise Purchases Only)}$$

$$S_{jt} = 1 - \theta_d \text{ (Equity Share Market)}$$

$$r_{jt} = 0 \text{ (Managerial Franchise Market)}$$

Government Budget Balances

$$T_t^{HH} + T_t^M = \int \tau_c (\Pi_{vjt}(1 - \gamma_s s_{jt}) - z_{jt} Q_{jt}) dj$$

Managers Consume Their Endowments

$$C_t^M = \int C_{jt}^M dj = \bar{C}^M Q_t$$

Resource Constraint and Aggregation Conditions are Satisfied

$$Y_t + \bar{C}^M Q_t = C_t + C_t^M + X_t + \Xi_t^{firm} + Z_t + AC_t \text{ (Goods Market Clearing)}$$

$$X_t = \int \psi X_{jt} dj \text{ (Intermediate Consumption)}$$

$$Z_t = \int z_{jt} Q_{jt} dj \text{ (R\&D Investment)}$$

$$\Xi_t^{Firm} = \int \xi^{firm} \mathbb{I}(\Pi_{jt}^{Street} < \Pi_{jt}^f) Q_{jt} dj \text{ (Firm Earnings Costs)}$$

$$AC_t = \int AC_m(m_{jt}) Q_{jt} dj \text{ (Accounting Manipulation Costs)}$$

B.2 Normalization and Recursive Firm Problem

Consider a stationary balanced growth bath equilibrium where average quality in the economy $Q_t = \int Q_{jt} dj$ grows at a constant rate g and there exists an invariant distribution $\mu(a_{jt}, \varepsilon_{jt}, q_{jt}, \pi_{jt}^f)$ of intermediate goods firm manager state variables with $q_{jt} = \frac{Q_{jt}}{Q_t}$ and π_{jt}^f defined above. Then, immediately, all of the aggregates in the economy grow at the rate g as well, since

$$X_t = \int \psi X_{jt} dj = Q_t \int \psi L(a_{jt} + \varepsilon_{jt})(1 - \gamma_s s_{jt}) q_{jt} d\mu \propto Q_t$$

$$Z_t = \int z_{jt} Q_{jt} dj = Q_t \int z_{jt} q_{jt} d\mu \propto Q_t$$

$$\Xi_t^{firm} = \int \xi^{firm} \mathbb{I}(\Pi_{jt}^{Street} < \Pi_{jt}^f) Q_{jt} dj = Q_t \int \xi^{firm} \mathbb{I}(\pi_{jt} < \pi_{jt}^f) q_{jt} d\mu \propto Q_t$$

$$AC_t = \int \gamma_m m_{jt}^2 Q_{jt} dj = Q_t \int \gamma_m m_{jt}^2 q_{jt} dj \propto Q_t$$

$$Y_t = \frac{L^\beta}{(1 - \beta)} \int_0^1 [Q_{jt}(a_{jt} + \varepsilon_{jt})(1 - \gamma_s s_{jt})]^\beta X_{jt}^{1-\beta} dj = \frac{L}{1 - \beta} Q_t \int q_{jt}(a_{jt} + \varepsilon_{jt})(1 - \gamma_s s_{jt}) d\mu \propto Q_t$$

$$C_t = Y_t - X_t - Z_t - AC_t - \Xi_t^{firm} \propto Q_t.$$

Therefore, the household intertemporal Euler equation for savings in one-period bonds yields the standard result of a constant interest rate $R_{t+1} = \frac{1}{\rho}(1+g)^\sigma = R$. Note, as will be shown below, that manager value maximization solves

$$\begin{aligned} & \max_{z_{jt}, m_{jt}, s_{jt}} \mathbb{E}_0 \left\{ \sum_{t=0}^{\infty} \left(\frac{1}{R} \right)^t D_{jt}^M \right\} \\ &= \max_{z_{jt}, m_{jt}, s_{jt}} \mathbb{E}_0 \left\{ \sum_{t=0}^{\infty} \left(\frac{1}{R} \right)^t Q_t \frac{D_{jt}^M}{Q_t} \right\} \leftrightarrow \max_{z_{jt}, m_{jt}, s_{jt}} \mathbb{E}_0 \left\{ \sum_{t=0}^{\infty} \left(\frac{1+g}{R} \right)^t \frac{D_{jt}^M}{Q_t} \right\}. \end{aligned}$$

The above trivially omits the monopoly pricing decision $p_{jt} = 1$ from the firm problem. Also, if $\sigma \geq 1$ then $\frac{1+g}{R} = \rho(1+g)^{1-\sigma} \leq \rho < 1$. D_{jt}^M , the manager flow return written in full in the equilibrium above, is homogenous in Q_{jt} and hence stationary since $q_{jt} = \frac{Q_{jt}}{Q_t}$ is stationary. Therefore, the intermediate goods firm manager's objective exists in stationary, normalized form.

Manager policies can be obtained as the result of maximization of manager flow returns discounted by the market interest rate, the objective written and analyzed above. To justify this, first note that manager j born in time $t-1$ will accept the offer of a managerial franchise (i.e. set $r_{jt-1} = 0$) for the following period t at price χ_{jt-1}^M if and only if

$$R_t \chi_{jt-1}^M \leq \mathbb{E}_{t-1} \left(\begin{array}{c} \theta_d D_{jt} - \xi \mathbb{I}(\Pi_{jt}^{Street} < \Pi_{jt}^f) Q_{jt} \\ + \lambda_e Q_{jt} + \chi_{jt}^M \end{array} \right).$$

Via backward induction, since χ_{jt-1}^M is a take-it-or-leave-it price from the previous manager and since the previous manager's utility is strictly increasing in χ_{jt}^M , it must always be the case that market clearing for managerial franchises pins down the price χ_{jt-1}^M :

$$\chi_{jt-1}^M = \frac{1}{R_t} \mathbb{E}_{t-1} \left(\begin{array}{c} \theta_d D_{jt} - \xi \mathbb{I}(\Pi_{jt}^{Street} < \Pi_{jt}^f) Q_{jt} \\ + \lambda_e Q_{jt} + \lambda_s s_{jt} Q_{jt} + \chi_{jt}^M \end{array} \right).$$

Repeated forward substitution into the expression for manager consumption in period t therefore implies that in period t the manager born in $t-1$ maximizes the present discounted stream of manager utilities from period t onwards, exactly the objective stated in the text.

Note that because they are exogenous to the manager's linear payoffs, the manager consumption endowments $\bar{C}^M Q_t$ and transfers T_t^M do not impact manager policies or intermediate goods firm values. However, both terms are useful technically. A high enough value of \bar{C}^M ensures that potentially negative dividends and clawbacks ξ^{pay} do not result in negative manager consumption levels. Meanwhile an appropriate and maintained choice of $T_t^M = - \int \theta_d D_{jt} dj + \int \xi^{pay} \mathbb{I}(\Pi_{jt} < \Pi_{jt}^f) Q_{jt} dj$ ensures that manager consumption on aggregate is equal to exogenous endowment levels $\bar{C}^M Q_t$ exactly. Hence, household consumption can be backed out via the resource constraint, i.e.

$$C_t = Y_t - X_t - AC_t - Z_t - \Xi_t^{firm},$$

which is the expression used to argue for $R_t = R$ above.

Also, trivially note that the analyst problem yields $\pi_{jt}^f = \mathbb{E}_\mu(\pi_{jt} | \pi_{jt-1})$ given the mean squared error loss function for analysts. Omitting t and j subscripts for clarity, using $'$ to denote future periods, and writing the manager problem recursively yields

$$\begin{aligned}
V^M(a, \varepsilon, q, \pi^f) &= \max_{z, m, s} \left\{ \theta_d d - \xi \mathbb{I}(\pi < \pi^f) q + \lambda_e q + \lambda_s s q + \left(\frac{1+g}{R} \right) \mathbb{E} V^M(a', \varepsilon', q', \pi^{f'}) \right\} \\
d &= (1 - \tau_c) (\beta(a + \varepsilon) q L (1 - \gamma_s s) - z q) - \gamma_m m^2 q \\
\pi &= (1 - \tau_c) (\beta(a + \varepsilon) L (1 - \gamma_s s) - z) + m \\
a' &= (1 - \rho_a) + \rho_a a + \zeta', \quad \zeta' \sim N(0, \sigma_a^2), \quad \varepsilon' \sim N(0, \sigma_\varepsilon^2) \\
q' &= \begin{cases} \frac{\lambda q}{1+g}, & \text{with prob. } \Phi(z) = Az^\alpha \\ \max \left\{ \frac{q}{1+g}, \omega \right\}, & \text{with prob. } 1 - \Phi(z) \end{cases} \\
\pi^{f'} &= \mathbb{E}_\mu(\pi' | \pi).
\end{aligned}$$

The stationary, recursive, normalized intermediate goods firm manager problem above features discounting at rate $(1+g)/R$ rather than $1/R$, and sees “depreciation” of normalized relative long-term quality levels q by the rate g each period. The manager problem also allows for the influence of corporate taxes, through the τ_c marginal rate, on firm decisions.⁶⁰ In this form, the problem can be solved using standard numerical dynamic programming techniques, as discussed in the Numerical Appendix C below. Also, once optimal policies are obtained, a similar recursive structure obtains for intermediate goods firm values themselves through direct substitution of manager optimal policies.

Now I explicitly define the notion of stationarity which must be satisfied by the distribution of normalized state variables $\mu(a, \varepsilon, q, \pi^f)$. The distribution must be invariant to forward iteration on both the exogenous driving profitability processes a and ε as well as the endogenous forecast and long-term quality transitions. Let $z(a, \varepsilon, q, \pi^f)$, $m(a, \varepsilon, q, \pi^f)$, and $\pi(a, \varepsilon, q, \pi^f)$ be the optimal R&D policy, optimal accounting manipulation policy, and induced normalized Street earnings functions, and let $f_a(a'|a)$ and $f_\varepsilon(\varepsilon')$ be the transition and density functions for the exogenous processes. Formally, the stationary distribution μ satisfies the following condition:

$$\begin{aligned}
\mu(a', \varepsilon', q', \pi^{f'}) &= \int \Phi(z(a, \varepsilon, q, \pi^f)) f_a(a'|a) f_\varepsilon(\varepsilon') \mathbb{I} \left[q' = \frac{\lambda q}{1+g}, \pi^{f'} = \mathbb{E}(\pi' | \pi(a, \varepsilon, q, \pi^f)) \right] d\mu(a, \varepsilon, q, \pi^f) \\
&\quad + \\
&\int (1 - \Phi(z(a, \varepsilon, q, \pi^f))) f_a(a'|a) f_\varepsilon(\varepsilon') \mathbb{I} \left[q' = \frac{q}{1+g}, \pi^{f'} = \mathbb{E}(\pi' | \pi(a, \varepsilon, q, \pi^f)) \right] d\mu(a, \varepsilon, q, \pi^f).
\end{aligned}$$

The aggregation condition which must further be satisfied on a stationary balanced growth path, which guarantees that the aggregate growth rate of long-term quality is generated by

⁶⁰All numerical results in the paper incorporate income taxation at a marginal 35% rate, but this consideration is omitted from the main text for brevity.

firm policies and the stationary distribution μ , repeats here from the main text.

$$1 + g = \frac{Q'}{Q} = \frac{\int \Phi(z(a, \varepsilon, q, \pi^f)) \lambda q d\mu(a, \varepsilon, q, \pi^f)}{\int_{q > \omega(1+g)} (1 - \Phi(z(a, \varepsilon, q, \pi^f))) q d\mu(a, \varepsilon, q, \pi^f)} + \frac{\int_{q \leq \omega(1+g)} (1 - \Phi(z(a, \varepsilon, q, \pi^f))) \omega(1 + g) d\mu(a, \varepsilon, q, \pi^f)}{\int_{q > \omega(1+g)} (1 - \Phi(z(a, \varepsilon, q, \pi^f))) q d\mu(a, \varepsilon, q, \pi^f)}$$

The first term represents quality growth generated by quality ladder innovation arrivals, the second term represents quality growth from lagging-quality firms away from the diffusion bound ω , and the final term represents quality growth from lagging quality firms at the diffusion boundary.

Note that the model used for *cost* estimation in Section 4 imposes $\lambda_e = \lambda_s = s_{jt} = 0$ and $\xi = \xi^{manager}$, i.e. the model assumes away agency conflicts and mechanical resource costs of earnings misses, while the shirking model in Section 5 assumes $\lambda_e = 0$ and the empire building case in Section 5 assumes $\lambda_s = s_{jt} = 0$. Both models of Section 5 assume $\xi = (1 - \theta_d)\xi^{pay}$, i.e. that the costs of earnings misses represent explicit manager compensation policies.

B.3 Welfare and Firm Value Change Formulas

The total consumption equivalent welfare gains from the removal of earnings targets, i.e. moving from $\xi > 0 \rightarrow \xi = 0$ comparing balanced growth paths only, can be written as 100Δ where Δ satisfies the following equation:

$$\sum_{t=0}^{\infty} \rho^t \frac{(C_{t,targets}(1 + \Delta))^{1-\sigma}}{1 - \sigma} = \sum_{t=0}^{\infty} \rho^t \frac{(C_{t,notargets})^{1-\sigma}}{1 - \sigma}.$$

All “targets” subscripts refer to cases with $\xi > 0$ and “notargets” subscripts refer to cases with $\xi = 0$. Trivially, this yields the following formula and decomposition of the welfare gains from removal of the earnings target friction:

$$\Delta = \underbrace{\frac{C_{0,notargets}}{C_{0,targets}}}_{\text{Static}} \underbrace{\left(\frac{1 - \rho(1 + g_{targets})^{1-\sigma}}{1 - \rho(1 + g_{notargets})^{1-\sigma}} \right)^{\frac{1}{1-\sigma}}}_{\text{Dynamic}}.$$

The above welfare calculations are general equilibrium, in that they take into account all aggregate changes in growth rates, forecasting systems, and the stationary distribution of the economy when targets are removed. By contrast, the partial equilibrium change in firm value resulting from the removal of earnings targets is computed leaving these quantities unchanged, since from the perspective of the firm such aggregates are fixed. The resulting formula for the average change in firm value used in the text is

$$100\mathbb{E}_{\mu_{targets}} \log \left(\frac{V_{notargets}}{V_{targets}} \right).$$

Note that the text reports in the cost estimation of Section 4 a conservative version of the measures above which omit the direct effect of the removal of earnings targets costs on the

aggregate consumption level and firm value by assuming costs are private to the manager, $\xi = \xi^{manager}$. Therefore, there is no mechanical effects of the target removal on aggregate household consumption or firm dividends through a resource channel. By contrast Section 5, which assumes that miss costs are based on manager compensation, prevents a mechanical impact of miss costs on aggregate consumption through the lump-sum transfers away from managers but does allow for clawback to increase firm flow dividends for valuation purposes.

B.4 Adding Measurement Error

The main text shows results for a version of the baseline model with “target measurement error” ν_{jt} for firms. ν_{jt} is a transitory white noise disturbance with variance σ_ν^2 for firm j in period t which is unknown at the time manager policies are determined but shifts the realized profits for firms and hence the relevant earnings target. More precisely, this involves replacement of the standard intermediate goods firm manager optimization problem from the equilibrium definition above with one that incorporates ν_{jt} :

$$\max_{z_{jt}, m_{jt}, p_{jt}} \mathbb{E} \left\{ \sum_{t=0}^{\infty} \left(\frac{1}{R} \right)^t \left(\begin{array}{l} (1 - \tau_c) (\Pi_v(Q_{jt}, a_{jt}, \varepsilon_{jt}, p_{jt}) - z_{jt} Q_{jt}) \\ -\gamma_m m_{jt}^2 Q_{jt} - \tilde{\xi} \mathbb{I}((\Pi_{jt}^{Street} + \nu_{jt}) < \Pi_{jt}^f) Q_{jt} \end{array} \right) \right\}$$

$$Q_{jt+1} = \begin{cases} \lambda Q_{jt}, & \text{with probability } \Phi(z_{jt}) \\ \max(Q_{jt}, \omega Q_{t+1}), & \text{with probability } 1 - \Phi(z_{jt}) \end{cases}, \quad \Phi(z_{jt}) = Az_{jt}^\alpha$$

$$a_{jt} = (1 - \rho_a) + \rho_a a_{jt-1} + \zeta_{jt}, \quad \zeta_{jt} \sim N(0, \sigma_a^2), \quad \varepsilon_{jt} \sim N(0, \sigma_\varepsilon^2), \quad \nu_{jt} \sim N(0, \sigma_\nu^2)$$

In practice, since ν isn't a state variable for the firm at the time policies are determined, the recursive normalized problem can be modified from the statement above to the following form:

$$V^M(a, \varepsilon, q, \pi^f) = \max_{z, m} \left\{ \left(\begin{array}{l} (1 - \tau_c) (\beta(a + \varepsilon)qL - zq) \\ -\gamma_m m^2 q - \tilde{\xi} \mathbb{E}_\nu \mathbb{I}((\pi + \nu) < \pi^f) q \end{array} \right) + \left(\frac{1+g}{R} \right) \mathbb{E} V^M(a', \varepsilon', q', \pi^{f'}) \right\}$$

$$\pi = (1 - \tau_c) (\beta(a + \varepsilon)L - z) + m$$

$$a' = (1 - \rho_a) + \rho_a a + \zeta', \quad \zeta' \sim N(0, \sigma_a^2), \quad \varepsilon' \sim N(0, \sigma_\varepsilon^2), \quad \nu \sim N(0, \sigma_\nu^2)$$

$$q' = \begin{cases} \frac{\lambda q}{1+g}, & \text{with prob. } \Phi(z) = Az^\alpha \\ \frac{\max\{\omega, q\}}{1+g}, & \text{with prob. } 1 - \Phi(z) \end{cases}$$

$$\pi^{f'} = \mathbb{E}_\mu (\pi' | (\pi + \nu)).$$

Note that since the measurement error version is only discussed in the context of the cost estimation model with $\lambda_e = \lambda_s = s = 0$, I omit those terms from the dividend flows above and write the earnings miss costs as $\tilde{\xi}$, which is simply equal to ξ/θ_d in previous notation.

C Numerical Solution

The aggregates of the model which are crucial for the general equilibrium solution include the growth rate g and the forecast function $\pi^f = \mathbb{E}_\mu(\pi|\pi_{-1})$. I approximate the forecast function with a linear rule $\pi^f = \eta_0 + \eta_1\pi_{-1}$. Comparison of model-implied conditional expectations and linear forecasts in Figure C.I, as well as a range of forecast accuracy checks with extended forecast rules and information sets in Table C.III, indicate that the linear forecast approximation based on lagged earnings is quantitatively reasonable.

Given the forecast rule approximation, the model is solved via a combination of discretization, policy iteration, and nonstochastic simulation, together with an outer loop over aggregates. In other words, the rough solution algorithm, given a parametrization of the model, consists of:

1. Guess values for the aggregate growth rate g , as well as forecast coefficients η_0, η_1 .
 - (a) Solve the normalized, recursive manager Bellman equation stated in Theory Appendix B to some specified tolerance, using discretization of the exogenous processes as discussed below, discretization of value and policy functions, and Howard policy acceleration. Within this step, the manager discounts the future using the growth-rate normalization as well as interest rate implied by the guess for g and the household Euler equation, and earnings targets transition according to the assumed forecast coefficients on normalized reported Street earnings.
 - (b) Given a solution to the firm problem, use the nonstochastic simulation approach of Young (2010) to iterate forward on exogenous processes and endogenous transitions until a stationary distribution μ is obtained to some tolerance.
 - (c) Compute the implied aggregate growth rate \tilde{g} , as well as the implied forecast coefficients $\tilde{\eta}_0, \tilde{\eta}_1$.
2. If the maximum absolute differences between the guessed and implied growth rates and forecast coefficients are less than some predetermined tolerances, the model is solved. If the outer loop has not yet converged, then update either the growth rate (using bisection) or the forecast coefficients (using dampened fixed-point iteration), until they converge to model-implied values.

Some of the practical choices for numerical implementation are listed in the table below. The model is solved using Fortran with heavy parallelization. Note that when required, forward iterations of endogenous variables required both for distributional iteration as well as expectations in the manager Bellman equation use linear interpolation in the endogenous variable.

Note that Table C.II records robustness checks of the earnings target costs estimates from the Baseline in the text to alternative parametrizations or assumptions for the model. Also, Figure C.II displays the ergodic or stationary marginal distributions of model state and policy variables in the Baseline and No Targets economies.

Table C.I: Some Practical Numerical Choices

Object	Value	Explanation
n_q	25	Density of q grid
	[0.08,12.24]	Bounds of q grid
n_π	20	Density of π grid
	[-0.5,1.5]	Bounds of π grid
n_a	7	Density of a grid
	[0.59,1.41]	Bounds of a grid
n_ε	3	Density of ε grid
	[-0.20,20]	Bounds of ε grid
n_z	15	Density of z grid
	[0.0,0.5]	Bounds of z grid
n_m	15	Density of m grid
	[-0.5,0.5]	Bounds of m grid
N_{Howard}	250	Number of Howard accelerations
ε_{pol}	0.0	Tolerance for discretized policy convergence
ε_{dist}	1e-9	Tolerance for distributional convergence
$\varepsilon_{outer,g}$	1e-5	Tolerance outer GE loop for g
$\varepsilon_{outer,\eta}$	1e-2	Tolerance outer GE loop for η
η_{update}	0.25	Dampening weight on new values for η

Note: The table above describes some practical numerical choices made to solve the normalized recursive model described in the Theory Appendix B. The model is solved with discretization, and the grid boundaries as well as densities are displayed above together with tolerances for the various fixed-points required by the model and described in the numerical solution overview.

Table C.II: Robustness Checks in the Baseline Model

	%	Δg	ΔW_{stat}	ΔW_{dyn}	ΔW	$\Delta \mathbb{E}$ (R&D z)	$\Delta \sigma$ (R&D z)
$\sigma_a = 0.04$	0.11	-1.09	2.51	1.40	-7.20	23.12	
$\sigma_a = 0.12$	0.06	2.74	1.29	4.06	-5.11	11.20	
$\sigma_\varepsilon = 0.06$	0.06	-0.71	1.27	0.55	-0.63	22.42	
$\sigma_\varepsilon = 0.14$	0.06	-0.06	1.29	1.23	-3.80	29.31	
$\rho_a = 0.85$	0.06	-1.66	1.36	-0.33	-4.17	45.52	
$\rho_a = 0.95$	0.06	0.22	1.45	1.67	-3.98	10.41	
$A = 0.21$	0.05	-0.32	1.25	0.92	-2.25	5.57	
$A = 0.275$	0.06	-0.13	1.32	1.19	-3.68	23.05	
$\gamma_m = 0.25$	0.05	-0.57	1.18	0.61	-3.18	31.37	
$\gamma_m = 0.35$	0.07	-0.82	1.48	0.65	-0.90	26.13	
$\gamma_m = \infty$	0.05	-1.04	1.12	0.08	-4.50	54.54	
$\xi = 0.5\hat{\xi}$	0.05	-1.37	1.04	-0.34	-0.17	22.74	
$\xi = 2.0\hat{\xi}$	0.13	-0.30	2.96	2.64	-6.53	44.27	
$\alpha = 0.4$	0.07	-0.86	1.55	0.68	-8.08	30.93	
$\alpha = 0.6$	0.08	-0.15	1.94	1.79	-2.07	25.90	
$\beta = 0.5$	0.07	0.21	1.84	2.06	-2.28	25.01	
$\lambda = 1.2$	0.05	-0.32	1.57	1.25	-8.86	35.29	
Random Walk Forecast	0.01	1.44	0.15	1.57	-1.10	25.89	
Quadratic Fcst	0.07	0.05	1.62	1.67	-3.69	23.85	
Fcst Bias = 0.01	0.08	-0.80	1.82	1.01	-6.05	31.90	
Fcst Bias = -0.01	0.06	-0.86	1.32	0.44	-0.32	23.06	
Baseline	0.06	-0.86	1.32	0.44	-0.32	23.1	

Note: The entries above represent percent differences between the counterfactual $\xi = 0$ and estimated benchmark $\hat{\xi}$ cases. The moments are computed from the stationary distributions μ of the respective economies.

Table C.III: Alternative Forecast System Accuracy

Higher-Order Terms	RMSE	New Information Terms	RMSE
Mean Only	1.0000	Mean Only	1.0000
Add $\eta_1 \pi_{-1}$	0.8998	Add $\eta_1 \pi_{-1}$	0.8998
Add $\eta_2 \pi_{-1}^2$	0.8993	Add $\eta_2 (\pi_{-1} - \pi_{-1}^f)$	0.8852
Add $\eta_3 \pi_{-1}^3$	0.8993	Add $\eta_3 z_{-1}$	0.8801

Note: All statistics are computed using the stationary distribution μ of the Baseline model, based on a forecast system of $\pi^f = \eta_0 + \eta_1 \pi_{-1}$. RMSE is the root mean squared error of a given forecasting rule, i.e. for system i , $\text{RMSE}_i = \sqrt{\mathbb{E}_\mu (\pi_i^f - \pi)^2}$, where π_i^f is the forecast from system i and π is model Street earnings from the Baseline. Each column reports the scaled value of $\text{RMSE}_i / \text{RMSE}_1$, where RMSE_1 is the RMSE implied by the forecast rule with only a constant or mean prediction. Movement down rows within each column tracks forecast accuracy improvement when sequentially adding terms to the mean only forecast rule.

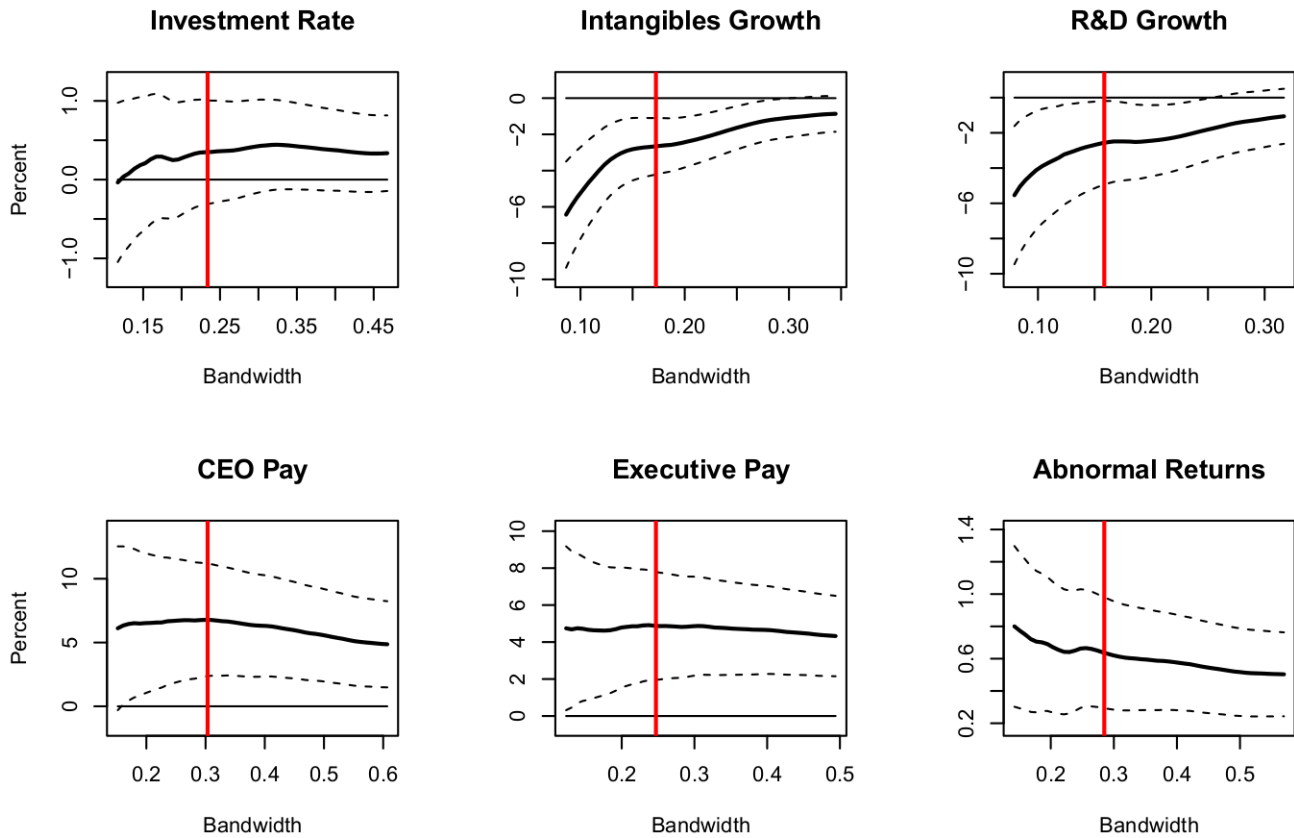


Figure A.I: Regression Discontinuity Estimates for Alternative Bandwidth Choices

Note: Standard errors are clustered at the firm level. The baseline regression discontinuity estimation relies on local linear regressions and a triangular kernel, with bandwidth chosen via the optimal Imbens and Kalyanaraman (2011) approach. The figures above plot, for each outcome variable, regression discontinuity estimates and 90% confidence intervals for a range from one half to twice the optimal bandwidth amount. The optimal bandwidth choice is indicated by red vertical lines. The estimates represent the mean predicted differences for firms just meeting earnings forecasts relative to firms just failing to meet forecasts. Earnings forecast errors are Street earnings minus median analyst forecasts from a 2-quarter horizon, scaled by firm assets as a percentage. Investment Rate is the percentage tangible annual investment rate. Intangibles growth is annual percent selling, general, and administrative expenditures growth. R&D growth is annual percent research and development expenditure growth. CEO Pay, Executive Pay are the log of total compensation for the CEO and several most highly compensated executives at a firm, respectively. Abnormal Returns are the cumulative abnormal returns for a firm in a ten-day window to the announcement date, market adjusting using the returns of the S&P 500. For returns analyst forecasts are drawn from a 1-quarter horizon.

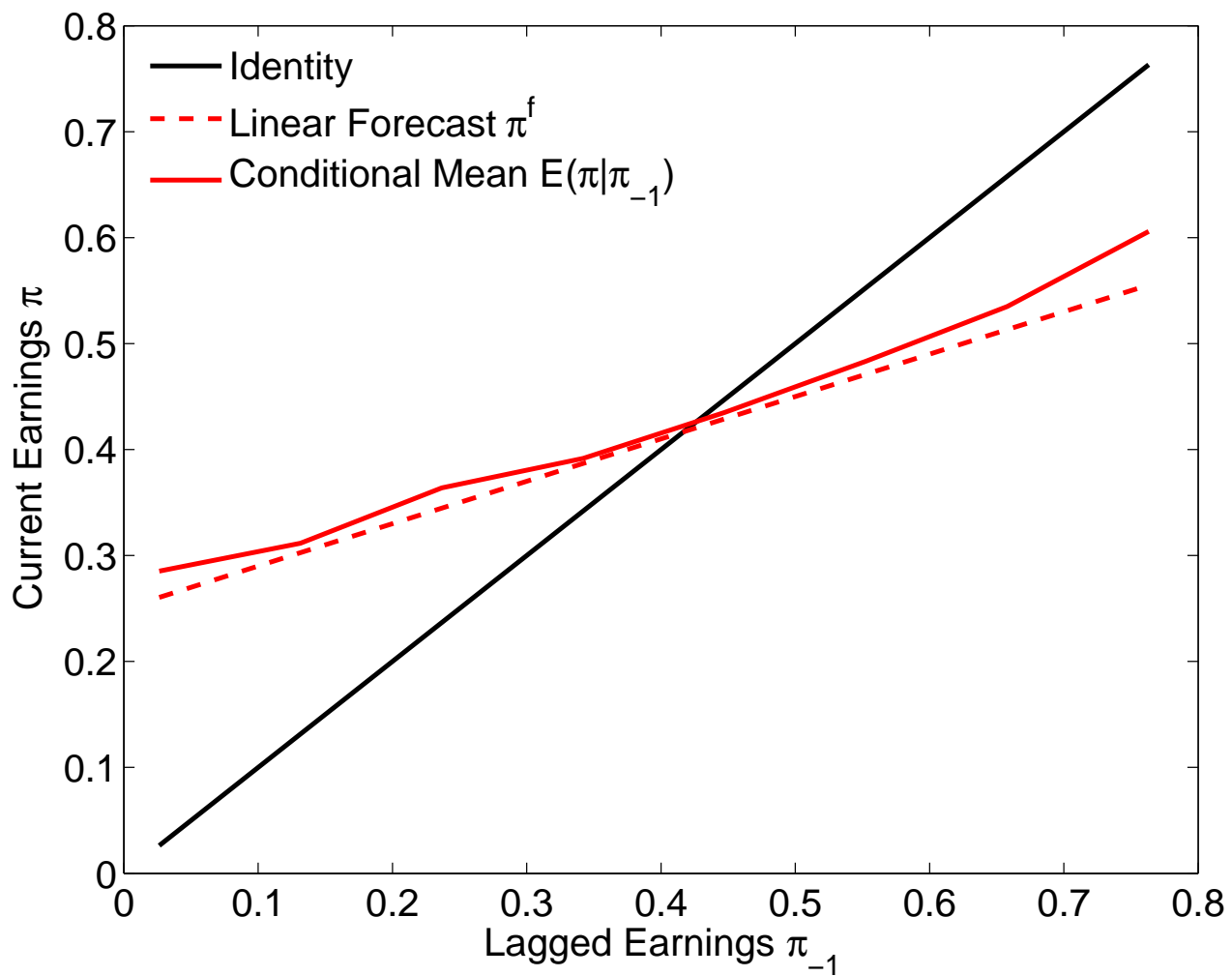


Figure C.I: Linear Forecast Rule is a Reasonable Approximation

Note: The figure plots the linear forecast of normalized earnings π^f , together with the conditional mean of earnings $E(\pi|\pi^f)$, given lagged earnings π_{-1} , with expectations taken over the stationary distribution of the Baseline model. The model was solved via discretization, policy iteration, and nonstochastic simulation.

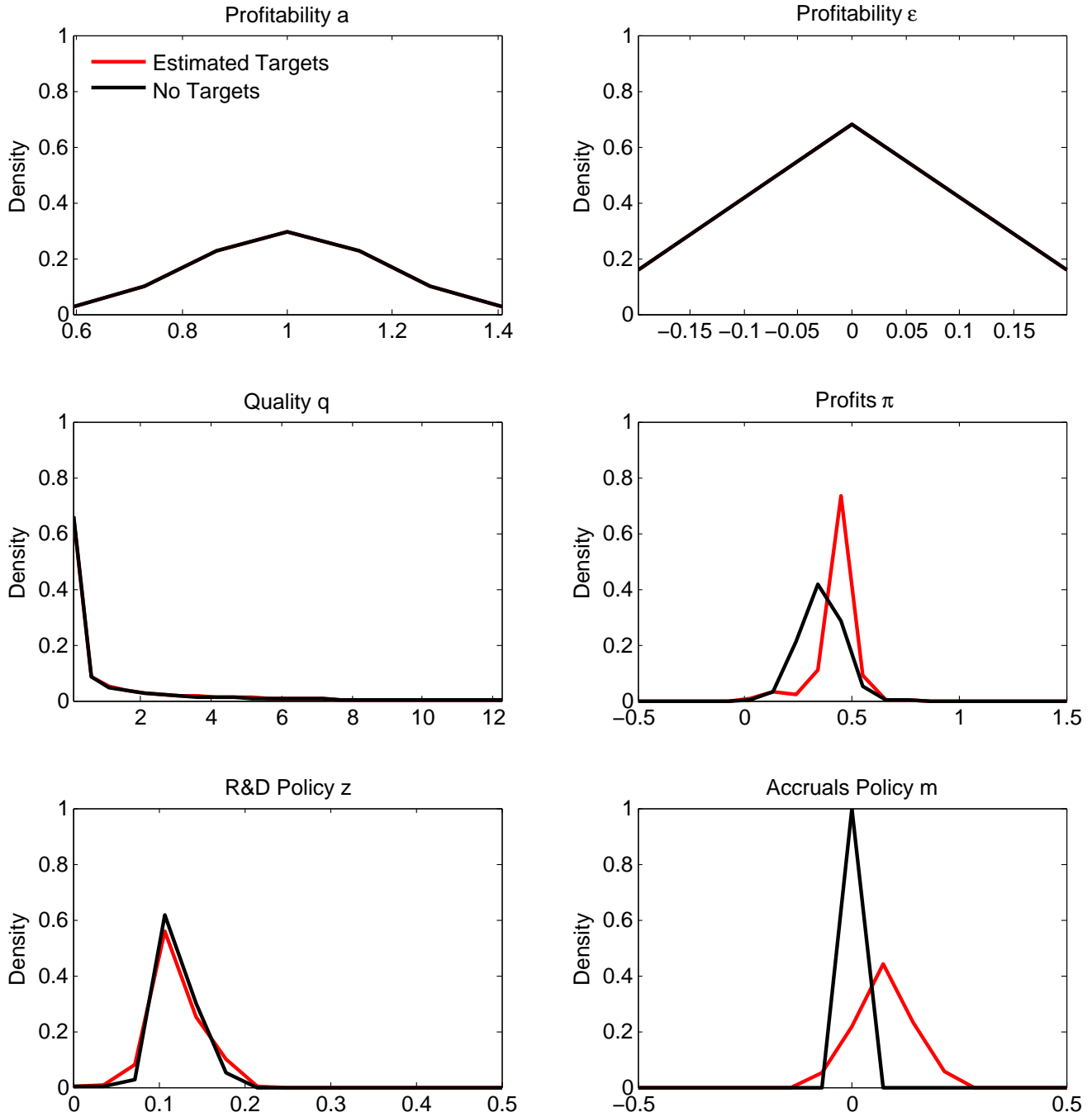


Figure C.II: Ergodic Distributions in the Estimated and No Targets Models

Note: The figure plots the marginal ergodic distributions of the firm-level state variables and policy variables in both the estimated Baseline model and the counterfactual No Targets economy. The model was solved via discretization, policy iteration, and nonstochastic simulation.

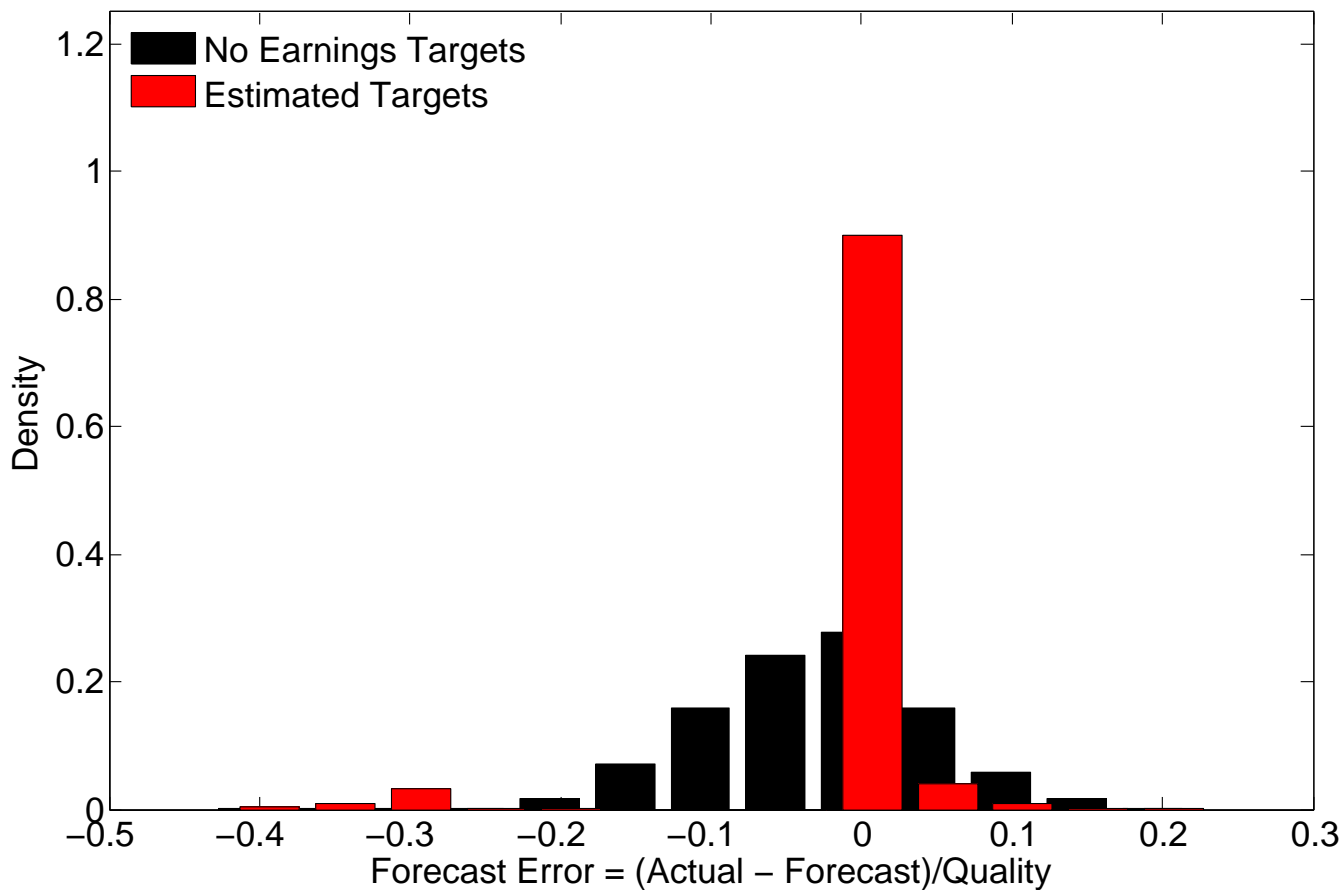


Figure C.III: Forecast Error Distribution, No Measurement Error

Note: The figure above represents the distribution of forecast errors $\pi - \pi^f$ computed from the stationary distribution of the balanced growth path associated with both the estimated earnings miss cost $\hat{\xi}$ (in red) and the counterfactual $\xi = 0$ (in black). The model was solved via discretization, policy iteration, and nonstochastic simulation.

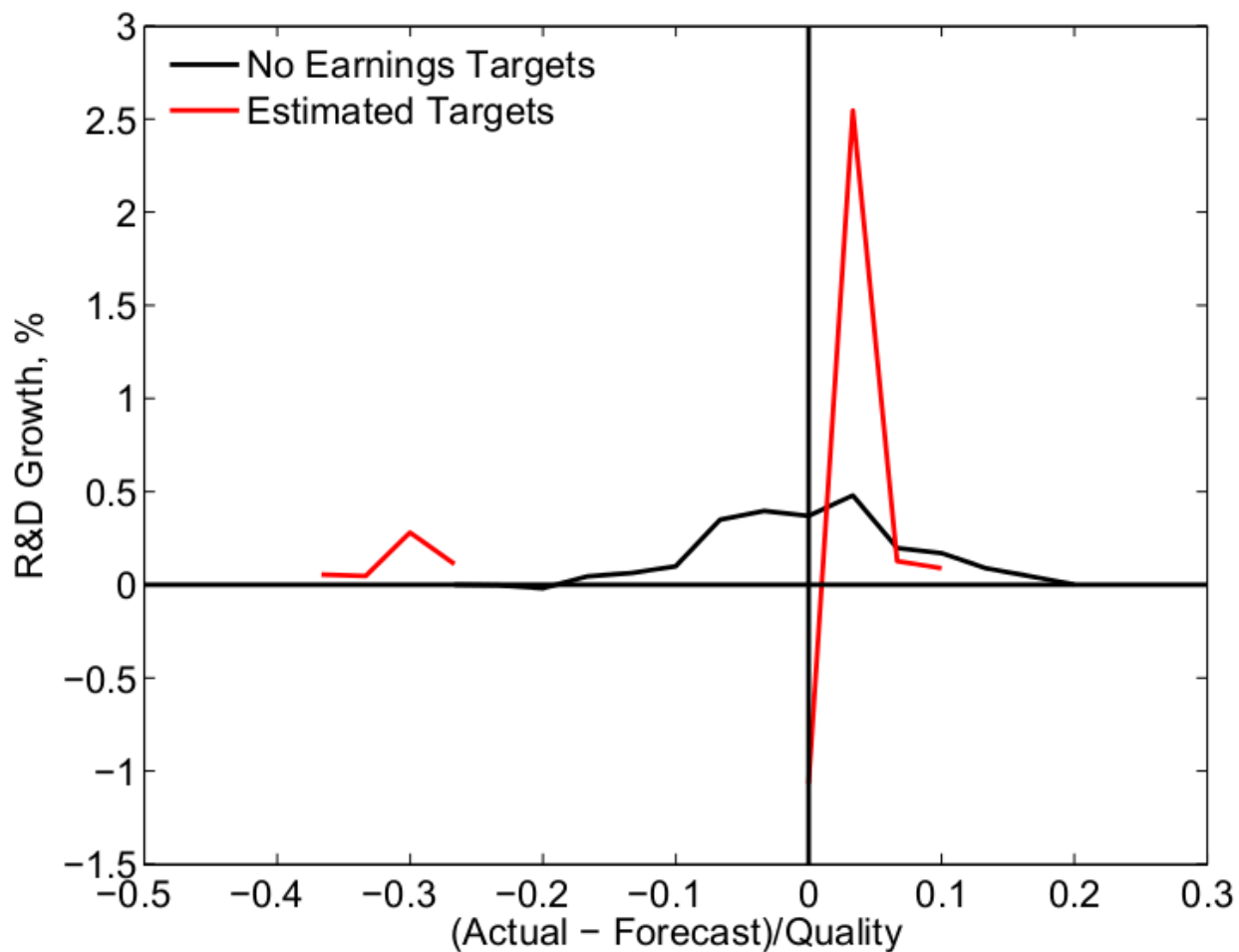


Figure C.IV: R&D Growth, No Measurement Error

Note: The figure plots the average R&D growth in the estimated benchmark model with miss cost $\hat{\xi}$ (in red) and no miss cost (in black) conditional upon bins of the forecast error $\pi - \pi^f$, computed from the stationary distribution of the balanced growth path. The model was solved via discretization, policy iteration, and nonstochastic simulation.

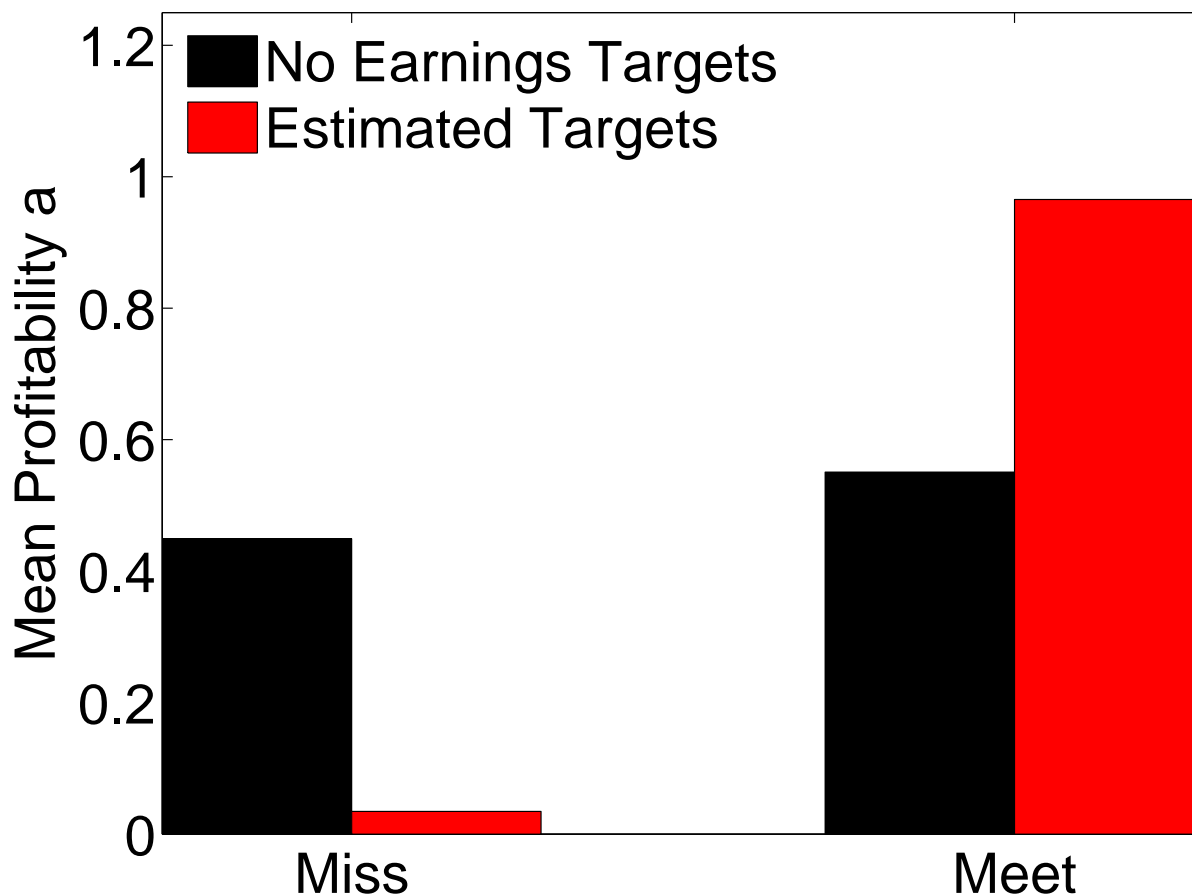


Figure C.V: Firm Selection, No Measurement Error

Note: The figure above represents the conditional mean of profitability a for firms missing their forecasts ($\pi < \pi^f$), and firms meeting their forecasts ($\pi \geq \pi^f$), computed from the stationary distribution of the balanced growth path associated with both the estimated earnings miss cost $\hat{\xi}$ (in red) and $\xi = 0$ (in black). The difference in mean profitability from missing is -193% in the estimated baseline, compared to -25% for $\xi = 0$.

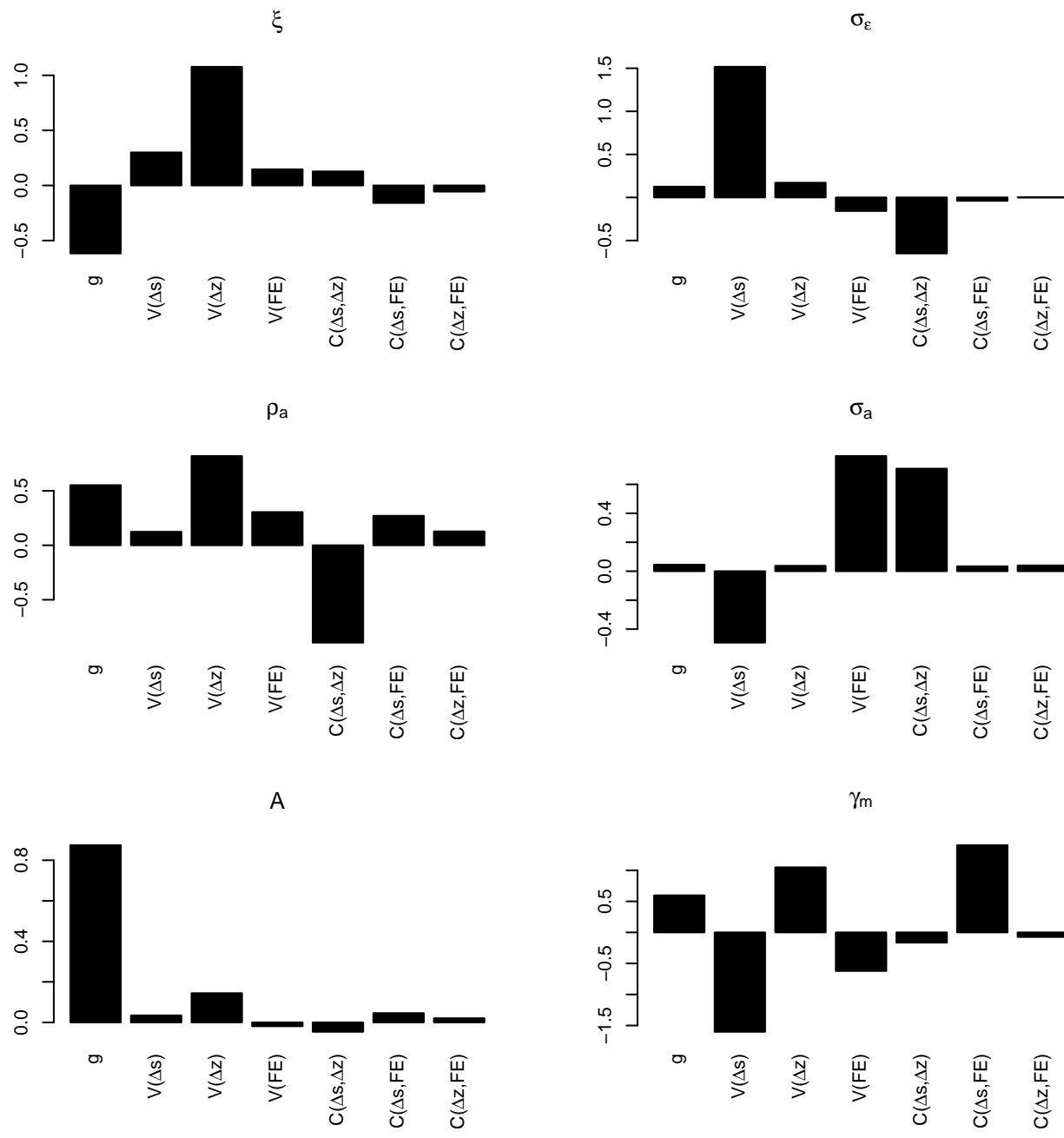


Figure C.VI: Elasticities of Model Parameters with Respect to Moments

Note: The figure plots Gentzkow and Shapiro (2014) sensitivity estimates of each of the estimated model parameters to the seven moments used in GMM estimation of the baseline model. The sensitivity estimates represent the coefficients of a theoretical regression of the estimated parameters on data moments over their joint asymptotic distribution. For ease of reference, the sensitivity parameters are reported as elasticities of the parameter to the relevant data moment. The label g represents the aggregate growth rate, while microeconomic moment labels V and C are variance and covariance, respectively, for sales growth Δs , R&D growth Δz , and forecast errors FE.

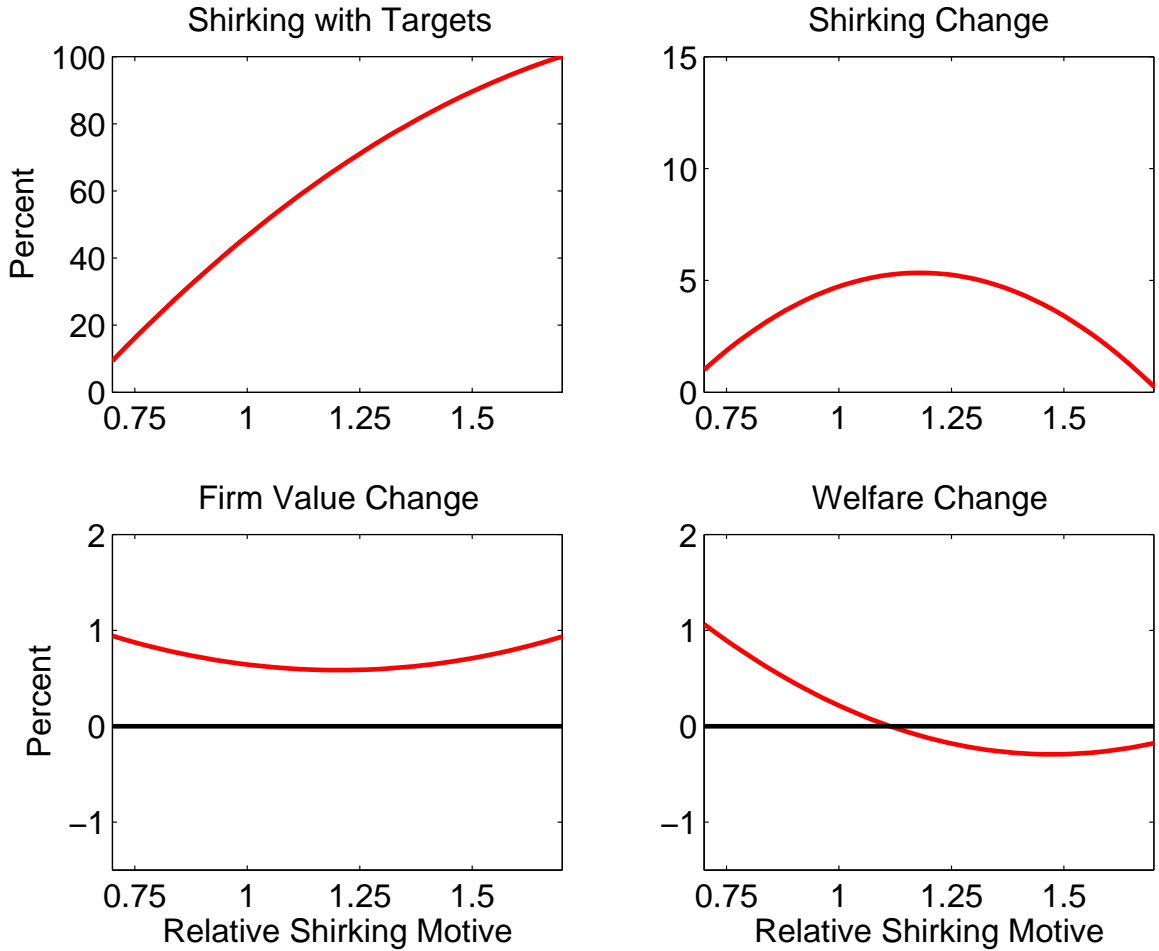


Figure C.VII: A Levels-Growth Tradeoff with Shirking

Note: Horizontal axis is $r(\lambda_s) = \lambda_s / \mathbb{E}(\theta_d \Pi_v \gamma_s / q)$, where $\gamma_s = 0.025$. The top left panel plots the average shirking level $100\mathbb{E}_\mu s$ with earnings targets, the top right panel plots the percent difference in shirking from target removal, the bottom left panel plots the average PE percent change in firm value from target removal, and the bottom right panel plots the GE total consumption equivalent percent change in social welfare from target removal. Numerical comparative statics have been smoothed using a polynomial approximation.