

# Capital (Mis)allocation and Managerial Compensation

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## Abstract

This paper studies how managerial pay shapes the allocation of capital. We leverage quasi-experimental variation in the composition of managerial pay between cash bonuses and equity compensation. We find that a relative increase in cash bonuses leads firms to reallocate capital toward less durable investment projects. To interpret the evidence and quantify the effects of managerial compensation, we build a model with agency frictions and investment heterogeneity. In the model, higher cash bonuses intensify managerial short-termism, shifting investment toward less durable projects. The observed change in managerial pay exacerbates within-firm capital misallocation and generates a sizable output contraction.

*Keywords:* Investment, Firms, Managerial Pay, Capital Misallocation.

*JEL:* D25, E22, E32, G31.

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# 1 Introduction

Capital misallocation depresses real economic activity. In contrast to between-firm misallocation, little is known about the sources and implications of within-firm misallocation. We study how managerial pay shapes the (mis)allocation of capital within firms. Managers with short-term incentives are more inclined to invest in short-lived projects (e.g., computer equipment) than in long-lived projects (e.g., production facilities), which may lead to within-firm capital misallocation. We show that such short-termism arises from the composition of managerial pay, which generally includes cash bonuses—depending on current profits—and equity-based compensation. While cash bonuses incentivize short-term profit maximization, equity-based compensation better aligns managerial incentives with maximizing long-term firm value.

Our paper makes two contributions to the literature. First, we provide novel empirical evidence showing that firms reallocate capital toward less durable investment projects when managerial pay shifts toward cash bonuses relative to equity compensation. Second, we develop a model with agency frictions and investment heterogeneity, which rationalizes the evidence and allows us to quantify the implications of a change in managerial pay for the allocation of capital within firms and the economy.

Our empirical analysis leverages a quasi-natural experiment, which provides a shift in the composition of managerial pay that is unrelated to economic fundamentals and incentive-contracting problems within firms. In particular, we exploit the 2005 FAS 123R reform of accounting rules in the U.S. that raised the costs of equity-based compensation. In response to the reform, firms lowered equity-based compensation relative to cash bonuses (Hayes et al. 2012). To assess whether the change in pay altered the composition of firm investment, we use balance-sheet data for listed U.S. firms from Compustat together with data from FactSet to distinguish seven investment categories that differ in their depreciation rates.

The main empirical finding of this paper is that firms exposed to the reform reduced in-

vestment in projects with low depreciation rates relative to high-depreciation projects. The estimated effect is statistically significant, robust in various dimensions, and quantitatively meaningful. For managers exposed to the reform, equity-based compensation falls by 23–32% as a share of total compensation. The exposed managers invest 5–10% more in investment projects with a 10 percentage point higher depreciation rate. This shift toward short-term investment projects translates into a one percentage point higher weighted average capital depreciation rate in exposed firms. Consistent with managerial pay changing managerial incentives, we find that the discount rate that exposed managers use to evaluate new investment opportunities increases by 0.4 percentage points.

We then develop and quantify a structural model that rationalizes these empirical findings and allows us to quantify the implications of changes in managerial pay. Our model extends a standard dynamic model of firm investment in two dimensions. First, we introduce two types of capital that differ in their depreciation rates. Second, we introduce a manager who receives a compensation package that includes a cash bonus. i.e., a fraction of current profits, and equity compensation, similar to Nikolov and Whited (2014). The manager’s incentives are better aligned with firm value maximization the more equity is provided to the manager. The presence of any cash bonus implies that managerial incentives are not fully aligned with firm value maximization. Formally, we show that the rational manager’s optimization problem mirrors an optimization problem under quasi-hyperbolic discounting (Laibson 1997), which formalizes the notion of managerial short-termism as present bias.<sup>1</sup> We analytically characterize the effects of managerial compensation on managerial short-termism and investment choices. A higher cash bonus strengthens managerial short-termism and shifts the composition of investment toward the high-depreciation capital good.

We calibrate the model to match firm-level and sectoral moments of the U.S. economy prior to the accounting reform. We then simulate the effects of an unexpected exogenous change in the

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<sup>1</sup>Our model poses similar numerical challenges as solving models of quasi-hyperbolic discounting (Krusell and Smith 2003, Maliar and Maliar 2005, 2016). Following Maliar and Maliar (2016), we solve the model using the method of endogenous gridpoints (Carroll 2006).

managerial pay structure that matches the change around the FAS 123R accounting reform. The change in managerial pay raises present bias. The (quasi-hyperbolic) present-bias factor (Laibson 1997) falls from 0.92 to 0.89 on average, with 1.00 corresponding to no present bias. In response, the investment rate drops by 20 percentage points in the short run but stabilizes in the long run. Output falls by little in the short run but converges to a 3% decline in the long run. Beneath the surface, the investment decline is asymmetric with investment in low-depreciation capital goods declining more strongly than investment in high-depreciation capital goods. The change in investment raises within-firm capital misallocation leading to an increase in the unit cost of production by up to 0.4% in the long run. In general equilibrium, conservatively assuming fixed labor supply, the long-run decline in aggregate output is 1%, and likewise, the real wage falls by 1%.

This paper relates to a growing literature that studies the effects of short-termism.<sup>2</sup> Our paper is most closely related to Terry (2023), who studies the implications of managerial short-termism on R&D and growth. Instead, we study how managerial short-termism affects the allocation of capital across capital goods with different depreciation rates and provide novel empirical evidence and a quantitative analysis. While Terry (2023) emphasizes the impact of short-termism on productivity growth through R&D externalities, our study demonstrates that short-termism affects capital misallocation within firms. Our paper is thereby also related to a large literature studying factor misallocation between firms (e.g., Hsieh and Klenow 2009, Alder 2016, Kehrig and Vincent 2019, Midrigan and Xu 2014, David and Venkateswaran 2019, Peters 2020, Meier and Reinelt 2024).

Our model setup builds on Bénabou and Tirole (2016) and Garicano and Rayo (2016). We formalize managerial short-termism as a multitasking problem in which agents choose between short-term projects and long-term projects. We embed this idea into a dynamic model of firm investment. Our model further relates to Aghion et al. (2010), which studies an

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<sup>2</sup>Policy-makers, business executives and investors have often warned about the dangers of boosting short-term profits at the cost of long-term value (e.g., Dimon and Buffet 2018 or Barton 2011).

investment model with two types of capital without considering managerial short-termism.

Our empirical results build on Edmans et al. (2022, 2017) and Ladika and Sautner (2020) who show that managers with less equity-based compensation lower total investment. In addition, Asker et al. (2014) argue that private firms, whose management is presumably less prone to short-termism, have substantially higher capital expenditures and are more responsive to investment opportunities. Our contribution to the literature is to show that not only the level of investment but also the composition of investment across depreciation rates depends on managerial incentives.

Finally, our paper contributes to a literature studying within-firm misallocation (e.g., Giroud 2013, Kehrig and Vincent 2019, Giroud and Mueller 2019, Doerr et al. 2025). These papers study the allocation of capital across multiple plants within firms. In contrast, we study the allocation of capital across types of capital within firms absent multi-plant dynamics.

## **2 Empirical Evidence**

In this section, we provide evidence on the implications of managerial pay for the allocation of capital within firms. Our empirical analysis leverages an accounting reform that provides a quasi-natural experiment that shifts managerial pay toward cash bonuses. We find that firms exposed to the reform: (i) invested relatively more in investment projects with high depreciation rates, (ii) their weighted average capital depreciation rate increased, and (iii) their self-reported discount rates increased.

### **2.1 Accounting Reform**

Since the composition of managerial pay across cash bonuses and equity-based compensation is endogenous to observable and unobservable firm characteristics, we exploit an accounting reform that is unrelated to firm characteristics and provides a shift of managerial pay toward

cash bonuses. The reform is the revision of Financial Accounting Standard Board (FASB) Statement No. 123 (shortly: FAS 123R), which constituted an unexpected and unprecedented change in accounting practices for U.S. firms.

In December 2004, the FASB revised the standards to account for transactions in which an entity exchanges its equity or related instruments for goods or services. The reform became effective for companies with their first full reporting period beginning after June 15, 2005. Before the reform, companies were allowed to expense equity-based compensation such as stock options or long-term incentive plans to employees at their intrinsic value. The pre-reform accounting standard thereby created low accounting expenses of equity-based compensation.<sup>3</sup> In contrast, FAS 123R obliges firms to expense equity-based compensation at fair value, effectively abolishing the accounting advantage.<sup>4</sup> The principal motivation behind the reform was to correct the accounting misrepresentation of the economic expenses incurred by managerial pay. Other reasons for the revision were to simplify U.S. Generally Accepted Accounting Principles (GAAP) and to make them more comparable with international accounting rules. Importantly, the reform provides us with quasi-exogenous variation in the composition of managerial pay.

## 2.2 Data

Our empirical analysis uses data on executive compensation from ExecuComp as well as balance sheet data for listed U.S. firms from Compustat and FactSet. We focus on a period around the accounting reform from 2000 through 2014. Table 1 provides summary statistics for the main variables used in our empirical analysis.

We use ExecuComp data to construct a measure of firm exposure to the accounting reform:  $\text{Option}_{i,2004}$  is a dummy variable that equals one for firms with unexercised CEO equity op-

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<sup>3</sup>The intrinsic value of an option is the difference between the firm's stock price on the date the equity option is granted and the strike price. Equity options with a strike price equal to the stock price have no intrinsic value and, therefore, generate no accounting expenses under the pre-reform accounting standard.

<sup>4</sup>Fair value accounts for the option value of a higher future stock price.

**Table 1: Selected Summary Statistics**

Variable	Mean	Std. Dev.	p10	p25	p50	p75	p90	Obs.
<i>Compensation</i>								
Option Dummy	0.797	0.402	0	1	1	1	1	725
Total Compensation	5.33	9.44	0.81	1.59	3.34	6.31	11.23	10,498
Non-Curr. Compensation	4.20	9.07	0.12	0.82	2.34	5.12	9.37	10,498
<i>Investment</i>								
Land	33.82	461.50	0.00	0.07	1.53	8.47	34.82	4,966
Buildings	100.97	404.21	0.90	3.34	13.45	52.49	193.62	7,335
Machines	438.52	2,046.36	6.02	20.56	75.32	272.57	909.52	7,300
Transport	141.79	590.74	0.06	0.37	2.35	21.49	260.14	938
Research	279.38	900.53	0.00	3.16	29.56	130.58	522.10	6,764
Computer	101.04	300.98	3.85	9.81	24.03	80.25	199.37	1,979
Advertising	240.92	607.38	1.34	6.21	38.07	164.46	619.67	4,625
<i>Other</i>								
Depreciation Rate	15.35	10.01	7.04	10.42	12.69	18.09	25.44	10,532
Corporate Discount Rate	14.61	2.41	11.89	12.96	14.36	15.98	17.71	6,199

*Notes:* Option Dummy equals one for firms with unexercised CEO equity options outstanding in 2004 and zero else. Non-current and total compensation and all investment expenditures are denoted in million USD of year 2000 capital prices. Depreciation and discount rates are denoted in percent. The table presents summary statistics for Option Dummy across firms in 2004 and for all other variables across firms and years from 2000 through 2014.

tions outstanding in 2004 and zero else. Across the 725 firms in our sample, 80% of CEOs had unexercised equity options in the pre-reform year.<sup>5</sup> In Compustat, we observe the composition of total compensation between current (cash bonus) compensation and non-current compensation of CEOs in our sample. The average CEO receives annual compensation of \$5.3 million (measured in year 2000 prices) of which \$4.2 million is non-current compensation and the remainder are cash bonuses.<sup>6</sup>

The main focus of our empirical analysis is the investment composition of firms. Combining data from Compustat and FactSet allows us to analyze firm-level investment across seven different investment categories: land, buildings, machinery, transport equipment, R&D, com-

<sup>5</sup>Our sample includes all firms in the sample that are covered in Compustat and ExecuComp, and classified as active in Compustat. We exclude firms that never report any investment between 2000 and 2014, firms that enter the sample after 2004 or exit before 2006, and firms in the utilities, financial, and public sectors.

<sup>6</sup>Notably, current (cash bonus) CEO compensation as reported in the firm's proxy statement for the fiscal year is commonly considered to capture short-term incentive pay tied to performance in that year. This is in line with Gopalan et al. (2014), who assign a short (current-year) duration to bonus and salary payments. Furthermore, bonus payouts from long-term incentive plans (LTIPs) are recorded separately in Execucomp.

**Table 2: Investment Categories and Depreciation Rates**

Category	<i>Land</i>	<i>Buildings</i>	<i>Machines</i>	<i>Transport</i>	<i>R&amp;D</i>	<i>Computer</i>	<i>Advertising</i>
Depreciation	0%	3%	12%	16%	20%	30%	60%

*Notes:* The depreciation rates are based on the literature survey in Garicano and Steinwender (2016).

puter equipment, and advertising. We obtain annual expenses on R&D and advertising from Compustat. Data on the remaining investment categories are obtained from Factset.<sup>7</sup> Table 1 shows that investments in machinery, R&D, and advertising tend to be the largest, whereas investments into land and IT are typically smaller.<sup>8</sup> A fundamental dimension in which the investment categories differ is their depreciation rate. Table 2 provides estimates of investment category-specific depreciation rates based on the literature survey in Garicano and Steinwender (2016). The capital-weighted average depreciation rate in our sample is 15%, and 8% when excluding intangible capital, i.e., R&D and advertising. Finally, we use data on corporate discount rates from Gormsen and Huber (2025), measured as the minimum required return on new investments announced in firms' earning calls.

## 2.3 Main Empirical Results

This section provides the main empirical results. We estimate the change in managerial pay, the composition of investment, the depreciation rate, and the discount rate for firms exposed to the reform relative to non-exposed firms in the years around the accounting reform.

**Managerial Pay:** We first examine the effects of the accounting reform on the composition of managerial pay. We find that cash bonuses increased relative to total compensation for exposed firms around the reform.

<sup>7</sup>We use a perpetual inventory method to transform stock variables into annual gross investment for the tangible investment categories.

<sup>8</sup>Some categories of firm-level investment are frequently missing, thus the difference in the number of observations across investment categories. Our empirical analysis considers all category-firm-year observations as long as we observe at least two investment categories per firm-year.



Formally, we estimate difference-in-differences regressions of the type

$$y_{it} = \beta_1 \left( \text{FAS123}_t \times \text{Option}_{i,2004} \right) + \beta_2 \times \Delta_{it} + \lambda_i + \lambda_t + \varepsilon_{it}, \quad (1)$$

where  $y_{it}$  is a variable related to managerial pay in firm  $i$  in year  $t$ . On the right-hand side,  $\text{FAS123}_t$  is a step dummy that equals one for years succeeding the reform ( $t > 2005$ ) and zero otherwise,  $\text{Option}_{i,2004}$  is the option dummy introduced in Section 2.2,  $\Delta_{it}$  is a vector of control variables, and  $\lambda_i$  and  $\lambda_t$  denote firm and year fixed effects. The key coefficient of interest is  $\beta_1$ . It captures the relative change of  $y_{it}$  after the accounting reform for firms with outstanding CEO equity options in the pre-reform year relative to firms without outstanding CEO equity options in the pre-reform year.

We define  $y_{it}$  as the log of non-current CEO compensation minus the log of total CEO compensation. The first two columns of Table 3 show the associated estimates of  $\beta_1$ , respectively, for a long and a short time window around the reform year. In the third column, we additionally control for a linear trend that may differ between exposed and non-exposed firms ( $t \times \text{Option}_{i,2004}$ ). Standard errors, clustered at the firm level following Abadie et al. (2023), are in parentheses. We find that exposed firms significantly reduced the share of non-current compensation by 22–32% in comparison to non-exposed firms.<sup>9</sup> Our evidence hence suggests that the reform increased the relative cost of long-term incentive pay.

**Investment:** The focus of our empirical analysis is whether managerial pay shapes the composition of firm investment. The central empirical finding of our paper is that exposed firms changed their investment toward investment projects with high depreciation rates.

We use investment data at the firm-year-investment category level allowing us to control for

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<sup>9</sup>We further do not find a significant increase in grants of restricted stock to executives in exposed firms compared to non-exposed firms. While the overall level of restricted stock grants did increase after FAS 123R (see Hayes et al. 2012), this increase does not significantly differ between exposed and non-exposed firms.

**Table 3: Managerial Compensation**

	Share of Non-Current Compensation		
	(1)	(2)	(3)
FAS123 $\times$ Option	-0.321 (0.0995)	-0.314 (0.119)	-0.228 (0.132)
Year FE	$\times$	$\times$	$\times$
Firm FE	$\times$	$\times$	$\times$
Time Trend			$\times$
Observations	9,806	3,912	9,806
No. Firms	699	695	699
Sample Period	'00-'14	'02-'07	'00-'14

*Notes:* The table reports estimates of equation (1). *Option* is a dummy that indicates if any unexercised options are outstanding in 2004. *FAS123* takes value 0 for all years until 2005 and value 1 afterwards. *Share of non-current compensation* is defined as log equity-linked compensation minus log total compensation (of the CEO). Columns (1) and (2) vary in sample period, while column (3) additionally controls for a linear time trend interacted with the option dummy. Standard errors (in parentheses) are clustered at the firm-level.

a rich set of fixed effects. Formally, we estimate triple-differences regressions of the type

$$\begin{aligned}
invest_{ict} = & \beta_1 \left( FAS123_t \times Option_{i,2004} \times \delta_c \right) + \beta_2 \left( FAS123_t \times \delta_c \right) \\
& + \beta_3 \left( Option_{i,2004} \times \delta_c \right) + \lambda_{it} + \lambda_{c(i)} + \varepsilon_{ict},
\end{aligned} \tag{2}$$

where  $invest_{ict}$  denotes investment by firm  $i$  in investment category  $c$  in year  $t$ . On the right-hand side,  $FAS123_t$  and  $Option_{i,2004}$  are defined as below equation (1), and  $\delta_c$  denotes the depreciation rate of investment category  $c$  presented in Table 2. The regression further includes firm-year fixed effects,  $\lambda_{it}$ , which absorb unobserved firm-specific time variation in demand or supply factors that affect investment decisions. Hence, our identification strategy exploits within-firm variation across investment categories in a given year. Finally,  $\lambda_{c(i)}$  contains either investment category fixed effects  $\lambda_c$  or category-firm fixed effects  $\lambda_{ci}$ . Including fixed effects  $\lambda_{ci}$  allows us to absorb differences in the investment rate across investment

categories (and firms) that are constant over time, which may, for example, control for category-specific capital intensities.<sup>10</sup>

The key coefficient of interest is  $\beta_1$ . It captures the relative change of investment in high-depreciation capital goods after the accounting reform for firms with outstanding CEO equity options in the pre-reform year. If the reform induces exposed firms to adjust their investment composition toward short-term investment projects,  $\beta_1$  will be positive. It will be negative if the investment composition shifts toward long-term projects. Our baseline measure of investment is the inverse hyperbolic sine of investment expenditures.<sup>11</sup>

Table 4 presents the main empirical result of the paper. It shows the estimated coefficients of equation (2) for different measures of category-specific capital depreciation, different fixed effects, and sample periods. A key takeaway is that the estimate of  $\beta_1$  is positive and statistically significant at the 5% level across a variety of specifications. In the upper panel of the table, we define  $\delta_c$  as the depreciation rate in Table 2. In the lower panel,  $\delta_c$  is the ordinal rank of the depreciation rate ranging from 1 (for land) to 7 (for advertising). The ordinal rank addresses concerns about the estimates of the depreciation rates in Table 2. Between columns (1) and (2), we replace the investment-category fixed effect  $\lambda_c$  by a category-firm fixed effect  $\lambda_{ci}$ . The first two columns are based on a wide sample around the reform. While a wide sample helps to capture relative differences in investment that build up slowly, it creates the risk of contamination from unrelated, other developments. We therefore repeat the analysis for a shorter sample around the reform in columns (3) and (4). Finally, we address the concern of potential pre-trends by controlling for the interaction between a linear time trend, the option dummy, and the depreciation measure in column (5). Across specifications (in both panels), the estimates of  $\beta_1$  are positive and significant. Quantitatively, the coeffi-

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<sup>10</sup>Including a fixed effect  $\lambda_{ci}$  absorbs the regressor  $(\text{Option}_{i,2004} \times \delta_c)$ .

<sup>11</sup>Formally,  $\text{invest}_{ict} = \text{arsinh}(I_{ict}) = \ln(I_{ict} + \sqrt{I_{ict}^2 + 1})$ , where  $I_{ict}$  denotes investment expenditures in million USD as in Table 1. The transformation has the advantage that we include zero investments in our estimations while we get  $\text{arsinh}(I_{ict}) \rightarrow \ln 2 + \ln I_{ict}$  for large investment expenditures such that the interpretation is almost identical to a log regression. To address concerns about the inverse hyperbolic sine transformation in Mullahy and Norton (2024), we also consider the alternative investment measures  $I_{ict}/K_{ict}$  and  $\log(I_{ict})$ . Our results are robust to these alternative investment measures, see Section 2.4.

**Table 4: Investment Composition**

	Investments					
	(1)	(2)	(3)	(4)	(5)	(6)
<i>Measure of Depreciation:</i>	<i>Depreciation Rate</i>					
FAS123 $\times$ Option $\times$ Depr	0.999 (0.247)	0.668 (0.216)	0.721 (0.233)	0.462 (0.186)	0.805 (0.254)	0.680 (0.220)
FAS123 $\times$ Depr	-0.766 (0.209)	-0.344 (0.197)	-0.673 (0.199)	-0.421 (0.166)	-0.766 (0.209)	-0.532 (0.191)
Option $\times$ Depr	-0.303 (0.344)		-0.387 (0.355)		-54.03 (39.71)	-0.098 (0.331)
FAS123 $\times$ Option						-0.217 (0.056)
<i>Measure of Depreciation:</i>	<i>Ordinal Rank</i>					
FAS123 $\times$ Option $\times$ Depr	0.092 (0.025)	0.056 (0.021)	0.069 (0.026)	0.042 (0.020)	0.063 (0.027)	0.061 (0.022)
FAS123 $\times$ Depr	-0.057 (0.022)	-0.013 (0.019)	-0.062 (0.022)	-0.036 (0.018)	-0.057 (0.022)	-0.035 (0.019)
Option $\times$ Depr	-0.060 (0.035)		-0.069 (0.035)		-8.214 (4.17)	-0.037 (0.034)
FAS123 $\times$ Option						-0.312 (0.092)
Category FE	×		×		×	×
Category-Firm FE		×		×		
Firm-Year FE	×	×	×	×	×	
Time Trend					×	
Firm FE and Year FE						×
Observations	32,947	32,875	13,097	12,941	32,947	33,775
No. Firms	681	677	666	661	681	699
Sample Period	'00-'14	'00-'14	'02-'07	'02-'07	'00-'14	'00-'14

*Notes:* The table reports estimates of equation (2). *Option* is a dummy that indicates if any unexercised options are outstanding in 2004. *FAS123* takes value 0 for all years until 2005 and value 1 afterward. *Depr* is a measure of depreciation: the rate of depreciation in the upper panel and the ordinal depreciation rank in the lower panel. Columns (1)–(4) vary in sample period and fixed effects. Column (5) controls for a linear time trend interacted with the interaction of the option dummy and the measure of depreciation. Column (6) allows estimating the average investment response. Standard errors (in parentheses) are clustered at the firm level.

cient estimates in the upper panel mean that exposed firms increase by 5–10% their relative investment in capital categories with a 10 percentage point higher depreciation rate relative to non-exposed firms.

In column (6), we estimate the average change in investment for exposed firms after the reform. In columns (1)–(5), the average change is subsumed by the firm-year fixed effects  $\lambda_{it}$ . In column (6), we instead include firm fixed effects  $\lambda_i$  and year fixed effects  $\lambda_t$ . Across categories, the average investment response corresponds to the coefficient in the first row, 0.680, times the average depreciation rate in the estimation sample, which is 0.1535, plus the coefficient in the fourth row, -0.217. The average investment response is -0.10 for exposed firms. The lower panel of Table 4 implies a similar average investment decline.

As a plausibility analysis, we next provide year- and category-specific estimates in Figure 1. We estimate the year-specific differences in the relative investment in high-depreciation projects between exposed firms and non-exposed firms using the regression

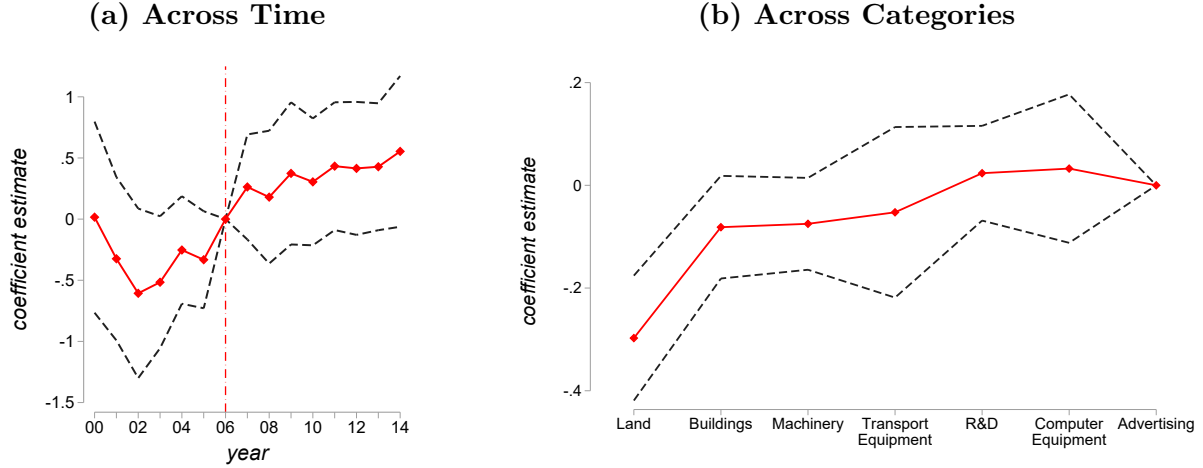
$$invest_{ict} = \sum_j \mathbb{1}\{j = t\} \left[ \beta_{1,j} (\text{Option}_{i,2004} \times \delta_c) + \beta_{2,j} \delta_c \right] + \lambda_{it} + \lambda_{ci} + \varepsilon_{ict}, \quad (3)$$

where  $\mathbb{1}\{\cdot\}$  denotes an indicator function. Panel (a) of Figure 1 shows the estimates of  $\beta_{1,t}$  together with 95% confidence bands. Maybe not surprisingly, the year-specific estimates of  $\beta_{1,t}$  are less precisely estimated than the corresponding pooled estimates in Table 4. However, the figure broadly confirms our main finding: firms exposed to the reform shifted their investment composition toward high-depreciation projects. We find a shift in the investment composition that slowly builds up in the years following the reform. We can reject the null hypothesis that post-FAS-123R coefficients equal their pre-FAS-123R counterparts at the 1%-level. The  $\beta_{1,t}$  estimates further reveal a non-significant trend in the pre-reform period. The null hypothesis that  $\beta_{1,2002} + \beta_{1,2003} = \beta_{1,2004} + \beta_{1,2005}$  has a p-value of 0.22, meaning what may appear as a pre-trend in the point estimates is highly insignificant.<sup>12</sup>

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<sup>12</sup>We further cannot reject  $\beta_{1,2000} = \dots = \beta_{1,2005} = 0$ . The associated F-test has a p-value of 0.35.

**Figure 1: Investment Composition across Time and Categories**



*Notes:* Panel (a) shows point estimates of  $\beta_{1,t}$  (solid line) in equation (3). The measure of depreciation is the rate of depreciation. Panel (b) shows point estimates of  $\beta_{1,c}$  (solid line) in equation (4). Standard errors are clustered at the firm level and the dashed lines show 95% confidence intervals. The regressors associated with  $\beta_{1,2006}$  and  $\beta_{1,advertising}$  are absorbed by fixed effects.

We further estimate the category-specific differences in the investment between exposed firms and non-exposed firms using the regression

$$invest_{ict} = \sum_j \mathbb{1}\{j = c\} \left[ \beta_{1,j} (\text{FAS123}_t \times \text{Option}_{i,2004}) \right] + \lambda_{it} + \lambda_{ci} + \varepsilon_{ict}. \quad (4)$$

Panel (b) of Figure 1 shows that firms with outstanding options reduced investment more in low-depreciation categories such as land, causing a reallocation of capital toward more high-depreciation categories such as transportation and computer equipment. The coefficient on advertising investment is absorbed by the fixed effects. The null hypothesis of coefficient equality across categories can be rejected at the 1%-level ( $p < 0.001$ ). The relation between the category-specific investment response and the category-specific depreciation rate is almost monotonic, which supports the regression specification in (2).

**Depreciation Rate:** We next estimate the change in the depreciation rate for exposed firms following the reform. In line with the evidence on the investment composition, we find

that the depreciation rates of exposed firms increased following the reform.

**Table 5: Capital Stock Depreciation and Corporate Discount Rates**

	(1)	(2)	(3)
<i>Average Depreciation Rate</i>			
FAS123 $\times$ Option	1.245 (0.517)	0.781 (0.566)	1.122 (0.668)
Observations	9,339	3,779	9,339
No. Firms	697	682	697
<i>Corporate Discount Rate</i>			
FAS123 $\times$ Option	0.133 (0.143)	0.371 (0.162)	0.318 (0.191)
Observations	6,189	2,416	6,189
No. Firms	558	494	558
Year FE	$\times$	$\times$	$\times$
Firm FE	$\times$	$\times$	$\times$
Trend			$\times$
Sample Period	'00-'14	'02-'07	'00-'14

*Notes:* The table reports estimates of equation (1) with the left-hand side being the average depreciation rate across capital categories weighted by capital stocks in a given firm-year (upper panel) and the corporate discount rates in a given firm-year from Gormsen and Huber (2025) (lower panel). Otherwise, the table is analogous to Table 3. Standard errors (in parentheses) are clustered at the firm level.

We estimate equation (1) defining  $y_{it}$  as the firm-year weighted average depreciation rate (across capital categories) and specifying the control vector ( $\Delta_{it}$ ) to include firm-year-specific total capital and costs of capital.<sup>13</sup> The upper panel of Table 5 shows our estimates for three different specifications that differ in the sample and whether we control for pre-trends. Across all specifications, we find that the depreciation rate increased for exposed firms. The estimates in columns (1) and (3) are significant at the 5% level. Quantitatively, the depreciation rate increased by about 1 percentage point for exposed firms relative to other firms.

<sup>13</sup>We use perceived costs of capital from Gormsen and Huber (2025), which are a firm's internal estimates of weighted average costs of debt and equity.

We have constructed the weighted average depreciation rate assuming time-invariant depreciation rates (Table 2). Hence, the findings for the weighted average depreciation rate reflect changes in the composition of the capital stock across categories, which changes the weights. We have also directly estimated the change in capital stock across categories. Table A.1 shows that the accounting reform led to substantial reallocation of capital within firms. On average, exposed firms increased the stock of a capital category with a 10 percentage point higher depreciation rate by 2–12% compared to non-exposed firms.

**Corporate Discount Rate:** A possible explanation for our empirical findings is that the reform-induced change in managerial pay toward cash bonuses provides more short-term incentives to managers. In response, firm managers allocate investment toward more short-lived projects. We provide empirical evidence that is consistent with the change in managerial pay increasing managerial short-termism.<sup>14</sup> We find that the corporate discount rates of exposed firms increase relative to other firms.

We use equation (1) but with the corporate discount rate as left-hand-side variable and specifying the control vector ( $\Delta_{it}$ ) to include firm-year-specific total capital and costs of capital. The lower panel of Table 5 shows our estimates for three different specifications that differ in the sample and whether we control for pre-trends. Across all specifications, we find that the discount rate increased for exposed firms. The estimates are significant at the 5% level for the last two columns. Quantitatively, the discount rate increased by 0.13–0.37 percentage points for exposed firms relative to other firms.

## 2.4 Sensitivity Analysis

**Ex-ante Differences:** In Table A.2, we compare firms by exposure status in the pre-reform year. Firms exposed to the reform are larger, invest relatively less in intangibles, have a lower share of liquid assets, have lower equity volatility, and their CEOs receive higher

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<sup>14</sup>We formally study the link between pay and incentives in the structural model in Section 3.



current compensation. To address the concern that these ex-ante differences may drive our main result, we repeat the analysis controlling for these ex-ante differences, in interaction with  $FAS123_t \times Option_{i,2004}$ . We find that neither controlling for size differences (Table A.3) nor controlling for the other ex-ante differences listed above (Table A.4) strongly change our finding in Table 4. It thus appears unlikely that our main finding is driven by ex-ante differences between exposed and non-exposed firms.

**CEO Turnover:** A possible concern is that the compensation scheme may differ between CEOs who are newly appointed and those close to losing their job, which may also affect the CEOs' investment incentives. To address this concern we focus on the subsample of firms without CEO turnover during the sample period. Compared to Table 4, the estimates for this subsample are larger and more significant, see Table A.5.

**Alternative Measurement of Investments:** Table A.6 shows that our results in Table 4 are broadly robust for a range of alternative investment measures.

**Intangibles:** Under U.S. GAAP rules, expenses for R&D and advertisement are fully deducted from profits in the period of the expense. In addition, intangibles have a less direct impact on balance sheets than tangibles.<sup>15</sup> The accounting practice is particularly striking for R&D given its role for long-term growth. We address the potential concern that the accounting treatment of R&D investment biases our estimates. We repeat our analysis when excluding R&D expenditures, see the first three columns of Table A.7. Compared to Table 4, the  $\beta_1$  estimates are highly similar in magnitude and significance. Additionally, we consider investment variation within tangible and intangible categories in the last three columns of Table A.7 by including an additional interaction  $FAS123_t \times Option_{i,2004} \times intangible_c$ . The estimates are broadly similar to the estimate in Table 4.

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<sup>15</sup>Only externally acquired intangible assets appear on the balance sheet.

## 2.5 Evidence Beyond the Accounting Reform

The final part of our empirical analysis goes beyond the accounting reform. Instead of exploiting changes in equity-based compensation due to the accounting reform, we exploit differences in the managerial equity ownership share across firms and years. We find a negative correlation between managerial equity ownership and the share of investment in high-depreciation capital goods. The broader scope of this exercise comes at the expense of stronger assumptions needed to interpret our estimates causally.

We define the managerial ownership share  $\eta_{it}^e$  for firm  $i$  and year  $t$  as the ratio of the CEO's firm-related wealth over the market capitalization of the firm. We obtain data on CEOs' firm-related wealth from Coles et al. (2006) who use Compustat ExecuComp data to construct a measure of managers' equity ownership (as in Core and Guay 2002). We estimate the

**Table 6: Investment Composition and Equity Ownership**

<i>Measure of Depreciation:</i>	Investments			
	(1) <i>Depreciation Rate</i>	(2)	(3) <i>Ordinal Rank</i>	(4)
Equity Share $\times$ Depr	-0.355 (0.123)	-0.254 (0.132)	-2.500 (1.280)	-1.461 (1.318)
Equity Share	0.635 (0.614)		-0.200 (0.428)	
Category-Firm FE	$\times$	$\times$	$\times$	$\times$
Year FE	$\times$		$\times$	
Firm-Year FE		$\times$		$\times$
Observations	29,330	28,611	29,330	28,611
No. Firms	672	649	672	649
Sample Period	'00-'14	'00-'14	'00-'14	'00-'14

*Notes:* The table reports estimates of equation (5). *Equity Share* is the CEO's ownership share. *Depr* is a measure of depreciation: the rate of depreciation in columns (1)-(2) and the ordinal depreciation rank in (3)-(4). Standard errors (in parentheses) are clustered at the firm-level.

following regression

$$invest_{ict} = \beta_1 \left( \eta_{it}^e \times \delta_c \right) + \beta_2 \eta_{it}^e + \lambda_{ci} + \lambda_{t(i)} + \varepsilon_{ict}, \quad (5)$$

which includes either a year fixed effect  $\lambda_t$  of a year-firm fixed effect  $\lambda_{ti}$ . Our parameter of interest is  $\beta_1$ , which captures the relative change of investment in high-depreciation capital goods for firms with higher managerial ownership.

Table 6 presents our findings. The estimates of  $\beta_1$  are negative in all specifications, which suggests that reductions in managerial equity ownership are associated with relatively more investment in short-term investment categories. Alternatively, we interact our measure of managerial ownership with dummies for each investment category. Consistent with Table 6, we find that investments in more durable projects, such as land or buildings, depend more strongly on managerial equity ownership compared to investments in less durable projects, such as computer equipment or advertising, see Figure A.1.

### 3 Model

The previous section established empirically that a shift toward short-term managerial compensation leads to relatively more investment in high-depreciation capital goods, a higher weighted average depreciation rate, and a higher discount rate. In this section, we develop a firm model to rationalize the empirical evidence and to understand its implications for firms and the economy. In the model, firms produce using two types of capital goods that differ in their depreciation rate. Investment decisions are made by a risk-neutral manager who maximizes the present value of her compensation package, which includes a cash bonus based on current profits and equity compensation. We analytically characterize the effects of managerial compensation on managerial short-termism and investment choices.

**Technology and Profits:** Consider a firm that uses labor  $N_t$  and a set of two capital inputs  $\mathbf{K}_t = [K_{lt}, K_{st}]$ , a long-lived and a short-lived capital good with the associated depreciation rates given by  $0 < \delta_l < \delta_s < 1$ . The firm produces output  $Q_t$  according to the Cobb-Douglas production technology

$$Q_t = ZF(\mathbf{K}_t, N_t) = Z \left( K_{lt}^\nu K_{st}^{1-\nu} \right)^\alpha N_t^{1-\alpha}, \quad \nu, \alpha \in (0, 1) \quad (6)$$

where  $Z$  denotes firm productivity. The firm faces isoelastic demand,  $Q_t = BP_t^{-\varepsilon}$ , where  $B$  is a demand shifter and  $\varepsilon > 1$  the demand elasticity. Accordingly, the firm's revenues are

$$R_t = P_t Q_t = X^{1-a-b} \left( K_{lt}^\nu K_{st}^{1-\nu} \right)^a N_t^b, \quad (7)$$

where  $X^{1-a-b} = B^{1/\varepsilon} Z^{1-1/\varepsilon}$  captures the firm's overall business conditions with  $a = \alpha(1 - 1/\varepsilon)$ , and  $b = (1 - \alpha)(1 - 1/\varepsilon)$ . Capital follows the law of motion

$$K_{jt+1} = (1 - \delta_j)K_{jt} + I_{jt}, \quad j \in \{l, s\}, \quad (8)$$

where  $I_{jt}$  denotes gross investment for capital type  $j$ . Capital is subject to one-period time to build and a convex adjustment friction. Total capital expenses are given by

$$C_t^K = \sum_{j \in \{l, s\}} \left[ (K_{jt+1} - (1 - \delta_j)K_{jt}) + \gamma \left( \frac{K_{jt+1}}{K_{jt}} - 1 \right)^2 K_{jt} \right]. \quad (9)$$

Labor adjustment is frictionless and we denote the wage rate by  $w_t$ . Accounting for optimal labor demand, profits are given by

$$\Pi_t = \max_{N_t} \left\{ R_t - w_t N_t \right\} - C_t^K. \quad (10)$$

**Managerial Pay:** The decision-maker in the firm is a manager. There is an exogenous endowment of managers, and thus firms. The manager's compensation consists of a fixed

salary  $w_t^f$  that is independent of firm performance, a cash bonus that is a share  $\eta^b \in [0, 1)$  of (current) profits  $\Pi_t$ , and equity compensation that is a share  $\eta^e \in (0, 1)$  of the market value of equity  $E_t$ .<sup>16</sup> Total managerial compensation is

$$\Gamma_t = w_t^f + \eta^b \Pi_t + \eta^e E_t. \quad (11)$$

The key feature of managerial compensation is that it may depend on current profits and on (long-term) firm value. As in Nikolov and Whited (2014), we do not derive the optimal contract but instead model the compensation contracts that we observe in the data. This approach allows us to identify the effects of changing contractual features on firms' investment policies, and on real economic activity. To keep the model tractable, we follow Glover and Levine (2015) in assuming that contracts last for one period and that the manager does not hold shares in the firm at the beginning of the period.<sup>17</sup>

The market value of equity  $E_t$  depends on the discounted stream of expected dividends. Taking into account the fixed salary and the cash bonus of the manager, the dividend in period  $t$  is given by  $(1 - \eta^b)\Pi_t - w_t^f$ . In addition, the manager receives equity compensation. Under complete financial markets and rational expectations, the market value of equity  $E_t$  is

$$E_t = (1 - \eta^b)\Pi_t - w_t^f + \frac{1}{1 + r} \mathbb{E}_t \left\{ (1 - \eta^e) E_{t+1} \right\}, \quad (12)$$

where  $r$  is the risk-free interest rate. Note that equity compensation leads to share dilution.<sup>18</sup>

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<sup>16</sup>Equity compensation is (locally) equivalent to equity options as long as the options are 'in the money.'

<sup>17</sup>Considering (explicit) multi-period contracts between managers and owners complicates the model and its solution and may necessitate further structural assumptions, e.g.: managers' preferences regarding payoffs at different points in time, managers' ex-ante exposure to the firm's performance via pre-existing holdings of equity, a process linking managers' probability of staying with the firm to firm performance, and uncertainty about future remuneration packages.

<sup>18</sup>Shareholders in period  $t$  anticipate that the share of future total market capitalization they hold shrinks by a factor of  $1 - \eta^e$ . The effect of equity-based compensation on share dilution is a well-known fact in finance (see, e.g., Asquith and Mullins 1986, Huson et al. 2001, Core et al. 2002).

Using (12), we can rewrite the value of the period  $t$  compensation package in (11) as

$$\Gamma_t = w_t^f - \eta^e \sum_{\tau=0}^{\infty} \theta^\tau \mathbb{E}_t \{ w_{t+\tau}^f \} + \varphi \left[ \Pi_t + \beta \sum_{\tau=1}^{\infty} \theta^\tau \mathbb{E}_t \{ \Pi_{t+\tau} \} \right], \quad (13)$$

where

$$\varphi = \eta^b + \eta^e(1 - \eta^b), \quad \beta = \frac{\eta^e(1 - \eta^b)}{\eta^b + \eta^e(1 - \eta^b)}, \quad \theta = \frac{1 - \eta^e}{1 + r}. \quad (14)$$

The presence of equity compensation means the manager's compensation in period  $t$  depends on future profits and future managerial compensation. Because the term  $w_t^f - \eta^e \sum_{\tau=0}^{\infty} \theta^\tau \mathbb{E}_t \{ w_{t+\tau}^f \}$  is exogenous to the manager's decisions we will ignore it in the following and focus on the last term in (13). For related reasons,  $\varphi$  is irrelevant to the manager's decisions.

The payout profile in (13) is akin to the preferences of a risk-neutral agent with quasi-hyperbolic discounting preferences over the stream of profits  $\Pi_t$  (Laibson 1997). The implicit preferences feature present bias if  $\beta < 1$ . We denote the rate of present bias, or managerial short-termism, by  $\rho = \beta^{-1} - 1 \geq 0$ , with  $\rho = 0$  indicating no short-termism. The following proposition characterizes the effect of managerial pay on managerial short-termism.

**Proposition 1 (Managerial pay and short-termism).** *Managerial pay, defined by  $\eta^b \in [0, 1)$  and  $\eta^e \in (0, 1)$ , determines short-termism  $\rho = \beta^{-1} - 1$ , with  $\beta$  defined in (14):*

- *Short-termism is present ( $\rho > 0$ ) iff the cash bonus share is strictly positive ( $\eta^b > 0$ ).*
- *Short-termism strictly increases in  $\eta^b$ .*
- *Short-termism weakly decreases in the equity share  $\eta^e$  (strictly if  $\eta^b > 0$ ).*

The proof is straightforward and omitted here. Next to  $\beta$ , the model features a second type of short-termism captured by  $\theta$ . A higher  $\eta^e$  lowers the factor by which the manager discounts future profits. Stronger discounting arises because the present manager's equity compensation is diluted by the equity compensation of future managers. The key distinction

between  $\beta$  and  $\theta$  is that the former parametrizes the degree of present bias while the latter parametrizes the rate of exponential discounting. We focus on short-termism in the form of  $\beta$  because it is quantitatively more important, see Section 4.

We have restricted the parameter space to rule out three peculiar cases:  $\eta^b = 1$ ,  $\eta^e = 0$ , and  $\eta^e = 1$ . In these cases, either  $\beta = 0$  or  $\theta = 0$ , meaning the manager's compensation does not depend on future profits. Given one-period time to build, the firm's capital stock will then converge toward zero, because each successive manager will find it optimal to sell capital.

**Investment Problem:** The manager decides how much to invest in each type of capital. The period  $t$  choice of  $\mathbf{K}_{t+1}$  depends on the history of previous managers' decisions  $\mathcal{H}_t = \{\mathbf{K}_s | s \leq t\}$ . It also depends on the strategy of managers in period  $\tau > t$ , which we denote by  $s_\tau$ . The formal decision problem of the manager in  $t$  is

$$\begin{aligned} \max_{\mathbf{K}_{t+1}} \Gamma_t \quad \text{s.t.} \quad & (13), (10), (9), (7), \\ & \text{given } \mathcal{H}_t, \text{ and beliefs regarding } s_\tau \text{ for } \tau > t. \end{aligned} \tag{15}$$

This type of problem has a large strategy space and a multitude of equilibria can occur. We focus on symmetric, smooth Markov-perfect equilibria, for which the state variable is  $\mathbf{K}_t$ .

**Optimal Capital Policy:** In general, the optimal capital policy has no closed-form solution. However, we can implicitly characterize how present bias affects the capital policy function. We denote this function by  $\mathcal{K}(\mathbf{K}) = [\mathcal{K}_l(\mathbf{K}), \mathcal{K}_s(\mathbf{K})]$ , where  $\mathcal{K}_j(\mathbf{K})$  is the policy function for capital good  $j \in \{l, s\}$ . In period  $t$ , the manager of a firm with a predetermined capital stock  $\mathbf{K}_t$  chooses  $K_{j,t+1} = \mathcal{K}_j(\mathbf{K}_t)$ . The function  $\mathcal{K}(\cdot)$  is the solution to the manager's first-order conditions associated with (15). With a slight abuse of notation, the policy

function is the solution  $\mathbf{K}_{t+1}$  of the following self-referencing characterization:

$$0 = \frac{\partial \Pi_t}{\partial K_{j,t+1}} + \beta \theta \frac{\partial \Pi_{t+1}}{\partial K_{j,t+1}} + (\beta - 1) \theta \sum_{k=l,s} \frac{\partial \mathcal{K}_k(\mathbf{K}_{t+1})}{\partial K_{j,t+1}} \frac{\partial \Pi_{t+1}}{\partial K_{k,t+2}}. \quad (16)$$

The derivation is relegated to Appendix B.1. Equation (16) takes into account the strategic dependence of future behavior on current decisions. The first two terms are standard and incorporate the costs of investment and its marginal return. The final term is a peculiarity of models with quasi-hyperbolic discounting. It captures the marginal effect of changes in today's investment on future investment behavior, which feeds back into today's equity and thus today's decisions. The (unknown) gradients of the capital policy functions  $\frac{\partial \mathcal{K}_k(\mathbf{K}_{t+1})}{\partial K_{j,t+1}}$  for  $j, k \in \{l, s\}$  determine the effects of future investment on today's equity. Whenever managers receive a cash bonus,  $\beta \neq 1$  and the last term does not cancel out, rendering the optimal capital policy analytically non-tractable.

**A Tractable Special Case:** The optimal capital policy has a closed-form solution in the special case  $\gamma = 0$ . Absent capital adjustment costs, the capital choice of the manager in  $t$  does not depend on the predetermined period  $t$  capital stock, chosen by the manager in  $t - 1$ . The gradient of the policy function is zero:  $\frac{\partial \mathcal{K}_k(\mathbf{K}_t)}{\partial K_{j,t}} = 0$  for  $j \in \{l, s\}$ . We can therefore simplify the optimality condition (16):

$$1 = \beta \theta \frac{\partial \Pi_{t+1}}{\partial K_{j,t+1}} \quad (17)$$

We next characterize the effects of managerial present bias in this special case.

**Proposition 2 (Short-termism and investment).** *Given  $\gamma = 0$ , the optimal investment policy defined by (15) depends on short-termism  $\rho = \beta^{-1} - 1$  as follows:*

- *The demand for both types of capital ( $K_l$  and  $K_s$ ) strictly falls in  $\rho$ :  $\frac{\partial K_l}{\partial \rho}, \frac{\partial K_s}{\partial \rho} < 0$ .*



- *The demand for long-lived capital  $K_l$  relative to the demand for short-lived capital  $K_s$  strictly falls as  $\rho$  increases:  $\frac{\partial(K_l/K_s)}{\partial \rho} < 0$ .*

The proof is as follows. Defining the manager's user cost of capital type  $j$  as

$$u_j = (\beta\theta)^{-1} - 1 + \delta_j,$$

we obtain from (17) the optimal (time-invariant) capital stocks

$$K_s = \zeta \left( \frac{1-\nu}{u_s} \right)^{\frac{1-\nu\phi}{1-\phi}} \left( \frac{\nu}{u_l} \right)^{\frac{\nu\phi}{1-\phi}}, \quad K_l = \zeta \left( \frac{1-\nu}{u_s} \right)^{\frac{\phi(1-\nu)}{1-\phi}} \left( \frac{\nu}{u_l} \right)^{\frac{1-\phi(1-\nu)}{1-\phi}},$$

where  $\zeta \in \mathbb{R}$  denotes a firm-specific constant that does not depend on  $u_j$  and  $\phi = a/(1-b)$ .

An increase in present bias  $\rho$  raises both user costs and thus unambiguously depresses both capital stocks. One can further show that

$$\frac{K_l}{K_s} = \frac{\nu}{1-\nu} \frac{u_s}{u_l},$$

which proves the second part of the proposition. An increase in  $\rho$  lowers the ratio of long-lived capital relative to short-lived capital.

**Discussion:** In this section, we have described the model of a firm. In the next section, we use the model to quantify the effects of managerial compensation. We study the effects in both partial equilibrium and general equilibrium. The partial-equilibrium exercise abstracts from spillovers between firms by assuming a fixed wage. The general equilibrium closure is described in the next section.

Our model allows for rich investment dynamics, but it abstracts from other potential factors that affect investment. One of these potential factors is managerial risk aversion. While difficult to measure, a manager with high risk aversion may have an even stronger preference

to tilt the within-firm capital allocation further toward short-term assets as these assets expose the decision-maker to less uncertainty in the future. We also neglect the role of convexity in compensation schemes. In our defense, Hayes et al. (2012) provide empirical evidence that the change in convexity induced by FAS 123R had little impact on CEOs' risk-taking behavior.

## 4 Quantitative Analysis

We employ our model to quantify the effects of a shift in managerial pay on the capital allocation of firms and real economic activity. The calibrated model rationalizes the empirical evidence and predicts sizable effects of managerial pay on real economic activity.

### 4.1 Solution Method

The decision problem of the manager features present bias and resembles a quasi-hyperbolic discounting problem. Solving our model involves similar challenges as those documented in previous neoclassical growth models with quasi-geometric discounting (e.g., Krusell and Smith 2003, Maliar and Maliar 2016). As the optimal capital policy does not have a closed-form solution in general, we solve the model numerically. Since Euler-equation methods are likely to fail (cf. Maliar and Maliar 2016), we solve the model by adapting the endogenous gridpoint method first introduced by Carroll (2006). This method works similarly to backward induction: for a fixed number of possible future stocks of both types of capital, we use the managers' optimality conditions to obtain current capital stocks.

### 4.2 Calibration

A period in the model is a year. We calibrate the model to match the change in managerial compensation in the years around the accounting reform for a simulated sample of firms.

**Table 7: Summary Statistics on Incentive Contracts**

Variable	Mean	Std. Dev.	p25	p50	p75	Obs
Bonus Share $\eta^b$						
2005	0.00034	0.00060	0.00004	0.00014	0.00036	7,786
2007	0.00046	0.00200	0.00005	0.00015	0.00041	8,534
Equity Share $\eta^e$						
2005	0.0097	0.0254	0.0009	0.0024	0.0067	7,786
2007	0.0063	0.0168	0.0006	0.0016	0.0045	8,534
Present Bias $\beta$						
2005	0.918	0.078	0.874	0.943	0.982	7,786
2007	0.890	0.087	0.803	0.910	0.968	8,534

*Notes:* The table reports summary statistics on the bonus share  $\eta^b$ , the equity share  $\eta^e$  and the associated values of  $\beta$  before and after the FAS 123R reform (2005 and 2007) based on equation (14) and data from Execucomp, Compustat, Coles et al. (2006), and Core and Guay (2002). See Appendix C.1 for details.

Model parameters not directly related to managerial compensation are calibrated to match salient features of the data before the reform.

**Calibrating Incentive Contracts:** Table 7 provides summary statistics for three key parameters that describe managerial incentive contracts. We document the empirical distribution of the equity share ( $\eta^e$ ), the cash bonus shares ( $\eta^b$ ), and the present bias ( $\beta$ ) in the year before and after the accounting reform, respectively. We compute  $\eta^b$  as the sum of bonuses and non-equity incentive compensation divided by firm sales. The equity share  $\eta^e$  is computed as the manager’s equity-linked firm wealth divided by the firm’s market capitalization, see Appendix C.1 for details. We compute  $\beta$  following equation (14). Between 2005 and 2007, the sample mean of  $\beta$  falls by 3 percentage points from 0.918 to 0.890, driven by both lower  $\eta^e$  and higher  $\eta^b$ .

We simulate a sample of 2,400 firms.<sup>19</sup> Each firm is endowed with a pre-reform value of  $\beta$  and a post-reform value of  $\beta$ . The  $\beta$  values are random draws from the empirical joint distribution of pre- and post-reform  $\beta$ . In particular, we discretize the distribution of  $\beta$  into 10 equally-sized bins ranging from 0.75 to 1.0 and compute the distribution across bins in

<sup>19</sup>We choose a relatively large number of simulated firms in order to represent well heterogeneity across industries and to keep sampling noise small.

2005 and the transition probabilities across bins between 2005 and 2007. Figure C.1 shows the shift in the distribution of  $\beta$  (across bins) between 2005 and 2007. For 70% of the firms  $\beta$  remains the same, while it changes for 30% of firms, mostly downward. Thus, the incentive structure of managers shifted toward stronger present bias around the reform. In addition, firms draw a value of  $\eta^e$  from a discretized beta distribution that approximates the empirical distribution of  $\eta^e$ .<sup>20</sup>

**Other Parameters:** The remaining parameters of the model are the two depreciation rates  $(\delta_l, \delta_s)$ , technology parameters  $(\alpha, \nu)$ , and demand parameters  $(\varepsilon, B)$ . The first part of our analysis explores the effect of changes in managerial pay in partial equilibrium. For this exercise, we also calibrate the wage rate  $w_t = w$ . The second part of our analysis explores the general equilibrium effects. We will set up the general equilibrium model such that the wage rate calibrated in the partial equilibrium model clears the pre-reform labor market. The post-reform wage rate will be solved in equilibrium.

In order to capture heterogeneity across sectors, we randomly assign firms to sectors, using as probability weights the number of firms per sector in the U.S. based on the OECD Structural Statistics of Industry and Services database. We consider the 13 sectors listed in Table 8. We calibrate the depreciation rates to sector-specific weighted average depreciation rates when grouping capital goods into the long-lived category (buildings and structures) and the short-lived category (various types of equipment). For the remaining parameters, we target sector-specific revenues  $R$ , the share of long-lived capital  $\frac{K_l}{K_l + K_s}$ , the ratio of long-lived capital over revenues  $\frac{K_l}{R}$ , the ratio of labor costs over revenues  $\frac{wN}{R}$ , and the wage  $w$ . We abstract from incentive distortions when calibrating these sector-specific production and demand parameters using the steady-state conditions of the model, see Appendix C.2 for details. Table 8 shows the calibrated sector-level model parameters.<sup>21</sup>

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<sup>20</sup>The change in  $\eta^e$  between 2005 and 2007 documented in Table 7 also implies a change in  $\theta = \frac{1-\eta^e}{1+r}$ . However, the change is of secondary quantitative importance. While  $\beta$  drops by 0.03,  $\theta$  increases by only 0.003. To keep our quantitative exercise transparent, we let  $\theta$  remain constant over time.

<sup>21</sup>In line with the data, our calibration assumes  $\beta$  to be identically distributed across sectors. We cannot

Table 8: Industry-Level Parameters

Code	Industry Name	Industry Weight (in %)	Value Added (in Mio. USD, 2010 prices)	Capital Stock (in Mio. USD, 2010 prices)	Share of Long-Term Capital Stock	Depreciation Rates		Production Function Parameters		Wage Rate (in Thd. USD, 2010 prices)	Demand Elasticity	Demand Shifter (in Thd. USD, 2010 prices)
						$\delta_l$	$\delta_s$	$\nu$	$\alpha$	$w$	$\varepsilon$	$B$
A	Agriculture, forestry and fishing	2.0	138,161	462,506	0.58	0.02	0.13	0.30	0.55	28.4	2.4	17,426
B	Mining and quarrying	0.3	260,953	1,481,196	0.93	0.02	0.14	0.79	0.58	113.5	2.3	184,719
C	Total manufacturing	7.9	1,726,301	2,794,956	0.47	0.03	0.11	0.27	0.24	57.4	3.4	22,978,000
D, E	Electricity, gas and water supply	0.5	288,219	1,665,872	0.79	0.02	0.10	0.59	0.55	58.1	3.3	628,381
F	Construction	12.6	748,735	228,765	0.32	0.03	0.16	0.13	0.07	51.5	2.9	3,633,884
G	Wholesale and retail trade	22.3	1,777,411	1,367,003	0.71	0.03	0.15	0.45	0.12	48.6	2.6	976,920
H	Transportation and storage	3.1	472,378	1,051,537	0.60	0.03	0.14	0.35	0.25	57.5	10.1	$34,204 \times 10^{12}$
I	Accommodation and food service activities	7.9	414,118	466,458	0.78	0.03	0.14	0.56	0.13	28.9	3.5	5,043,535
J	Information and communication	0.4	698,043	1,374,041	0.71	0.04	0.13	0.52	0.29	66.9	2.9	27,135,000
K	Financial and insurance activities	5.0	930,028	925,047	0.62	0.04	0.18	0.35	0.18	76.2	3.0	13,328,000
M, N	Other business services	17.8	1,343,732	1,056,987	0.50	0.04	0.15	0.28	0.13	81.3	4.0	563,140,000
Q	Healthcare	9.0	929,544	940,826	0.76	0.03	0.15	0.51	0.10	48.7	11.8	$792,530 \times 10^{15}$
R, S	Arts, entertainment and recreation	11.2	510,096	743,230	0.85	0.05	0.15	0.71	0.17	40.8	4.7	350,250,000

*Notes:* Industry weights are based on the number of enterprises across sectors from the OECD Structural Statistics of Industry and Services database for the year 2005. All other industry-level information is based on US 2003-2005 files from EU KLEMS data. Depreciation rate  $\delta_s$  displays the depreciation rate of the short-term capital stock, which is given by the capital stock-weighted depreciation rates of telecommunication equipment (N11322G), computer hardware (N11321G), transport (N1131G) and other machinery equipment and weapons (N110G). Accordingly, depreciation rate  $\delta_l$  is the industry-specific long-term depreciation rate, given by the depreciation rate for other buildings and structures (N110G).

A firm's overall business condition  $X$  is the composite of a sector-wide demand condition  $B$  and productivity  $Z$  according to  $X = B^{\frac{1}{\varepsilon}} Z^{\frac{\varepsilon-1}{\varepsilon}}$ . We allow for permanent productivity differences across firms, and draw  $Z$  from a log-normal distribution with mean zero and a standard deviation of 0.52 matching the corresponding estimate in İmrohoroglu and Şelale Tüzel (2014). We set the quadratic adjustment-cost parameter  $\gamma = 0.9$ , which matches a half-life of capital adjustment between three and four years. Finally, we set the interest rate  $r$  to 2.98%.

**Non-Targeted Moments:** A key test of our calibrated model is whether it can replicate the (non-targeted) empirical evidence in Table 4 of Section 2. We run the regression in equation (2) on our simulated sample of firms. To replicate a model analog to  $\text{Option}_{i,2004}$  in the empirical analysis, we first create a dummy variable which is one for firms that experienced a reduction in  $\beta$  and zero else. To mimic the fact that  $\text{Option}_{i,2004}$  does not perfectly predict reductions in  $\beta$  in the data, we add classical measurement error to the model dummy variable.<sup>22</sup> The dependent variable is the inverse hyperbolic sine of investment as in the empirical regression.<sup>23</sup>

Table 9 reports the estimates of equation (2) in our simulated sample of firms. Across specifications, the estimates of  $\beta_1$  are positive. The estimates are also fairly close in magnitude compared to their empirical counterparts in Table 4. E.g., for the specification in column (1), the estimate of  $\beta_1$  (first row) is 0.865 in simulated data compared to 0.999 in the actual data. The average investment response estimated on simulated data is -0.10 and thus matches the -0.10 responses implied by the empirical estimates in Table 4.<sup>24</sup> In an additional exercise,

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reject the null hypothesis of equal average *beta* across sectors at  $p=0.89$  for 2005 and  $p=0.57$  for 2006.

<sup>22</sup>In 32% of the empirical observations, either  $\text{Option}_{i,2004} = 1$  and  $\beta_i$  does not fall, or  $\text{Option}_{i,2004} = 0$  and  $\beta_i$  falls. We construct  $\text{Option}_{i,2004}$  in the model as the dummy variable for reductions in  $\beta$  when re-coding the dummy from zero to one, or from one to zero, for randomly selected 32% of firms. Appendix Table C.1 shows the results when not introducing measurement error, which naturally leads to larger coefficient estimates.

<sup>23</sup>Due to the scale variance of this transformation, we scale investment in the calibrated sample to match the sample mean of investment in the data in order to ensure comparability of the estimates.

<sup>24</sup>We obtain the average investment response in column (6) by multiplying the coefficient in the first row, 0.865, with the average depreciation rate in the model, 0.09, and adding the fourth row, -0.175.

**Table 9: Simulated Firms - Regression Results**

	Investments					
	(1)	(2)	(3)	(4)	(5)	(6)
<i>Measure of Depreciation:</i>	<i>Depreciation Rate</i>					
FAS123 $\times$ $\beta$ Reduced $\times$ Depr	0.865 (0.153)	0.865 (0.153)	1.785 (0.254)	1.785 (0.254)	3.541 (0.325)	0.865 (0.153)
FAS123 $\times$ Depr	0.598 (0.0795)	0.598 (0.0795)	1.042 (0.122)	1.042 (0.122)	0.598 (0.0795)	0.598 (0.079)
$\beta$ Reduced $\times$ Depr	0.948 (0.247)		1.556 (0.287)		2.018 (0.292)	0.948 (0.247)
FAS123 $\times$ $\beta$ Reduced						-0.175 (0.025)
Category FE	$\times$		$\times$		$\times$	
Category-Firm FE		$\times$		$\times$		
Firm-Year FE	$\times$	$\times$	$\times$	$\times$	$\times$	
Trend					$\times$	
Firm FE and Year FE						$\times$
Years around reform	15	15	6	6	15	15

*Notes:* This Table reports the results on the relationship between managerial incentives and investment decisions based on the panel of simulated firms.  $\beta$  Reduced is defined as dummy variable which indicates if a firm experiences a reduction in its firm-specific  $\beta$ . FAS123 is a dummy variable indicating the post-shock period. Empirical specifications in columns 1 to 5 resemble those in Table 4. The treatment-specific linear trend in column 5 is Trend  $\times$   $\beta$  Reduced  $\times$  Depr. Standard errors (reported in parentheses) are clustered at the firm-level.

we revisit the empirical regressions (on real data) when replacing the option dummy by the firm-specific  $\beta$ . Appendix Table C.2 shows that reductions in  $\beta$  are associated with a shift of investments toward more short-lived capital goods. Moreover, we use  $FAS123_t \times Option_{i,2004}$  as an instrument for decreases in  $\beta$  allowing us to confirm that the reform-induced shift in incentives caused a more short-term investment behavior.

### 4.3 Quantitative Results

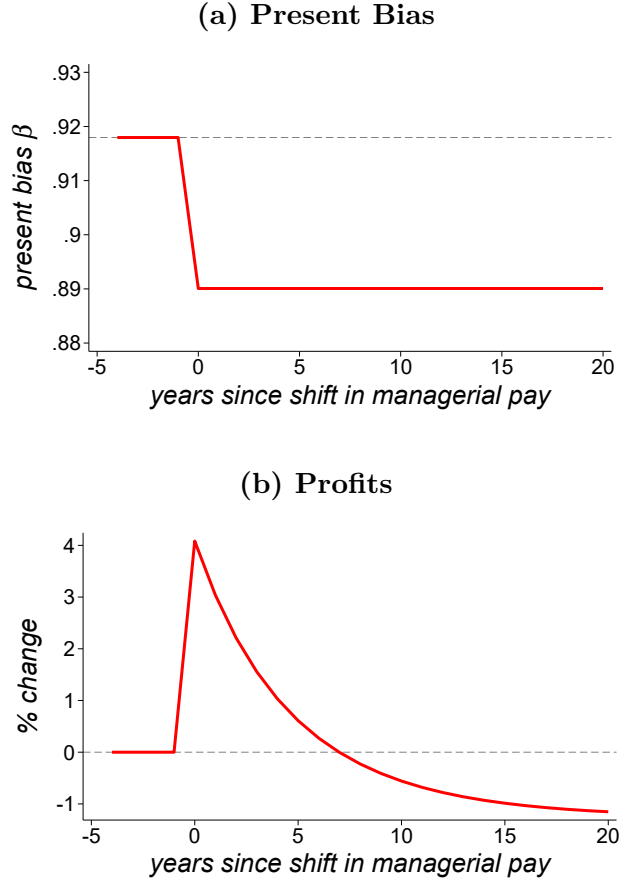
In the calibrated model, the shift in managerial compensation toward cash bonuses leads to managerial short-termism. Profits rise in the short term but subsequently fall below the initial level. Managers lower total investment, in particular investment in long-term capital, leading to a contraction of output. In the following, we will first quantify the effects of managerial compensation in partial equilibrium and subsequently explore the general equilibrium effects.

**Managerial Pay and Profits:** Figure 2 shows the change in  $\beta$  caused by the shift in managerial pay. The average present bias  $\beta$  across firms is constant initially. The exogenous shift in managerial pay permanently lowers  $\beta$  by almost three percentage points on average, matching the pre- and post-reform level of  $\beta$  in the data (Table 7). Consistent with a lower  $\beta$ , i.e., stronger present bias, firm profits initially increase. However, starting seven years after the shift in managerial pay, profits fall below the level prevailing before the shift and subsequently remain permanently suppressed. The increase in present bias due to a lower  $\beta$  hence raises short-term profits at the expense of long-term profits.

**Investment and Capital:** We next study the change of managerial behavior underlying the response of profits. The key managerial decision is how much to invest, respectively, in short-lived and long-lived capital. Panel (a) of Figure 3 shows the change in the investment-capital ratio caused by the shift in managerial pay. Increased present bias reduces the managers' incentive for any investment. In response, the ratio of total investment over total capital falls by 20 percentage points on average in the first year and slowly recovers subsequently. Consistent with our empirical findings in Table 4, the response in investments is asymmetric across capital goods. While the investment ratio of short-term capital initially falls 9 percentage points, the investment ratio of long-term capital plummets 49 percentage points. The shift in managerial pay hence causes a sizable contraction and reallocation of investment.



**Figure 2: Present Bias and Profits**

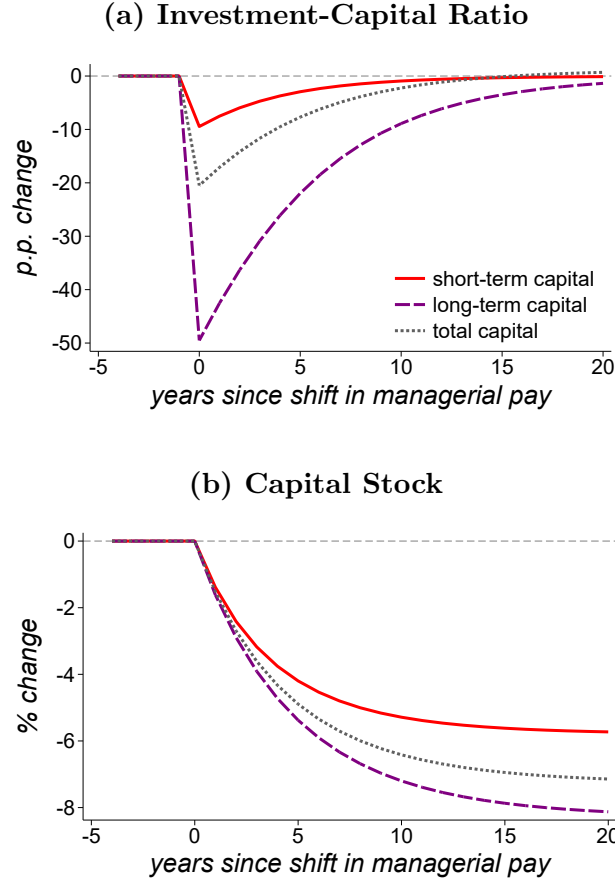


*Notes:* The figure shows the evolution of the average present bias  $\beta$  and profits  $\Pi_t$  across firms, the latter in % deviation from the pre-shock level.

Panel (b) shows the change in capital stocks. Consistent with lower investment rates and sluggish capital adjustment, we observe a permanent decline in the firms' capital stock that builds up slowly. In the long run, the average stock of long-lived capital is 8% below the initial level, short-lived capital is 6% lower and the sum of short-lived and long-lived capital about 7% lower.<sup>25</sup> The patterns of investment and capital are important to understand the response of profits in Figure 2. In the short term, managers lower investment (especially in long-lived capital) to raise profits, but in the long term, a lower capital stock depresses

<sup>25</sup>The permanent shift in the capital composition toward short-lived capital explains why the total investment-capital ratio converges to a level slightly above the initial level. Maintaining a constant capital stock in the new steady state requires higher investment to offset higher depreciation.

**Figure 3: Investment and Capital**

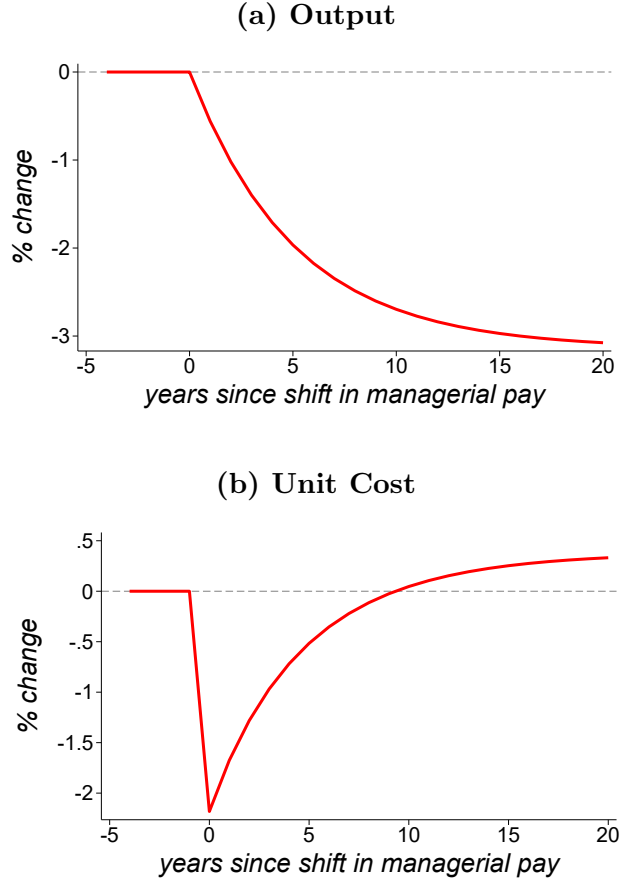


*Notes:* The figure shows the evolution of the investment-capital ratios and capital stocks. The investment-ratio is defined as  $I_{jt}/K_{jt}$  for short-term capital ( $j = s$ ) and long-term capital ( $j = l$ ), and as  $(I_{st} + I_{lt})/(K_{st} + K_{lt})$  for total capital. For all investment ratios we show average percentage point deviation from the pre-shift level. For all capital stocks we show average percent deviation from the pre-shift level.

profits.

**Output and Unit Cost:** Finally, we analyze the effects of the shift in managerial pay on output and unit cost. Panel (a) of Figure 4 shows the response of output. The initial response is small. In the long term, however, average output drops by 3%. The dynamic pattern reflects the response of capital stocks in Figure 3. We consider it worthwhile to stress that the size of the output decline is sizable given what may seem to be small changes in the managerial pay structure in Table 7.

**Figure 4: Output and Unit Cost**



*Notes:* The figure shows the average evolution of output  $Q_t$ , in percent and indexed to pre-shock values, and the average response of unit cost, defined as total cost divided by output.

The drop in output underlies an increase in capital misallocation. Capital misallocation shows up in the unit cost, which we measure as the total cost per unit of production,  $(C_t^K + wN_t)/Q_t$ . Panel (b) shows the response of unit cost. Unit cost plummets initially as the increase in short-termism leads to a drop in investment, but exceed their initial level at longer horizons, similar to the pattern of profits in Figure 2. At longer horizons, the capital stock and thus investment converges to a new steady state in which unit costs are 0.38% above its level before the shift in pay. Given the increased present bias, managers behave as if they faced higher costs of capital, which makes them change their mix of short-term and long-term capital and ultimately translates into higher unit costs.

**General Equilibrium:** We finally analyze the effects of changes in managerial pay in general equilibrium. We have shown that the simulated change in managerial pay lowers capital demand, and thus lowers labor demand. In general equilibrium, we may expect the contraction in factor demand to be dampened by the adjustment of factor prices.

We analyze the same sample of firms as before but complement the model of the firm with a demand structure, households, and market clearing. We assume the firms' output are variety goods which are combined into a sector-specific CES bundle. The sector-specific bundles are then combined into an aggregate Cobb-Douglas final good. We assume that capital adjustment costs are labor costs and that households' labor supply is fixed. This assumption renders our general equilibrium results conservative. Labor is an important factor in production and keeping aggregate labor fixed limits the aggregate contraction in real economic activity after the simulated change in managerial pay. We use the final good as numéraire and normalize the aggregate price index to unity. The remaining equilibrium price is the wage rate. We formally define the general equilibrium in Appendix B.2.<sup>26</sup>

Table 10 presents the aggregate effects of the simulated change in managerial pay in the new stationary equilibrium relative to the stationary equilibrium before the change. Output contracts by about 1%, about one third of the long-term output decline in partial equilibrium (Figure 4). The real wage contracts by the same magnitude, as may be expected given the Cobb-Douglas production technology. Long-term capital falls 5.4% in general equilibrium relative to 8% in partial equilibrium. For short-term capital, the contraction is 4.3% in general equilibrium relative to 6% in partial equilibrium. Hence, the general-equilibrium decrease in the real wage somewhat dampens the capital response to the change in managerial pay. However, the dampened output response in general equilibrium mostly reflects fixed labor supply.

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<sup>26</sup>For comparability with the partial equilibrium results, we calibrate the quantity of fixed household labor supply to correspond to aggregate labor demand in the partial equilibrium steady state before the reform. This means differences between the partial equilibrium response and the general equilibrium response to the change in managerial pay solely reflect the response of the real wage that is needed to clear the labor market.

**Table 10: General-Equilibrium Effects**

Variable	Change (%)	Variable	Change (%)
Output	-1.06	Real wage	-1.06
Long-term investment	-5.50	Short-term investment	-4.35
Long-term capital stock	-5.44	Short-term capital stock	-4.34
Total investment	-4.69	Total capital stock	-5.05

*Notes:* The table shows the percentage change of aggregate variables between the stationary equilibrium before and after the change in managerial pay.

## 5 Conclusion

In this paper, we analyze how managerial pay affects the allocation of capital. We provide empirical evidence showing that firms systematically shift investment expenditures toward less durable assets in response to a shift in managerial pay toward more short-term incentives. To quantify the impact of managerial present bias on capital (mis)allocation and output, we calibrate a model of heterogeneous firms that are subject to agency frictions since there is a separation between ownership and control and managers are incentivized with equity-bonus contracts. Our results indicate that changes in incentives away from motivating managers to maximize long-term firm values cause substantial economic distortions. Firms cut their investments into long-term assets and within-firm capital misallocation increases due to a mismatch in decision-makers' private marginal products of capital and social marginal products of capital, causing a decline in economic activity in the long run. We conclude that corporate decision-makers' incentives are crucial for economic policy-making as managers respond very sensitively to changes in their incentives, which in turn affects economic outcomes.

## References

- Abadie, Alberto, Susan Athey, Guido W. Imbens, and Jeffrey Wooldridge.** When Should You Adjust Standard Errors for Clustering? *Quarterly Journal of Economics*, 138(1):1–35, 2023.
- Aghion, Philippe, George-Marios Angeletos, Abhijit Banerjee, and Kalina Manova.** Volatility and Growth: Credit Constraints and the Composition of Investment. *Journal of Monetary Economics*, 57(3):246–265, 2010.
- Alder, Simeon D.** In the Wrong Hands: Complementarities, Resource Allocation, and TFP. *American Economic Journal: Macroeconomics*, 8(1):199–241, 2016.
- Asker, John, Allan Collard-Wexler, and Jan De Loecker.** Dynamic Inputs and Resource (Mis)Allocation. *Journal of Political Economy*, 122(5):1013–1063, 2014.
- Asquith, Paul and David W. Mullins.** Equity Issues and Offering Dilution. *Journal of Financial Economics*, 15(1):61–89, 1986.
- Barton, Dominic.** Capitalism for the Long Term. *Harvard Business Review*, 2011.
- Bénabou, Roland and Jean Tirole.** Bonus Culture: Competitive Pay, Screening, and Multitasking. *Journal of Political Economy*, 124(2):305–370, 2016.
- Carroll, Christopher D.** The Method of Endogenous Gridpoints for Solving Dynamic Stochastic Optimization Problems. *Economics Letters*, 91(3):312–320, 2006.
- Coles, Jeffrey L., Naveen D. Daniel, and Lalitha Naveen.** Managerial Incentives and Risk-Taking. *Journal of Financial Economics*, 79(2):431–468, 2006.
- Core, John and Wayne Guay.** Estimating the Value of Employee Stock Option Portfolios and Their Sensitivities to Price and Volatility. *Journal of Accounting Research*, 40(3):613–630, 2002.
- Core, John E., Wayne R. Guay, and S. P. Kothari.** The Economic Dilution of Employee Stock Options: Diluted EPS for Valuation and Financial Reporting. *The Accounting Review*, 77(3):627–652, 2002.
- David, Joel M. and Venky Venkateswaran.** The Sources of Capital Misallocation. *American Economic Review*, 109(7):2531–67, 2019.
- Dimon, Jamie and Warren E. Buffet.** Short-Termism Is Harming the Economy: Public Companies Should Reduce or Eliminate the Practice of Estimating Quarterly Earnings. *Wall Street Journal*, 2018.
- Doerr, Sebastian, Dalia Marin, Davide Suverato, and Thierry Verdier.** International Trade and the Allocation of Capital within Firms. *Journal of International Economics*, (104023), 2025.
- Edmans, Alex, Vivian W. Fang, and Allen Huang.** The Long-Term Consequences of

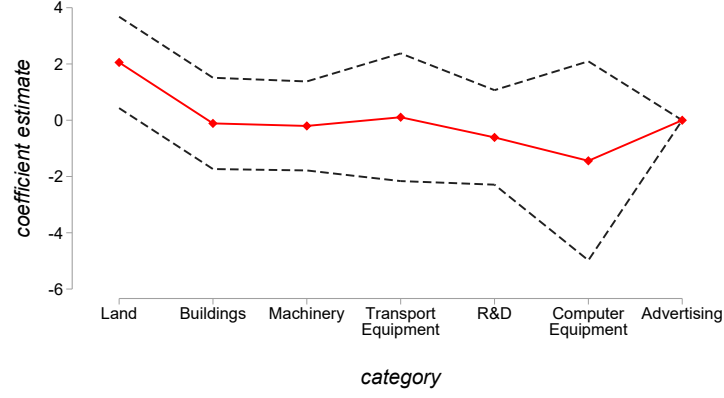
- Short-Term Incentives. *Journal of Accounting Research*, 60(3):1007–1046, 2022.
- Edmans, Alex, Vivian W. Fang, and Katharina A. Lewellen.** Equity Vesting and Investment. *Review of Financial Studies*, 30(7):2229–2271, 2017.
- Garicano, Luis and Luis Rayo.** Why Organizations Fail: Models and Cases. *Journal of Economic Literature*, 54(1):137–92, 2016.
- Garicano, Luis and Claudia Steinwender.** Survive Another Day: Using Changes in the Composition of Investments to Measure the Cost of Credit Constraints. *Review of Economics and Statistics*, 98:913–924, 2016.
- Giroud, Xavier.** Proximity and Investment: Evidence from Plant-Level Data. *Quarterly Journal of Economics*, 128(2):861–915, 2013.
- Giroud, Xavier and Holger M. Mueller.** Firms’ Internal Networks and Local Economic Shocks. *American Economic Review*, 109(10):3617–49, 2019.
- Glover, Brent and Oliver Levine.** Uncertainty, Investment, and Managerial Incentives. *Journal of Monetary Economics*, 69:121–137, 2015.
- Gopalan, Radhakrishnan, Todd Milbourn, Fenghua Song, and Anjan V. Thakor.** Duration of Executive Compensation. *Journal of Finance*, 69(6):2777–2817, 2014.
- Gormsen, Niels and Kilian Huber.** Corporate Discount Rates. *American Economic Review*, 115(6):2001–2049, 2025.
- Hayes, Rachel M., Michael Lemmon, and Mingming Qiu.** Stock Options and Managerial Incentives for Risk Taking: Evidence from FAS 123R. *Journal of Financial Economics*, 105(1):174–190, 2012.
- Hsieh, Chang-Tai and Peter J. Klenow.** Misallocation and Manufacturing TFP in China and India. *Quarterly Journal of Economics*, 124(4):1403–1448, 2009.
- Huson, Mark R., Thomas W. Scott, and Heather A. Wier.** Earnings Dilution and the Explanatory Power of Earnings for Returns. *The Accounting Review*, 76(4):589–612, 2001.
- İmrohoroglu, Ayşe and Şelale Tüzel.** Firm-Level Productivity, Risk, and Return. *Management Science*, 60(8):2073–2090, 2014.
- Kehrig, Matthias and Nicolas Vincent.** Good Dispersion, Bad Dispersion. NBER Working Papers 25923, National Bureau of Economic Research, Inc, 2019.
- Krusell, Per and Anthony A. Smith.** Consumption-Savings Decisions with Quasi-Geometric Discounting. *Econometrica*, 71(1):365–375, 2003.
- Ladika, Tomislav and Zacharias Sautner.** Managerial Short-Termism and Investment: Evidence from Accelerated Option Vesting. *Review of Finance*, 24(2):305–344, 2020.
- Laibson, David.** Golden Eggs and Hyperbolic Discounting. *Quarterly Journal of Economics*, 112(2):443–478, 1997.

- Maliar, Lilia and Serguei Maliar.** Solving the Neoclassical Growth Model with Quasi-Geometric Discounting: A Grid-Based Euler-Equation Method. *Computational Economics*, 26(2):163–172, 2005.
- Maliar, Lilia and Serguei Maliar.** Ruling Out Multiplicity of Smooth Equilibria in Dynamic Games: A Hyperbolic Discounting Example. *Dynamic Games and Applications*, 6(2):243–261, 2016.
- Meier, Matthias and Timo Reinelt.** Monetary Policy, Markup Dispersion, and Aggregate TFP. *Review of Economics and Statistics*, 106(4):1012–1027, 2024.
- Midrigan, Virgiliu and Daniel Yi Xu.** Finance and Misallocation: Evidence from Plant-Level Data. *American Economic Review*, 104(2):422–58, 2014.
- Mullahy, John and Edward C Norton.** Why Transform Y? The Pitfalls of Transformed Regressions with a Mass at Zero. *Oxford Bulletin of Economics and Statistics*, 86(2):417–447, 2024.
- Nikolov, Boris and Toni M. Whited.** Agency Conflicts and Cash: Estimates from a Dynamic Model. *Journal of Finance*, 69(5):1883–1921, 2014.
- Peters, Michael.** Heterogeneous Markups, Growth and Endogenous Misallocation. *Econometrica*, 88(5):2037–2073, 2020.
- Terry, Stephen J.** The Macro Impact of Short-Termism. *Econometrica*, 91(5):1881–1912, 2023.
- World Bank.** Real interest rate (%) - United States. 2020. Data retrieved from <https://data.worldbank.org/indicator/FR.INR.RINR?locations=US>.



## A Empirical Appendix

Figure A.1: Equity Ownership and the Durability of Investments - By Category



*Notes:* The figure plots jointly estimated category-specific associations between investment and managerial equity ownership. Formally, it shows the estimated  $\beta_{1,j}$  in

$$invest_{ict} = \sum_j \left[ \mathbb{1}\{j = c\} \beta_{1,j} \eta_{it}^e \right] + \lambda_{it} + \lambda_{ci} + \varepsilon_{ict},$$

where  $j$  denotes an investment category. Advertising investment is absorbed by the fixed effects. The null hypothesis of coefficient equality across categories can be rejected at the 5%-level ( $p = 0.015$ ).

**Table A.1: Composition of Capital Stock**

	Capital Stocks				
	(1)	(2)	(3)	(4)	(5)
<i>Measure of Depreciation:</i>	<i>Depreciation Rate</i>				
FAS123 $\times$ Option $\times$ Depr	0.790 (0.287)	0.513 (0.226)	0.477 (0.238)	0.220 (0.170)	1.166 (0.284)
FAS123 $\times$ Depr	-1.112 (0.265)	-0.634 (0.214)	-0.504 (0.220)	-0.164 (0.163)	-1.112 (0.265)
Option $\times$ Depr	-0.623 (0.349)		-0.603 (0.355)		103.5 (27.17)
<i>Measure of Depreciation:</i>	<i>Ordinal Rank</i>				
FAS123 $\times$ Option $\times$ Depr	0.062 (0.026)	0.042 (0.019)	0.038 (0.022)	0.022 (0.014)	0.085 (0.026)
FAS123 $\times$ Depr	-0.079 (0.025)	-0.039 (0.018)	-0.036 (0.020)	-0.011 (0.013)	-0.079 (0.025)
Option $\times$ Depr	-0.062 (0.034)		-0.062 (0.034)		6.31 (2.41)
Category FE	$\times$		$\times$		$\times$
Category-Firm FE		$\times$		$\times$	
Firm-Year FE	$\times$	$\times$	$\times$	$\times$	$\times$
Trend					$\times$
Observations	36,765	36,694	14,640	14,532	36,765
No. Firms	690	684	670	661	690
Sample Period	'00-'14	'00-'14	'02-'07	'02-'07	'00-'14

*Notes:* The table reports estimates of equation (2) when replacing the left-hand side by capital. *Option* is a dummy that indicates if any unexercised options are outstanding in 2004. *FAS123* takes value 0 for all years until 2005 and value 1 afterward. *Depr* is a measure of depreciation: the rate of depreciation in the upper panel and the ordinal depreciation rank in the lower panel. Columns (1)–(4) vary in sample period and fixed effects. Column (5) controls for a linear time trend interacted with the interaction of the option dummy and the measure of depreciation. Standard errors (in parentheses) are clustered at the firm level.

**Table A.2: Ex-Ante Differences across Firms**

Variable	Option-Paying (N=553)	Non-Option-Paying (N=144)	<i>t</i> -test	<i>p</i> -value
Total Assets	8,153	7,491	0.29	0.77
Sales	7,512	7,145	0.16	0.87
Capital Stock	3,709	2,897	1.02	0.31
Employment	32.15	17.56	3.10	<b>&lt;0.01</b>
Labor Productivity	115.4	98.9	1.44	0.15
Depreciation Rate	0.17	0.18	-1.35	0.18
Intangible Share	0.49	0.56	-2.01	<b>0.05</b>
Investment Rate	0.05	0.04	1.23	0.22
Leverage Ratio	0.20	0.19	0.19	0.85
Liquidity Ratio	0.15	0.21	-3.46	<b>&lt;0.01</b>
Equity Volatility	0.34	0.40	-3.64	<b>&lt;0.01</b>
Current CEO Compensation	1,929	1,538	2.05	<b>0.04</b>

*Notes:* A firm is classified as an option-paying firm if it has unexercised stock options to its management in 2004. We report arithmetic means across various outcomes in 2004. *Total Assets*, *Sales* and *Capital Stock* are denoted in millions USD, *Employment* is denoted in thousands. *Labor Productivity* is value added per employee in thousands USD (calculated as (SALE - COGS) / EMP). *Capital Stock* is obtained by summing up category-specific capital stocks for each firm, *Depreciation Rate* is the capital-stock weighted mean of category-specific depreciation rates for each firm. *Intangible Share* is the ratio of intangible investments (sum of advertising and R&D investments) to total investments. *Investment Rate* is capital expenditures (CAPX) relative to total assets (AT). The *Leverage Ratio* is defined as the ratio of total debt (sum of items DLC and DLTT) to total assets. The *Liquidity Ratio* equals the ratio of cash and short-term investments (CHE) to total assets. *Equity Volatility* is the annualized equity-return volatility, calculated as the standard deviation of daily stock returns multiplied by  $\sqrt{252}$ . Daily returns are calculated as (PRCCD  $\times$  TRFD / AJEXDI) relative to the previous day. *Current CEO Compensation* is the current compensation of the CEO in thousands USD (compensation excluding equity). The last two columns show the *t*-test statistic for the null hypothesis that the arithmetic average is equal between option-paying and non-option-paying firms, and the associated *p*-value.

**Table A.3: Investment Composition – Controlling for Firm Size**

<i>Firm Size Measure:</i>	Investments					
	(1)	(2)	(3)	(4)	(5)	(6)
	<i>Employment</i>		<i>Assets</i>		<i>Capital Stock</i>	
<i>Measure of Depreciation:</i>	<i>Ordinal Rank</i>	<i>Depreciation Rate</i>	<i>Ordinal Rank</i>	<i>Depreciation Rate</i>	<i>Ordinal Rank</i>	<i>Depreciation Rate</i>
FAS123 $\times$ Option $\times$ Depr	0.0464 (0.0201)	0.473 (0.191)	0.0477 (0.0201)	0.503 (0.192)	0.0456 (0.0200)	0.489 (0.190)
FAS123 $\times$ Depr	-0.0240 (0.0188)	-0.386 (0.183)	0.0347 (0.0353)	0.0674 (0.342)	0.00577 (0.0315)	-0.116 (0.301)
FAS123 $\times$ Firm Size $\times$ Depr	-0.00685 (0.00484)	-0.0194 (0.0460)	-0.00984 (0.00463)	-0.0676 (0.0443)	-0.00655 (0.00420)	-0.0477 (0.0395)
Category-Firm FE	$\times$	$\times$	$\times$	$\times$	$\times$	$\times$
Firm-Year FE	$\times$	$\times$	$\times$	$\times$	$\times$	$\times$
Observations	12,887	12,887	12,953	12,953	12,953	12,953
No. Firms	659	659	663	663	663	663
Sample Period	'02-'07	'02-'07	'02-'07	'02-'07	'02-'07	'02-'07

*Notes:* The table reports estimates of equation (2) when controlling for various measures of firm size (employment, assets, capital stock) interacted with the *Option* dummy and the *FAS123* dummy. Standard errors (in parentheses) are clustered at the firm level.

Table A.4: Investment Composition – Controlling for Other Firm Differences

Firm Control: Measure of Depreciation:	Investments							
	(1) Intangible Share		(3) Liquidity Ratio		(5) Equity Volatility		(7) Current CEO Compensation	
	Ordinal Rank	Depreciation Rate	Ordinal Rank	Depreciation Rate	Ordinal Rank	Depreciation Rate	Ordinal Rank	Depreciation Rate
FAS123 $\times$ Option $\times$ Depr	0.0409 (0.0201)	0.453 (0.189)	0.0392 (0.0201)	0.398 (0.188)	0.0463 (0.0206)	0.483 (0.196)	0.0479 (0.0209)	0.483 (0.200)
FAS123 $\times$ Depr	-0.0254 (0.0231)	-0.324 (0.232)	-0.0275 (0.0207)	-0.229 (0.195)	-0.0618 (0.0300)	-0.562 (0.288)	0.0375 (0.0790)	-0.163 (0.748)
FAS123 $\times$ Control $\times$ Depr	-0.0192 (0.0265)	-0.168 (0.255)	-0.0380 (0.0508)	-0.849 (0.484)	0.0692 (0.0587)	0.378 (0.548)	-0.0107 (0.0113)	-0.0377 (0.107)
Category-Firm FE	$\times$	$\times$	$\times$	$\times$	$\times$	$\times$	$\times$	$\times$
Firm-Year FE	$\times$	$\times$	$\times$	$\times$	$\times$	$\times$	$\times$	$\times$
Observations	12,933	12,933	12,953	12,953	12,953	12,953	12,902	12,902
No. Firms	661	661	663	663	663	663	661	661
Sample Period	'02-'07	'02-'07	'02-'07	'02-'07	'02-'07	'02-'07	'02-'07	'02-'07

*Notes:* The table reports estimates of equation (2) when controlling for various firm characteristics (intangible asset share, liquid asset ratio, equity volatility, current CEO compensation) interacted with the *Option* dummy and the *FAS123* dummy. Standard errors (in parentheses) are clustered at the firm level.

**Table A.5: Investment Composition – Subsample Without CEO Turnover**

	Investments				
	(1)	(2)	(3)	(4)	(5)
<i>Measure of Depreciation:</i>	<i>Depreciation Rate</i>				
FAS123 $\times$ Option $\times$ Depr	1.331 (0.379)	0.823 (0.345)	0.855 (0.309)	0.393 (0.259)	0.779 (0.382)
FAS123 $\times$ Depr	-0.873 (0.320)	-0.515 (0.320)	-0.816 (0.247)	-0.488 (0.226)	-0.872 (0.320)
Option $\times$ Depr	-1.109 (0.474)		-1.195 (0.481)		-153.1 (60.33)
<i>Measure of Depreciation:</i>	<i>Ordinal Rank</i>				
FAS123 $\times$ Option $\times$ Depr	0.125 (0.036)	0.071 (0.031)	0.086 (0.033)	0.039 (0.026)	0.051 (0.037)
FAS123 $\times$ Depr	-0.061 (0.031)	-0.029 (0.028)	-0.078 (0.028)	-0.045 (0.023)	-0.061 (0.031)
Option $\times$ Depr	-0.120 (0.053)		-0.128 (0.052)		-20.48 (6.37)
Category FE	$\times$		$\times$		$\times$
Category-Firm FE		$\times$		$\times$	
Firm-Year FE	$\times$	$\times$	$\times$	$\times$	$\times$
Trend					$\times$
Observations	14,810	14,779	5,919	5,851	14,810
No. Firms	292	291	286	285	292
Sample Period	'00-'14	'00-'14	'02-'07	'02-'07	'00-'14

*Notes:* The table reports estimates of equation (2) for the subsample of firms without CEO turnover, either for 2000–2014 or 2002–2007. Standard errors (in parentheses) are clustered at the firm level.

Table A.6: Investment Composition – Alternative Investment Measures

	Investments							
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
<i>Investment Measure:</i>	<i>Investment Rate</i>	<i>Logarithms</i>		<i>Ln(Investment+1)</i>		<i>Missings as 0s</i>		
FAS123 $\times$ Option $\times$ Depr	0.00542 (0.00219)	0.062 (0.021)	0.093 (0.027)	1.013 (0.277)	0.052 (0.019)	0.623 (0.196)	0.040 (0.023)	0.430 (0.220)
FAS123 $\times$ Depr	-0.00116 (0.00194)	-0.015 (0.018)	-0.048 (0.026)	-0.742 (0.259)	-0.00900 (0.017)	-0.293 (0.178)	0.055 (0.020)	0.332 (0.193)
Category-Firm FE	$\times$	$\times$	$\times$	$\times$	$\times$	$\times$	$\times$	$\times$
Firm-Year FE	$\times$	$\times$	$\times$	$\times$	$\times$	$\times$	$\times$	$\times$
Observations	31,074	31,074	30,384	30,384	32,953	32,953	73,724	73,724
No. Firms	680	680	681	681	683	683	725	725
Sample Period	'00-'14	'00-'14	'00-'14	'00-'14	'00-'14	'00-'14	'00-'14	'00-'14

*Notes:* The table reports estimates of equation (2) for alternative investment measures. *Depr* is the measure of depreciation, following an ordinal scale in odd columns and expressed in absolute depreciation rates in even columns. Standard errors (in parentheses) are clustered at the firm level.

**Table A.7: Investment Composition – Sensitivity for Intangibles**

	Investments					
	(1)	(2)	(3)	(4)	(5)	(6)
	<i>Omitting R&amp;D</i>			<i>Controlling f. Intangibles</i>		
FAS123 × Option × Depr	0.978 (0.250)	0.711 (0.224)	0.704 (0.242)	0.787 (0.352)	0.674 (0.280)	0.557 (0.295)
Option × Depr	-0.363 (0.331)		-0.418 (0.340)	0.758 (0.696)		0.683 (0.719)
FAS123 × Depr	-0.865 (0.215)	-0.417 (0.204)	-0.792 (0.211)	-0.754 (0.311)	-0.531 (0.258)	-0.606 (0.255)
Category FE	×		×	×		×
Category-Year FE		×			×	
Firm-Year FE	×	×	×	×	×	×
Observations	25,726	25,645	10,230	32,947	32,875	13,097
No. Firms	674	669	657	681	677	666
Sample Period	'00-'14	'00-'14	'02-'07	'00-'14	'00-'14	'02-'07

*Notes:* The table reports estimates of equation (2) when omitting R&D investment or when controlling for the interaction between a dummy that indicates intangible investment categories (R&D and advertising) and the *Option* dummy and the *FAS123* dummy. Standard errors (in parentheses) are clustered at the firm level.



## B Theoretical Appendix

### B.1 Derivation of Managers' Optimal Behavior

We restrict attention to a symmetric equilibrium of the manager's decision problem. We denote the policy function for capital as  $\mathcal{K}(\mathbf{K}) = [\mathcal{K}_l(\mathbf{K}), \mathcal{K}_s(\mathbf{K})]$ . If manager  $t$  follows this strategy profile, she will set  $\mathbf{K}_{t+1} = \mathcal{K}(\mathbf{K}_t)$  given a predetermined capital stock  $K_t$ . We next represent manager  $t$ 's maximization problem recursively. We drop time indices and use  $'$  to indicate subsequent periods. Period profits are given by

$$\begin{aligned} \pi(\mathbf{K}, \mathbf{K}') = \max_N \bigg\{ & Z^{1-a-b} (K_l^\nu K_s^{1-\nu})^a N^b - wN \bigg\} \\ & - \sum_{j \in \{l, s\}} \left[ \frac{\gamma}{2} \left( \frac{K'_j}{K_j} - 1 \right)^2 K_j + K'_j - (1 - \delta_j) K_j \right]. \end{aligned} \quad (\text{B.1})$$

Next, the value of equity can be written as

$$E(\mathbf{K}, \mathbf{K}') = \pi(\mathbf{K}, \mathbf{K}') + \theta V(\mathbf{K}'),$$

where  $V(\mathbf{K}')$  denotes a continuation value defined by

$$V(\mathbf{K}) = E(\mathbf{K}, \mathcal{K}(\mathbf{K})) = \pi(\mathbf{K}, \mathcal{K}(\mathbf{K})) + \theta V(\mathcal{K}(\mathbf{K})).$$

The value of the manager's remuneration is also a function of their decision according to

$$\Gamma(\mathbf{K}, \mathbf{K}') = \varphi(\pi(\mathbf{K}, \mathbf{K}') + \beta \theta V(\mathbf{K}')).$$

We can now express the manager's decision problem in (15) as:

$$\mathcal{K}(\mathbf{K}) = \arg \max_{\mathbf{K}'} \Gamma(\mathbf{K}, \mathbf{K}'). \quad (\text{B.2})$$

The first-order condition is given by:

$$\frac{\partial \pi(\mathbf{K}, \mathbf{K}')}{\partial K'_j} + \beta \theta \frac{\partial V(\mathbf{K}')}{\partial K'_j} = 0. \quad (\text{B.3})$$

The envelope condition is given by:

$$\frac{\partial V(\mathbf{K})}{\partial K_j} = \frac{\partial \pi(\mathbf{K}, \mathcal{K}(\mathbf{K}))}{\partial K_j} + \sum_{k=l,s} \frac{\partial \mathcal{K}_k(\mathbf{K})}{\partial K_j} \left[ \frac{\partial \pi(\mathbf{K}, \mathcal{K}(\mathbf{K}))}{\partial K'_k} + \theta \frac{\partial V(\mathcal{K}(\mathbf{K}))}{\partial K'_k} \right].$$

We then use the first-order condition to rewrite the envelope condition

$$\frac{\partial V(\mathbf{K})}{\partial K_j} = \frac{\partial \pi(\mathbf{K}, \mathcal{K}(\mathbf{K}))}{\partial K_j} + \frac{\beta - 1}{\beta} \sum_{k=l,s} \frac{\partial \mathcal{K}_k(\mathbf{K})}{\partial K_j} \frac{\partial \pi(\mathbf{K}, \mathcal{K}(\mathbf{K}))}{\partial K'_k},$$

and combine it with the first-order condition to obtain

$$\frac{\partial \pi(\mathbf{K}, \mathbf{K}')}{\partial K'_j} + \beta \theta \frac{\partial \pi(\mathbf{K}', \mathcal{K}(\mathbf{K}'))}{\partial K'_j} + (\beta - 1) \theta \sum_{k=l,s} \frac{\partial \mathcal{K}_k(\mathbf{K}')}{\partial K'_j} \frac{\partial \pi(\mathbf{K}', \mathcal{K}(\mathbf{K}'))}{\partial K''_k} = 0, \quad (\text{B.4})$$

which is the characterization of the optimal capital policy in equation (16).

## B.2 General Equilibrium

We compute the effects of changes in managerial pay in general equilibrium based on the same sample of firms used for our main quantitative results. Formally, the economy is populated by firms indexed by  $f = 1, \dots, \mathcal{N}_f$  that are allocated across sectors indexed by  $s = 1, \dots, S$ . We denote firm  $f$ 's sector by  $s_f$  and the sector  $s$  is composed of a set of firms  $F_s = \{f = 1, \dots, \mathcal{N}_f | s_f = s\}$ . The economy is further populated by a representative household, which will be specified below. We will abstract from transition dynamics and focus on stationary equilibrium, respectively before and after the change in managerial pay.

### B.2.1 Aggregation and Goods Prices

Competitive final goods firms produce a final consumption good  $\mathcal{Q}$  by combining sectoral inputs  $Q_s$  according to the Cobb-Douglas production function

$$\mathcal{Q} = \prod_{s=1}^S Q_s^{\psi_s}. \quad (\text{B.5})$$

The parameters  $\psi_s$  are calibrated to match the value added share of sector  $s$  relative to total value added based on Table 8 satisfying  $\psi_s \in (0, 1)$  and  $\sum_{s=1}^S \psi_s = 1$ . The associated

aggregate price-level is given by

$$\mathcal{P} = \prod_{s=1}^S \left( \frac{\mathcal{P}_s}{\psi_s} \right)^{\psi_s}, \quad (\text{B.6})$$

where  $\mathcal{P}_s$  denote sectoral price levels. The demand structure implies that each sector faces a demand curve given by

$$Q_s = \frac{\psi_s \mathcal{P} Q}{\mathcal{P}_s}. \quad (\text{B.7})$$

The sectoral goods are a CES-aggregate of the firms' (variety) outputs  $Q_f$  according to

$$Q_s = \left( \sum_{f \in F_s} Q_f^{\frac{\varepsilon_s - 1}{\varepsilon_s}} \right)^{\frac{\varepsilon_s}{\varepsilon_s - 1}}. \quad (\text{B.8})$$

The parameters  $\varepsilon_s$  are calibrated as in Table 8. Firms engage in monopolistic competition. The associated sectoral price level based on firms' prices  $P_f$  is given by

$$\mathcal{P}_s = \left( \sum_{f \in F_s} P_f^{1 - \varepsilon_s} \right)^{\frac{1}{1 - \varepsilon_s}}. \quad (\text{B.9})$$

Consequently each firm  $f$  in sector  $s$  faces the following demand

$$Q_f = P_f^{-\varepsilon_s} \mathcal{P}_s^{\varepsilon_s} Q_s. \quad (\text{B.10})$$

Hence, the sector-specific demand shifter is given by

$$B_s = \mathcal{P}_s^{\varepsilon_s} Q_s. \quad (\text{B.11})$$

This links firms on product markets while we also need to link firms' input usage  $K_{lf}, K_{sf}$  and  $N_f$  to factor markets.

### B.2.2 Managers

Managers decide how much capital and labor to use in the production of firms' variety goods. The problem of the manager is fundamentally the same as to the decision problem described in in equations (6)–(16). The difference is that the demand shifters and wages reflect general equilibrium prices, taken as given by the individual manager.

For concreteness, we state the equations defining the manager problem in a stationary equilibrium:

$$Q_f = Z_f (K_{lf}^{\nu_s} K_{sf}^{1-\nu_s})^{\alpha_s} N_f^{1-\alpha_s} \quad (\text{B.12})$$

$$Q_f = B_s P_f^{-\varepsilon_s}, \quad B_s = \mathcal{P}_s^{\varepsilon_s} \mathcal{Q}_s \quad (\text{B.13})$$

$$R_f = X_f^{1-a_s-b_s} (K_{lf}^{\nu_s} K_{sf}^{1-\nu_s})^{\alpha_s} N_f^{b_s}, \quad X_f^{1-a_s-b_s} = B_s^{1/\varepsilon_s} Z_f^{1-1/\varepsilon_s} \quad (\text{B.14})$$

$$C_f^K = \sum_{j=l,s} \left[ (K'_{jf} - (1 - \delta_j) K_{jf}) + \gamma \left( \frac{K'_{jf}}{K_{jf}} - 1 \right)^2 K_{jf} \right] \quad (\text{B.15})$$

$$\Pi_f = R_f - w_s N_f - w C_f^K, \quad w_s = \bar{w}_s w \quad (\text{B.16})$$

$$N_f = \left( \frac{b_s X_f^{1-a_s-b_s} (K_{lf}^{\nu_s} K_{sf}^{1-\nu_s})^{\alpha_s}}{w_s} \right)^{\frac{1}{1-b_s}} \quad (\text{B.17})$$

$$0 = \frac{\partial \Pi_f}{\partial K'_{jf}} + \beta_f \theta_f \frac{\partial \Pi'_f}{\partial K'_{jf}} + (\beta_f - 1) \theta_f \sum_{k=l,s} \frac{\partial K''_{kf}}{\partial K'_{jf}} \frac{\partial \Pi'_f}{\partial K''_{kf}} \quad (\text{B.18})$$

Note that we treat  $\bar{w}_s$  as a parameter, which may reflect different (static) hiring costs across sectors, whereas  $w$  determines the equilibrium price of labor. Remember that the wage rate  $w$  will equal one in the pre-shock equilibrium. This setup conveniently allows our general equilibrium model to nest the partial equilibrium model.

### B.2.3 Households

There is a continuum of households that inelastically supply homogeneous labor aggregating to  $\bar{N}$ . We further assume time-separable, homothetic preferences with respect to consumption of a final good, as well as complete markets. Households are assumed to hold equity only indirectly via a competitive mutual fund. In each period, individual households are randomly chosen as managers of a random firm  $f$ , for which they receive the corresponding compensation  $\Gamma_f$ . We assume that managers neglect the effects that their individual decisions have on the mutual fund and—as before—we assume they (correctly) expect not to manage the same firm in the future.

### B.2.4 Factor Markets

Since capital is owned by the firm, we need an assumption about how investment is produced. For simplicity, we assume investment is produced using only labor as an input. We further assume that the adjustment of capital goods also requires only labor input. Labor demand

of firm  $f$  is then given by

$$\bar{N}_f = N_f + \sum_{j \in \{l, s\}} (K'_{jf} - (1 - \delta_{js})K_{jf}) + \gamma \left( \frac{K'_{jf}}{K_{jf}} - 1 \right)^2 K_{jf}. \quad (\text{B.19})$$

### B.2.5 Market Clearing

We let the final consumption good  $\mathcal{Q}$  be the numéraire, allowing us to normalize  $\mathcal{P} = 1$ . The remaining equilibrium price is  $w$ , which is the real wage. Given the aggregation structure, managerial behavior, and household behavior, a general equilibrium is characterized by a real wage that clears the labor market

$$\bar{N} = \sum_{f=1}^{\mathcal{N}_f} \bar{N}_f. \quad (\text{B.20})$$

The market for the final consumption good is then cleared by Walras's law.

### B.2.6 Equilibrium Definition

A stationary equilibrium is a collection of firm factor demand  $\{K_{lf}, K_{sf}, N_f\}$ , household labor supply  $N$ , and the real wage  $w$  such that:

- Managers choose capital and labor to maximize their compensation: (B.17), (B.18)
- Household labor supply is exogenous and fixed:  $N = \bar{N}$
- The labor market clears: (B.19)

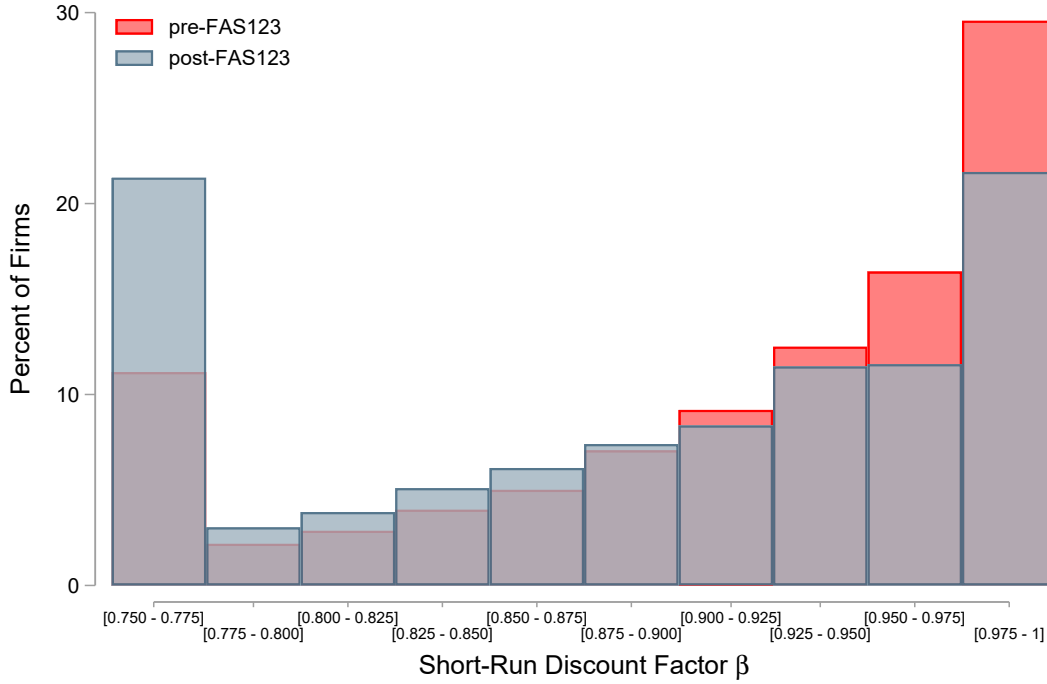
## C Parameterization and Solution Method

### C.1 Managerial Pay

As we have derived in Section 3,  $\beta$  is determined solely by the bonus share  $\eta^b$  and the equity share  $\eta^e$  (see Equation (14)). Both shares can be estimated directly from the data relying on data sources which have been widely used in the literature. To estimate  $\eta^b$ , we obtain the amount of cash bonuses from ExecuComp. To address a change in the reporting requirements for executive compensation after December 2006, we add the amount of non-equity incentive compensation to the bonus, which is available in the *Plan-Based Awards*

(PBA) file in ExecuComp. This reclassification of bonuses is stressed by Hayes et al. (2012) and we follow their approach. We then divide the total amount of cash bonus payments by the sales of the firm (obtained from Compustat), i.e.  $\eta^b = \frac{\text{Bonus} + \text{Non-eq-Targ}}{\text{Sales}}$ . To estimate  $\eta^e$ , we rely on data on the manager's firm-related wealth provided by Coles et al. (2006) and Core and Guay (2002), which we divide by the total market capitalization of the respective firm (obtained from Compustat), i.e.  $\eta^e = \frac{\text{Firm-related Wealth}}{\text{Market Capitalization}}$ . To account for outliers, we winsorize  $\eta_b$  and  $\eta_e$ , respectively at the top and bottom 1%. Figure C.1 shows the shift in the distribution of  $\beta$  (across bins) between 2005 and 2007. We restrict  $\beta$  to not fall below 0.75. We consider values below 0.75 ex-ante less plausible and they might reflect measurement error. In addition, our numerical algorithm becomes less stable below this threshold.

**Figure C.1: Changes in the Short-Run Discount Factor Around FAS 123R**



*Notes:* The figure depicts the empirical distribution of the parameter  $\beta$  before (red) and after (blue) the introduction of FAS 123R. We group  $\beta$ s into ten bins each ranging 2.25 percentage points. Data is left-censored at 0.75, which applies to 14.39% of the observations.

## C.2 Other Parameters

We calibrate the sector-specific parameters  $\delta_l$ ,  $\delta_s$ ,  $\nu$ ,  $\alpha$ ,  $w$ ,  $\varepsilon$ , and  $B$  using sector-specific moments from the U.S. files of the EU KLEMS database, averaged over the years 2003–

2005 at constant prices. The moments we use are for  $\delta_s$ ,  $\delta_l$ ,  $R$ ,  $\frac{K_l}{K_l+K_s}$ ,  $\frac{K_l}{R}$ ,  $\frac{wN}{R}$ , and  $w$  (approximating  $R$  by the average value added of a firm in the sector). For the calibration of the sector-specific parameters, we abstract from incentive distortions and thus consider a long-run discount factor  $\theta = \frac{1}{1+r}$ .<sup>27</sup> For  $r$ , we use the real interest rate for the United States from the year 2005, which was 2.98% according to World Bank (2020).

We combine the two FOCs of individual capital goods to get an expression that maps the moments into  $\nu$ :

$$\nu = \frac{1 - \theta(1 - \delta_l)}{1 - \theta \left[ 1 - \delta_s - \frac{K_l}{K_l+K_s} (\delta_l - \delta_s) \right]} \frac{K_l}{K_l + K_s}.$$

The steady-state share of long-term capital goods in the total capital stock is larger than  $\nu$ , since the term  $\frac{1 - \theta(1 - \delta_l)}{1 - \theta \left[ 1 - \delta_s - \frac{K_l}{K_l+K_s} (\delta_l - \delta_s) \right]}$  is strictly smaller than 1. This is due to the fact that the user cost of capital is higher for short-term capital, such that the share of long-term capital exceeds the Cobb-Douglas production exponent  $\nu$ . Given  $\nu$ , we can solve the first-order condition of the long-term capital good for  $a$  as

$$a = \frac{\frac{1}{\theta} - (1 - \delta_l)}{\nu} \frac{K_l}{R}.$$

Likewise,  $b$  directly follows from optimal labor demand as

$$b = \frac{wN}{R}.$$

With  $a$  and  $b$ , we obtain  $\varepsilon$  and  $\alpha$  as

$$\varepsilon = \frac{1}{1 - a - b}, \quad \alpha = \frac{a}{a + b}.$$

Finally, we can determine the demand-scaling parameter  $B$ , using labor demand as well as the production function, which yields

$$B = \left( \frac{w^{\frac{b}{1-b}} R}{b^{\frac{b}{1-b}} (K_l^\nu K_s^{1-\nu})^{\frac{a}{1-b}}} \right)^{\frac{1-b}{1-a-b}}.$$

---

<sup>27</sup>Hence, this calibration step recovers model parameters under an efficient-benchmark technology. In a subsequent step, we add share dilution when computing the investment decision of the manager. Given the small size of  $\eta^e$  (see Table 7), the bias in the calibrated parameters is quantitatively negligible.

### C.3 Numerical Solution Method

We next describe the solution method. Using the definition of the profit function in (B.1), we first rewrite the first-order condition in (B.3) as

$$\gamma \left( \frac{K'_j}{K_j} - 1 \right) + 1 = \beta \theta \frac{\partial V}{\partial K'_j}(\mathbf{K}', \xi),$$

and solve the equation for  $K_j$ :

$$K_j = \frac{\gamma K'_j}{\gamma + \beta \theta \frac{\partial V}{\partial K'_j}(\mathbf{K}', \xi) - 1}. \quad (\text{C.1})$$

Equation (C.1) is central for our application of the endogenous grid method. Our solution method is described by Algorithm 1 below.

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**Algorithm 1:** EGM used to solve the model (for a given firm)

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- 1 Set  $i_{max}$  as well as convergence thresholds  $\bar{\epsilon}^v, \bar{\epsilon}^{invp} > 0$  for the continuation value and inverse policy, respectively. Set gridpoints  $\tilde{\mathcal{K}}' = (\tilde{\mathbf{k}}'_g)_{g=1, \dots, G}$ , an initial guess for  $\hat{V}_{0,g}$  for  $g = 1, \dots, G$ , and an interpolation scheme  $\rho(x, X, Y)$ . Compute the interpolated values  $v_0(\mathbf{K}) = \rho(\mathbf{K}, (\mathbf{k}'_g)_{g=1, \dots, G}, (\hat{V}_{0,g})_{g=1, \dots, G})$ .
  - 2 Set *continue*=true and  $i = 1$ . **while** *continue* **do**
  - 3     **for**  $g=1, \dots, G$  **do**
  - 4         Set  $\hat{\mathbf{k}}_{j,i,g} = \frac{\gamma k'_{jg}}{\gamma + \beta \theta \frac{\partial}{\partial \mathbf{K}'_j} v_{i-1}(\mathbf{k}'_g) - 1}$  for  $j = l, s$ .
  - 5         Set  $\tilde{v}_g = \Pi(\mathbf{k}_{i,g}, \mathbf{k}_g) + \theta \hat{V}_{i-1,g}$ .
  - 6     Compute interpolant  $v_i(\mathbf{K}) = \rho(\mathbf{K}, (\mathbf{k}_{i,g})_{g=1, \dots, G}, (\tilde{v}_g)_{g=1, \dots, G})$ .
  - 7     **for**  $g=1, \dots, G$  **do**
  - 8         Set  $\hat{V}_{i,g} = v_i(\mathbf{K}_g)$ .
  - 9         Set  $\epsilon_{ig}^v = \left| \frac{\hat{V}_{i,g}}{\hat{V}_{i-1,g}} - 1 \right|$ .
  - 10        Set  $\epsilon_{jig}^{invp} = \left| \frac{k_{j,i,g}}{k_{j,i-1,g}} - 1 \right|$ .
  - 11     **if**  $\max_{g \in \{1, \dots, G\}} \{\epsilon_{ig}^v\} < \bar{\epsilon}^v$  **and**  $\max_{j \in \{l, s\}, g \in \{1, \dots, G\}} \{\epsilon_{ig}^{invp}\} < \bar{\epsilon}^{invp}$  **then**
  - 12         Set *continue*=false.
  - 13     **else**
  - 14         Set  $i=i+1$ ;
  - 15 Obtain policy function as  $\mathcal{K}(\mathbf{K}, \xi) \approx \tilde{\mathcal{K}}(\mathbf{K}, \xi) := \rho(\mathbf{K}, (k_{i,g})_{g \in \{1, \dots, G\}}, (\mathbf{k}_g)_{g \in \{1, \dots, G\}})$ .
-



Essentially, we start with a set of  $G$  gridpoints  $\tilde{\mathcal{K}}' = (\tilde{\mathbf{K}}'_h)_{h=1,\dots,G}$ , which represent different outcomes of  $\mathbf{K}'$ , and an initial (differentiable) guess  $\hat{V}_0(\cdot)$  for  $V(\cdot)$ . By differentiating  $V(\cdot)$ , we get the gradient at each point in  $\tilde{\mathcal{K}}'$ . Then applying the backward induction step in (C.1), we can solve for the optimal solution of the previous manager. Next, we update our guess for the continuation value function  $V(\cdot)$  according to the profit function and our current guess. We then iterate on this until convergence is achieved. This algorithm is implemented as MATLAB code (tested against MATLAB R2018b and R2020a) and can be found in the replication package.

The simulated sample of firms is based on idiosyncratic parameter draws in the  $(K'_l, K'_s)$ -space. The coordinates of the gridpoints correspond to Chebyshev nodes in a range around the steady state with  $\beta = 1$ . To be precise, the grid ranges from factor 0.3 to 1.2 of the analytical steady state of that parameterization. As an interpolation scheme  $\rho(\cdot)$  we apply Chebyshev polynomials up to degree 10 in both dimensions.<sup>28</sup> Since the endogenous grid method inherently involves interpolation with a changing set of interpolation bases, the domain of the chosen functions was expanded as needed to keep all points within the domain.

To specify an initial guess for the value function, we apply the following procedure. First, we analytically derive the steady state assuming  $\beta = 1$ . As an initial guess of the value function, we assume the model converges uniformly to that steady state within a certain number of periods. Using the resulting net present value of profits gives a reasonably accurate initial guess for the case of  $\beta = 1$ . However, for lower  $\beta < 1$ , this does not necessarily lead to convergence. For this reason, we first solved the model for the  $\beta = 1$  case. Then, we use the final value function computed and use this as an initial guess to solve the model with a slightly lower value of  $\beta$ . Repeating this process while slowly decreasing  $\beta$  yields satisfactory convergence. The entire process is then repeated for all firms in the sample.

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<sup>28</sup>We have chosen Chebyshev polynomials because they have preferable interpolation properties compared to other polynomials functions. Also, Splines were considered, but computing the gradient of a spline is computationally expensive. Experiments with cubic splines showed inferior convergence properties. We also experimented with Chebyshev polynomials with a total degree of 30. However, most coefficients with a higher degree are virtually identical to zero. In fact, higher order polynomials present a problem for the algorithm since for these higher order polynomials, the gradient quickly becomes very large in absolute terms, even if the corresponding coefficient is small; this generates additional sources of numeric error, which leads to far worse convergence properties. Given that this method ultimately generates an inverse of the policy function, we eventually have to back the real policy functions out. This final step is done using cubic splines.

## C.4 Additional Quantitative Results

**Table C.1: Simulated Firms - Regression Results without Introducing Noise**

	Investments					
	(1)	(2)	(3)	(4)	(5)	(6)
<i>Measure of Depreciation:</i>	<i>Depreciation Rate</i>					
FAS123 $\times$ $\beta$ Reduced $\times$ Depr	3.106 (0.212)	3.106 (0.212)	5.799 (0.341)	5.799 (0.341)	8.494 (0.482)	3.106 (0.212)
FAS123 $\times$ Depr	-0.000817 (0.000817)	-0.000817 (0.000817)	-0.000948 (0.000948)	-0.000948 (0.000947)	-0.000817 (0.000817)	-0.000817 (.000817)
$\beta$ Reduced $\times$ Depr	3.308 (0.271)		5.156 (0.328)		5.463 (0.352)	3.308 (0.271)
FAS123 $\times$ $\beta$ Reduced						-0.612 (0.034)
Category FE	$\times$		$\times$		$\times$	
Category-Firm FE		$\times$		$\times$		
Firm-Year FE	$\times$	$\times$	$\times$	$\times$	$\times$	
Trend					$\times$	
Firm and Year FE						$\times$
Years around reform	15	15	6	6	15	15

*Notes:* This Table reports the results on the relationship between managerial incentives and investment decisions based on the panel of simulated firms.  $\beta$  *Reduced* is defined as dummy variable which indicates if a firm experiences a reduction in its firm-specific  $\beta$ . *FAS123* is a dummy variable indicating the post-shock period. Empirical specifications in columns 1 to 5 resemble those in Table 4. The treatment-specific linear trend in column 5 is  $\text{Trend} \times \beta$  *Reduced*  $\times$  Depr. Standard errors (reported in parentheses) are clustered at the firm level.

**Table C.2: Beta and the Durability of Investments/Capital Stock Depreciation**

	Investments				Weighted Avg. Depr. Rate
	(1)	(2)	(3)	(4)	(5)
Model	OLS		IV		OLS
			<i>1st Stage</i>	<i>2nd Stage</i>	
$(1 - \beta) \times \text{Depr}$	0.281 (0.081)	0.091 (0.036)			
$\text{FAS123} \times \text{Option} \times \text{Depr}$			0.046 (0.004)		
$(1 - \widehat{\beta}) \times \text{Depr}$				0.862 (0.212)	
$(1 - \beta)$					0.015 (0.006)
Category FE	×				
Category-Year FE		×	×	×	
Firm-Year FE	×	×	×	×	
Firm FE					×
Year FE					×
Observations	28,695	28,611	28,611	28,611	8,614
No. Firms	655	649	649	649	672
Sample Period	'00-'14	'00-'14	'00-'14	'00-'14	'00-'14
Kleibergen-Paap $F$ -Statistic			113.20		

*Notes:* The Table reports the results on the relationship between the model-specific incentive measure  $\beta$  and the durability of investments, respectively the depreciation of firms' capital stock. The calculation of  $\beta$  follows Equation (14), details on the computation can be found in Appendix C.1. *Depr* is the measure of depreciation, following an ordinal scale. *Option* is a dummy that indicates if any unexercised options are outstanding in 2004. *FAS123* takes value 0 for each year until 2005 and value 1 afterwards. In columns 1 and 2, we investigate the relationship between the firm-specific  $\beta$  and the durability of investments. In column 4, we address endogeneity concerns related to  $\beta$  by instrumenting  $(1 - \beta) \times \text{Depr}$  with  $\text{FAS123} \times \text{Option-Dummy} \times \text{Depr}$ . First-stage results are given in column 3. Column 5 estimates the effect of  $\beta$  on the capital stock depreciation by taking a firm-specific capital-stock-weighted depreciation rate as dependent variable. Standard errors (reported in parentheses) are clustered at the firm level.