“Testing the sunk cost effect in publicly traded manufacturing companies”

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TESTING THE SUNK COST EFFECT IN PUBLICLY TRADED MANUFACTURING COMPANIES

Abstract

Investment efficiency is crucial for investors and creditors. This study examines whether managers of publicly traded manufacturing firms exhibit sunk-cost bias in capital expenditure decisions. Economic theory dictates that sunk costs – unrecoverable past expenditures – should be ignored in forward-looking decisions. Depreciation expense, which allocates historical capital expenditures under GAAP, represents such a sunk cost, yet limited empirical research tests whether it systematically influences capital replacement decisions.

Using regression analysis with Compustat data for U.S. manufacturing firms from 2003–2024, we examine whether capital expenditures are predicted by past depreciation expenses, controlling for established economic determinants including Tobin's Q, cash flow, growth opportunities, and firm characteristics. Manufacturing firms are selected due to their heavy reliance on capital assets and substantial depreciation expenses.

The results provide strong evidence of sunk-cost bias: higher depreciation expense predicts significantly larger future capital investments, controlling for economic fundamentals. The depreciation coefficient is positive (0.0158) and highly significant ($p < 0.01$), contributing meaningfully to explained variance beyond traditional predictors. These findings suggest managers allow accounting allocations to influence economic decisions, affecting optimal asset replacement timing.

The findings alert investors that managerial capital allocation may be suboptimal and influenced by accounting measures rather than purely economic considerations. This bias may cause over-investment when depreciation is high and under-investment when depreciation is low, potentially affecting firm value and competitive positioning.

Keywords depreciation, capital expenditure, manufacturing, capital budgeting, sunk-cost, behavioral finance

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INTRODUCTION

Capital expenditures represent critical strategic decisions that fundamentally shape firm value and long-term competitiveness. In U.S. manufacturing firms, property, plant, and equipment typically constitute the largest category of assets, with capital investment decisions directly influencing shareholder wealth (McConnell & Muscarella, 1985), economic growth (Harris & Raviv, 1996), and firm survival (Klammer et al., 1991). Given these high stakes, understanding whether managers make optimal capital allocation decisions has important implications for investors, creditors, boards of directors, and policymakers.

Economic theory provides clear guidance: managers should base capital investment decisions on expected future incremental costs and benefits while ignoring sunk costs – past expenditures that cannot be recovered (Brealey et al., 2017). However, accounting practice under GAAP requires firms to systematically allocate historical capital expenditures to future periods through depreciation expense. This creates a potential conflict: while depreciation expense appears promi-

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nently in financial statements that inform managerial performance evaluation and compensation, it represents precisely the type of sunk cost that economic theory says should be irrelevant to forward-looking decisions.

Recent evidence suggests this conflict may affect real investment decisions. Guenzel (2025) documents a sunk-cost effect in merger and acquisition decisions, finding that CEOs who made initial acquisitions exhibit bias in subsequent related investments. However, research examining whether routine capital expenditure decisions – the bread-and-butter investments that sustain operations – are similarly affected by sunk-cost bias remains limited, particularly in publicly traded firms where monitoring mechanisms should theoretically prevent such behavioral biases.

Understanding whether such bias exists in publicly traded firms has practical importance. If managers systematically allow accounting depreciation to influence economic decisions, this could lead to predictable patterns of over-investment (when depreciation is high) or under-investment (when depreciation is low), with implications for firm value, competitive positioning, and capital market efficiency. Such findings would suggest a need for improved governance mechanisms, decision frameworks, and investor awareness regarding potential systematic biases in capital allocation.

1. LITERATURE REVIEW AND HYPOTHESIS

The sunk-cost effect – the tendency to continue investing because of prior commitments rather than future returns – represents a fundamental deviation from rational decision-making. While economic theory prescribes that only incremental costs and benefits should guide choices, extensive research shows decision-makers frequently violate this prescription (Barberis & Thaler, 2003). This review synthesizes key findings on sunk costs in consumer behavior, organizational decision-making, and corporate capital investment.

1.1. Theoretical foundations and consumer evidence

Mental accounting theory posits that individuals track costs in psychological accounts rather than treating resources as fungible (Thaler, 1980, 1985, 1999). People use 'mental depreciation' to gradually write down initial purchase prices, experiencing wastefulness when disposing of assets before fully depreciating them mentally (Heath & Fennema, 1996; Okada, 2001). Experimental evidence supports these predictions: consumers who pay more for cars drive them more frequently (Ho et al., 2018), theater subscribers attend more when costs are salient (Gourville & Soman, 1998), and auction bidders escalate commitments (Augenblick, 2016).

1.2. Sunk costs in corporate decisions

Managers exhibit sunk-cost bias despite professional training and oversight. Early work documented escalating commitment to failing projects (Staw, 1976), with accountability reducing bias (Simonson & Nye, 1992; Moon, 2001), with self-justification amplifying it (Staw et al., 1997). Recent research demonstrates these biases persist in sophisticated corporate contexts. Baker et al. (2022) show reference point prices influence M&A decisions, while Malmendier and Wachter (2024) provide a framework for how past experiences shape current choices. Dessaint and Matray (2023) find managers overreact to salient risks, with firms adjusting investment following hurricanes even when undamaged – paralleling how salient depreciation expense might trigger behavioral responses consistent with sunk-cost bias. Guenzel (2025) provides striking evidence that CEOs who initiated acquisitions invest more in acquired firms than successor CEOs, consistent with sunk-cost bias even in decisions subject to board oversight and market scrutiny.

1.3. Depreciation and investment decisions

Despite extensive research on capital investment determinants (Chen & Chen, 2023), whether accounting depreciation influences capital expenditure remains underexplored. Jackson (2008) provides experimental evidence that students make non-value-maximizing replacement decisions influenced by depreciation methods, with Jackson et al. (2009) finding firms using accelerated depreciation replace assets more frequently. Recent accounting research provides context for these effects. Curtis et al. (2021) show managers distinguish transitory versus permanent earnings components, suggesting they may similarly view depreciation as both an accounting allocation and economic signal. Corona et al. (2024) demonstrate theoretically how accounting systems distort real decisions even when managers understand allocations are arbitrary. Kraft et al. (2018) provide empirical evidence that reporting quality affects investment efficiency, underscoring that accounting information systematically shapes capital allocation.

1.4. Competing perspectives

Several factors suggest managers might ignore depreciation. Business education emphasizes ignoring sunk costs (Hilton, 2002; Horngren et al., 2005; Noreen et al., 2020), managers face monitoring by boards and shareholders, and depreciation estimates are unreliable and manipulable (Lev et al., 2010). Markets reward fundamental-based decisions (Kerstein & Kim, 1995). Conversely, sunk costs affect judgments subconsciously even when decision-makers understand they should be irrelevant (Heath & Fennema, 1996; Okada, 2001). Managers may use depreciation as a heuristic for asset condition when direct assessment proves difficult, and historical evidence suggests accounting methods affect internal decisions (Hatfield, 1944; Gschwandtner & Lambson, 2012). Negrini et al. (2022) find in an experimental setting that subjects invested less in the subsequent round if their initial investment levels were higher. This evidence also suggests a bias in investment decision, but a reverse of sunk-cost bias. Subsequent investment should not be affected by the initial level of investment, whether low or high; it should be based entirely on the expected future cash flow.

1.5. Research gap

Whether routine capital expenditure decisions in publicly traded manufacturing firms are influenced by accounting depreciation remains unaddressed. Evidence of sunk-cost bias here would be striking because it would demonstrate behavioral bias persists despite professional education that emphasizes ignoring sunk cost, sophisticated monitoring by boards and shareholders, known unreliability of depreciation estimates, and routine decisions benefiting from organizational learning. Such findings would have important implications for corporate governance, investor analysis, and understanding behavioral bias persistence in professional settings.

Building on the literature review, this study addresses a specific gap in our understanding of sunk-cost effects in corporate capital investment decisions. While recent research documents sunk-cost bias in mergers and acquisition decisions (Guenzel, 2025) and prior experimental work suggests depreciation methods affect student judgments (Jackson, 2008), no published research has directly tested whether the magnitude of reported depreciation expense in the previous period systematically predicts current period capital expenditure decisions in publicly traded manufacturing firms using a large-scale archival sample with proper controls for economic determinants.

Our research objective is to provide clean, direct evidence on whether accounting depreciation expense – which represents the systematic allocation of sunk costs to future periods – predicts future capital expenditures after controlling for established economic determinants. Under economic theory, depreciation expense should be irrelevant to forward-looking capital investment decisions because it represents unrecoverable past costs. However, mental accounting theory and behavioral research suggest managers may use depreciation as a signal of asset condition and replacement urgency.

Specifically, the sunk-cost hypothesis predicts that managers treat higher depreciation expense as indicating greater asset usage and deterioration, prompting increased capital expenditures to replace worn assets. Conversely, lower depreciation may signal assets remain productive, reducing perceived replacement urgency. This behavioral mechanism would create a positive association between depreciation expense and future capital expenditures, controlling for economic fundamentals.

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Therefore, the following hypothesis is tested:

H0: Depreciation expense is not associated with future capital expenditure after controlling for economic determinants (no sunk-cost effect).

Ha: Depreciation expense is positively associated with future capital expenditures after controlling for economic determinants (sunk-cost effect exists).

2. METHODOLOGY

2.1. Sample selection and data

The analysis focuses on U.S. publicly traded manufacturing firms during 2003–2024, a period selected for several reasons. First, this post-Sarbanes-Oxley Act (US Government, 2002) timeframe provides greater assurance against earnings manipulation involving depreciation expense. Prior to SOX, the SEC charged firms like Waste Management with inflating salvage values and extending useful lives to avoid depreciation expenses. SOX's enhanced controls and auditing requirements strengthen confidence in reported accounting numbers. Second, manufacturing firms provide an ideal setting for testing sunk-cost effects in capital investment because they maintain substantial property, plant, and equipment (PPE), report significant depreciation expenses, and face regular capital replacement decisions. This contrasts with service firms where intangible assets and human capital dominate. Third, focusing on a single broad industry sector (manufacturing) allows more homogeneous comparison while maintaining substantial sample size and variation in depreciation practices.

We identify manufacturing firms using the North American Industry Classification System (NAICS), which has largely replaced the Standard Industry Classification (SIC) system. NAICS provides improved international consistency and alignment with International Standard Industry Classification (ISIC). Firms with two-digit NAICS codes between 31 and 33 are classified as manufacturers.

Financial data are from annual Compustat files accessed through Wharton Research Data Services (WRDS). We select all U.S. domiciled firms for years 2003–2024 with (a) NAICS codes between 31 to33 and (b) non-missing values for regression variables. To minimize influence of extreme values, all variables are winsorized at one-percent level on both sides. The final sample consists of 41,705 firm-year observations across 21 manufacturing sub-industries.

We closely follow Shroff (2017) model for modeling capital expenditure. Our dependent variable, *CAPEXAT,* measures capital expenditures (Compustat variable CAPX) scaled by average total assets.

The key independent variable for testing our hypothesis is DEPRECIATION, calculated as depreciation expense (DP) minus amortization of intangibles (AM), scaled by average total assets. Mental accounting theory suggests people track sunk costs using unobservable mental depreciation (Heath & Fennema, 1996; Okada, 2001). Depreciation is used as a proxy for sunk cost effects because it is superior to the alternative, net book value of PPE.

The net book value (gross PPE minus accumulated depreciation) suffers because GAAP reporting includes non-depreciable land in PPE balances. This introduces measurement error for testing depreciation-based sunk-cost effects.

Periodic depreciation expense avoids these problems by directly measuring the annual allocation of sunk costs that appears prominently in income statements. Higher depreciation expense signals (under mental accounting) that assets are being "used up" more quickly, potentially triggering replacement decisions. Conversely, lower depreciation suggests assets remain productive, reducing perceived urgency for replacement.

A natural question arises: why would sophisticated managers, educated in finance and monitored by boards, allow accounting depreciation – known to be based on estimates and potentially manipulated – to influence economic decisions?

Several mechanisms may explain this seemingly irrational behavior. First, managers facing numerous decisions daily may use depreciation as a simple heuristic for asset condition, especially when directly assessing economic depreciation proves costly or difficult. Second, when compensation and evaluation explicitly depend on income statement performance, depreciation's prominence in quarterly and annual results may unconsciously anchor capital budgeting decisions. Third, capital budgeting processes may institutionalize rules-of-thumb like "replace when accumulated depreciation exceeds X%" that embed accounting measures into decision protocols. Fourth, mental accounting operates largely unconsciously (Thaler, 1999). Even managers who explicitly understand depreciation should be irrelevant may experience psychological discomfort from "wastefully" disposing of assets before they're "fully depreciated" in accounting terms. Finally, lower-level managers recommending capital expenditures may have better information about operational needs but use depreciation to justify requests to senior executives who rely on financial statement signals.

Following Shroff (2017), we include established economic determinants of capital investment as controls, described below.

TOBINSQ: The ratio of firm market value to book value, calculated as (market value of equity + short-term debt + long-term debt) / total assets. Tobin's (1969) Q theory predicts that firms invest more when market values exceed replacement costs (Q > 1), suggesting profitable investment opportunities. We expect $\beta_1 > 0$.

CFO: Operating cash flow from the statement of cash flows, scaled by average total assets. Cash flow availability facilitates investment by reducing reliance on costly external financing. We expect $\beta_2 > 0$.

CASH: Cash and equivalents scaled by average total assets. Higher cash balances provide financial flexibility for investment. We expect $\beta_4 > 0$.

GROWTH: Percentage change in total assets from t-1 to t. Faster-growing firms require more capital investment to support expansion. We expect $\beta_3 > 0$.

AGE: Natural logarithm of firm age, measured as the greater of years that Compustat reports common shares outstanding or total assets. Older firms may have more mature assets requiring replacement but may also face slower growth. The predicted sign is ambiguous, though Shroff (2017) finds $\beta_5 < 0$, possibly because older firms have more established asset bases.

LEVERAGE: The sum of short-term and long-term debt scaled by average total assets. Higher leverage may constrain investment through debt covenants and financial distress concerns. Alternatively, leverage may proxy for investment opportunities if firms borrow to invest. We expect $\beta_6 < 0$ based on Shroff (2017).

MKTVALEQ: Natural logarithm of market value of equity (stock price × shares outstanding). This controls for firm size. Larger firms may invest more in absolute terms, though scaling by assets partly addresses this. We expect $\beta_7 > 0$.

CAPEXAT_{t − 1}: Lagged capital expenditures scaled by assets. Capital investment exhibits substantial persistence as firms complete multi-year projects and maintain regular replacement cycles. We expect $\beta_8 > 0$.

All variables except *TOBINSQ, GROWTH, AGE, LEVERAGE, MKTVALEQ*, and dummy variables are scaled by average total assets to facilitate cross-firm comparison and reduce heteroskedasticity.

2.2. Regression model

The following regression model is estimated using ordinary least squares (OLS):

$$\begin{aligned} & CAPEXAT\_t = \beta_0 + \beta_1 TOBINSQ\_\{t-1\} \\ & + \beta_2 CFO\_\{t-1\} + \beta_3 GROWTH\_\{t-1\} \\ & + \beta_4 CASH\_\{t-1\} + \beta_5 AGE\_\{t-1\} \\ & + \beta_6 LEVERAGE\_\{t-1\} + \beta_7 MKTVALEQ\_t \\ & + \beta_8 CAPEXAT\_\{t-1\} \\ & + \beta_9 DEPRECIATION\_\{t-1\} \\ & + \gamma_j Year\ Dummies \\ & + \theta_k Industry\ Dummies + \varepsilon\_\{t,j,k\}. \end{aligned} \tag{1}$$

The coefficient of interest is $\boldsymbol{\beta_9}$ on *DEPRECIATION_{t − 1}*. Under the null hypothesis of no sunk-cost effect, $\boldsymbol{\beta_9} = 0$ – depreciation expense does not pre-

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dict future capital expenditures after controlling for economic fundamentals. Under the alternative hypothesis of a sunk-cost effect, $\beta_9 > 0$ – higher depreciation expense predicts greater future capital investment, ceteris paribus. We use firm clustered standard errors, in addition *tp* year and industry fixed effects.

Table 1. Sample distribution across industries

Industry	N	Percent, %
Apparel	619	1.48
Beverage and Tobacco	782	1.88
Chemical	12,973	31.11
Computer	10,006	23.99
Electrical	1,539	3.69
Food	1,452	3.48
Furniture	320	0.77
Leather	201	0.48
Machinery	3,304	7.92
Metal1	961	2.30
Metal2	1,248	2.99
Mineral	452	1.08
Miscellaneous	3,132	7.51
Paper	672	1.61
Petroleum and coal	436	1.05
Plastics and Rubber	638	1.53
Printing	161	0.39
Textile 1	113	0.27
Textile 2	64	0.15
Transportation	2,229	5.34
Wood	403	0.97
Total	41,705	100.00

Table 1 reports the industry distribution of our 41,705 firm-year observations. The sample is relatively concentrated: Chemical (NAICS 325) and Computer (NAICS 334) industries account for 31.1% and 24.0%, respectively, together comprising over half the sample. This concentration reflects both the economic importance of these sectors in U.S. manufacturing and their capital-intensive nature. Machinery (7.9%), Miscellaneous Manufacturing (7.5%), Transportation Equipment (5.3%), and Food (3.5%) each contribute 3-8% of observations. Other sectors including Electrical, Metals, Minerals, Paper, Petroleum, Plastics, and Textiles each represent 0.15-3.7% of the sample. This industry distribution is typical of large-sample manufacturing studies and provides substantial variation in capital intensity, depreciation methods, and replacement cycles across sectors.

3. RESULTS

Table 2 reports descriptive statistics and Pearson correlation coefficients for all variables used in our analyses. Mean capital expenditures (*CAPEXAT*) equal 3.63% of total assets in the current period and 3.38% in the prior period, indicating a slight upward trend in capital spending over our sample period from 2003–2024. This level of capital investment is consistent with prior research on manufacturing firms, which typically maintain substantial property, plant, and equipment requiring regular replacement and modernization.

Mean (standard deviation) of depreciation expense is 2.73% (2.12%) of total assets. This substantial depreciation relative to total assets reflects the capital-intensive nature of manufacturing operations. Tobin's Q averages 2.69, with a standard deviation of 5.83. A high premium to book value suggests the presence of intangible assets, growth opportunities, and expected profitability beyond recorded book values. High standard deviations of both depreciation expense and Tobin's Q indicates a of 5.83 reveals considerable heterogeneity in our sample. Average firm age (AGE) is 3.11 (in logarithms), corresponding to approximately 22 years since first appearance in Compustat. Market value of equity (MKTVALEQ) averages 5.74 (in logarithms), corresponding to approximately \$312 million in market capitalization.

The depreciation of previous period exhibits a strong positive correlation with current capital expenditures ($r = 0.354$, $p < 0.01$), providing preliminary univariate evidence consistent with the sunk-cost hypothesis. Lagged capital expenditures correlate very strongly with current capital expenditures ($r = 0.591$, $p < 0.01$), demonstrating substantial persistence in capital investment over time. This persistence likely reflects multi-year capital projects, established replacement cycles, and organizational routines around capital budgeting. Interestingly, cash holdings correlate negatively with capital expenditures ($r = -0.077$, $p < 0.01$), possibly because firms accumulate cash when attractive investment opportunities are scarce rather than immediately deploying capital.

Both Tobin's Q and Age show relatively weak positive correlation with capital expenditures Tobin's

Table 2. Descriptive statistics and Pearson correlation coefficients

Variable	1	2	3	4	5	6	7	8	9	10
1. *CAPEXAT*$_t$	1	–	–	–	–	–	–	–	–	–
2. *DEPRECIATION*$_{t-1}$	0.354**	1	–	–	–	–	–	–	–	–
3. *TOBINSQ*$_{t-1}$	0.029**	–0.063**	1	–	–	–	–	–	–	–
4. *CFO*$_{t-1}$	0.082**	0.152**	–0.484**	1	–	–	–	–	–	–
5. *GROWTH*$_{t-1}$	0.100**	–0.146**	0.105**	–0.226**	1	–	–	–	–	–
6. *CASHAT*$_{t-1}$	–0.077**	–0.275**	0.190**	–0.430**	0.431**	1	–	–	–	–
7. *AGE*$_{t-1}$	0.030**	0.151**	–0.118**	0.318**	–0.177**	–0.319**	1	–	–	–
8. *LEVERAGE*$_{t-1}$	0.008	0.063**	0.298**	–0.276**	0.040**	–0.064**	–0.029**	1	–	–
9. *MKTVALEQ*$_t$	0.153**	0.004	–0.077**	0.339**	–0.008	–0.185**	0.299**	–0.061**	1	–
10. *CAPEXAT*$_{t-1}$	0.591**	0.398**	0.014**	0.104**	0.023**	–0.138**	0.029**	0.032**	0.112**	1
Variable Mean	0.0363	0.0273	2.6904	–0.1162	0.219	0.2354	3.1099	0.26	5.743	0.0338
Variable Std Dev	0.0447	0.0212	5.8331	0.4882	0.8654	0.2827	0.6824	0.5407	2.4573	0.0399

Note: N = 41,705. * $p < .05$; ** $p < .01$. Two-tailed tests.

Q correlation suggests long-term growth opportunities that may not immediately translate into current-period capital spending. Correlations of Age likely suggest competing forces – older firms may have more assets requiring replacement but also face slower growth requiring less expansion investment.

Growth opportunities (GROWTH) correlate positively with capital expenditures (r = 0.100, $p < 0.01$), as expected for firms expanding operations. Growth also shows strong positive correlation with cash holdings (r = 0.431, $p < 0.01$), possibly reflecting precautionary liquidity management by rapidly growing firms facing uncertainty. Several control variables exhibit correlations exceeding 0.40 in absolute value: CFO and Tobin's Q (r = –0.484, $p < 0.01$), CFO and CASH (r = –0.430, $p < 0.01$), and GROWTH and CASH (r = 0.431, $p < 0.01$). While notable, these correlations do not raise serious multicollinearity concerns. Variance inflation factors (VIFs) calculated for all regression variables (untabulated) remain well below the conventional threshold of 10, with the highest VIF being 2.8 for CFO. This indicates that multicollinearity does not materially impair our ability to estimate individual coefficient effects reliably.

Table 3 presents ordinary least squares (OLS) regression estimates testing the primary hypothesis that depreciation expense predicts capital expenditures beyond what economic fundamentals alone predict. We report three nested model specifications to demonstrate the robustness of the depreciation effect and show how it performs relative to established economic controls. All models include year and industry fixed effects (coefficients not reported for brevity) and cluster standard errors by firm to account for within-firm correlation over time.

Model I in Table 3 includes only the two most fundamental economic determinants of capital investment identified in prior theoretical and empirical research: Tobin's Q (investment opportunities) and cash flow from operations (internal financing capacity). Both variables exhibit coefficients in the predicted direction and achieve high statistical significance. Tobin's Q shows a positive coefficient (β_1 = 0.0001, $p < 0.01$), consistent with Q theory's prediction that firms invest more when market values exceed replacement costs, signaling profitable investment opportunities. Cash flow from operations similarly shows a positive coefficient (β_2 = 0.007, $p < 0.01$), supporting the importance of internal financing for capital investment documented extensively in prior research.

Model II in Table 3 adds six additional control variables following Shroff (2017): growth opportunities (*GROWTH*), cash holdings (*CASH*), firm age (*AGE*), leverage (*LEVERAGE*), market value of equity (*MKTVALEQ*), and lagged capital expenditures (*CAPEXAT_{t* – 1}). This comprehensive specification explains 38.14% of variation in capital expenditures (R^2 = 0.3814, F-statistic = 525.61, $p < 0.01$), representing a highly significant improvement of 32.62 percentage points over Model I (F-test for R^2 change, $p < 0.01$).

The control variables generally perform as predicted by theory and prior research:

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Lagged capital expenditures (*CAPEXAT_*{*t* – 1}) shows the strongest effect (β_8 = 0.6279, p < 0.01), confirming substantial persistence in capital investment over time. Growth opportunities (*GROWTH*) exhibit a strong positive coefficient (β_3 = 0.0044, p < 0.01), indicating that firms experiencing higher asset growth invest more heavily in capital expenditures to support expansion.

Table 3. Regression results

Variables/ Model	Predicted Sign	Model I	Model II	Model III
INTERCEPT	–	0.0253**	0.0030**	0.0019
		(0.0016)	(0.0015)	(0.0018)
$TOBINSQ_{t-1}$	+	0.0001**	0.0002	0.0003**
		(0.0001)	(0.0001)	(0.0001)
CFO_{t-1}	+	0.007**	0.0005	–0.0000
		(0.0012)	(0.0010)	(0.0010)
$CASH_{t-1}$	+	–	–0.0006	0.0020
			(0.0011)	(0.0011)
$GROWTH_{t-1}$	+	–	0.0044**	0.0046**
			(0.0004)	(0.0004)
AGE_{t-1}	–	–	–0.0019**	–0.0036**
			(0.0004)	(0.0004)
$LEVERAGE_{t-1}$	–	–	–0.0013*	–0.0024
			(0.0006)	(0.0004)
$MKTVALEQ_{t-1}$	+	–	0.0017**	0.0021**
			(0.0001)	(0.0006)
$CAPEXAT_{t-1}$	+	–	0.6279**	0.5734**
			(0.0123)	(0.0128)
$DEPRECIATION_{t-1}$	+	–	–	0.0158**
				(0.0009)
Model F-Value	–	57.64**	525.61**	540.51**
R-square	–	0.0552	0.3814	0.3928
R-square change	–	–	0.3262**	0.0114**

Note: N = 41,705. * *p* < .05; ** *p* < .01. Unstandardized regression coefficients are reported. Standard errors are reported in parentheses.

Firm age (AGE) negatively predicts capital investment (β_5 = –0.0019, p < 0.01), consistent with older firms having more established asset bases and facing slower growth requiring less expansion investment. Market value of equity (MKTVALEQ) positively predicts investment (β_7 = 0.0017, p < 0.01), indicating larger firms invest more even after scaling by assets. This may reflect economies of scale in capital project identification and execution, or greater ability to finance large projects. Leverage shows a marginally significant negative coefficient (β_6 = –0.0013, p < 0.05), weakly consistent with the hypothesis that higher leverage constrains investment through debt covenants or financial distress concerns. However, the modest magnitude and marginal significance suggest leverage plays a relatively minor role in capital expenditure decisions for our sample firms.

Interestingly, cash flow from operations becomes insignificant in Model II (β_2 = 0.0005, p > 0.10) after controlling for lagged capital expenditures. This suggests CFO's univariate relationship with capital expenditures operates primarily through investment persistence rather than representing a contemporaneous financing constraint. Firms with high cash flow historically have invested heavily, creating the observed persistence, but current cash flow adds little incremental predictive power. Similarly, cash holdings show no significant incremental explanatory power (β_4 = –0.0006, p > 0.10) after controlling for other variables. The negative point estimate, while insignificant, suggests cash accumulation may proxy for lack of immediate investment opportunities rather than facilitating higher investment. Tobin's Q remains positive and significant (β_1 = 0.0002, p > 0.10 but directionally consistent) though with modest magnitude, consistent with Q capturing long-term opportunities that translate imperfectly to current-period spending.

Overall, Model II demonstrates that established economic determinants explain substantial variation in capital expenditures, with investment persistence playing the dominant role. This comprehensive control model provides a strong baseline for testing whether our behavioral variable – depreciation expense – adds incremental predictive power beyond economic fundamentals.

Model III of Table 3 adds our variable of interest, lagged depreciation expense (*DEPRECIATION_*{*t* – 1}), to the full set of economic controls from Model II. This specification directly tests our hypothesis that sunk costs embedded in accounting depreciation predict capital expenditures beyond what economic theory alone would predict.

The depreciation coefficient is positive (β_9 = 0.0158) and highly statistically significant (p < 0.01), providing strong support for our alternative hypothesis of a sunk-cost effect. To interpret the economic magnitude: the standard deviation of depreciation is 2.12% of assets (from Table 2). Therefore, a one-standard-deviation increase in depreciation predicts a 0.033 percentage point increase in capital expenditures (0.0158 × 2.12% = 0.033%). Given mean capital expenditures of 3.63%, this represents approximately 0.92% of mean capital spending. While modest compared to the large persistence effect captured by lagged capital expenditures, this represents a systematic and statistically robust behavioral bias affecting billions of dollars in capital allocation annually across U.S. manufacturing firms.

The R^2 increases from 38.14% in Model II to 39.28% in Model III, an improvement of 1.14 percentage points that is highly statistically significant (F-test for R^2 change, $p < 0.01$). The model F-statistic increases from 525.61 to 540.51 (both $p < 0.01$), confirming that depreciation contributes meaningful explanatory power to the model. As a non-economic behavioral variable, depreciation's ability to explain 1.14 percentage points of additional variance beyond comprehensive economic controls is noteworthy. Many behavioral biases identified in experimental research fail to manifest detectably in large-scale archival data where noise and competing economic forces dominate. The robust statistical significance and incremental explanatory power of depreciation despite these challenges provides compelling evidence for the sunk-cost effect in corporate capital expenditure decisions.

Notably, including depreciation in Model III reduces the coefficient on lagged capital expenditures from 0.6279 in Model II to 0.5734 in Model III. This suggests depreciation partially explains the observed persistence in capital investment – firms with systematically high depreciation repeatedly invest more due to the sunk-cost bias, creating what appears as pure persistence in models omitting depreciation. This pattern supports interpreting depreciation as a systematic behavioral factor influencing decisions rather than merely proxying for omitted economic variables that should themselves be controls.

To further assess the strength of the depreciation effect, we estimated a parsimonious model (untabulated) including only depreciation expense as a predictor, plus industry and year fixed effects, without any economic controls. This specification isolates depreciation's total predictive power before parsing how much operates through economic channels versus behavioral bias. The depreciation-only model yields a coefficient of 0.70 ($p < 0.01$) and explains 14.3% of variation in capital expenditures ($R^2 = 0.143$). This substantial explanatory power – approaching one-third of Model II's R^2 despite using a single variable – demonstrates that depreciation powerfully predicts capital investment patterns in the raw data.

The reduction from 0.70 in the univariate specification to 0.0158 in the full multivariate Model III indicates that most of depreciation's predictive power operates through correlation with economic fundamentals (firm size, asset base, industry capital intensity). However, the fact that a meaningful and highly significant effect persists after controlling comprehensively for economic determinants provides evidence for behavioral influence beyond pure economic factors.

Table 4 reports results from bivariate Granger causality tests examining the temporal dynamics between depreciation and capital expenditures. Following Granger (1969), we estimate vector autoregression (VAR) models with two lags of each variable and test whether depreciation's lagged values help predict current capital expenditures beyond what capital expenditure's own lags predict. These tests provide additional evidence on whether depreciation temporally precedes capital expenditures in a manner consistent with causal influence rather than merely reflecting contemporaneous correlation.

The key statistical test compares Models I (unrestricted) and II (restricted): does adding the two depreciation lags significantly improve the model's fit beyond what capital expenditure lags alone provide? An F-test (not tabulated) strongly rejects the null hypothesis that the two depreciation coefficients jointly equal zero ($p < 0.01$). This confirms that depreciation Granger-causes capital expenditures – depreciation's lagged values contain information useful for predicting current capital expenditures beyond what past capital expenditures alone provide. The Durbin-Watson statistics

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of 1.96 (Model I) and 1.97 (Model II) are very close to 2.0, suggesting minimal first-order autocorrelation in the residuals. This supports the validity of the Granger causality tests – if substantial autocorrelation remained, it would indicate misspecification and potentially invalid inference. This finding supports our interpretation that depreciation influences capital expenditure decisions rather than merely reflecting spurious correlation. If the relationship were purely mechanical or driven by common omitted factors, we would not expect depreciation lags to add predictive power once we control for capital expenditure's own lags.

Table 4. Granger causality test

Variables/Model	Predicted Sign	Model I	Model II
DEPENDENT VARIABLE	–	$CAPEXAT_t$	$CAPEXAT_t$
INTERCEPT	–	0.0013**	0.0027**
		(0.0001)	(0.0001)
$CAPEXAT_{t-1}$	+	0.6044**	0.645
		(0.0057)	(0.0057)
$CAPEXTAT_{t-2}$	+	0.0680**	0.1030
		(0.0053)	(0.0052)
$DEPRECIATION_{t-1}$	+	−0.1644**	–
		(0.0179)	
$DEPRECIATION_{t-2}$	+	0.4441**	–
		(0.0)	
Durbin-Watson	–	1.96	1.97
R-square	–	0.725	0.394

Note: N = 41,705. * $p < .05$; ** $p < .01$. Unstandardized regression coefficients are reported. Standard errors are reported in parentheses.

4. DISCUSSION

Our results provide strong evidence that depreciation expense – an accounting allocation of sunk costs – systematically predicts capital expenditures in publicly traded manufacturing firms beyond what economic fundamentals alone would predict. This finding has several important implications for theory, practice, and our understanding of managerial decision-making.

The positive relationship between depreciation and capital expenditures aligns with predictions from mental accounting theory (Thaler, 1980, 1985) and research on sunk-cost effects (Heath & Fennema, 1996; Okada, 2001). These theories propose that decision-makers maintain mental accounts tracking how much of an asset's initial cost has been "used up" through depreciation. When mental depreciation is high, decision-makers perceive assets as worn and requiring replacement; when low, assets seem to retain value, reducing replacement urgency.

The findings extend this consumer-focused theory to corporate managers in publicly traded firms. Managers appear to use accounting depreciation expense as a proxy for unobservable economic depreciation or asset condition, treating higher depreciation as a signal to increase capital expenditures. This behavioral mechanism persists despite monitoring by boards and shareholders, professional business education emphasizing the irrelevance of sunk costs, and known reliability problems with depreciation estimates (Lev et al., 2010).

Our findings both complement and extend prior research in several ways. Our approach of using actual reported depreciation expense amounts provides more direct measurement and avoids this classification problem noted in Jackson et al. (2009), yielding cleaner evidence for the sunk-cost effect. Guenzel (2025) documents a sunk-cost bias in M&A. Our findings complement this by showing sunk-cost effects extend beyond high-stakes M&A decisions to routine capital expenditure choices. Importantly, while M&A decisions are infrequent and may reflect CEO-specific characteristics, capital expenditures are regular operational decisions made across organizational levels, suggesting the sunk-cost bias may be even more pervasive than Guenzel's findings alone would indicate. We complement Shroff (2017) who examines how changes in GAAP reporting requirements affect capital expenditures. Our study takes a different approach by examining whether the level of depreciation expense – holding reporting rules constant – predicts investment. Our finding that depreciation matters controlling for Shroff's economic variables suggests behavioral factors operate alongside the information and contracting channels Shroff identifies.

Our contribution to sunk-cost literature is to test the sunk-cost hypothesis by using a large sample archival data from publicly traded firms. Prior sunk-cost research has primarily used experimental methods with students (Garland & Newport, 1991; Jackson, 2008) or examined consumer behavior (Gourville & Soman, 1998; Augenblick, 2016; Ho et al., 2018). The results show that sunk-cost effects operate in high-stakes corporate settings despite mechanisms that should promote rational decision-making. This finding suggests behavioral biases may be more difficult to eliminate through monitoring and incentive design than standard agency theory assumes.

Persistence of sunk-cost bias among professional managers deserves some explanations. Sunk-cost bias can arise from managers using depreciation as a cognitive heuristic under information overload, organizational routines that institutionalize depreciation-based replacement rules, and performance evaluation systems where depreciation prominently affects compensation metrics. Multi-level decision processes allow lower-level managers to justify requests using depreciation to financially-oriented executives, while managers may also believe depreciation-aligned investments signal prudence to boards and analysts. These factors collectively explain how accounting depreciation systematically influences capital allocation despite being economically irrelevant to forward-looking decisions. We leave testing of these explanations to future researchers.

CONCLUSION

Economic theory unambiguously prescribes that sunk costs – unrecoverable past expenditures – should not influence forward-looking investment decisions. Managers should base capital allocation on expected future incremental costs and benefits, ignoring historical investments that cannot be recovered. However, behavioral research on mental accounting and sunk-cost effects suggests that decision-makers frequently violate this prescription, allowing past commitments to bias future choices.

This study tests whether depreciation expense – which represents the systematic allocation of sunk capital expenditures to future accounting periods under GAAP – predicts capital investment decisions in U.S. publicly traded manufacturing firms beyond what economic fundamentals alone predict. Using Compustat data spanning 2003–2024 and comprising 41,705 firm-year observations, we employ OLS regression analysis with comprehensive controls for established economic determinants including Tobin's Q, cash flow, growth opportunities, firm characteristics, and investment persistence.

We find robust evidence supporting the sunk-cost hypothesis: depreciation expense positively and significantly predicts future capital expenditures (coefficient = 0.0158, $p < 0.01$), controlling for economic fundamentals. This effect increases explained variance by 1.14 percentage points beyond a model already explaining 38% of variation through economic variables alone – a meaningful contribution for a non-economic behavioral factor. Granger causality tests confirm that depreciation helps predict future capital expenditures beyond what lagged capital expenditures alone predict, supporting temporal precedence consistent with causal influence.

We acknowledge several limitations. Our firm-level analysis aggregates across diverse assets and decision contexts, potentially masking heterogeneity in sunk-cost effects across asset types or managerial circumstances. Restricting to manufacturing limits generalizability but provides appropriate context for testing given capital intensity. While our research design supports causal interpretation through temporal ordering, comprehensive controls, and Granger tests, observational research cannot definitively establish causality as experimental designs can.

Our research has at least three practical implications: boards should scrutinize capital budgeting for inappropriate reliance on depreciation over cash flow analysis and redesign processes to emphasize economic metrics; investors should incorporate depreciation as a predictor of capital spending, identify potential over/under-investment when capex aligns with depreciation rather than economic fundamen-

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tals, and adjust valuation assessments accordingly; and standard setters should encourage disclosure of economic versus accounting useful lives and consider how accounting choices affect internal managerial decisions beyond external reporting.

Future research should examine manager-level characteristics affecting susceptibility to sunk-cost bias, governance mechanisms that moderate the depreciation-capex relationship, asset-level variations in the effect, international comparisons across accounting regimes and cultures, experimental tests of causality, long-term performance consequences of depreciation-influenced investment decisions, and the effectiveness of debiasing interventions such as EVA systems or structured decision protocols. Addressing these questions will deepen our understanding of behavioral influences on corporate investment and inform the design of more effective decision systems.

AUTHOR CONTRIBUTIONS

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Visualization: Atul Rai, Joseph Kerstein, Steven Farmer.
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