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Capitalization of Costs and Expected Earnings Growth

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ABSTRACT This paper offers a model that shows how the capitalization of costs affects contemporaneous earnings and the growth path of expected earnings. It makes three points. First, reported earnings under successful efforts are more price relevant than earnings under full costing or full expensing. Second, whether conditional or unconditional, conservatism always enhances the growth rate of expected earnings. Third, independent of capitalization policy, the long-run expected earnings growth rate converges either to the long-run expected free cash flow growth rate or to the depreciation rate. Therefore, while capitalization policy affects the price relevance of earnings and short-run expected earnings growth, it does not affect long-run expected earnings growth.

1. Introduction

The rules governing the capitalization of costs vary across accounting jurisdictions. US Generally Accepted Accounting Principles (GAAP) (FASB, 1974) require immediate expensing of speculative research costs whereas development costs allocated to viable revenue streams may be capitalized and amortized. IAS 38.54 (IASB, 1998) requires expensing of research costs and permits development costs to be capitalized 'only after technical and commercial feasibility of the asset have been established'. In the same spirit, US industry GAAP for software (FASB, 1985) stipulates that, while all research costs prior to technological and economic feasibility must be expensed, development costs after technological and economic feasibility may be capitalized and amortized as part of product inventory. Oil and gas industry GAAP (FASB, 1979) allows for even more discretion. SFAS 19 (FASB, 1977) originally required firms to immediately expense drilling costs leading to dry holes ('successful efforts

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(SE)'). Fearing that SE accounting would discourage oil and gas exploration by smaller firms, the US Securities and Exchange Commission forced FASB to suspend SFAS 19 and permit public companies to use either successful efforts or to capitalize and amortize all drilling costs ('full costing (FC)').

How does capitalization of costs affect earnings? MBA textbooks (White *et al.*, 2003) and academic theory (Sunder, 1976; Lev *et al.*, 2005) argue that unconditional capitalization of exploration and development ('E&D') costs:

- suppresses the correlation between price and contemporaneous earnings;
- enhances and smoothes earnings for firms with growing revenues; and
- endows earnings with the possibility of reflecting subsequent asset impairment with timely write-off expenses.

Numerical simulations support these conclusions. Healy *et al.* (2002) show, in a simulation of the biotech R&D pipeline, that SE earnings correlate better to price than FC earnings even though the former are more volatile.

Despite the aforementioned research, there is no analytical model that captures how the capitalization of costs affects the value relevance of earnings and the expected earnings growth path. This paper fills this gap in the literature by offering a simple model linking capitalization policy to contemporaneous earnings and the growth path of expected earnings. At each date, a firm undertakes costly exploration activities (e.g. drilling new holes) and, at the same time, develops projects (oil wells) uncovered by successful prior exploration activities. A novel feature of the model is that development costs are conditional on the success of antecedent exploration activities. This feature enables us to examine how the immediate expensing of development costs (unconditional conservatism) affects earnings and expected earnings when antecedent exploration costs are completely or partially capitalized under FC and SE accounting.

I focus on three results. First, the model captures the idea that earnings under successful efforts are more price relevant than earnings under full costing because SE expenses contain more timely information about the outcome of exploration activities. Second, the model characterizes exactly how more aggressive E&D expensing policies enhance the growth rate of expected earnings. It supports the conventional wisdom that expensing up front induces more future growth. Third, the model implies that the long-run expected earnings growth rate, regardless of capitalization policy, converges either to the long-run expected free cash flow growth rate or the depreciation rate. Thus, while capitalization policy affects short-run expected earnings growth, it does not affect long-run expected earnings growth. Long-run expected earnings growth is robust to capitalization policy in a fundamental way.

These results provide modeling support for ideas already familiar from conventional wisdom or prior research. The main new contribution is to capture and integrate all these ideas within an analytically tractable model.

Researchers designing future empirical studies of the affects of capitalization policy on earnings may benefit by using this model to guide their hypothesis development.

2. The Model

As depicted in Figure 1, the firm drills N exploratory wells at all periods $\tau \geq 1$. Of these N wells, $s_\tau \in \{0, \ldots, N\}$ are successful and $N - s_\tau$ are dry. Whenever a well is successful, the firm invests additional dollars to develop the well, which then generates cash revenues in subsequent periods. In contrast, dry holes incur no further costs and generate no future revenues.

The value of s_τ is determined by S_τ, an i.i.d. random variable distributed according to the binomial distribution

$$\Pr(S_\tau = s_\tau) = \frac{N!}{(N - s_\tau)!s_\tau!}\theta^{s_\tau}(1-\theta)^{N-s_\tau}.$$

$\theta \in (0,1)$ is the *ex ante* probability that an exploratory well will be productive. The expected value of S_τ is $N\theta$ and its variance is $N(1-\theta)\theta$.

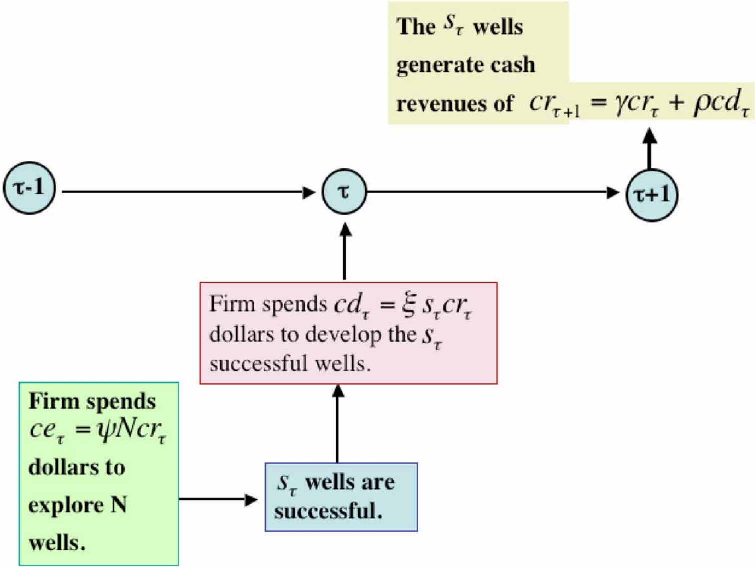

Figure 1. At each period τ, the firm spends $ce_\tau = \psi\, Ncr_\tau$ dollars to explore N wells. Exploration reveals that s_τ wells are successful and $N - S_\tau$ are dry, where s_τ is an unpredictable random number. The firm then spends $cd_\tau = \xi S_\tau cr_\tau$ dollars to develop the productive wells, which boost subsequent cash revenues by a shock proportional to cd_τ. Exploration and development repeats every period in perpetuity

To complete the model, let $\{cr_\tau, ce_\tau, cd_\tau, c_\tau\}$ refer respectively to cash revenues, cash expenditures for exploration, cash expenditures for development and free cash flows. For $\tau \geq 0$, cash flows evolve according to

$$\begin{aligned} cr_{\tau+1} &= \gamma cr_\tau + \rho cd_\tau \\ ce_\tau &= \psi N cr_\tau \\ cd_\tau &= \xi s_\tau cr_\tau \end{aligned} \qquad \text{CF}$$

with initial values $cr_0 > 0$ and $cd_0 > 0$. Free cash flow equals cash revenue minus cash expenditures for E&D: $c_\tau \equiv cr_\tau - ce_\tau - cd_\tau = (1 - \psi N - \xi s_\tau)cr_\tau$. In CF, $\{\gamma, \rho, \psi, \xi\}$ are strictly positive real parameters. Because $cr_0 > 0$ and $cd_0 > 0$ by assumption, every cash flow component is positive for all $\tau \geq 0$. According to CF, the firm spends $ce_\tau = \psi N cr_\tau$ dollars to drill N exploratory wells at a cost of ψcr_τ dollars per well. That cost-per-well scales with cr_τ captures the idea that bigger revenue firms undertake the exploration of commensurately bigger wells. Upon learning how many wells are successful, the firm spends $cd_\tau = \xi s_\tau cr_\tau$ dollars to develop the productive wells. The $N - s_\tau$ dry holes are discarded without incurring additional costs. Period development cost cd_τ scales in proportion to the number of productive wells and cr_τ, which proxies for the size of the wells. The growth rate of cash revenues is $\gamma - 1$; if consumer demand causes oil prices to rise, then $\gamma > 1$. The value of ρ is the one-period cash rate of return on cash expenditures for development.

To focus on settings of most relevance, I shall maintain three conditions on the parameters of CF:

1. $1 - \psi N - \xi\theta N > 0$.
2. $\gamma + \rho\xi N\theta < R$.
3. $\left(\dfrac{\rho}{R - \gamma} - 1\right)\xi\theta - \psi > 0$.

The first and third conditions imply that $\Gamma \equiv \gamma + \rho\xi\theta N$, a parameter that will characterize long-run expected free cash flow growth, is strictly positive. These three conditions will be regarded as being permanently attached to assumption CF. The first condition guarantees that the expected per-period cash contribution margin for E&D activities is positive. The second condition guarantees that free cash flows do not grow or shrink faster than the discount rate. The third condition implies that E&D is, on average, a positive net-present-value activity. These assumptions guarantee that the present value of expected free cash flows, $V_\tau \equiv \sum_{s=1}^{\infty} R^{-s} E[c_{\tau+s} | cr_\tau, s_\tau]$, converges to the strictly positive value

$$V_\tau = \left(\frac{1 - \psi N - \xi\theta N}{R - [\gamma + \rho\xi\theta N]}\right)[\gamma + \rho\xi s_\tau]cr_\tau.$$

Thus far, I have characterized only cash flows. I now turn to accounting policy and the construction of earnings. US GAAP permits oil and gas firms to choose either FC or SE accounting for exploration costs, and to capitalize and amortize development costs for productive wells. Alternatively, a firm might choose to expense exploration or development costs immediately. In total, there are six different possible combinations of accounting treatments for E&D costs:

- ***Full costing for exploration, capitalization of development*** (‘$FC:C$’): capitalize both E&D costs.
- ***Full costing for exploration, expensing of development*** (‘$FC:E$’): capitalize exploration costs and expense development costs.
- ***Successful efforts for exploration, capitalization of development*** (‘$SE:C$’): capitalize only E&D costs associated with productive wells. Expense costs for dry holes.
- ***Successful efforts for exploration, expensing of development*** (‘$SE:E$’): capitalize only exploration costs associated with productive wells. Expense costs for dry holes and development.
- ***Full expensing for exploration, capitalization of development*** (‘$FE:C$’): expense exploration costs and capitalize only development costs.
- ***Full expensing for exploration and development*** (‘$FE:E$’): expense E&D costs.

‘Capitalize’ means to recognize a cash expenditure as an asset at historical cost and to amortize said asset in subsequent periods through earnings. ‘Expense’ means to recognize the cash expenditure as an immediate expense in earnings.

To model these six capitalization policies, let $\{oa_\tau, x_\tau\}$ refer respectively to the book value of operating assets and operating earnings. For all $\tau \geq 1$, suppose that

$$oa_\tau = \delta_0 oa_{\tau-1} + \left(\delta_e + \delta_{es}\frac{s_\tau}{N}\right)ce_\tau + \delta_d cd_\tau$$

with given initial value $oa_0 \in [0,\infty)$ and that

$$x_\tau = cr_\tau - \left(1 - \delta_e - \delta_{es}\frac{s_\tau}{N}\right)ce_\tau - (1-\delta_d)cd_\tau - (1-\delta_0)oa_{\tau-1}. \qquad \text{AP}$$

I shall use ‘AP’ to refer to both preceding equations. In AP, $\delta_0 \in (0,1)$ is the depreciation parameter and $\{\delta_A \in \{0,1\} | A \in \{e, es, d\}\}$ are capitalization policy parameters. The three capitalization policy parameters determine when and how much E&D costs are recognized. Table 1 indicates the values of these parameters that implement the six aforementioned capitalization policies.

Table 1. The three accounting policy parameters that define each capitalization policy

Capitalization policy	AP parameters $\{\delta_e, \delta_{es}, \delta_d\}$
$FC:C$	{1, 0, 1}
$FC:E$	{1, 0, 0}
$SE:C$	{0, 1, 1}
$SE:E$	{0, 1, 0}
$FE:C$	{0, 0, 1}
$FE:E$	{0, 0, 0}

AP implies that book values and earnings depend on capitalization policy. I will append a superscript

$$j \in \mathbf{J} \equiv \{FC:C,\ FC:E,\ SE:C,\ SE:E,\ FE:C,\ FE:E\}$$

to oa^j_τ and x^j_τ to indicate the capitalization policy. I will assume that the initial value of book value, oa_0, is the same across all accounting regimes ($oa^j_0 = oa_0 \forall j \in \mathbf{J}$) so that any $\tau > 0$ differences in book values across accounting regimes are due to subsequent capitalization and depreciation policy.

The information set Ω_τ available to capital market participants at date τ consists of the realized values of all past and contemporaneous cash flows, book values and earnings numbers. Formally, in an accounting regime with capitalization policy $j \in \mathbf{J}$

$$\Omega_\tau = \left\{oa_0, \{cr_t, ce_t, cd_t\}^\tau_{t=0}, \{x^j_t, oa^j_t\}^\tau_{t=1}\right\}.$$

Under this assumption for Ω_τ, the amount of information available to investors is the same across all accounting regimes because participants in any one regime have enough information to determine the as-if values of contemporaneous book value and earnings under any alternative regime. This is consistent with what some empirical researchers have assumed about E&D accounting. For example, Bryant (2003) constructs and uses as-if book values and as-if earnings in her study of E&D accounting in the oil and gas industry.

3. Impact of Capitalization Policy on Expected Earnings Levels

To establish how capitalization policy affects earnings levels and earnings volatility, consider the following set of price relevance indicators:

$$\left\{\rho^j_\tau \equiv \text{cov}(x^j_\tau, V_\tau|\Omega_{\tau-1})/\text{var}(V_\tau|\Omega_{\tau-1})|\, j \in \mathbf{J}\right\}.$$

If x^j_τ is not price relevant, then $\rho^j_\tau = 0$. Otherwise, ρ^j_τ could be any positive or negative real number. One can think of ρ^j_τ as being a coefficient of the regression model $x^j_\tau = \rho^j_\tau V_\tau + u^j_\tau$, where $\text{cov}(u^j_\tau, V_\tau|\Omega_{\tau-1}) = 0$.

Proposition 1 confirms conventional wisdom about how capitalization policy affects earnings levels and earnings volatility:

Proposition 1. *CF and AP imply that for all* $\tau > 0$:

i. If $\Gamma \geq 1$, *then* $E[x_\tau^{i:C}|\Omega_0] \geq E[x_\tau^{i:E}|\Omega_0]$ for $i \in \{FC, SE, FE\}$ and $E[x_\tau^{FC:k}|\Omega_0] \geq E[x_\tau^{SE:k}|\Omega_0] \geq E[x_\tau^{FE:k}|\Omega_0] fork \in \{C,E\}$.
ii. $\rho_\tau^{SE:C} > \rho_\tau^{FC:C} = \rho_\tau^{FE:C} = 0 > \rho_\tau^{FC:E} = \rho_\tau^{FE:E} and\, \rho_\tau^{SE:E} = (1 - \psi/\xi)\rho_\tau^{FC:E}$.
iii. $\text{var}(x_\tau^{SE:C}|\Omega_{\tau-1}) > \text{var}(x_\tau^{FC:C}|\Omega_{\tau-1}) = \text{var}(x_\tau^{FE:C}|\Omega_{\tau-1}) = 0$, $\text{var}(x_\tau^{FC:E}|\Omega_{\tau-1} = \text{var}(x_\tau^{FE:E}|\Omega_{\tau-1}) > 0$ *and* $\text{var}(x_\tau^{SE:E}|\Omega_{\tau-1}) = (1 - \psi/\xi)^2 \text{var}(x_\tau^{FC:E}|\Omega_{\tau-1})$.

Proof. All proofs are in Appendix B.

Part (i) of Proposition 1 confirms the intuition that immediate expensing reduces earnings for firms with growing expected cash flows. For example, $E[x_\tau^{i:C}|\Omega_0] \geq E[x_\tau^{i:E}|\Omega_0]$ means that expected earnings when development costs are unconditionally capitalized exceed expected earnings when development costs are unconditionally expensed. Likewise, $E[x_\tau^{FC:k}|\Omega_0] \geq E[x_\tau^{SE:k}|\Omega_0]$ means that expected earnings under full costing are greater than or equal to expected earnings under successful efforts.

Part (ii) of Proposition 1 implies that SE accounting yields more price relevant accounting numbers than FC and FE accounting independent of whether development costs are capitalized or expensed. Moreover, $SE:C$ earnings are strictly positively correlated to price. In contrast, $FC:E$ and $FE:E$ earnings are negatively correlated to price. The final equality in part (ii) implies that, when per-well development cost ξ exceeds per-well exploration cost ψ, then $SE:E$ earnings are also negatively correlated to price.

Part (iii) of Proposition 1 concerns earnings volatility. It implies that SE earnings are more volatile than FC and FE earnings when development costs are capitalized. However, if development costs are expensed, then $SE:E$ earnings are less volatile than $FC:E$ and $FE:E$ earnings if per-well development costs are sufficiently large compared to per-well exploration costs (e.g. $\xi > \psi/2$). Otherwise, $SE:E$ earnings are less volatile than $FC:E$ and $FE:E$ earnings.

Parts (ii) and (iii) of Proposition 1 are consistent with prior empirical findings that SE earnings and book values are more price relevant than FC or FE earnings and book values (Harris and Ohlson, 1987; Bandyopadhyay, 1994). Based on a sample of oil and gas firms, Harris and Ohlson report that book values under SE accounting correlate more strongly to market price than book values under FC accounting. In addition, Harris and Ohlson find that SE book values have more explanatory power than FC book values.[1] Bandyopadhyay compares earnings response coefficients (ERCs) of SE and FC oil and gas firms around their quarterly earnings announcements. Bandyopadhyay finds that SE ERCs are larger than FC ERCs after controlling for self-selection factors such as risk and earnings predictability.

Proposition 1 focuses on earnings properties. Proposition A.1 in Appendix A extends Proposition 1 to make statements about book values under the different capitalization policies.

4. Earnings Growth and Capitalization Policy

Ohlson and Juettner-Nauroth (2005) and Yee (2005) identify expected earnings, the cost of capital, expected earnings growth and long-run expected earnings growth as determinants of equity value. However, existing theory does not model the relationship between capitalization policy and the earnings growth trajectory. While Feltham and Ohlson (1996) and Zhang (2000) link long-run expected earnings growth with the asymptotic valuation function, they are silent about *short-run* expected earnings growth and how capitalization policy affects expected earnings growth.

The model laid out in Section 2 fills the gap in the literature by linking capitalization to expected earnings growth and showing how capitalization policy matters as follows. CF and AP imply that[2]

$$E[x_\tau|\Omega_0] = \left\{1 - (\psi + \xi\theta)N + \left(\frac{\Gamma - 1}{\Gamma - \delta_0}\right)N\Delta\right\}\Gamma^{\tau-1}cr_1 + (1 - \delta_0)\left\{\frac{Ncr_1\Delta}{\Gamma - \delta_0} - oa_0\right\}\delta_0^{\tau-1} \quad \text{EX}$$

where $\Gamma \equiv \gamma + \rho\xi\theta N$ and $\Delta \equiv \delta_e\psi + (\delta_{es}\psi + \delta_d\xi)\theta$ reflects the impact of capitalization policy. A capitalization policy such as $FC : C$ that capitalizes more E&D costs is associated with a larger Δ value than another capitalization policy, such as $FC : E$ or $SE : C$, that capitalizes less. Equation EX shows that expected earnings is a linear combination of a term that compounds according to Γ and a term that compounds according to the depreciation parameter δ_0.

Proposition 2 shows that capitalization policies that capitalize more E&D costs result in smaller expected earnings growth in the short run:

Proposition 2. *Let* $G_\tau^j \equiv E[x_{\tau+1}^j|\Omega_0]/E[x_\tau^j|\Omega_0]$ *denote the growth of expected earnings for* $j \in \mathbf{J}$ *and any* $\tau \geq 1$. *Then CF and AP imply that for all* $\tau \geq 1$:

i. *If* $\Gamma \geq 1$, *then* $G_\tau^{FC:k} < G_\tau^{SE:k} < G_\tau^{FE:k}$ *for* $k \in \{C,E\}$ *and* $G_\tau^{i:C} < G_\tau^{i:E}$ *for* $i \in \{FC, SE, FE\}$.
ii. *If* $\Gamma = \delta_0$, *then* $G_\tau^j = \Gamma$.

Proposition 2 implies that, for a firm with positive expected cash flow growth, the growth rate of expected earnings is larger when exploration or development costs are expensed than when exploration or development costs are capitalized.

Two mutually reinforcing effects drive this result. First is a denominator effect: by suppressing current earnings, taking an expense at τ enhances G_τ^j by making its denominator smaller. Second is a numerator effect: taking an upfront expense at τ alleviates future depreciation charges that would drag down the numerators of $\{G_{\tau+s}^j\}_{s=0}^{\infty}$.

Expected earnings growth varies substantially across capitalization policies. Figure 2 depicts G_τ^j for the six capitalization policies when $\Gamma = 1.1 > \delta_0$. As shown

$$G_\tau^{FC:C} < G_\tau^{FC:E} < G_\tau^{SE:C} < G_\tau^{FE:C} < G_\tau^{SE:E} < G_\tau^{FE:E}$$

for all $\tau \geq 2$, which is consistent with Proposition 2.

When expected cash flows shrink at the knife-edge rate that exactly equals the depreciation rate (so that $\Gamma = \delta_0$), expected earnings do not grow under any capitalization policy. In this knife-edge case, the depreciation charge exactly equals expenditures so that, regardless of capitalization policy, expected earnings shrinks at the same rate as expected cash flows.

Proposition 2 is silent about expected earnings growth when expected cash flows shrink not at the depreciation rate ($\Gamma < 1$ and $\Gamma \neq \delta_0$). In this case, expected earnings may grow or shrink. This means that the rate of expected

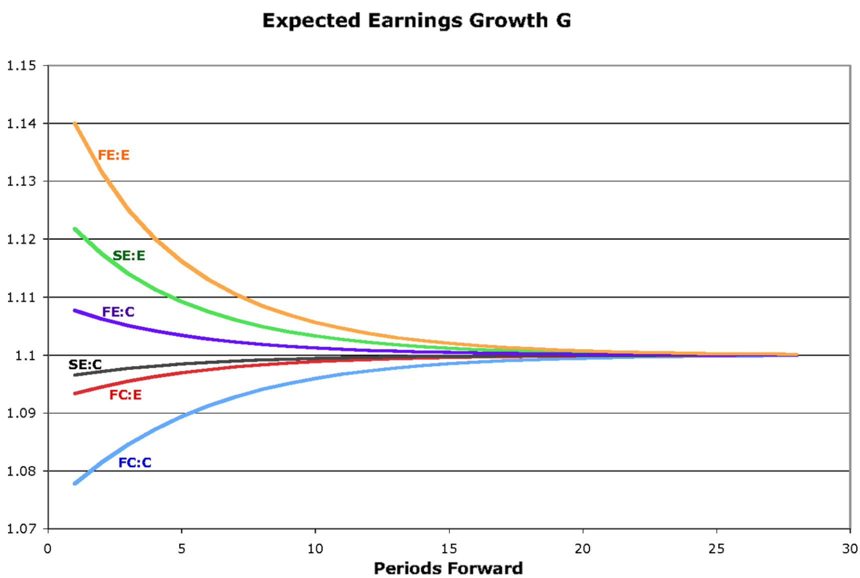

Figure 2. Expected earnings growth when $\Gamma = 1.1 > \delta_0$. As depicted, more capitalization-intensive policies result in smaller expected earnings growth. In the long run, however, expected earnings growth converges to $\Gamma = 1.1$, expected free cash flow growth, for all capitalization policies. Thus, capitalization policy matters only in the short run, not the long run

earnings *shrinkage* may be more for capitalizing firms than for expensing firms. This situation is depicted in Figure 3, where $\delta_0 < \Gamma < 1$. As depicted, when τ is sufficiently small

$$E[x_\tau^{FC:C}|\Omega_0] > E[x_\tau^{FC:E}|\Omega_0] > E[x_\tau^{SE:C}|\Omega_0] > E[x_\tau^{SE:E}|\Omega_0]$$
$$> E[x_\tau^{FE:C}|\Omega_0] > E[x_\tau^{FE:E}|\Omega_0].$$

However, these inequalities do not persist indefinitely. If the initial amount of capitalized assets is sufficiently large, the capitalization overhang induces depreciation charges that eventually overwhelm revenues and cause expected earnings to shrink. Since the capitalization overhang is bigger under accounting policies that capitalize more, the ranking of expected earnings completely reverses in Figure 3 when $\tau = 15$ and

$$E[x_\tau^{FC:C}|\Omega_0] < E[x_\tau^{FC:E}|\Omega_0] < E[x_\tau^{SE:C}|\Omega_0] < E[x_\tau^{SE:E}|\Omega_0]$$
$$< E[x_\tau^{FE:C}|\Omega_0] < E[x_\tau^{FE:E}|\Omega_0].$$

Aboody and Lev (1998) report that the US Software Publishers Association (SPA) in 1996 faced exactly such a reversal of accounting fortunes. Apparently,

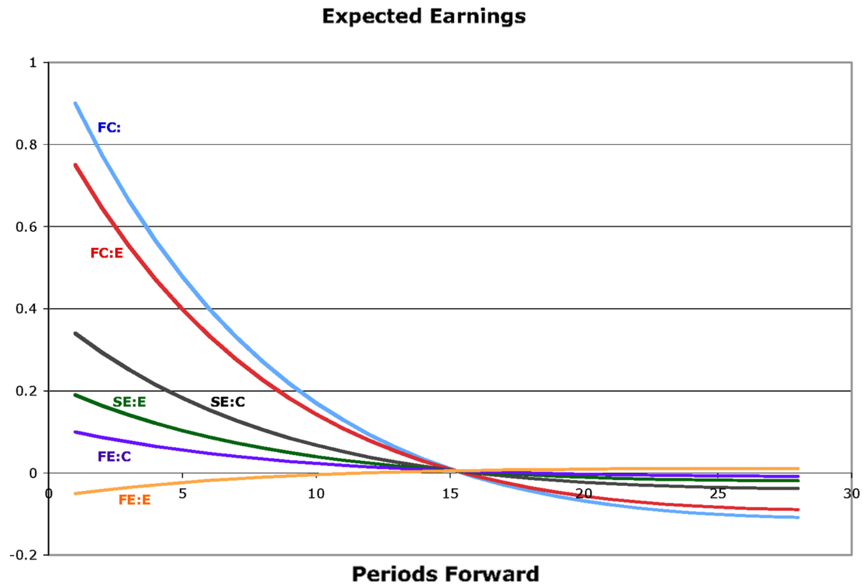

Figure 3. Expected earnings according to equation EX with $\delta_0 < \Gamma < 1$ and $oa_0/cr_1 > 1 - (\psi + \xi\theta)N$. As depicted, the rank ordering of expected earnings across capitalization policies flips at $\tau = 15$. This is because the capitalization overhang, which accrues faster under policies that capitalize more, dominates and drags down expected earnings growth in the long run

prior software capitalization had created such an overhang that amortization expenses started to exceed new cash expenditures for software development and, thus, act as a drag on earnings. Thus, SPA proposed abolishing capitalization of software development and to allow members to take a one-time write-off of capitalized software.

5. Capitalization Policy Invariance of Long-Run Expected Earnings Growth

Proposition 2 holds that conservative accounting enhances short-run expected earnings growth. This is because upfront expenses reduce the capitalization overhang and, accordingly, future depreciation expenses. Do conservative capitalization policies also enhance long-run expected earnings growth?

Examination of Figure 2 reveals that, in the long run ($\tau > 25$ in Figure 2), every G_τ^j converges to a common value, $\Gamma = 1.1$, regardless of its short-run value. In particular, $G_\tau^{FC:C}$, $G_\tau^{FC:E}$ and $G_\tau^{SE:C}$ converge to $\Gamma = 1.1$ from below whereas the other three growth paths approach $\Gamma = 1.1$ from above. More generally, there is no rule that constrains expected earnings growth rates to one side of Γ. Growth rates are sensitive to book value bias and the size of the existing capitalization overhang.

Proposition 3 shows that these properties hold generally.

Proposition 3. *CF implies that* $\lim_{\tau\to\infty} E[c_{\tau+1}|\Omega_0]/E[c_\tau|\Omega_0] = \Gamma$. *CF and AP imply that*

$$\lim_{\tau\to\infty} \frac{E[x^j_{\tau+1}|\Omega_0]}{E[x^j_\tau|\Omega_0]} = \max\{\Gamma, \delta_0\} \quad \textit{for all } j \in \mathbf{J}.$$

Proposition 3 says that long-run expected earnings growth is capitalization policy invariant. Regardless of capitalization policy and how it affects short-run expected earnings growth, the long-run expected earnings growth rate is determined completely by the long-run growth rate of expected free cash flows and the depreciation rate, whichever is larger. If free cash flows are expected to manifest positive long-run growth ($\Gamma > 1$), then long-run expected earnings growth is completely determined by Γ since $\delta_0 < 1$. On the other hand, if free cash flows are expected to shrink in the long run and the rate of shrinkage exceeds the depreciation rate $1 - \delta_0$, then the long-run earnings growth rate is determined by δ_0. In the latter scenario, expected earnings are overwhelmed by depreciation expenses stemming from the capitalization overhang, which is shrinking at a lower rate than free cash flows. The capitalization policy parameters $\{\delta_e, \delta_{es}, \delta_d\}$ do not affect long-run expected earnings growth in any scenario.

6. Conclusion

While capitalization is a central accounting concept, the existing literature does not provide a model that captures how capitalization policy affects earnings levels and expected earnings growth. This paper fills the void by offering an analytically tractable model of E&D activity in which development expenditures are contingent on the success of antecedent exploration. The model sheds light on how capitalization policy changes the price relevance of earnings and short- and long-run expected earnings growth rates. The main take-away is that capitalization policy can and does cause expected earnings growth rates to vary substantially, and that the variation differs between the short and the long run. While this take-away is not surprising, this paper is the first to capture it in a tractable analytic framework that integrates price relevance properties with short- and long-run expected earnings growth.

The first result, Proposition 1, implies that SE accounting leads to more price relevant earnings than full costing or full expensing earnings. While this concept itself is not new, it is useful to see it captured in a formal analytical model.

The second and third results, Propositions 2 and 3, concern earnings growth and are new. Proposition 2 reveals how the expected earnings growth path is altered by capitalization policy. As illustrated in Figure 2, the expected earnings growth rate of aggressively expensing firms exceeds that of capitalizing firms for all finite time horizons. Hence, capitalization aggressiveness affects expected earnings growth in a systematic way. Proposition 3 links the long-run growth rate of expected earnings directly to that of cash flows. In the long run, cash flow growth and depreciation compete to determine the expected earnings growth rate. If cash flows are expected to grow in perpetuity, then cash flow growth wins the competition and the rate of long-run expected earnings growth converges to the expected cash flow growth rate. This situation is depicted in Figure 2.

If cash flows are expected to shrink in the long run, then expected long-run earnings also shrink and may even become negative. This scenario is depicted in Figure 3. The shrinkage rate is the smaller of the long-run cash flow shrinkage rate and the depreciation rate. In either case, the growth or shrinkage rate of long-run expected earnings is independent of capitalization policy. Long-run expected earnings growth can depend on only the expected cash flow growth (or shrinkage) rate or the depreciation rate. Therefore, the expected earnings growth rate in the long run is capitalization policy invariant.

These findings suggest several avenues for further research. For example, it would be interesting to extend the model here to analytically study the Beaver and Ryan (2005) numerical simulation of conditional conservatism. Basu (1997, p. 4) define conditional conservatism as the 'tendency to require a higher degree of verification for recognizing good news than bad news', and note that conditional conservatism implies that 'earnings reflects bad news more quickly than good news' (1997, p. 4). SE accounting is conditionally conservative in that it expenses costs associated with failed exploration immediately and capitalizes costs associated with successful exploration. In comparison, full expensing is unconditionally conservative while FC accounting can be thought of as being unconditionally unbiased. Beaver and Ryan show that the impact of conditional conservatism (e.g. the treatment of second-stage development costs) depends on whether the firm uses SE or FC treatment for first-stage exploration costs. Beaver and Ryan conclude that excessive unconditional conservatism hinders the effectiveness of conditional conservatism. Perhaps, their important result could be generalized using the modeling approach proposed in this paper.

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Appendix A: Impact of Capitalization Policy on Book Values

Proposition A.1 extends Proposition 1 to book values and compares the properties of book value across capitalization regimes:

Proposition A.1. *CF and AP imply that, for all* $\tau > 0$:

i. $oa_\tau^{FC:k} \geq oa_\tau^{SE:k} \geq oa_\tau^{FE:k}$ *for* $k \in \{C,E\}$ *and* $oa_\tau^{i:C} \geq oa_\tau^{i:E}$ *for* $i \in \{FC, SE, FE\}$.
ii. $\mathrm{cov}(oa_\tau^{SE:k}, V_\tau|\Omega_{\tau-1}) > \mathrm{cov}(oa_\tau^{FC:k}, V_\tau|\Omega_{\tau-1}) = \mathrm{cov}(oa_\tau^{FE:k}, V_\tau|\Omega_{\tau-1})$ *for* $k \in \{C, E\}$ *and* $\mathrm{cov}(oa_\tau^{SE:C}, V_\tau|\Omega_{\tau-1}) > \mathrm{cov}(oa_\tau^{SE:E}, V_\tau|\Omega_{\tau-1}) > 0$.
iii. $\mathrm{cov}(oa_\tau^{FC:E}, V_\tau|\Omega_{\tau-1}) = \mathrm{cov}(oa_\tau^{FE:E}, V_\tau|\Omega_{\tau-1}) = 0$.

The first two parts of Proposition A.1 confirm intuition that expensing leads to more conservative book values. Part (i) says that, independent of the treatment of development costs, full expensing is more conservative than successful efforts, which is more conservative than full costing. Likewise, independent of the treatment of exploration costs, expensing development costs leads to smaller book values than capitalizing development costs.

The remaining two parts of Proposition A.1 characterize how capitalization policy affects the price relevance of book value. Part (ii) says that, independent of the treatment of development costs, book value under SE accounting for exploration costs is more price relevant than under full costing or full expensing. Under SE accounting, exploration expenses are proportional to the number of productive wells. Thus, SE accounting induces book values to depend on the number of productive wells, which is predictive of future cash flows. In contrast, exploration expenses do not depend on the number of dry holes under FC and FE accounting. The second part of part (ii) says that treatment of development costs can enhance the price relevance of book value by making book value reflect the number of productive wells. Accordingly, book value is more price relevant when development costs are capitalized. Part (iii) says that book value is not price relevant under FC and FE accounting when development costs are expensed. This is because under $FC:E$ and $FE:E$ accounting book values do not reflect any information about the number of productive wells.

Proposition A.1 is consistent with the empirical findings of Harris and Ohlson (1987) and Bandyopadhyay (1994). Yee (2006) describes how book value bias affects accounting-based equity valuation functions and identifies the special valuation functions that are invariant to book value bias.

Appendix B: Proofs

Proof of Proposition 1. Taking the partial derivative of equation EX yields

$$\frac{\partial E[x_\tau|\Omega_0]}{\partial \Delta} = \{(\Gamma - 1)\Gamma^{\tau-1} + (1-\delta_0)\delta_0^{\tau-1}\}\left(\frac{Ncr_1}{\Gamma - \delta_0}\right).$$

This implies that $\partial E[x_\tau|\Omega_0]/\partial\Delta > 0$ whenever $\Gamma \geq 1$. Thus, when $\Gamma \geq 1$ expected earnings at each date are monotonically ranked according to the values of the capitalization function Δ, whose values are listed in Table B1 in the proof of Proposition 2. When $\Gamma < 1$, the sign of the first factor of $\partial E[x_\tau|\Omega_0]/\partial\Delta$ may be either positive or positive depending on depreciation policy. Thus, there is no analogous ranking when $\Gamma < 1$. This proves part (i) of Proposition 1.

Next, AP implies

$$x_\tau = \left\{1 - \left(1 - \delta_e - \delta_{es}\frac{s_\tau}{N}\right)\psi N - (1-\delta_d)\xi s_\tau\right\}cr_\tau - (1-\delta_0)oa_{\tau-1}.$$

For $k \in \{C,E\}$, this implies

$$x_\tau^{FC:k} = \{1 - (1-\delta_d(k))\xi s_\tau\}cr_\tau - (1-\delta_0)oa_{\tau-1}^{FC:k}$$
$$x_\tau^{SE:k} = \left\{1 - \left(1 - \frac{s_\tau}{N}\right)\psi N - (1-\delta_d(k))\xi s_\tau\right\}cr_\tau - (1-\delta_0)oa_{\tau-1}^{SE:k}$$
$$x_\tau^{FE:k} = \{1 - \psi N - (1-\delta_d(k))\xi s_\tau\}cr_\tau - (1-\delta_0)oa_{\tau-1}^{FE:k}$$

Table B1. The value of Δ associated with each capitalization policy in the proof of Proposition 1

Capitalization policy j	Δ
$FC:C$	$\psi + \xi\theta$
$FC:E$	ψ
$SE:C$	$\psi\theta + \xi\theta$
$SE:E$	$\psi\theta$
$FE:C$	$\xi\theta$
$FE:E$	0

where $\delta_d(C) = 1$ and $\delta_d(E) = 0$. This means that

$$x_\tau^{FC:k} = x_\tau^{SE:k} + \left(1 - \frac{s_\tau}{N}\right)\psi N cr_\tau + (1 - \delta_0)[oa_{\tau-1}^{SE:k} - oa_{\tau-1}^{FC:k}]$$
$$x_\tau^{SE:k} = x_\tau^{FE:k} + \psi s_\tau cr_\tau + (1 - \delta_0)[oa_{\tau-1}^{FE:k} - oa_{\tau-1}^{SE:k}]$$
$$x_\tau^{FC:k} = x_\tau^{FE:k} + \psi N cr_\tau + (1 - \delta_0)[oa_{\tau-1}^{FE:k} - oa_{\tau-1}^{FC:k}]$$

Parts (ii) and (iii) of Proposition 1 follow from these expressions, the expression for V_τ given in the main text, that $oa_{\tau-1}^j \in \Omega_{\tau-1}$, that

$\text{cov}(oa_{\tau-1}^j, cr_\tau|\Omega_{\tau-1}) = \text{cov}(oa_{\tau-1}^j, s_\tau cr_\tau|\Omega_{\tau-1}) = 0$, that
$\text{cov}(cr_\tau, cr_\tau|\Omega_{\tau-1}) = \text{cov}(cr_\tau, s_\tau cr_\tau|\Omega_{\tau-1}) = 0$ and that

$\text{cov}(s_\tau cr_\tau, s_\tau cr_\tau|\Omega_{\tau-1}) = N\theta(1-\theta)cr_\tau^2 > 0, \quad \text{where} cr_\tau = (\gamma + \rho\xi s_{\tau-1})cr_{\tau-1}.$
Together, these expressions imply

$$\text{cov}(x_\tau^{FC:k}, V_\tau|\Omega_{\tau-1}) = \text{cov}(x_\tau^{FE:k}, V_\tau|\Omega_{\tau-1}) = -(1 - \delta_d(k)) \times \left(\frac{1 - \psi N - \xi\theta N}{R - [\gamma + \rho\xi\theta N]}\right)\rho\xi^2 N\theta(1-\theta)cr_\tau^2$$
$$\text{cov}(x_\tau^{SE:k}, V_\tau|\Omega_{\tau-1}) = \left\{\frac{\psi}{\xi} - (1 - \delta_d(k))\right\} \times \left(\frac{1 - \psi N - \xi\theta N}{R - [\gamma + \rho\xi\theta N]}\right)\rho\xi^2 N\theta(1-\theta)cr_\tau^2$$

and

$$\text{var}(x_\tau^{FC:k}|\Omega_{\tau-1}) = \text{var}(x_\tau^{FE:k}|\Omega_{\tau-1}) = (1 - \delta_d(k))^2\xi^2 N\theta(1-\theta)cr_\tau^2$$
$$\text{var}(x_\tau^{SE:k}|\Omega_{\tau-1}) = \left\{\frac{\psi}{\xi} - (1 - \delta_d(k))\right\}^2 \xi^2 N\theta(1-\theta)cr_\tau^2.$$

Comparing these expressions with $\delta_d \in \{0,1\}$ implies

$$\text{cov}(x_\tau^{SE:E}, V_\tau|\Omega_{\tau-1}) = \left(1 - \frac{\psi}{\xi}\right)\text{cov}(x_\tau^{FC:E}, V_\tau|\Omega_{\tau-1})$$

and the variance relations stated in Proposition 1. Identifying
$\rho_\tau^j = \text{cov}(x_\tau^j, V_\tau|\Omega_{\tau-1})/\text{var}(V_\tau|\Omega_{\tau-1})$ completes the proof.

Proof of Proposition 2. Following equation EX, $G_\tau^j \equiv E[x_{\tau+1}^j|\Omega_0]/E[x_\tau^j|\Omega_0]$ may be written as

$$G_\tau^j = \left(\frac{1+(\delta_0/\Gamma)^\tau z^j}{1+(\delta_0/\Gamma)^{\tau-1}z^j}\right)\Gamma$$

where

$$z^j = (1-\delta_0)\left\{\frac{N\Delta - (\Gamma-\delta_0)(oa_0/cr_1)}{(\Gamma-\delta_0)[1-(\psi+\xi\theta)N]+(\Gamma-1)N\Delta}\right\}$$

and j refers to capitalization policy. Capitalization policy is determined by the capitalization function $\Delta \equiv \delta_e\psi + (\delta_{es}\psi + \delta_d\xi)\theta$, which takes on the values listed in Table B1.

Table B1 implies that

$$\Delta^{FC:k} > \Delta^{SE:k} > \Delta^{FE:k} \quad \forall k \in \{C,E\}$$
$$\Delta^{i:C} > \Delta^{i:E} \quad \forall i \in \{FC, SE, FE\}.$$

Since the capitalization function assumes strictly bigger values in some capitalization regimes than others, the variation of expected earnings growth G_τ^j across capitalization regimes is determined by how G_τ^j varies with Δ. The chain rule implies that

$$\frac{\partial G_\tau^j}{\partial \Delta} = \frac{\partial G_\tau^j}{\partial z^j}\frac{\partial z^j}{\partial \Delta} = -(1-\delta_0)(\Gamma-\delta_0)^2 N \frac{(\delta_0/\Gamma)^{\tau-1}}{(1+(\delta_0/\Gamma)^{\tau-1}z^j)^2}$$
$$\frac{[1-(\psi+\xi\theta)N+(\Gamma-1)(oa_0/cr_1)]}{\{(\Gamma-\delta_0)[1-(\psi+\xi\theta)N]+(\Gamma-1)N\Delta\}^2}.$$

The fact that $\partial G_\tau^j/\partial\Delta$ is proportional to $(1-\delta_0)$ indicates that it is the capitalization overhang that causes the expected earnings growth to vary across capitalization regimes. Since $0 < \delta_0 < 1$ by construction of AP, if $\Gamma \neq \delta_0$, then

$$\operatorname{sign}\left[\frac{\partial G_\tau^j}{\partial \Delta}\right] = -\operatorname{sign}[1-(\psi+\xi\theta)N+(\Gamma-1)(oa_0/cr_1].$$

Recalling that $1-(\psi+\xi\theta)N > 0$ and $oa_0/cr_1 \geq 0$ by construction of AP, one sees immediately that

$$\frac{\partial G_\tau^j}{\partial \Delta}\begin{cases} < 0 & \text{if } \Gamma \geq 1 \\ = 0 & \text{if } \Gamma = \delta_0. \end{cases}$$

On the other hand, if $\Gamma < 1$ and $\Gamma \neq \delta_0$, the sign of $\partial G_\tau^j/\partial\Delta$ may go either way depending on the relative magnitudes of $1-(\psi+\xi\theta)N$ and oa_0/cr_1. Thus, the rate of expected earnings growth of firms with shrinking cash flows varies across capitalization regimes in more complex ways than that of firms with growing cash flows.

Proof of Proposition 3. It is straightforward to show that CF implies $\lim_{\tau\to\infty} E[c_{\tau+1}|\Omega_0]/E[c_\tau|\Omega_0] = \Gamma$. CF and AP imply that, under capitalization policy $\{\delta_e, \delta_{es}, \delta_d\}$

$$oa_\tau = \delta_0\, oa_{\tau-1} + \delta_e \psi N cr_\tau + (\delta_{es}\psi + \delta_d \xi) s_\tau\, cr_\tau$$
$$x_\tau = \left\{1 - \left(1 - \delta_e - \delta_{es}\frac{s_\tau}{N}\right)\psi N - (1-\delta_d)\xi s_\tau\right\} cr_\tau - (1-\delta_0) oa_{\tau-1}$$

for all $\tau \geq 1$. Recall that $\Omega_0 = \{oa_0, cr_0, ce_0, cd_0\}$. If $\Gamma \neq \delta_0$, iterating these equations yields that, for $\tau \geq 1$,

$$E[oa_\tau|\Omega_0] = \delta_0^\tau oa_0 + \{\delta_e\psi + (\delta_{es}\psi + \delta_d\xi)\theta\}\left[\frac{\Gamma^\tau - \delta_0^\tau}{\Gamma - \delta_0}\right] N cr_1$$
$$\begin{aligned} E[x_\tau|\Omega_0] = &\{1 - (1 - \delta_e - \delta_{es}\theta)\psi N - (1-\delta_d)\xi\theta N\}\Gamma^{\tau-1} cr_1 \\ &- (1-\delta_0)\delta_0^{\tau-1} oa_0 - (1-\delta_0)\{\delta_e\psi + (\delta_{es}\psi + \delta_d\xi)\theta\} \\ &\times \left[\frac{\Gamma^{\tau-1} - \delta_0^{\tau-1}}{\Gamma - \delta_0}\right] N cr_1 \end{aligned}$$

where $cr_1 = \gamma cr_0 + \rho cd_0$. On the other hand, if $\Gamma = \delta_0$, iterating the same equations yields that, for $\tau \geq 1$

$$E[oa_\tau|\Omega_0] = \{oa_0 + (\delta_e\psi + (\delta_{es}\psi + \delta_d\xi)\theta)\Gamma^{-1}\tau N cr_1\}\Gamma^\tau$$
$$E[x_\tau|\Omega_0] = \left\{\begin{array}{l} \{1 - (1 - \delta_e - \delta_{es}\theta)\psi N - (1-\delta_d)\xi\theta N\} cr_1 \\ -(1-\delta_0)\{oa_0 + (\delta_e\psi + (\delta_{es}\psi + \delta_d\xi)\theta)\Gamma^{-1} \\ (\tau - 1) N cr_1\} \end{array}\right\}\Gamma^{\tau-1}.$$

The latter expression implies that

$$\lim_{\tau\to\infty} E[x_\tau|\Omega_0] \sim$$
$$\begin{cases} \left\{\frac{1}{N} - (1-\delta_e-\delta_{es}\theta)\psi - (1-\delta_d)\xi\theta - (1-\delta_0) \left(\frac{\delta_e\psi + (\delta_{es}\psi + \delta_d\xi)\theta}{\Gamma - \delta_0}\right)\right\}\Gamma^{\tau-1} N cr_1 & \text{if } \Gamma > \delta_0 \\ -(1-\delta_0)(\delta_e\psi + (\delta_{es}\psi + \delta_d\xi)\theta)\tau N cr_1 \Gamma^{\tau-2} & \text{if } \Gamma = \delta_0 \\ -(1-\delta_0)\left[oa_0 + \left(\frac{\delta_e\psi + (\delta_{es}\psi + \delta_d\xi)\theta}{\delta_0 - \Gamma}\right) N cr_1\right]\delta_0^{\tau-1} & \text{if } \Gamma < \delta_0. \end{cases}$$

(The symbol '$\sim$' means 'asymptotically converges to'.[3]) Thus, the long-run growth rate of expected operating earnings is max $\{\Gamma, \delta_0\}$.

Proof of Proposition A.1. Since $oa_0^{FE:k} = oa_0^{SE:k} = oa_0^{FC:k} = oa_0$ for $k \in \{C,E\}$, AP implies

$$oa_\tau^{FE:k} = \delta_0^\tau oa_0 + \sum_{s=1}^{\tau} \delta_0^{\tau-s}[\delta_d(k)cd_s]$$

$$oa_\tau^{SE:k} = \delta_0^\tau oa_0 + \sum_{s=1}^{\tau} \delta_0^{\tau-s}\left[\frac{s_s}{N}ce_s + \delta_d(k)cd_s\right]$$

$$oa_\tau^{FC:k} = \delta_0^\tau oa_0 + \sum_{s=1}^{\tau} \delta_0^{\tau-s}[ce_s + \delta_d(k)cd_s]$$

where $\delta_d(C) = 1$ and $\delta_d(E) = 0$. Moreover, CF implies $cr_s > 0$ for all $s \geq 0$, which implies $ce_s \geq (s_s/N)ce_s = \psi s_s cr_s \geq 0$ and $cd_\tau = \xi s_\tau cr_\tau \geq 0$. With this in mind, part (i) of Proposition A.1 follows from inspection of these expressions for oa_τ^j.

Next, AP implies that, under capitalization policy $\{\delta_e, \delta_{es}, \delta_d\}$,

$$oa_\tau = \delta_0 oa_0 + \delta_e \psi N cr_\tau + (\delta_{es}\psi + \delta_d \xi)s_\tau cr_\tau.$$

$\text{cov}(oa_{\tau-1}^j, cr_\tau|\Omega_{\tau-1}) = \text{cov}(oa_{\tau-1}^j, s_\tau cr_\tau|\Omega_{\tau-1}) = 0$ because $oa_{\tau-1}^j \in \Omega_{\tau-1}$. CF implies that $\text{cov}(cr_\tau, cr_\tau|\Omega_{\tau-1}) = \text{cov}(cr_\tau, s_\tau cr_\tau|\Omega_{\tau-1}) = 0$ and $\text{cov}(s_\tau cr_\tau, s_\tau cr_\tau|\Omega_{\tau-1}) = N\theta(1-\theta)cr_\tau^2 > 0$, where $cr_\tau = (\gamma + \rho\xi s_{\tau-1})cr_{\tau-1}$. Thus, plugging in the expression for V_τ given in the main text yields

$$\text{cov}(oa_\tau, V_\tau|\Omega_{\tau-1}) = \left(\frac{1 - \psi N - \xi\theta N}{R - [\gamma + \rho\xi\theta N]}\right)\rho\xi(\delta_{es}\psi + \delta_d\xi)N\theta(1-\theta)cr_\tau^2.$$

Plugging in the values of $\{\delta_{es}, \delta_d\}$ corresponding to the six capitalization policies under consideration and comparing the resulting values of $\text{cov}(oa_\tau^j, V_\tau|\Omega_{\tau-1})$ yields the remaining parts of Proposition A.1.

Notes

[1]Bryant (2003) finds that regression models with both FC book values and FC earnings as explanatory variables have more explanatory power than analogous models with SE book values and SE earnings as explanatory variables. In light of Harris and Ohlson, Bryant's results imply that FC book values and FC earnings provide better *incremental* information than SE book values and SE earnings to the other information variables in her regressions.

[2]This formula, which is valid for all $\tau \geq 1$, is derived in the proof of Proposition 3.

[3]Formally $\lim_{\tau\to\infty} A \sim B$ if, and only if, for any $\varepsilon > 0$, there exists a $T > 0$ such that $\|A - B\| < \varepsilon$ for all $\tau > T$.

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