Historical Cost as a Commitment Device

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1 Introduction

Researchers in accounting and economics have long questioned firms reporting book values of assets and depreciation expenses based on historical costs, yet the practice remains persistent and widespread. Hatfield (1936) reports the custom of straight-line depreciation as early as the Roman Empire. Modern accounting reports routinely include historical cost depreciation charges and undepreciated book values of assets. Parties contracting with the firm voluntarily use reported income and book value – both of which are based on historical cost depreciation – in, for example, reporting to shareholders, debt covenants, and management compensation.[1] In contrast, classical economics eschews historical costs in favor of opportunity costs and market prices.

We offer some conjectures to help resolve this puzzle. Our conjectures are based on one salient property of historical cost: in an agency relation, historical cost is the present value of future cash flows the agent initially commits to exceed if the principal funds the investment. We propose that an economic function of historical cost depreciation and book values based on undepreciated historical cost is to monitor initial or subsequent agents' commitments, in order to reduce agents' incentives to over-invest in, under-invest in, and under-maintain durable assets. For durable assets that are specific, in the Alchian (1984) sense of having no market prices or opportunity costs, historical cost information obviously cannot be useful for evaluating alternative uses, but we propose it can be a useful part of the contracting relation between principal and agent.

We do not demonstrate that using historical cost depreciation and book value as a contractual commitment device precisely resolves the incentive problems associated with durable assets. For example, we show that contracting situations exist where charging agents accounting depreciation reduces firm value. We propose that historical cost accounting reduces, rather than eliminates, agency problems with investments in specific durable assets, by inducing more credible commitments from agents to generate cash flows, and by assisting in monitoring those commitments. In a costly contracting world, inducing the agent to take firm-value-maximizing investments likely involves a complex combination of institutional arrangements such as organization structures, performance measures, and compensation schemes tailored to a firm's particular situation. Managers likely select a set of complementary policies (see, for example, Milgrom and Roberts 1995). Accounting depreciation can be useful at controlling investment problems when used in conjunction with other institutional arrangements.

We suggest that accounting depreciation and book values assist in monitoring agents' commitments to produce cash flows from expenditures on specific durable assets. Consider a simple one-asset scenario, where an agent with private information about a durable asset's incremental future cash flows proposes its purchase. Tying agent's compensation to accounting income which includes historical cost depreciation reduces the likelihood the agent over-invests (i.e., invests in negative net present value projects) and under-invests (i.e., foregoes positive net present value projects).

In some cases charging managers accounting depreciation dominates alternative methods of accounting for those investments. Continuing with our one-asset example above, suppose instead that the agent is charged its 'economic depreciation' each period, defined as the change in market value of the asset. In the case of a totally specific asset, the agent would be charged with all of the asset's

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historical cost immediately, and zero thereafter. If the horizon of the agent is less than that of the expected cash flows, then charging the agent the entire cost of the durable asset immediately reduces the likelihood the agent proposes the investment; that is, an under-investment problem exists. Alternatively, not charging the agent at all for the cost of capital investments (i.e. no depreciation) causes the agent to over-propose capital expenditures since, from the agent's perspective, capital investments are free.

We also propose that the optimum depreciation method is one that reduces inter-generational agency problems arising when the asset's life exceeds the individual agent's horizon. Over the life of a durable project, historical cost accounting requires successive agents to generate cumulative incremental cash flow in excess of the investment outlay, to produce positive cumulative accounting income. If agents are compensated on the basis of residual income, net of the cost of capital applied to undepreciated book value, then the cross-generational requirement is equivalent to the present value of cash flows exceeding the investment. This requirement, which is independent of depreciation methods, does not solve the problem of the initial agent's incentive to promise 'high' cash flows beyond his or her present horizon. We propose that the particular historical cost depreciation method is chosen to reduce that incentive. Viewing accounting depreciation as a contractual commitment device suggests that accelerated depreciation methods are more likely used when the investment's cash flows are declining over the investment's life, when managers have short expected tenures, or when managers are likely to use capital investments to entrench themselves (Shleifer and Vishny, 1989).

The conjecture that accounting depreciation is a commitment device follows from a wider view of accounting as an integral part of firms' technologies for efficient contracting (Watts, 1974 and Jensen and Meckling, 1976). Watts and Zimmerman (1986, pp. 347-349) hypothesize that depreciation is due at least in part to political intervention, in the form of industry regulation and tax law. This hypothesis does not explain why accounting depreciation is widespread in non-regulated industries and in countries, such as the U.S., where tax and book depreciation routinely differ. Nor does it explain why allocated depreciation charges are widely employed in firms' internal budgeting and performance reporting practices. Finally, the political-cost hypothesis does not address why depreciation is widely computed as an allocation of the original price, rather than, say, change in market value of the asset.[2]

2 'Classical' Literature on Accounting and Economic Depreciation

The distinction between current market prices and book values based on undepreciated historical costs has attracted considerable critical attention in the accounting literature.[3] Equivalently, the distinction between accounting depreciation (allocation of historical cost over time) and economic depreciation (change in asset price over time) provides a well-known puzzle.

The view that depreciation is change in value, not an allocation of past cost, appears almost uniformly accepted by economists. Samuelson (1964 p. 606, emphasis in original) concludes:

The only sensible definition of depreciation relevant to measurement of *true money income* is putative decline in economic value.

An early advocate of economic depreciation and critic of accounting depreciation was Coase (1938, p. 631):

> I believe there can be little doubt ... that the problem of depreciation arises from the fact that assets may fall in value. ... The reason why depreciation has to be considered when the notion of 'opportunity' cost is being examined is that the value of an asset is sometimes affected by the use to which it is put. ... It is this fact that I wish to take into account. If the value of an asset, as this phrase is used by accountants, has no relation to future payments and receipts, but is equal to the original cost of the asset reduced by the appli-cation of some mechanical rule, then changes in that value clearly have no connection with [opportunity] cost.

A similar view seems prevalent among accountants. While depreciation has been viewed in the literature as a financial accounting issue, important in determining net income and book values, managerial accountants typically argue that historical cost depreciation is irrelevant for decision making. Horngren et al. (1997, p. 386, emphasis in original) state:

> *Although they may be a useful basis for making informed judgments for predicting expected future costs, historical costs in themselves are irrelevant to a decision.*

Samuelson (1964) offers the only proof of these propositions, based on a model of prices as present values of future cash flows.[4] This 'classical' approach – attributed to Fisher (1930) – assumes that

future cash flows (or relevant parameters of their distribution) are costlessly observable by all economic actors. We conjecture that information asymmetry arising from the unobservability of relevant cash flow parameters provides an important economic role for accounting depreciation. More specifically, we observe that in an agency setting the historical cost of an investment has an important though frequently-neglected property: it is the amount the agent who proposed the investment outlay promised to at least recover, in terms of the present value of future cash flows arising from the investment. We propose that book values and accounting depreciation play an economic role in keeping track of such commitments and in incenting agents to make optimal commitments.

3 Accounting, Depreciation, and Firms' Internal Transactions

This section discusses the role of internal accounting and more specifically the role of accounting depreciation from a costly-contracting perspective.

3.1 Costly-contracting Interpretation of Internal Accounting

The origin of costly-contracting theories of the firm is widely attributed to Coase (1937), who proposed (p. 390): 'The main reason why it is profitable to establish a firm would seem to be that there is a cost of using the price mechanism.' Coase used the 'thought experiment' of imagining a world in which contracting is costless. In such a world, Coase realized, there would be no economic role for firms. Every transfer from one production process to another could be effected by market contracts and all production could occur as a result of contracting across markets. The existence of firms, Coase concluded, must be due to costs of contracting.[5]

In a world with costly contracting firms as intermediaries (between factor owners and consumers) create efficient contracting technologies for repetitive transactions (Ball 1989). Because firms survive in competition with market-directed production, firms must be more efficient than markets in their domain of contracting. Market prices do not exist to guide firms' internal transacting. If market prices were efficient for intra-firm transactions, then there would be no economic rationale for the firm to exist: they could be liquidated without loss. Hence, market prices do not necessarily measure the resource cost of transactions within firms. Accounting numbers are not market prices. The existence of accounting technologies – including budgets, standard costs, transfer pricing, cost allocations, accounting accruals, depreciation, and auditing – implies that they offer a comparative advantage over market price-based contracting.

Extending Coase's thought experiment, imagine a costless contracting world in which consumers of a product individually contract in a competitive market with the person who both owns and operates a machine press that performs a particular operation (e.g. punching holes in sheet metal). The transaction is executed at a market price, allowing the press owner-operator a competitive return. Now consider the same operation conducted inside a firm, which employs a press operator and sells a completed product to consumers. Presumably, having the press inside the firm creates value over outsourcing this operation. The press operator is an agent for the owner of the press – the firm. There is no market price inside the firm that automatically measures the performance and compensates the press operator. Administrative mechanisms must be devised. The firm's accounting system is part of the administrative mechanism for measuring performance. It reports a cost of performing a press operation. Accounting costs are the 'currency' used by parties within the firm who implicitly contract with each other.

3.2 Agency Problems, Commitment and Durable Assets

Assume an owner employs an agent to manage the firm. Both are risk neutral. To begin, assume there are no durable assets in the firm. The agent proposes to purchase labor and materials, the justification being the generation of revenues in excess of the purchases. The agent's information about cash flows is perfect but private, i.e., not directly observable by the owner. They agree to establish a profit center to keep track of and monitor the agent's commitment to recover the purchases and generate budgeted profits. The budget then is a contractual commitment between owner and agent, and in a multi-commitment setting, with multiple proposed expenditures, the accounting system keeps track of all such commitments (that is, it budgets for all expenditures) and monitors the actual outcomes (records actual expenditures and the actual revenues they generate). Compensating the manager on the difference between budgeted and actual profits involves paying the manager to meet commitments. Notice that in this simple example, the agent has incentives to lowball the projected revenues and exaggerate the projected expenditures in the budget.

Durable assets present an additional dimension to the agency problem: the horizon of the pro-

mised cash flows can exceed that of the agent's job tenure. Consequently, the owner and agent seek a system to minimize incentives to over-invest and under-invest in new assets, and to under-maintain existing assets. We conjecture that allocating historical cost between periodic depreciation charges and undepreciated book value reduces these agency costs.

3.2.1 Over-investment and Under-investment Problems

To illustrate how accounting depreciation can serve as a commitment device, we make three assumptions. First, the agent's horizon, H, is shorter than the asset's useful life, L. The useful life is the period the asset produces cash flows, CF_t, $t=1, ..., L$. The agent's horizon is less than the asset's useful life because the agent may retire, resign, die, or be transferred to a new position within the firm before the end of the investment's life. Second, the investment cost is I and is totally specific, in the Alchian (1984) sense that the market value of the asset once the investment is made is zero: it has no opportunity cost. Hence, economic depreciation is I in the first year and zero thereafter. Third, the agent knows more about the investment cash flows, CF_t, than the owner. Specifically, the agent knows the expected sum of the cash flows over his or her horizon, $E\left(\sum_{t=1}^{H} CF_t\right)$, and also the expected sum of the CFs over the life of the project. The owner knows about the general types of investments available to the agent. In particular, the owner knows whether the cash flows are increasing or decreasing over the investment's life, L, and the agent's horizon, H. The owner does not know whether the investment being proposed by the agent has a positive or negative NPV.

To begin, we assume the agent is evaluated as a profit center. Investment centers are discussed below. To simplify the analysis, assume the discount rate is zero and both the owner and agent are risk neutral.

If the agent is held responsible for periodic cash flows, including the outlay for the durable specific asset, the agent will not propose such an outlay unless it returns expected cash before the agent's horizon at least equal to its cost, I. An accounting system that charges the agent economic depreciation, $E\left(\sum_{t=1}^{H} CF_t\right)/H \geq I$, increases the likelihood of an under-investment problem since some positive NPV projects may not generate CFs over the agent's horizon in excess of their costs. Alternatively, if there is no charge for durable assets, then the agent acquires durable assets as long as $E\left(\sum_{t=1}^{H} CF_t\right) > 0$, even if the assets' NPVs are negative. In this case, the agent over-invests.

Compensating the agent based on accounting profit including a depreciation charge holds the agent accountable for generating net cash flows in excess of the accounting depreciation, over the agent's horizon. The agent commits to returning at least part of the asset's historical cost. With straight-line depreciation, agents must generate cash flows over their horizon of at least:

$$E\left(\sum_{t=1}^{H} CF_t\right) > I/L \times H \qquad (1 \geq t \geq H) \qquad (1)$$

Relative to expensing the asset's cost at the time of acquisition, accounting depreciation decreases the likelihood of the agent foregoing positive NPV projects, but it also increases the likelihood that the agent proposes negative NPV projects. Analogously, relative to *never* charging the agent for the cost of the assets, accounting depreciation decreases the likelihood that the agent invests in negative NPV projects, but it also increases the likelihood that the agent passes up positive NPV projects. We conjecture that the firm's choice of depreciation policies reflects a tradeoff between foregone positive NPV projects and undertaken negative NPV projects.

3.2.2 Numerical Example

Table 1 illustrates the preceding points with a simple numerical example. Assume the agent is compensated on accounting profit. The agent is evaluating a specific investment that costs $100 and has a five-year life. As soon as the investment is made it has no salvage value. The discount rate is zero and the agent has a three-year horizon. In Panel A the agent has private information that the investment's expected annual net cash flows are $25 and it is in fact a positive NPV investment. If accounting profit is calculated by writing off the asset when acquired because it is specific (Policy I), the agent rejects the project because by the time the agent leaves the firm in year three the project's expected cumulative accounting profit is -$25. Under-investment results. If accounting profit is calculated by either excluding depreciation (Policy II) or by depreciating the asset over its useful life (Policy III) the agent accepts the project. Cumulative accounting profit in year three under both methods is positive.

In Panel B of Table 1 all the facts remain the same except now the agent knows the project's

expected cash flows will be only $15 annually. In this case the project has a negative NPV. Writing off the asset (Policy I) or depreciating it over its useful life (Policy III) lead to the correct decision to reject the project whereas ignoring depreciation (Policy II) causes the agent to accept the unprofitable project. Panels A and B illustrate how immediate write-off of the asset can lead to rejecting profitable projects and ignoring depreciation can lead to accepting unprofitable projects. In panels A and B, depreciating the asset over its useful life leads the agent to take firm-value-increasing investments.

However, accounting depreciation does not always lead the agent to firm-value-maximizing investment decisions. Consider Panel C where the agent knows the investment is unprofitable for the firm because after the agent leaves in three years the cash flows fall to zero. In this case, the agent will still undertake the investment if accounting profit is calculated by either ignoring depreciation (Policy II) or depreciating the asset over its useful life (Policy III). Only writing off the asset immediately (Policy I) leads to the value-maximizing decision. Notice that in this case straight-line depreciation induces an over-investment problem while double-declining-balance depreciation induces the agent to correctly reject this project.

Panel D presents a positive NPV project rejected by the agent if accounting profits are calculated either by writing off the asset immediately (Policy I) or depreciating it over its useful life (Policy III). Here the investment's cash flows occur after the agent leaves the firm. In this case, the agent will propose the project only if depreciation is not included in the calculation of accounting profit (i.e., the cost of the investment is ignored).[6] Thus, panels C and D illustrate how depreciating the asset over its useful life will not always lead the agent to take firm value-maximizing investments. As discussed earlier, we do not claim that accounting depreciation uniquely solves all opportunism surrounding investments in durable assets. And in fact, when substantial information asymmetry exists regarding the agent's projected future cash flows beyond the agent's horizon, H, (Panel C) we would expect to observe accelerated depreciation. When the owner knows the cash flows are increasing over the investment's life (Panel D), we predict a lower incidence of accounting depreciation-based compensation plans. In fact, when the owner expects projects with long expected lives and increasing cash flows, younger agents will be hired and compensation schemes that lengthen agents' horizons will be deployed.

3.2.3 Investment Centers

In the preceding analysis, the agent's compensation is assumed to be tied to accounting income; that is, agents are evaluated and compensated as *profit* centers. We now assume the owner and agent agree to establish an *investment center*, which alters the agent's commitment. Here, the agent is evaluated based on residual income (such as EVA).[7] Specifically, we now assume the agent's investment center is assessed the sum of two related accounting charges:

1. A periodic depreciation charge D_t calculated under any depreciation rule that fully deprec-

Table 1: Examples Comparing Investment Incentives under Alternative Depreciation Treatments

Investment	$100	Agent's horizon	3 years
Salvage value	$0	Depreciation method	straight-line
Investment life	5 years	Market value of asset after installed	$0

A. Investment: positive NPV project. Agent's private information: $25 for 5 years

		Policy I			**Policy II**		**Policy III**		
		Asset Written Off when Acquired			**No Depreciation**		**Straight-line Depreciation**		
Year	Agent's private information	Deprec.	Acctg. Profit	Cum. Acctg. Profit	Acctg. Profit	Cum. Acctg. Profit	Deprec.	Acctg. Profit	Cum. Acctg. Profit
1	$25	$100	-$75	-$75	$25	$25	$20	$5	$5
2	$25	$0	$25	-$50	$25	$50	$20	$5	$10
3	$25	$0	$25	-$25	$25	$75	$20	$5	$15
4	$25	$0	$25	-	$25	-	$20	$5	-
5	$25	$0	$25	-	$25	-	$20	$5	-
		Reject Project			**Accept Project**		**Accept Project**		
		Under-investment			**Correct**		**Correct**		

B. Investment: negative NPV project. Agent's private information: $15 for 5 years

		Policy I			Policy II		Policy III		
		Asset Written Off when Acquired			No Depreciation		Straight-line Depreciation		
Year	Agent's private information	Deprec.	Acctg. Profit	Cum. Acctg. Profit	Acctg. Profit	Cum. Acctg. Profit	Deprec.	Acctg. Profit	Cum. Acctg. Profit
1	$15	$100	-$85	-$85	$15	$15	$20	-$5	-$5
2	$15	$0	$15	-$70	$15	$30	$20	-$5	-$10
3	$15	$0	$15	-$55	$15	$45	$20	-$5	-$15
4	$15	$0	$15	-	$15	-	$20	-$5	-
5	$15	$0	$15	-	$15	-	$20	-$5	-
		Reject Project			**Accept Project**		**Reject Project**		
		Correct			**Over-investment**		**Correct**		

C. Investment: negative NPV project. Agent's private information: $25, $25, $25, $0, $0

		Policy I			Policy II		Policy III		
		Asset Written Off when Acquired			No Depreciation		Straight-line Depreciation		
Year	Agent's private information	Deprec.	Acctg. Profit	Cum. Acctg. Profit	Acctg. Profit	Cum. Acctg. Profit	Deprec.	Acctg. Profit	Cum. Acctg. Profit
1	$25	$100	-$75	-$75	$25	$25	$20	$5	$5
2	$25	$0	$25	-$50	$25	$50	$20	$5	$10
3	$25	$0	$25	-$25	$25	$75	$20	$5	$15
4	$0	$0	$0	-	$0	-	$20	-$20	-
5	$0	$0	$0	-	$0	-	$20	-$20	-
		Reject Project			**Accept Project**		**Accept Project**		
		Correct			**Over-investment**		**Over-investment**		

D. Investment is a positive NPV project. Agent's private information: $0, $0, $50, $50, $50

		Policy I			Policy II		Policy III		
		Asset Written Off when Acquired			No Depreciation		Straight-line Depreciation		
Year	Agent's private information	Deprec.	Acctg. Profit	Cum. Acctg. Profit	Acctg. Profit	Cum. Acctg. Profit	Deprec.	Acctg. Profit	Cum. Acctg. Profit
1	$0	$100	-$100	-$100	$0	$0	$20	-$20	-$20
2	$0	$0	$0	-$100	$0	$0	$20	-$20	-$40
3	$50	$0	$50	-$50	$50	$50	$20	$30	-$10
4	$50	$0	$50	-	$50	-	$20	$30	-
5	$50	$0	$50	-	$50	-	$20	$30	-
		Reject Project			**Accept Project**		**Reject Project**		
		Under-investment			**Correct**		**Under-investment**		

iates the cost of the asset over its life (that is, satisfy the constraint $\sum_{t=1}^{L} D_t = I$; and

2. A periodic capital charge equal to the agreed or target rate of return R on the beginning-of-period net book value of the asset,

$$BV_{t-1} = I \sum_{\tau=1}^{t-1} D_\tau$$

It is well-known and straightforward to show that at the time of the investment outlay the present value of the sum of these charges is exactly equal

to the amount of the investment outlay I, independent of the depreciation rule followed:

$$\sum_{t=1}^{L} \left[(D_t + R \times BV_{t-1})(1 + R)^{-t}\right] = I$$

This result occurs because any change in depreciation in any period produces two exactly-offsetting effects in present value terms: (1) a change in the present value of future depreciation charges; and (2) a change in the present value of future capital charges, arising from the effect of depreciation on book value.

While the present value of the charges over the entire asset life is independent of depreciation methods, present values over agents' shorter horizons are not. Hence, the time pattern of the depreciation method continues to influence agents' commitments to produce cash flows. Straight-line depreciation over L years creates a commitment to produce incremental cash flows in year t $(1 \leq t \leq L)$ of at least:

$$CF_t \geq I/L + R[I(L - t + 1)/L] \qquad (2)$$

Summing over the L years, this is a total commitment to generate total cash flows of $I[1+R(L+1)/2]$. Investment centers using straight-line depreciation face a declining cash flow commitment, because the book value of the asset $[I(L-t+1)/L]$ is decreasing in t. Accelerated depreciation yields an even more rapidly declining commitment pattern.

The accounting system tracks all commitments to generate incremental cash flows by recording book values for all expenditures and monitors the actual outcomes by observing the actual ROA the investment center achieves. Compensating the manager on the difference between budgeted and actual ROA involves paying the manager to meet cash flow commitments over the durable asset's useful life.

3.2.4 Commitments Based on Accounting Depreciation Versus Promised Cash Flows

Why is it not more efficient to simply contract on delivered cash flows promised in the capital expenditure request? We conjecture that accounting depreciation provides cash flow commitments that are based on more independently-observable factors, and thus that are less manipulable by the agent.

Suppose the agent's compensation is based on the difference between actual and promised cash flows. If the agent's promised cash flows are unbiased, then the agent's expected compensation from the project (as the difference between actual and promised cash flows) is zero. However, the agent has an incentive to understate promised payments in the early years and overstate them in periods beyond the agent's expected horizon.[8] In contrast, an accounting-based commitment relies on comparatively objective information (I, R and L). Thus, basing the agent's performance on the difference between actual cash flows and a contractual target formula using accounting depreciation likely is less subject to agent gaming.

3.2.5 Accounting Depreciation Analogy: Take-or-pay Contracts

Accounting depreciation is analogous to take-or-pay clauses prevalent in natural gas contracts. Once a natural gas company builds the pipeline from its gas fields to the gas purchaser's facilities, the pipeline has no alternative use; it is a totally specific asset. Once the pipeline is built the gas buyer has an incentive to negotiate a gas price at just above the pipeline company's marginal cost, excluding the cost of building the pipeline. This is an example of the 'hold-up' problem. Expecting such opportunistic behavior, the seller will not build the pipeline without a long-term take-or-pay contract that limits this behavior. Such a contract reduces buyer opportunism by requiring the purchaser to commit, as a condition of the construction of the pipeline, to a minimum payment per period regardless of the amount of gas actually purchased. The discounted value of the minimum payments per period guarantees the seller recovers the cost of building the pipeline.[9] Analogously, inside firms owners worry that agents behave opportunistically when proposing investments in fixed assets. To reduce opportunism, owners require agents to commit, in advance of approving the investment, to be held accountable for a periodic depreciation charge against the agent's income.

Take-or-pay contracts are *ex ante* pricing mechanisms that encourage the parties to maximize expected value when a durable asset is specific. We speculate that accounting depreciation has a similar economic structure to take-or-pay contracts. The agent commits to pay a fixed amount per year (the depreciation charge), independent of how much of the asset's capacity is actually used.[10]

Sunder (1997) argues that accounting depreciation involves trading off under-utilization against over-investment. Charging users depreciation for capital assets with excess capacity (and hence zero opportunity cost) discourages use and leads to under-utilization. However, not charging depreciation when excess capacity exists causes future users to over invest to ensure excess capacity exists, thereby eliminating future depreciation charges.[11]

3.3 Extensions

Building on the basic notion of accounting depreciation as a commitment device, this section suggests how other features of accounting for maintenance, write-downs, and full costing influence the agency problems associated with durable assets.

3.3.1 Asset Write-downs, Book Values and Maintenance

Accountants' track undepreciated book value over the asset's useful life, and write off all or part of the book value against the agent's income whenever there is evidence the asset is impaired (its future service flows are less than originally expected). If cash flows fall below expectations, and the owner believes that the current period's shortfall presages future shortfalls, the owner can require a write-down of the assets. The write-down results in a large one-period charge against the agent's earnings that approximates the sum of all expected future cash flow shortfalls, reducing the agent's performance-based compensation for the period. Thus, we suggest that write-downs reduce the incentives of agents to over-promise future cash flows to justify capital expenditures. Such write-down policies surrounding the termination or departure of the agent, especially when coupled with deferred compensation for the agent, likely further reduce the agent's over-investment incentives.

A related role for accounting write-downs involves reducing the agent's incentives to under-maintain the asset. The asset's book value commits the agent to maintaining its productive capacity. If the outgoing agent under-maintains assets prior to termination or departure, then the replacement agent will argue for a write-down to lower the replacement agent's future depreciation commitment. Tying the outgoing agent's bonus and reputation to the reported income (net of depreciation and write-downs) in the horizon year reduces the outgoing agents' incentive to under-maintain the asset. The replacement agent's incentive is to maximize the write-down, so we conjecture that the owner (or board of directors) arbitrates the write-down.

3.3.2 Full Costing

Within firms, chains of agency relationships exist. The shareholders (as principal) hold top management and the board of directors (as agent) to a commitment to cover *total* firm-wide accounting depreciation. This corresponds to 'financial' reporting of depreciation. In turn, top management (as principals) hold business unit managers (as agents) to a commitment to cover business unit depreciation. Business unit managers (as principals) hold product line managers (as agents) to a commitment to cover product line depreciation. A chain of monitoring is facilitated by the additivity property of both depreciation and book values.[12] Thus, accounting depreciation disaggregates prior unexpired commitments to individual managers. Viewed in this way, there is little distinction other than aggregation between 'financial' and 'managerial' accounting.

Consider the situation where the firm consists of a manufacturing division (a profit center) that buys specific, durable assets and produces products for several lines of business (also profit centers). The lines of business can 'hold-up' the manufacturing division once specific assets are purchased by refusing to buy their products from manufacturing at any price above variable cost. This is similar to the hold-up problem addressed by take-or-pay contracts. To overcome opportunism in this bilateral monopoly, accounting depreciation is built into the lines of business' product costs based on budgeted capacity, and at the end of the year, each line of business is charged for any volume variance. Charging lines of business for any unused capacity reduces their incentives to advocate adding capacity larger than their expected needs. Including depreciation (and other fixed) charges in product costs is known as 'full costing.' We conjecture that full costing reduces the opportunistic behavior by the lines of business during the investment decision. Each line of business in effect has a take-or-pay contract with the manufacturing division.[13]

We also conjecture that the accounting practice of basing average unit costs on 'practical' or 'normal' capacity is a method to prevent over-statement of product costs. Instead of basing overhead rates (which include the annual depreciation charge) on expected or actual volume, some firms use the practical capacity of the plant. If practical capacity is used and the plant is operating below practical capacity, the overhead rate remains constant and the unabsorbed overhead (the volume variance) is written off as a period expense by charging it to the product lines. This 'take-or-pay' treatment commits the agent to 'paying' for the capacity before it is built while not affecting reported product costs.

4 Some Additional Implications

4.1 Choice of Depreciation Method

If accounting depreciation is a commitment device as we conjecture, then it is primarily a contractual device, not a valuation mechanism. The

optimal contractual commitment pattern likely depends on a number of factors including the expected pattern of the cash flows, the pattern of expected maintenance expenditures, and characteristics of the managers such as their turnover rates. For example, if the principal expects the capital investment to yield roughly uniform cash flows over its life and the agent is expected to stay with the firm over most of the asset's life, then straight-line depreciation will be used, *ceteris paribus*.

In the absence of contractual commitments, managers with short tenures in their present jobs, for example due to rapid job advancement, have incentives to select investment projects with large cash flows in the early years, during their expected tenures. If straight-line depreciation is used to provide observable commitments for these investments, then incumbent managers reap the rewards while successor managers bear the cost when future cash flows fall below the depreciation commitments. Accelerated depreciation mitigates this problem. Hence, we predict, *ceteris paribus*, that accelerated depreciation is used within firms with fast promotion policies.

ments reduce the likelihood the manager is fired and allow managers to extract more pay. Accelerated depreciation reduces this entrenchment incentive by making it more difficult for incumbent managers to recover the cost of the investment over their horizons. Manager-specific investments still entrench managers; however, basing their pay on earnings after accelerated depreciation lowers their compensation; thereby partially offsetting the entrenchment incentive. Table 2 summarizes our predictions regarding the various factors affecting depreciation method choice.

We also predict firm-wide depreciation policies for classes of assets within the firm. The principal and agent have different specialized knowledge. The principal (senior managers and boards of directors) likely understand the general types of investments available to the firm, the competitive structure of the industry and hence the general pattern and life of the likely investments' cash flows. Unlike the principal, the agent has knowledge of the expected cash flows from individual investments. Because of the information asymmetry between the principal and agent, we conjecture that the principal chooses a depreciation poli-

Table 2: Factors Predicted to Affect Depreciation Method Choice

Depreciation Method	Factors
Straight-line	Uniform annual cash flows over the investment's life Constant/declining maintenance over the investment's life Long-tenured managers Few manager-specific investment opportunities
Accelerated	Declining annual cash flows over the investment's life Increasing maintenance over the investment's life Short-tenured managers Many manager-specific investment opportunities

The optimal pattern of depreciation charges also depends on the pattern of expected maintenance charges. For example, suppose a durable asset is expected to yield roughly constant cash flows (before maintenance costs) over its life, but maintenance costs are expected to increase with asset age. Cash flow net of maintenance thus decreases in time. In this case an accelerated depreciation schedule produces a declining commitment that more closely matches the asset's net cash flows including maintenance.

Shleifer and Vishny (1989) hypothesize that managers entrench themselves by making manager-specific investments (assets whose value is higher under the current manager than under the best alternative manager). Manager-specific investcy (such as accelerated depreciation) and sets asset-class lives (such as 20 years for buildings) to reduce agent opportunism to argue for less aggressive methods and longer depreciable lives. Such firm-wide, and largely rigid, policies reduce influence costs. Moreover, these policies are likely to require ratification by the board of directors or its audit committee as a way to monitor senior manager opportunism.

4.2 Asset Write-downs, Management Turnover, and Volume Variances

Under our contractual commitment view, treating depreciation as a periodic 'fixed' cost gives rise to unabsorbed overhead whenever practical capacity

exceeds production. We hypothesize that charging volume variances back to the business line managers *ex post* induces them to forecast more truthfully *ex ante* their expected usages of proposed capital assets. If the volume variance results from unforeseen events where the agent could not control the consequences of the event, then we hypothesize senior managers make an exception and do not charge the volume variance to the agent. Asset write-downs occur either when *ex post* actual performance persistently falls below practical capacity or when routine maintenance fails to keep the asset's capacity at planned levels. This latter situation serves to punish outgoing agents for under-maintaining assets, particularly when deferred compensation is a function of accounting income in the manager's final period.

Suppose *ex post* net cash flows fail to cover depreciation; that is, the *ex ante* commitment has not been kept. We conjecture that if this is an isolated occurrence, then the accounting technique is to record an under-absorption and charge the agent for this volume variance (analogous to a take-or-pay charge). If there is permanent excess capacity beyond the control of operating managers, then the accounting treatment is an asset write-down, whereby the write-down does not reduce the agent's accounting profits. The depreciable book value is written down until a revised commitment, to cover the reduced depreciation charges, can be made credibly.

Depreciation only works as a commitment device if writedowns are rare and costly to agents whenever they either over-invest or under-maintain durable assets. One cost that can be imposed on the agent is termination. Thus, asset write-downs are likely associated with management turnover. Asset write-downs, which typically are viewed as an 'external' reporting issue, thus can be viewed also as an accounting technique to revise contractual commitments within the firm as a result of new information.

5 Summary

This paper offers some conjectures about the existence and form of accounting depreciation and undepreciated book values. We suggest that when compensation is linked to earnings that include accounting depreciation the agent is committed to cover depreciation charges with either additional revenues or cost savings. Book values track unexpired commitments that will be charged to agents in the future as accounting depreciation, thereby creating incentives for managers not to over-invest in durable assets. These conjectures are based on a 'costly contracting economics' approach. In contrast, if assets are specific then so-called 'economic' depreciation – holding the agent responsible for the decline in market value in the first year – causes agents with horizons shorter than the investment's to reject profitable projects.

While there are cases when accounting depreciation can be shown to reduce the under-investment and over-investment problems, situations can arise when use of accounting depreciation cause agents to reject profitable projects and accept unprofitable projects. Thus, we do not argue that accounting depreciation always results in firm-value-maximizing actions. Our conjecture is that accounting depreciation, ROA targets and other institutional factors offer a menu of contracual options from which firms choose.

Viewing accounting depreciation as a commitment device leads to several predictions requiring more rigorous analysis. Straight-line depreciation is more likely used when the investment's cash flows (including maintenance) are not declining over the investment's life, when managers have long expected tenures, or when managers are unlikely to use capital investments to entrench themselves. Asset write-downs occur when routine maintenance fails to keep the asset's capacity at planned levels and serve to punish outgoing agents for under-maintaining assets. Thus, asset write-downs are likely associated with management turnover.

Overall, we believe that much can be gained from viewing accounting depreciation primarily as a contractual commitment device, not as a valuation mechanism. Commitments to deliver future cash flows over lengthy periods are made by corporate-level managers to shareholders, lenders and other parties. Comparable commitments are made to managers by their subordinates, down the organizational hierarchy. For managers whose wealths are a function of accounting income or of deviations from accounting budgets, charging accounting depreciation fundamentally alters the nature of their commitments.

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NOTES

1 Ball and Brown (1968) and Watts and Zimmerman (1986).

2 Several studies have explored specific situations where it is desirable to allocate capacity costs, including depreciation. See Zimmerman (1979), Suh (1987), Magee (1988), Banker and Hughes (1994), Baiman and Noel (1985), Hemmer (1996), Ball (1989),

Rogerson (1997), Sunder (1997, p. 56), and Reichelstein (1997).

3For example, Canning (1929), Chambers (1966) and Edwards and Bell (1961).

4Although Samuelson developed his analysis in the context of taxable income, it has come to be representative of economists' views of accounting depreciation for financial reporting.

5A considerable literature developed from Coase (1937). For example, Alchian and Demsetz (1972), Meckling and Jensen (1976 and 1991), and Williamson (1975 and 1985). Watts (1992) summarizes the various contracting costs.

6The use of a sufficiently 'decelerated' depreciation schedule - where depreciation charges increase over the asset's life - will also yield the correct decision of adopting the project.

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8Soviet-style penalties for lying can induce truthful reporting (Kirby, et. al, 1991). However, the infrequent use of these systems suggests that their costs exceed their benefits.

9Masten and Crocker (1985). A symmetric agency problem exists if the gas buyer builds the pipeline.

10 Instead of charging the agent depreciation using the units of production method, the agent is usually charged a fixed, pre-specified amount per year. Fewer than 10% of firms surveyed by *Accounting Trends and Techniques* (AICPA, 1990) use units-of-production methods and the vast majority of these are natural resource companies. Natural resource companies have proven the volume of their reserves, so there is little information asymmetry between the project manager and senior management regarding the quantity of reserves. There remains information asymmetry regarding the project manager's operating efficiency.

11 Zimmerman (2000) pp. 377-8.

12 In contrast, market prices of assets need not be additive, due to synergies.

13 Whang (1989, p. 1271) shows that in congestion-prone situations, allocating depreciation not only induces agents to reveal their true marginal values of proposed capacity 'but achieves *ex post* efficiency in allocating purchased capacity.'