

Efficiency Properties of Impairment Accounting in Debt Contracting

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Abstract

This study shows that conservatism, in the form of accounting for impairments, can serve to improve the efficiency of project choices and subsequent continuation decisions when firm managers acting on behalf of shareholders have discretion over projects after taking on debt. The model considers projects characterized by stochastic abandonment and continuation value processes where abandonment may occur at an interim date. Debt covenants determine whether the firm's shareholders or its creditors control the continuation decision. The main result is that impairment accounting can serve as a commitment to avoid inefficient project selection. Because the value of debt and, hence, the value of shareholders' equity reflects the firm's anticipated project choice, the firm benefits from this commitment. Noteworthy is that the accounting policy plays a crucial role in that merely tightening thresholds for technical default does not achieve similar efficiency.

1. Introduction

A frequent claim in the literature is that accounting conservatism contributes to debt contracting efficiency.¹ However, recent theoretical research finds that conservative accounting yields costly reductions in information that may actually inhibit efficient debt contracting.² Our purpose in this paper is to show that conservatism, in the form of what we term “impairment accounting”, can increase debt contracting efficiency when used as the basis for covenants that transfer control rights to creditors if violated.

We define impairment accounting as the valuation of assets at the minimum of the present value of expected future payoffs (continuation value) and value in liquidation (abandonment value). Broadly speaking, our analysis applies to cases where continuation and abandonment values of investment projects financed through debt evolve over time and covenants pertaining to continuation decision rights depend on values reported in financial statements that, in turn, depend on accounting policies in force. The firm’s manager acting on behalf of shareholders may alter project choices after finalizing the debt contract. At an interim date, the project chosen may be abandoned leading to realization of its abandonment value or it may be continued until a completion date when project payoffs will be realized. Debt covenants determine who possesses these continuation decision rights. Accounting policies play a crucial role in efficiently resolving incentive conflicts between creditors and shareholders; tightening covenants alone may be insufficient.

The principal insight to emerge from our results is that conservative accounting penalizes inefficient project choices relatively severely. In particular, impairment accounting expands the

¹ Debate on the role of conservatism in debt contracting is usefully summarized by Watts (2003a, 2003b).

² See Gigler, Kanodia, Sapat, and Venugopalan (2006).

prospect of continuation rights for inferior projects being transferred to creditors who would then choose to abandon too frequently. Stockholders understand this prospect and are deterred from investing in such projects once debt contracts are in place.

An example of impairment accounting in practice is the impairment test applied to asset groups such as business segments. This test calls for comparing the present value of expected future cash flows with preexisting book values to determine if a write down is required. One can interpret our continuation values as the former and abandonment values as a stylized representation of the latter. This interpretation of abandonment values is apt where project cash flows are reinvested and book value, inclusive of the initial investment in the project and assets arising from re-investment, approximates proceeds if the project is liquidated. While our model may not conform as directly to impairment accounting applied to other classes of assets,³ showing circumstances where impairment accounting dominates less conservative valuation policies is, we believe, a useful step toward our understanding of conservatism's potential contribution to debt contracting efficiency.

Elaborating on modeling details, the firm obtains financing by taking on pure discount debt that matures at the future date when payoffs are realized.⁴ The debt market is competitive and comprised of risk neutral lenders so that the debt proceeds equal the expected value of debt given the creditor's rational conjecture about the firm's project choice. As mentioned, the debt contract also includes a covenant. Covenants considered in the analysis specify a threshold for the value reported in the firm's statement of financial position that if not exceeded transfers continuation decision rights from shareholders to creditors. Depending on the accounting policy

³ Further discussion on applications of our model results to practice is provided in Section 5.

⁴ All of our results continue to hold in a qualitative sense for coupon debt.

in place, this threshold may alternatively be based on the continuation value of the project, its abandonment value, or the minimum of the continuation value and abandonment value (impairment accounting) at the interim date.⁵

There are conflicts of interest between shareholders and creditors relating to project selection and subsequent continuation. We assume that project choice decisions are made after covenants have been set and that these choices are non-contractible. In this regard, it would be a rare circumstance where the firm's managers do not have at least some post-contracting discretion over investments outside the purview of creditors. After establishing the debt contract, it may be feasible for the firm's managers to increase the value of equity by choosing suboptimal projects that transfer wealth from creditors to shareholders. Such inefficient projects are attractive when the reduction in creditor wealth exceeds the reduction in overall firm value. Even absent project selection conflicts, if shareholders of a levered firm are endowed with abandonment-continuation decision rights unmitigated by covenants, then they too often continue projects that should be abandoned. If creditors hold those rights, then they too often abandon projects that should be continued.

Of course, a competitive debt market and rational expectations imply that shareholders bear the cost of inefficient project selection and continuation decisions. Our analysis focuses on the choice of an accounting policy and a related covenant to reduce these costs. Covenants based on impairment accounting are effective at balancing the costs of inefficient continuation decisions with the costs of inefficient project choices. Tightening covenant thresholds without

⁵ While covenants based on a vector of both continuation and abandonment values are ruled out as inconsistent with conventions governing values reported in formal statements, as we later observe, such covenants produce efficient continuation decisions for a fixed project, but yield inefficient project selection when the firm has post-contracting discretion.

impairment accounting is unable to induce efficient project choices in some cases and in others transfers control rights to creditors too often, resulting in excess abandonment of firm value-enhancing projects.

Comparing the properties of each of the above classes of covenants with the case of no covenant leads to the following observations: A covenant that sets a threshold for transferring control rights based on abandonment value alone substantially reduces the prospect of inefficient continuation decisions by shareholders, but enhances the prospect of inefficient abandonment decisions by creditors. A covenant that sets such a threshold based on continuation value alone substantially reduces the prospect of inefficient continuation decisions by both shareholders and creditors. Last, a covenant that sets the threshold based on the minimum of continuation and abandonment values (impairment accounting) substantially reduces the prospect of inefficient continuation decisions by shareholders, but does not reduce the prospect of inefficient abandonment decisions by creditors as much as a covenant based on continuation values alone. This difference plays a principal role in inducing efficient project selection in certain scenarios.

For a fixed project choice, a covenant based on both continuation value and abandonment value is first-best; i.e., eliminates inefficient continuation decisions entirely. However, allowing for project selection within a non-trivial set of parameters characterizing the investment opportunity set, a covenant based on the minimum of continuation and abandonment values dominates covenants based on both values and either of those values individually.⁶ Said another way, our results identify conditions under which impairment accounting uniquely allows for debt covenants that implement projects maximizing the values of the firm and shareholders' equity.

⁶ Covenants based on impairment accounting also dominate covenants based on abandonment values even when the firm has no discretion over projects.

As is common in the finance literature on capital structure, numerical analysis is used to develop the principal results.⁷ Specifically, we consider two project selection problems displaying conditions under which impairment accounting dominates other accounting policies in terms of debt contracting efficiency. The first represents an asset substitution problem in which the firm's shareholders have the opportunity to pursue a riskier, but lower growth, project than may have been assumed at the time of contracting. Smith and Warner (1979) describe this as a source of conflict between shareholders and creditors that bond covenants are intended to mitigate.⁸ While rational creditors can price protect through the maturity value that they require, *sans* covenants, once price has been set, shareholders would still choose such an inferior project in equilibrium to their detriment. A covenant based on impairment accounting implies a larger region (than one based on continuation value) in which control rights are transferred to creditors resulting in a greater prospect of abandoning projects that shareholders would prefer to continue. This prospect may be sufficient to deter shareholders from choosing riskier, lower growth projects.

The second project selection problem involves a decline in the abandonment value of assets. This reflects either the wasting of assets possibly due to agency problems, or investments in project specific assets with eroding resale values. Such projects reduce firm value but, again, depending on the covenant and related accounting policy, they may be preferred by shareholders. A declining expected value from abandonment increases the likelihood of continuation regardless of whether creditors or shareholders control the continuation decision at the interim

⁷ See Goldstein, Ju and Leland (2001), Hennessy and Whited (2005, 2007), Leland (1998), and Tsyplakov (2008). A precedent in the accounting literature is Verrechia (1986).

⁸ Note that, due to the abandonment option, an increase in variance of the continuation value process alone also increases the present value of expected future payoffs. Therefore, an inferior risky project must have a low drift that offsets the value created by higher volatility *per se*.

date. However, from a project selection perspective, shareholders are deterred from choosing a project that leads to greater abandonment by creditors as would be the case under impairment accounting when compared to covenants based on continuation value.

Generalizing from discrete project selection as described above, we portray an efficient frontier characterizing feasible investment opportunities and tangency with shareholder indifference curves based on our examples; albeit, exercising some academic license with a free parameter. The characteristics of the project selection problems depicted by our examples and related generalization provide a basis for empirically observable cross-sectional differences in accounting policy preferences and covenant design. In particular, high technology firms appear likely to face project opportunity sets in which alternatives to project choices that are optimal under efficient continuation decisions include some with greater risk and lower growth and others involving loss of abandonment value over time.

The remainder of this paper is organized as follows: Section 2 reviews the prior literature. Section 3 lays out the basic model, Section 4 characterizes covenants based on information assumed to be available at an interim date when a covenant would be applied, Section 5 develops a numerical example that establishes contracting efficiency properties of alternative covenant types, Section 6 provides some thoughts relating the model to practice, and Section 7 concludes.

2. Prior Literature

Similar to Décamps and Faure-Grimaud (2002) our basic model portrays continuation and abandonment values as geometric Brownian motions. Leland (1998) considers a similar problem in which a firm can continuously choose between a high and low risk project modeled as changes to the diffusion coefficient on a project value process. In contrast, our model provides for a singular project choice decision subsequent to debt contracting and an option to

abandon at a later interim date. Moreover, the focus in our analysis is on the role of accounting policy choices on the effectiveness of covenants that transfer control rights from shareholders to creditors.

Gigler, Kanodia, Sapatra, and Venugopalan (2006) posit a similar model in which they assume a constant abandonment value with a fixed project choice and show that a covenant can implement efficient continuation decisions. Our finding that firms can obtain first-best results absent project choice implies that their result extends to more general settings so long as the firm has little to no leeway in project choice. However, as previously mentioned, first-best covenants for fixed projects may be strictly inferior to covenants based on impairment accounting when the firm has latitude in its post-contracting project choice.

Another related paper by Smith (2007) analyzes the effect of accounting conservatism from a regulator's perspective in a setting where investors sell a firm to new owners who then choose whether to abandon a project. He finds that conservative accounting can be optimal when investors expect the project to be abandoned. Göx and Wagenhofer (2008) consider impairment accounting in a moral hazard setting. They analyze a situation in which a firm must have sufficient capital to compensate lenders in the event that a project fails. The accounting system provides a signal of the value of the firm's assets at the time of borrowing that lenders use in assessing the firm's creditworthiness. Their model deals with post-contracting moral hazard and does not analyze post-contracting project selection and continuation decisions that are of interest in our paper.

Chava and Roberts (2007) lend empirical support to our focus on covenants that convey control rights control rights to creditors upon violation of debt covenants including covenants related to values appearing in statements of financial position. They provide strong evidence of

such transfers of rights in cases of covenant violations by firms more likely to be subject to agency and informational problems. Their findings of investment declines in these cases can be interpreted in the context of our model as a consequence of disinvestment in the form of project abandonment. Their discussion of the rationale for covenants that transfer control rights specifically refers to the “asset substitution” incentive of shareholders; a conflict of interest especially relevant to our inquiry given the results mentioned earlier.

Bushman and Piotroski (2006) find an association between accounting conservatism and the quality of countries’ court systems and prevalence of private borrowing.⁹ Ball, Bushman and Vasvari (2008) find evidence that conservative accounting facilitates loan syndication where the primary concern is a conflict between the lead bank and other syndicate members.¹⁰ Beatty, Weber and Yu (2008) find evidence that contract-specific accounting measures do not fully substitute for conservatism in the reported financial statements and that firms with high agency costs of debt employ both.¹¹ These empirical studies all suggest an association between accounting conservatism and debt contracts, but do not specifically identify conservatism with impairment accounting or address the issues of project selection and continuation choices.

Consistent with the predictions of our study, Zhang (2008) finds empirical evidence that conservative accounting benefits lenders *ex post* by signaling default risk so that they can take protective actions. She also finds that borrowers benefit from this *ex ante* via lower borrowing costs. While Zhang (2008) is not specific about the protective actions available to lenders in the event of a technical default, the results are consistent with this paper’s notion of giving creditors control over continuation decisions.

⁹ Also see the discussion by Guay and Verrecchia (2006).

¹⁰ Also see the discussion by Beatty (2008).

¹¹ Also see the discussion in Guay (2008).

3. Model

3.1. Basic Structure

This section derives the dynamics of the value process for a given project and also derives the shareholders' and creditors' decision criteria for abandoning the project at the interim date. The model consists of three dates illustrated in Figure 1. At Time 0, the firm borrows funds from creditors using zero coupon debt to invest in a project that will be chosen after signing the debt contract. At Time 1, the project may be abandoned, in which case the shareholders receive any residual of the abandonment value over the value of the debt. If the project is instead continued, then it yields a terminal value at Time 2 and shareholders receive any residual of the terminal value over the face value of the debt.

(Insert Figure 1 About Here)

Given the project choice, the dynamics of the firm value are similar to Décamps and Faure-Grimaud (2002) where the firm consists of the rights held by shareholders to invest in a project with a future payoff that depends on whether the project is continued to completion or abandoned at an interim date. The continuation and abandonment values, v_t and s_t , respectively, evolve according to the following stochastic differential equations

$$\frac{dv_t}{v_t} = \mu_v dt + \sigma_v dz_{vt} \quad \frac{ds_t}{s_t} = \mu_s dt + \sigma_s dz_{st} \quad (1)$$

where z_{vt} and z_{st} are correlated Brownian motions with $dz_{vt} dz_{st} = \rho dt$. Implementing the project requires an investment of s_0 all of which must be financed through pure discount debt with maturity value M due at the time of the project's completion. The debt market is competitive and all parties are risk neutral with a discount rate r . A debt covenant agreed to at

the time of borrowing specifies the technical default conditions under which creditors control the abandonment decision.

If abandoned, the project realizes a value s_1 and the shareholders must pay the creditors the present value $e^{-r} M$ of the Time 2 maturity value or default, in which case creditors receive s_1 . If continued, the project realizes a value v_2 with creditors receiving the lesser of M or v_2 and shareholders receiving any excess of v_2 over M .

The firm value is the following where I_c is an indicator variable that equals 1 when the project is continued at Time 1 and equals 0 otherwise:

$$e^{-2r} E[I_c v_2] + e^{-r} E[(1 - I_c) s_1]$$

Given a continuation policy, competitive pricing of the debt implies a maturity value that satisfies the following condition:

$$s_0 = E[I_c e^{-2r} \min\{v_2, M\} + (1 - I_c) e^{-r} \min\{s_1, e^{-r} M\}]. \quad (2)$$

The *ex ante* payoff for shareholders is, therefore,

$$\begin{aligned} E[I_c e^{-2r} \max\{0, v_2 - M\} + (1 - I_c) e^{-r} \max\{0, s_1 - e^{-r} M\}] \\ = e^{-2r} E[I_c v_2] + e^{-r} E[(1 - I_c) s_1] - s_0 \end{aligned} \quad (3)$$

The right-hand-side of (3) shows that the shareholders' *ex ante* value is the firm value less the value s_0 of debt. Shareholders bear the costs of inefficient project selection and continuation policies; however, apart from covenants to a debt contract, shareholders are unable to commit *ex ante* to an efficient policy.

The choice of a debt covenant impacts both the project selection and continuation policies by determining whether creditors or shareholders have control over the continuation decision. Without a covenant, continuation decision rights at Time 1 would remain with

shareholders. Shareholders, acting in their self interest at Time 1, would continue projects in some states for which an optimal *ex ante* continuation policy would have chosen to abandon. For example, shareholders never prefer to abandon a project when the abandonment proceeds are insufficient to pay creditors. Abandoning in such cases guarantees that the shareholders receive nothing whereas continuing provides, at worst, an out-of-the-money call option on the project that offers some chance, however remote, of receiving a payoff. Accordingly, without an ability to commit to a continuation policy, the value of the firm (project *cum* abandonment option) is diminished and, given a competitive and rational debt market, shareholders bear the loss. On one hand, a debt covenant that transfers continuation rights to creditors in states where abandonment is optimal from a firm-wide standpoint, but suboptimal for shareholders at Time 1, may be valuable as a commitment device.¹² On the other hand, creditors in some states have incentive to abandon projects too often so that transferring decision rights to creditors may lead to inefficient abandonment decisions.

The firm's investment opportunity set is common knowledge. However, the choice of a project by shareholders from that set is not contractible. While it may be possible to distinguish between some easily identifiable investments, management under the direction of shareholders plausibly have discretion over a range of less identifiable investments that may vary in their risk and return characteristics and for which writing detailed contracts to eliminate that discretion would be prohibitively costly. Debt covenants impact project choices by altering the distribution of control rights with the consequence that shareholders may find some projects unattractive if their continuation is likely to be controlled by creditors. While transferring control over

¹² If creditors were endowed with exclusive continuation rights, then they would have incentive to sub-optimally abandon a project in cases where the abandonment value, though less than the present value of the project, is greater than the discounted maturity value of debt.

continuation decisions to creditors may result in inefficient abandonment, this prospect may be worthwhile if it yields an improvement in project choice that outweighs the cost of excessive abandonment.

Information available for debt contracting is provided by the firm's accounting system. Consistent with the periodic nature of financial accounting reports, this information is determined from the values of projects observable at Time 1 in our model. At issue in later sections are the firm's choices of (i) what project to select under a given covenant and related accounting policy, (ii) how best to structure a covenant based on information supplied by financial statements, and (iii) what accounting policy to follow in the construction of those statements. Below we identify a benchmark first-best continuation policy for a fixed project and the shareholders' and creditors' continuation preferences. The actual continuation policy depends on the shareholders' and creditors' preferences and on the allocation of control rights.

3.2. First-Best Continuation Policy

The present value of continuing a project at Time 1 is

$$e^{-r} E[v_2 | v_1, s_1] = e^{-r} E[v_2 | v_1] = e^{\mu - r} v_1 \quad (4)$$

implying a first-best policy of continuing the project if and only if

$$e^{\mu - r} v_1 \geq s_1. \quad (5)$$

Ex ante (at Time 0) the value of the firm under this strategy is the expected present value of the project if continued plus the present value of an option to exchange the project for its abandonment value at Time 1:

$$\begin{aligned}
& e^{-2r} E[v_2 | e^{\mu_v - r} v_1 \geq s_1] P(e^{\mu_v - r} v_1 \geq s_1) + e^{-r} E[s_1 | e^{\mu_v - r} v_1 < s_1] P(e^{\mu_v - r} v_1 < s_1) \\
& = e^{-2r} E[v_2] + e^{-r} E[\max\{0, s_1 - e^{\mu_v - r} v_1\}] \\
& = e^{2(\mu_v - r)} v_0 \Phi \left(-\frac{\log(s_0/v_0) + \mu_s - 2\mu_v + r - (\sigma_v^2 + \sigma_s^2 - 2\rho\sigma_v\sigma_s)/2}{\sqrt{\sigma_v^2 + \sigma_s^2 - 2\rho\sigma_v\sigma_s}} \right) \\
& \quad + e^{\mu_s - r} s_0 \Phi \left(\frac{\log(s_0/v_0) + \mu_s - 2\mu_v + r + (\sigma_v^2 + \sigma_s^2 - 2\rho\sigma_v\sigma_s)/2}{\sqrt{\sigma_v^2 + \sigma_s^2 - 2\rho\sigma_v\sigma_s}} \right), \tag{6}
\end{aligned}$$

where $\Phi(\cdot)$ denotes a standard normal distribution.

It is useful to observe that in the context of our model where the value of the firm consists of the expected value of the project augmented by the value of an abandonment option, increasing the variance of the project's continuation value process alone is insufficient to produce a project substitution problem. Specifically, as long as the variance of the continuation value process is greater than the variance of the abandonment value process, then increasing the variance increases the value of the abandonment option without reducing the expected continuation value of the project. The abandonment option allows the firm to exit poorly performing high risk projects while continuing those that perform well; i.e., for which the risk is paying off. Hence, *ex ante* commitment by shareholders *ceteris paribus* to choose the project with the highest variance is both desirable and sustainable *ex post*. In order to create a conflict of interest between creditors and shareholders, shareholders must have further discretion such as in the continuation policy or other aspects of the continuation or abandonment value processes. Table 1 summarizes the sensitivities of firm value to various parameters of these processes.

(Insert Table 1 About Here)

3.3. Shareholders' Continuation Preferences

If shareholders retain the continuation rights at Time 1, then a project will be continued if and only if the present value of their expected payoff from continuing is not exceeded by their expected payoff from abandoning at that time. The former (latter) can be expressed as the value of a long position in a European call option on the project for which the exercise price equals maturity value (discounted maturity value) of the debt and the exercise date is Time 2 (immediate). Shareholders prefer to continue the project if and only if:

$$e^{-r} E[\max\{0, v_2 - M\} | v_1] \geq \max\{0, s_1 - e^{-r} M\}. \quad (7)$$

Shareholders will always continue if $s_1 < e^{-r} M$ since abandonment in this case implies they receive nothing and the option characteristic of continuation implies a strictly positive value. If $s_1 > e^{-r} M$, then the continuation policy can be expressed as the present value of the debt under abandonment plus the aforementioned call option on the project exercisable at Time 2:

$$\begin{aligned} s_1 &\leq e^{-r} M + e^{-r} E[\max\{0, v_2 - M\} | v_1] \\ &= e^{\mu_v - r} v_1 \Phi\left(\frac{\log(v_1/M) + \mu_v + \sigma_v^2/2}{\sigma_v}\right) + e^{-r} M \Phi\left(-\frac{\log(v_1/M) + \mu_v - \sigma_v^2/2}{\sigma_v}\right) \\ &\equiv \underline{s}_e(v_1). \end{aligned} \quad (8)$$

Recall that values of s_1 less than $e^{-r} M$ also imply continuation. Hence, (8) is a necessary and sufficient condition for continuation by shareholders.

The function \underline{s}_e demarks the threshold for continuation by shareholders and ranges from a minimum of $e^{-r} M$ at $v_1 = 0$, increasing monotonically without bound toward an asymptote $e^{\mu_v - r} v_1$, the first-best threshold. The bold line in Figure 2 provides an illustration of

the boundary of set of (v_1, s_1) values for which shareholders prefer to continue the project.

Shareholders prefer to continue projects for any (v_1, s_1) values that lie below and to the right of the bold line. This is a strict superset of the values for which continuation is efficient, where the efficient set of continuation values lies below and to the right of the line $s_1 = e^{\mu_v - r} v_1$.

(Insert Figure 2 About Here)

3.4. Creditors' Continuation Preferences

The analogous condition to (7) for creditors is expressible as follows:

$$e^{-r} E[\min\{v_2, M\} | v_1] \geq \min\{s_1, e^{-r} M\}. \quad (9)$$

Similar to the case for shareholders, the necessary and sufficient condition for continuation by creditors can be expressed as the Time 1 present value of the debt's maturity value less a put option on the project exercisable at Time 2:

$$\begin{aligned} s_1 &\leq e^{-r} M - e^{-r} E[\max\{0, M - v_2\} | v_1] \\ &= e^{\mu_v - r} v_1 \Phi\left(-\frac{\log(v_1/M) + \mu_v + \sigma_v^2/2}{\sigma_v}\right) + e^{-r} M \Phi\left(\frac{\log(v_1/M) + \mu_v - \sigma_v^2/2}{\sigma_v}\right) \\ &\equiv \underline{s}_d(v_1). \end{aligned} \quad (10)$$

The function \underline{s}_d demarks the threshold for continuation by creditors with asymptotes $e^{\mu_v - r} v_1$, the first-best threshold, as v_1 approaches 0, and $e^{-r} M$ as v_1 goes to infinity. The thin line in Figure 2 provides an illustration. Creditors prefer to continue projects for which (v_1, s_1) lies below and to the right of the thin line. This is a strict subset of the efficient continuation region which, in turn, is a strict subset of the values of (v_1, s_1) for which shareholders prefer to continue. It is apparent that the boundaries of the optimal continuation policies of shareholders and creditors never coincide. The difference in thresholds equals the sum of values of a put option

and a call option on the project exercisable at Time 2. This difference is strictly positive reflecting the fact that shareholders are always more willing than creditors to continue the project.

It can be further shown that the maturity value of the debt and the continuation rights afforded creditors act as partial substitutes suggesting a demand for covenants that convey such rights as a means to reduce the cost of financing projects. That is, the value of debt is increasing in both the maturity value of debt and in the likelihood that creditors control the continuation decision so that the two can be substituted when crafting a debt contract that satisfies the creditors' breakeven condition (2).

4. Covenant Orderings: Fixed Project

4.1. Covenants and Financial Reports

In this section, we consider the properties of covenants based on values reported under alternative accounting methods suppressing, for the moment, project choice subsequent to debt contracting.

Although we begin by considering the case where both continuation and abandonment values are reported, we later focus on cases where just one value is reported such as might appear on a formal statement of financial position. These include continuation value and the minimum of continuation value and abandonment value; i.e., impairment accounting. We also consider the case where only abandonment value is reported. However, as we will show, this choice is always dominated in maximizing firm value by impairment accounting.

4.2. First-Best Covenants for a Fixed Project

Given a fixed project, if both the continuation and abandonment values are reported and contractible, then the shareholders can implement the first-best continuation policy through a

covenant that transfers continuation rights to creditors if and only if the following condition is met:

$$s_1 > e^{\mu_v - r} v_1. \quad (11)$$

From the illustration of continuation policies in Figure 2, it is evident that creditors would make first-best continuation decisions in the region where (11) is satisfied and that shareholders would do so in the region where the inequality in (11) is reversed as in (5).

Firm value at Time 0 under a debt contract with the above first-best covenant is given by (6), while (2) ensures the value of the debt is s_0 . Firm value is invariant to changes in the maturity value of debt under such a covenant. Given an arbitrary maturity value, the value of the debt at time 0 can be expressed as the discounted expected value conditional on continuing plus the discounted expected value of an abandonment option under a first-best covenant:

$$e^{-2r} E[\min\{v_2, M\}] + e^{-r} E[I_{s_1 > e^{\mu_v - r} v_1} (\min\{s_1, e^{-r} M\} - e^{-r} E[\min\{v_2, M\} | v_1])]. \quad (12)$$

It is straightforward to verify that the value of debt is monotonically increasing in the maturity value, implying that there exists a unique M that solves (2).¹³

The ability to replicate the first-best continuation policy through a debt covenant conditional on project choice is similar to Gigler, Kanodia, Saprà, and Venugoplan's (2006) result that a continuation policy can be set independently of the debt maturity value when the abandonment value (in their model) is known *ex ante*. Knowledge of the abandonment value allows them to derive the first-best continuation policy and then determine the debt's maturity value conditional on that policy. We obtain a similar result here because the continuation policy

¹³ We note that $\min\{s_1, e^{-r} M\} - e^{-r} E[\min\{v_2, M\} | v_1] > 0$ for values above the creditor's abandonment threshold \underline{s}_1 and this threshold is bounded above by $e^{\mu_v - r} v_1$.

is independent of creditors' or shareholders' preferred policies were they to have the continuation rights. Subsequent cases consider covenants that cause continuation decisions to depend on such preferences and, therefore, on maturity values. In these cases we use (2) to determine maturity values. In the event of multiple solutions to (2) for a given continuation threshold policy, we will use the solution that has the smallest maturity value.

Notably, as we will show later, the first-best covenants conditional on a given project need not be optimal when the project choice follows the issuance of the debt and that choice is not contractible. In this richer case, covenants and maturity values are based on creditor's conjectures about the project selected rather than the project *per se*. Furthermore, the covenant triggers rely on values generated by the projects rather than the project selection, itself. Hence, once the covenants are in place, shareholders may have incentives to substitute a project that works more to their advantage under those covenants. Of course, in equilibrium creditors anticipate this behavior and price the debt accordingly so that the shareholders bear the consequences of such distortions from first-best project selections.

4.3. Covenants Based on Abandonment Value

In order to model an accounting system that reports the abandonment value, let \bar{s} denote the threshold such that continuation rights are conveyed to creditors when

$$s_1 < \bar{s}. \quad (13)$$

The following indicator function depicts continuation under this covenant:

$$I_c^s = I_{e^{\mu v - r} v_1 \geq s_1} + I_{s_1 > \bar{s}} I_{e^{\mu v - r} v_1 \leq s_1 \leq \bar{s}_c} - I_{s_1 < \bar{s}} I_{e^{\mu v - r} v_1 \geq s_1 > \bar{s}_d}. \quad (14)$$

The terms on the right hand side of (14) are indicator functions for continuation under a first-best covenant for a fixed project, additional (excessive) continuation by equity holders when rights

are retained, and additional (excessive) abandonment by creditors when rights are conveyed, respectively. Figure 3a illustrates regions of inefficiency stemming from excessive continuation and excessive abandonment by comparison to a first-best covenant.

(Insert Figure 3 About Here)

4.4. *Covenants Based on Impairment Accounting*

In the case of impairment accounting, let \bar{m} be the threshold such that continuation rights are conveyed to creditors when

$$\min\{s_1, e^{h_v-r} v_1\} < \bar{m}. \quad (15)$$

Setting \bar{m} equal to the optimal threshold for a covenant based on abandonment value, \bar{s}^* , it is apparent that continuation rights would be conveyed to creditors in a region that would reduce excessive continuation by shareholders (compare Figure 3b to Figure 3a). Moreover, the value of debt is increasing in the degree to which creditors control the continuation decision. As a result, the conveyance of greater continuation rights to creditors would enable shareholders to reduce the maturity value of the debt and still find takers. Together these observations imply dominance of impairment accounting over abandonment value for covenant purposes.¹⁴

4.5. *Covenants Based on Continuation Value*

Last, when the accounting reports the continuation value of the project, let \bar{v} be the threshold such that continuation rights are conveyed to creditors when

$$v_1 < \bar{v}. \quad (16)$$

¹⁴ Formally, the firm value with an impairment covenant with a threshold constrained to equal \bar{s}^* yields a higher firm value than the firm value with an abandonment value covenant. The firm value with impairment accounting without this constraint must be at least as high, so that impairment accounting dominates abandonment value accounting.

The ordering between covenants based on impairment accounting and continuation values is more complex in this setting. Figure 4 depicts this comparison.

(Insert Figure 4 About Here)

In effect, a covenant based on continuation value allows shareholders to retain additional continuation rights by comparison to a covenant based on impairment accounting. As illustrated in Figure 4b, this reduces excessive abandonment by creditors. However, what is not apparent from the figure, the covenant based on continuation value involves a reduction in creditors' control rights relative to the covenant based on the minimum of continuation and abandonment values. Merely dropping the threshold for the abandonment value from the impairment covenant reduces creditors' control and the shareholders must compensate for this reduction in control with a higher maturity value or a stricter threshold (higher v_1 cutoff), *ceteris paribus*. The higher maturity value creates inefficiencies by pushing shareholders' and creditors' continuation preferences further from first-best. Which effect dominates is parameter specific and therefore ambiguous.

In the example of Figure 4, a covenant based on continuation value dominates. Creditors are compensated by a stricter threshold on continuation values than implied by the optimal threshold for impairment accounting. The adjustment is small and yields a net reduction in continuation inefficiencies so that overall firm value increases. Allowing for changes to both maturity value and covenant threshold would yield a further increase in firm value. However, we have yet to consider project choice.

5. Optimal Covenants with Project Choice

5.1. Project Choice Set

In this section, we revisit the choice between covenants based on continuation value and those based on impairment accounting allowing for shareholders' choice of a project after debt contracting. Recall our assumption that project choice is not contractible. We believe this setting is representative of the discretion afforded managers with respect to investing activities once funding has been obtained. As discussed previously, *ceteris paribus*, an increase in the variance of a project as measured by the diffusion parameter σ_v increases firm value given an abandonment option, implying the absence of an agency conflict. Accordingly, ordering projects requires consideration of changes in drift coefficients μ_v or μ_s , as well as variances.

Because it is not possible to derive closed-form solutions for optimal covenant thresholds given project selection, we resort to numerical examples. The examples are illustrative of classes of projects for which covenants based on impairment accounting are more effective in inducing efficient project choices. We later generalize by superimposing these discrete project choices onto an efficient frontier and applying stockholder indifference curves conditioned on the type of covenants and related accounting policies to determine characteristics of inefficient projects such covenants would eliminate.¹⁵

We calibrate the examples as follows: For our baseline Project A, the risk free rate is 0.05 as in Décamps and Faure-Grimaud (2002) which is between 0.045 used by Goldstein, Ju, and Leland (2001) and 0.06 used by Leland (1998) in a similar model focused on continuous choice between high and low variance projects rather than a one-time choice with an

¹⁵ The efficient frontier requires fixing a free parameter, implying arbitrariness. However, the indifference curves are fully determined from the model specifications.

abandonment option. The drift parameters for continuation value of the project μ_v and abandonment value μ_s are double and half the risk free rate, respectively. The diffusion parameter for the continuation value process σ_v is 0.40 also from Décamps and Faure-Grimaud (2002) while that for the abandonment value process σ_s is half at 0.20 consistent with less volatile values in abandonment. The correlation is set at 0.40 based on the correlation between log asset and log market value returns of *Compustat* firms. The initial continuation and abandonment values are set at 100. These parameters imply that the *ex ante* value of the project, inclusive of the abandonment option, is 120.

There are two alternatives to the baseline project, Projects *B* and *C*. Project *B* reflects declining abandonment values possibly reflecting agency concerns in the form of consuming the abandonment value or erosion of abandonment value due to asset specificity. Specifically, the drift $\mu_s = -0.03$ is negative for Project *B*. A diminishing abandonment value benefits shareholders *ex post* by increasing the likelihood of continuation. Project *C* reflects an asset substitution problem in which the firm pursues a riskier project with volatility $\sigma_v = 0.6$. Because the firm has an option to abandon the project, volatility increases firm value, *ceteris paribus*, whereas an increase in volatility has no effect on the continuation value, itself.¹⁶ In order to offset the value created by higher volatility so that Project *C* is indeed inferior to Project *A*, we assume that Project *C* has a lower drift $\mu_v = 0.01$. Project *C* therefore represents a riskier project with lower expected payoffs that appeals to shareholders only because the wealth transfer from

¹⁶ The dynamics (1) of the continuation value process imply that $E[v_{t+1} | v_t] = e^{\mu_v} v_t$, which does not depend on volatility. The firm value under first-best continuation given by (6) is increasing in volatility because the abandonment option allows the firm to back out of risky projects that perform poorly.

creditors vis-à-vis Project A has the potential to exceed the reduction in firm value. This set of projects is apropos of investment opportunity sets for high technology firms. Table 2 summarizes the example parameters.

(Insert Table 2 About Here)

Projects B and C have *ex ante* values of approximately 118 and 116, respectively, that are lower than the 120 for Project A. Although Project C's higher variance of the continuation value process implies higher values for the option to default at maturity, this effect is more than offset by the lower growth in the project's continuation value.

Table 3 summarizes the project choices under the different covenants and Table 4 illustrates firm and equity values for the different combinations of assumed projects at the time of contracting and projects subsequently pursued by the firm. Table 4 makes apparent the incentive conflicts that arise with respect to the choice between Projects A, B, and C when covenants are set based on one or another of these projects under the alternative types of covenants.

(Insert Tables 3 and 4 About Here)

5.2. *Project Choices Given First-Best Covenants for a Fixed Project*

Previously, we characterized first-best covenants for a fixed project as one that transferred continuation rights to creditors when the firm-level abandonment value exceeds the firm-level present value of continuing as given by (11). However, covenants set in anticipation of shareholders choosing a project that maximizes firm value may create incentives for shareholders to select inferior projects; project choices that advance shareholders' interest at the expense of creditors. Rational creditors will recognize such incentives and require that the

maturity value of the debt be modified in a manner that imposes any loss of firm value on shareholders.

As shown in Panel A of Table 4, if a covenant of the first-best form given by (11) is set assuming that shareholders would choose Project *A*, then shareholders would prefer the choice of Project *C*, notwithstanding a loss in firm value. Project *C* is preferred because increasing the variance of the continuation value process increases the value of the option to default on the debt at maturity and this increase more than offsets the reduction in value from the lower drift. Again, rational creditors would anticipate this shift in projection selection and require a higher maturity value.

If the covenant is set assuming that shareholders would choose Project *B*, then, although Project *B* dominates Project *A*, Project *C* would still be preferred by shareholders. By choosing Project *C* when the covenant is based on Project *B*, shareholders reduce the region for transferring continuation rights to creditors, relative to first-best for Project *C*, resulting in more inefficient continuation. Shareholders cannot benefit from the higher volatility of Project *C* unless the project is continued, so that, post-contracting, they prefer this excessive continuation.

Last, if a covenant is set assuming that shareholders will choose Project *C*, then shareholders would choose Project *C*. Once the maturity value has been set anticipating this project choice, then it is the best shareholders can do.

The example implies scope for other types of covenants to outperform covenants of the form given by (11). In particular, as we will demonstrate, shareholders can do better if covenants are based on impairment accounting. We further observe that, while covenants of the form given by (11) require two values to be reported, accounting statements of financial position in accounting give precedence to a single value.

5.3. *Project Choices Given Covenants Based on Continuation Value Accounting*

Returning to our example, Table 4, Panel C illustrates the firm and equity values for different combinations of assumed and pursued projects when the firm uses a covenant of the form given by (16). A covenant based on continuation value also would not induce the choice of Project A; rather, if the covenant were set assuming that Project A would be chosen, then shareholders would choose Project C. A natural question is whether a stricter covenant threshold in the form of a higher \bar{v} will induce an efficient project choice. Thresholds above about 124 cause shareholders to have a post-contracting preference for Project A over Project C. On the other hand, such contracts cause shareholders to prefer Project B over Project A and therefore fail to induce an efficient project choice.

5.4. *Project Choices Given Covenants Based on Impairment Accounting*

Table 4, Panel B illustrates that basing a covenant of the form given by (15), i.e., impairment accounting, in our example implements Project A and increases the value of both the firm and shareholders' equity in equilibrium over a covenant based on continuation value. Project C is also implementable because the assumption of Project C at the time of contracting causes the shareholders to pursue Project C; however, this choice is strictly inferior to Project A. A comparison of Panels A and B of Table 4 also indicates that impairment accounting only produces modest inefficiencies in project continuation decisions. The firm value given Project A under is only slightly less than the value under a first-best continuation policy. Because the additional cost of inefficient continuation and abandonment induced by the impairment accounting are small relative to the cost of inefficient project choices induced by other accounting policies, impairment accounting appears to be an effective means of addressing both

inefficient continuation and inefficient project selection policies that arise from the conflicts of interest between shareholders and creditors.

Impairment accounting's penalty for risky projects arises from creditors' control rights when abandonment s_1 is relatively low compared to v_1 (see the bottom right quadrant on Figure 3b). Creditors hold a short put option that, as shown by their continuation preferences in (10), provides an incentive for them to abandon risky projects. The extra control rights granted to creditors with impairment accounting therefore have a greater impact on risky projects. In our example, impairment accounting increases the likelihood of abandoning Project *A* by only about 0.7 percentage points while it increases the likelihood of abandoning the riskier Project *C* by 8.8 percentage points. The higher likelihood of abandonment reduces the equity holders' chances of realizing the value from choosing the riskier project so that it becomes less attractive.

The effect of impairment accounting on the preference between Projects *A* and *B* stems from the fact that Project *B* is more likely to yield low abandonment values that, in turn, cede control rights to creditors implying a greater likelihood of inefficient abandonment.

Although the complexity of both a default option and abandonment option with a knockout provision compromises achievement of analytic results, it is evident that perturbing parameter values by small amounts preserves the orderings of project choices implying the existence of non-trivial regions in the parameter space such that impairment accounting enhances contracting efficiency.

5.5. Project choice with a continuum of projects

The preceding discussion assumes that the firm may choose between discrete Projects *A*, *B* and *C*. In practice, firms may have a wider and finer set of projects to pursue. In order to examine the effectiveness of different accounting rules in this setting, we consider an investment

opportunity set whose frontier includes projects *A*, *C* and a zero-volatility project that pays the risk-free rate.¹⁷ Figure 5 plots shareholders' indifference curves over (μ_v, σ_v) combinations when the debt contract assumes that the firm will pursue Project *A*. As previously discussed, the indifference curve with impairment accounting lies above Project *C* so that, post-contracting, shareholders prefer Project *A* to Project *C* with impairment accounting. The indifference curves under continuation value accounting and 'first-best' (for a fixed project) pass below Project *C* so that, post-contracting, shareholders prefer *C* to *A* with these forms of covenants.

(Insert Figure 5 About Here)

If the investment opportunity set were to include all (μ_v, σ_v) combinations within the curved line of Figure 5, a debt contract with impairment accounting that assumes the firm will pursue project *A* will dissuade shareholders from pursuing any inferior projects to the left of the point *P* noted on the figure, which corresponds to drift of 0.02 and volatility of 0.58.

Continuation-value and 'first-best' covenants induce the choice of projects where (μ_v, σ_v) lies to the right of the points $(-0.01, 0.62)$ and $(-0.04, 0.67)$, respectively, where the shareholders' indifference curves intersect the boundary of the investment opportunity set.

In this setting, there are available projects that shareholders would prefer to *A*, even under impairment accounting. Thus, if the investment opportunities are finer than in our previous analysis, a contract that assumes Project *A* and uses impairment accounting would not implement Project *A* as it does with the coarse investment opportunity set of the prior analysis. In order to determine what projects impairment accounting would implement with a richer investment

¹⁷ We omit Project *B* from this analysis because we frame the illustration in terms of trading continuation volatility σ_v against drift μ_v . The boundary of the investment opportunity set is a parabola that passes through the (μ_v, σ_v) combinations for Project *A*, Project *C* and a risk free project with $\sigma_v = 0$ and $\mu_v = r_f$.

opportunity set, we identify the project where the shareholders' indifference curve under impairment accounting is tangent to the curve representing investment opportunities. This project, denoted \bar{m} on Figure 5, yields an equity value of 17.3 versus the value of 19.5 obtainable when the firm can only choose between projects *A* and *C*. Similarly, the point \bar{v} on Figure 5 denotes the tangency project with continuation-value accounting. This project is inferior to the \bar{m} project and yields an equity value of 17.0. Last, the point *FB* on Figure 5 denotes the tangency project with 'first-best' accounting and yields a value of 16.9, which is inferior to the values obtainable under both impairment and continuation-value accounting.

Notwithstanding the possibility of impairment accounting allowing implementation of inferior projects such as those depicted by points \bar{m} , \bar{v} , and *FB* should they exist, such an accounting policy for debt contracting purposes rules out more higher variance/lower drift projects relative to Project *A* than any of the other accounting-based covenants considered. Impairment accounting also does as well as the other choices for covenants for all inferior projects with lower variance. This suggests a strict advantage to the use of impairment accounting in those industries more susceptible to shareholder discretion in choosing alternative projects of this description and weak dominance overall except for projects with variances greater than Project *A* and less than Project *P*.

The availability of inferior projects potentially reduces equilibrium shareholder value depending on characteristics of the set of alternative projects and the accounting policies upon which covenants transferring control rights may be based. Indeed, if the firm had no discretion over projects it could achieve a first-best outcome. Broadly speaking, the examples of this section suggest that the agency costs of debt decrease as the investment opportunities become more coarse, allowing the firm to implement relatively good projects without being penalized as

much as from strict debt contracts. Covenants based on impairment accounting perform well in comparison to those based on other accounting policies in circumstances analogous to those illustrated.

6. Relation to Practice

Although we chose an investment project as the object of financing for our model, nothing would be lost by assuming debt is issued to finance other types of assets with lives that extend beyond the maturity of the debt. The issue in relating our results to practice is the extent to which impairment accounting as defined in our model corresponds to conservatism as manifested in accounting valuation policies applied to those assets.

While impairment accounting in the sense of the lower of continuation and abandonment values departs from the notion of impairment tests as commonly understood in the context of a single asset for which the initial investment constitutes the measure of book value, the analogy applies more directly in the context of an asset group as defined by Statement of Financial Accounting Standards Nos. 142 and 144. In this context our abandonment value process can be interpreted as a stylized representation of book value of a development stage enterprise, production facility or business segment that has been financed by debt where book value consists of the initial outlay and subsequent stochastic changes in assets that result from reinvestment of interim cash flows and is a reasonable approximation of liquidation value. Given this interpretation, an impairment test comparing expected future cash flows and book value is similar to our definition of impairment accounting.¹⁸

¹⁸ In our model, expected cash flows are discounted whereas they are not under asset impairment tests.

Under certain circumstances our model provides a rationale for the lower of cost or market rule as applied to other assets that may be financed through debt such as inventories or receivables. Continuation value in the context of inventories may be viewed as net realizable value. Here again aggregate costs are likely to be susceptible to random shocks suggesting that abandonment values may be viewed as a stylized representation of book values. In the special case where book value approximates replacement cost and the inventory can be liquidated at that cost, then our model might apply to the valuation of inventories.¹⁹ The caveat is that, typically, merchandising firms are not in the position of manufacturers or wholesalers who serve as their suppliers. Rather their only recourse may be to sell through their usual outlets; i.e. at net realizable value. Hence, there may be no distinction between value if held (continuation value) or liquidated (abandonment value). A somewhat stronger case can be made for loan receivables when a liquid market exists for such financial assets.²⁰ In particular, if book value net of allowances for bad debts is an estimate of the present value of expected future collections and market value is the price at which receivables can be immediately sold, then an analogy seems plausible.

Another perspective on the applicability of our results to practice relates to U.S. GAAP (Generally Accepted Accounting Principles) and IFRS (International Financial Reporting Standards) procedures for determining fair value of financial instruments.²¹ Concepts of fair value range from market prices to estimates of the present value of expected future cash flows.

¹⁹ If the cost of inventories is always greater than both replacement cost and net realizable value and replacement cost approximates liquidation value, then our model applies quite well to the part of the lower of cost or market rule that sets net realizable value as a ceiling on replacement cost.

²⁰ However, the analogy would be inappropriate for trade receivables where fair value concepts are not directly applied.

²¹ For U.S. GAAP, the relevant standard is Statement of Financial Accounting Standards No. 157 and for IFRS it is International Accounting Standard No. 39.

At present, these alternatives are essentially posed as choices to be made according to a preference ordering; market value if a liquid market price is available and estimates of the present value of expected future cash flows otherwise. Our results are suggestive of efficiency consequences in debt contracting that may follow from an accounting policy applied to these alternatives. Specifically, if the rule for purposes of fair value disclosures was for firms to apply the lower of these two alternatives, then the analogy to our model is immediate.

7. Conclusion

The notion that conservative accounting policies contribute to debt contracting efficiency has been posited extensively in the accounting literature. In this study, we rationalize impairment accounting as a manifestation of conservatism that can enhance the efficiency of covenants that transfer control decisions to creditors contingent on investment performance. Investment projects are characterized by continuation and abandonment value processes. The role of covenants is to transfer continuation-abandonment rights to creditors if value thresholds are not met. Conflicts of interest between shareholders and creditors arise when debt contract terms set based on one project create incentives for shareholders to subsequently choose a different project that exploits creditors. Ultimately, creditors anticipate this conflict so that shareholders bear the costs of the ability to pursue inferior projects.

The accounting policy influences the structure of covenants and their properties in inducing project choices. Policies considered include reporting both continuation and abandonment values, the minimum of those two values as the representation of impairment accounting, continuation value, or abandonment value. Reporting both continuation and abandonment values is inconsistent with present accounting convention of reporting a single value in formal accounting statements of financial position. However, even if this were not the

case, optimal covenants of this form for fixed projects are generally sub-optimal when project choice follows debt contracting and is non-contractible itself.

Covenants based on impairment accounting tend to dominate those based on continuation value when projects maximizing firm value must compete with riskier lower growth projects or in settings where abandonment values are declining possibly due to agency issues or erosion in value of assets in place. In the former situation, a riskier project with lower expected value expands the region of inefficient abandonment under impairment accounting. This expansion takes away some of the value that shareholders may have hoped to obtain by choosing the riskier project, thereby deterring defection by shareholders to such projects. In the latter situation of declining abandonment values, lower abandonment values increase the likelihood of inefficient abandonment which, again, is sufficient to deter shareholder defection to such projects.

Speaking more broadly, the role of covenants based on impairment accounting in our model is consistent with the adage that conservative accounting is likely to induce technical default in a fashion that protects creditors and results in lower interest charges. Until now, the missing element to this rationalization is the impact that covenants may have on investment decisions made after debt contracts are set. Our study extends the debt contracting problem to encompass project selection. Conditioning debt covenants on conservative accounting values raises the specter of creditors obtaining control of continuation decisions and making inefficient choices. In turn, this may often be sufficient to discourage inefficient investment choices by the firm's shareholders.

Finally, we submit that our portrayal of covenants ties in nicely to recent empirical research on state contingent transfers of control rights from shareholders to creditors upon

violation of value-based covenants that implicitly depend on accounting policies in use when agency and informational problems are likely to be present.²²

²² As cited earlier, see Chava and Roberts (2007).

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Figure 1

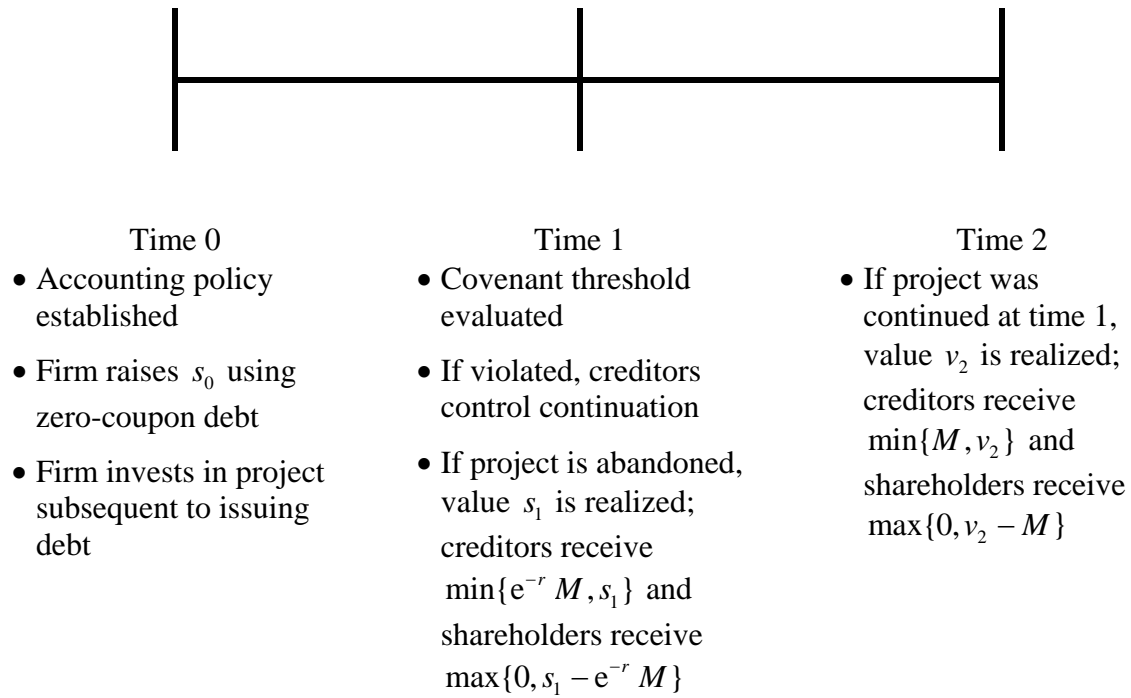


Figure 1 illustrates the model's timeline.

Figure 2

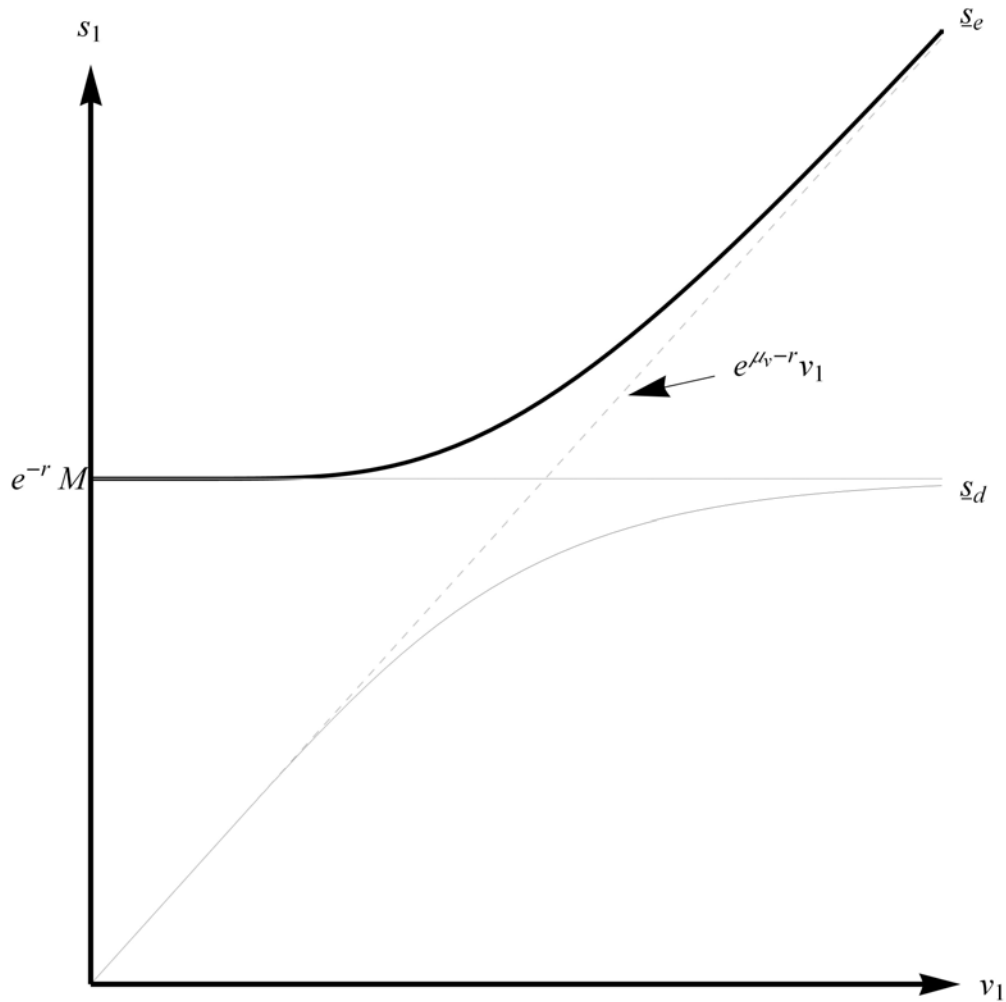


Figure 2 displays the continuation preferences of shareholders and creditors given the time 1 abandonment value s_1 and continuation value v_1 . Shareholders prefer to continue for values of s_1 that lie below the thick curve \underline{s}_e . Creditors prefer continuation for values of s_1 that lie below the thin curve \underline{s}_d . The first-best policy continues for values of s_1 that lie below the gray dashed line $e^{\mu_v - r} v_1$. The solid gray line $e^{-r} M$ is the present value of the debt's maturity value at Time 1. This figure uses the project A parameters $r = 0.05$, $\mu_v = 0.1$, $\sigma_v = 0.4$ and the face value $M = 132.8$ that satisfies the creditor's breakeven condition and corresponds to an annual interest rate of about 15.2%.

Figure 3

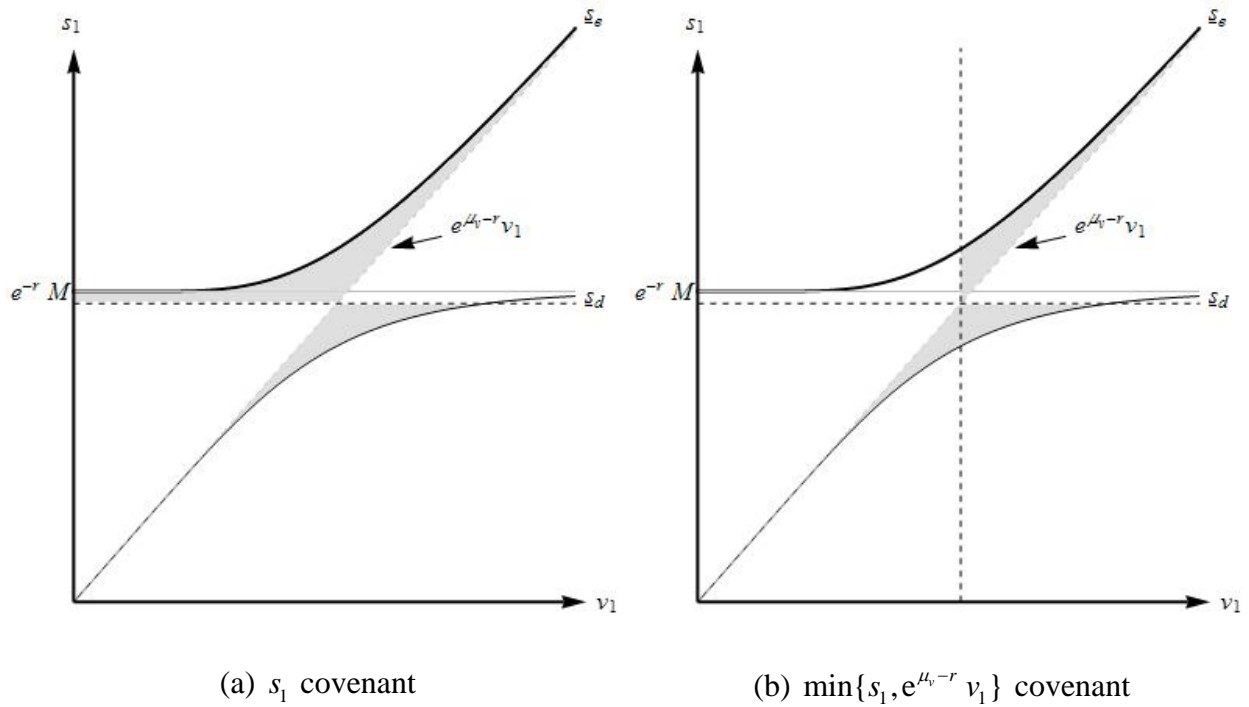


Figure 3 displays the continuation preferences of shareholders and creditors given the time 1 abandonment value s_1 and continuation value v_1 . It also displays the resulting inefficiencies in continuation decisions. Shareholders prefer continuation for values of s_1 that lie below the thick curve s_e . Creditors prefer continuation for values of s_1 that lie below the thin curve s_d . The first-best policy continues for values of s_1 that lie below the gray dashed line $e^{\mu_v - r} v_1$. The solid gray line $e^{-r} M$ is the Time 1 present value of the debt's maturity value. The shaded region that lies above the line $e^{\mu_v - r} v_1$ represents inefficient continuation and the shaded region that lies below the line $e^{\mu_v - r} v_1$ represents inefficient abandonment. Panel (a) displays inefficiencies that result from a contract in which creditors have decision rights when $s_1 < \bar{s}$ where the black dashed line denotes \bar{s} . Panel (b) displays inefficiencies that result from a contract in which creditors have decision rights when $\min\{s_1, e^{\mu_v - r} v_1\} < \bar{m}$, where the black dashed lines denote the covenant thresholds. The maturity value M and threshold \bar{s} are based on the debt contract that maximizes firm value under the covenant that conditions on abandonment value. The impairment cutoff $\bar{m} = \bar{s}$ for purposes of illustration and is not the optimal cutoff for the impairment contract. This figure uses the Project A parameters $r = 0.05$, $\mu_v = 0.1$, $\sigma_v = 0.4$. The maturity value $M = 135.8$ and the covenant threshold $\bar{s} = 124.1$.

Figure 4

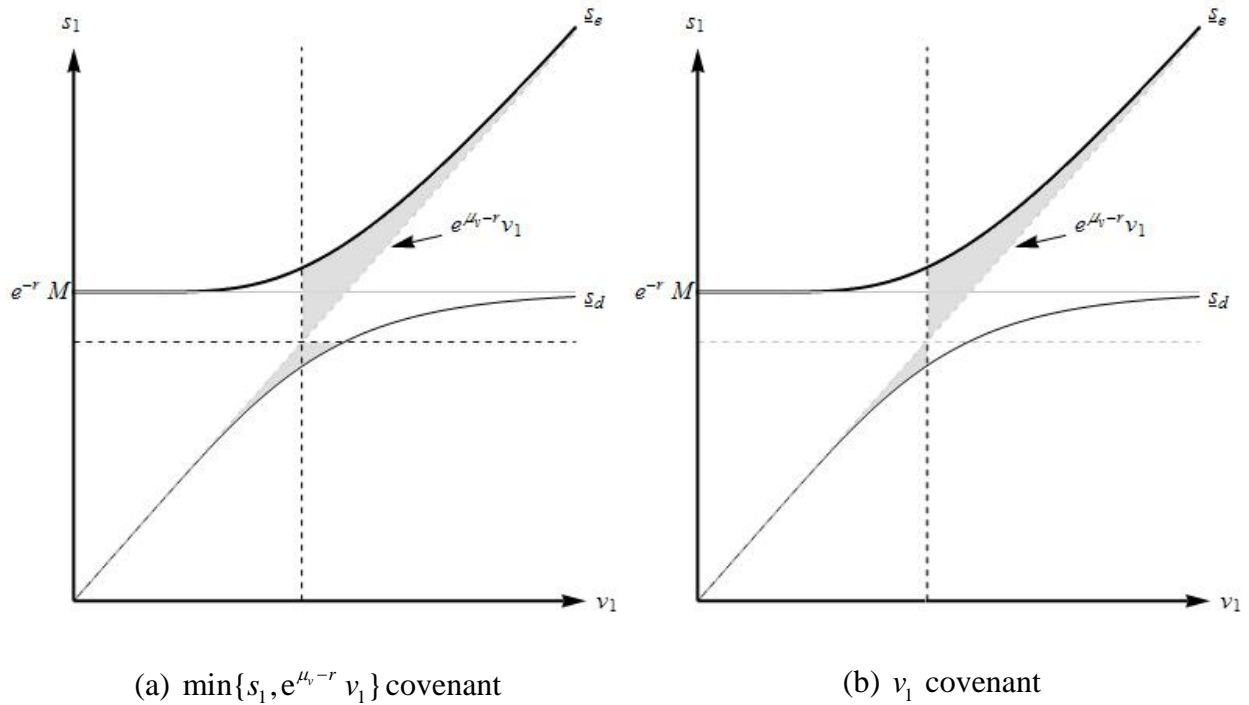


Figure 4 displays the continuation preferences of shareholders and creditors given the time 1 abandonment value s_1 and continuation value v_1 . It also displays the resulting inefficiencies in continuation decisions. Shareholders prefer continuation for values of s_1 that lie below the thick curve s_e . Creditors prefer continuation for values of s_1 that lie below the thin curve s_d . The first-best policy continues for values of s_1 that lie below the gray dashed line $e^{\mu_v - r} v_1$. The solid gray line $e^{-r} M$ is the Time 1 present value of the debt's maturity value. The shaded region that lies above the line $e^{\mu_v - r} v_1$ represents inefficient continuation and the shaded region that lies below the line $e^{\mu_v - r} v_1$ represents inefficient abandonment. Panel (a) displays inefficiencies that result from a contract in which creditors have decision rights when $\min\{s_1, e^{\mu_v - r} v_1\} < \bar{m}$ where the horizontal black dashed line denotes \bar{m} and the vertical black dashed line denotes $e^{r - \mu_v} \bar{m}$. Panel (b) displays inefficiencies that result from a contract in which creditors have decision rights when $v_1 < \bar{v}$, where the black dashed line denotes \bar{v} and the horizontal dashed line denotes the thresholds for the impairment covenant. The maturity value M and threshold \bar{m} are based on the debt contract that maximizes firm value under the covenant that conditions on impairment value. The impairment cutoff \bar{v} solves the creditors' breakeven constraint (2) given the optimal face value for the impairment covenant for purposes of illustration and does not represent the optimal combination of maturity value and covenant cutoff for the continuation value contract. This figure uses the Project A parameters $r = 0.05$, $\mu_v = 0.1$, $\sigma_v = 0.4$. The maturity value $M = 135.0$ and the covenant thresholds $\bar{m} = 107.7$ (s_1 cutoff), $e^{r - \mu_v} \bar{m} = 102.4$ (v_1 cutoff) and $\bar{v} = 103.2$.

Figure 5

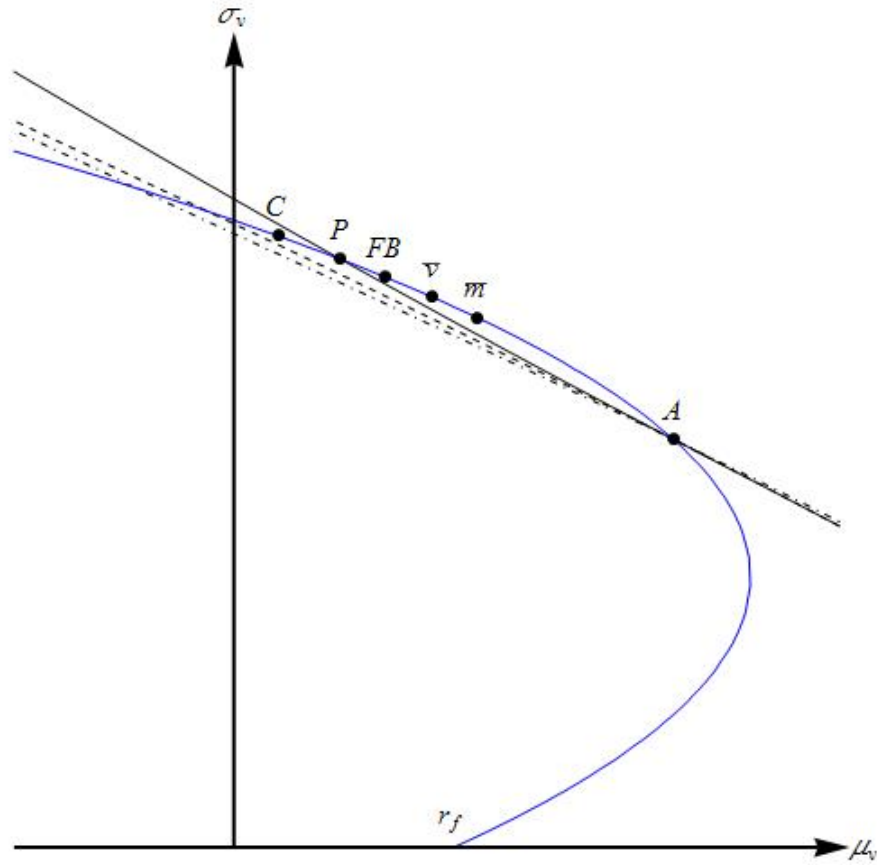


Figure 5 illustrates the shareholders' post-contracting indifference curves over the drift μ_v and volatility σ_v of the continuation-value for the different forms of debt covenants. The debt contract in each case is priced assuming that the firm pursues project A and sets the debt covenant threshold optimally conditional on that choice. The curved solid line represents an example investment opportunity set that earns the risk free rate r_f for a zero-risk project and passes through projects A and C, which are defined in the text. The solid line plots the shareholders' post-contracting indifference curve with a covenant based on impairment accounting. The dashed line plots the indifference curve with continuation-value accounting. The dot-dashed line plots the indifference curve with 'first-best' accounting that gives continuation rights to creditors when the abandonment value s_1 is less than $e^{\mu_v - r} v_1$. The additional points \bar{m} , \bar{v} and FB denote the projects at the tangency points for the shareholders' indifference curves under impairment, continuation-value, and first-best debt covenant policies and are therefore implementable under these covenant types. When the firm uses impairment accounting and the debt contract assumes that the firm will pursue project A, shareholders are indifferent between projects A and P and strictly prefer A to any project on the investment opportunity frontier to the left of P.

Table 1

Table 1 displays sensitivities of firm value V_{FB} under the first-best rule of continuing when $e^{\mu_v - r} v_1 < s_1$. $\Phi(\bullet)$ and $\phi(\bullet)$ denote the standard normal distribution and density, respectively.

The terms d_1 and d_2 equal:

$$d_1 \equiv \frac{\log(s_0 / v_0) + \mu_s - 2\mu_v + r + \frac{1}{2}\sigma_{v_1-s_1}^2}{\sigma_{v_1-s_1}} \quad d_2 \equiv d_1 - \sigma_{v_1-s_1}$$

$$\sigma_{v_1-s_1}^2 \equiv \sigma_v^2 + \sigma_s^2 - 2\rho\sigma_v\sigma_s$$

$$\frac{\partial V_{FB}}{\partial v_0} = e^{2(\mu_v - r)} \Phi(-d_2) > 0$$

$$\frac{\partial V_{FB}}{\partial s_0} = e^{\mu_s - r} \Phi(d_1) > 0$$

$$\frac{\partial V_{FB}}{\partial \mu_v} = 2e^{2(\mu_v - r)} v_0 \Phi(-d_2) > 0$$

$$\frac{\partial V_{FB}}{\partial \mu_s} = e^{\mu_s - r} s_0 \Phi(d_1) > 0$$

$$\frac{\partial V_{FB}}{\partial \sigma_v} = \frac{\sigma_v - \rho\sigma_s}{\sigma_{v_1-s_1}} e^{2(\mu_v - r)} v_0 \phi(d_2)$$

$$> 0 \Leftrightarrow \rho < \frac{\sigma_v}{\sigma_s}$$

$$\frac{\partial V_{FB}}{\partial \sigma_s} = \frac{\sigma_s - \rho\sigma_v}{\sigma_{v_1-s_1}} e^{2(\mu_v - r)} v_0 \phi(d_2)$$

$$> 0 \Leftrightarrow \rho < \frac{\sigma_s}{\sigma_v}$$

$$\frac{\partial V_{FB}}{\partial \rho} = -\frac{\sigma_s \sigma_v}{\sigma_{v_1-s_1}} e^{2(\mu_v - r)} v_0 \phi(d_2) < 0$$

Table 2

Table 2 displays the parameters of the project choices.

	<i>A</i>	<i>B</i>	<i>C</i>
Continuation value			
Initial value v_0	100	100	100
Drift μ_v	0.1	0.1	0.01
Volatility σ_v	0.4	0.4	0.6
Abandonment value			
Initial value s_0	100	100	100
Drift μ_s	0.025	-0.03	0.025
Volatility σ_s	0.2	0.2	0.2
Risk-free rate	0.05	0.05	0.05
Correlation ρ	0.4	0.4	0.4

Table 3

Table 3 illustrates project choices under the various covenant types. For a given covenant type, an optimal implementable project is a project that maximizes *ex ante* equity value under the constraint that the post-contracting project choice matches the project assumed at the time of contracting.

	Project choice	Firm value	Equity value
First-best covenant $e^{\mu_v - r} v_1 < s_1$	C	115.6	15.6
Impairment covenant $\min\{e^{\mu_v - r} v_1, s_1\} < \underline{s}_1$	A	119.5	19.5
Continuation value covenant $v_1 < \underline{v}_1$	C	115.2	15.2

Table 4

Table 4 illustrates the firm value, equity value and continuation probabilities for different combinations of projects assumed at the time of contracting and post-contracting project choices. The covenant thresholds and face values are based on the values that maximize firm value assuming the given project and ignoring the impact on project choice. The parameters that describe the projects are given in Table 2.

Panel A: First best covenants $e^{\mu_v - r} v_1 < s_1$

Project assumed	Project chosen		
	A	B	C
Face value	132.8	140.9	159.2
A Firm value	120.1	118.0	115.4
Equity value	20.1	20.2	20.9
P(Violation)	0.430	0.372	0.590
P(Continue)	0.567	0.628	0.410
B Firm value	120.1	118.0	115.4
Equity value	17.8	18.0	19.2
P(Violation)	0.430	0.372	0.590
P(Continue)	0.567	0.628	0.410
C Firm value	119.7	117.5	115.6
Equity value	13.1	13.4	15.6
P(Violation)	0.527	0.468	0.652
P(Continue)	0.473	0.532	0.348

Panel B: Impairment covenants $\min\{e^{\mu_v - r} v_1, s_1\} < \underline{m}$

Project assumed	Project chosen		
	A	B	C
Face value	135.0	142.3	164.5
Threshold $\underline{v}_1 = e^{r - \mu_v} \underline{m}$	102.4	105.1	115.2
Threshold $\underline{s}_1 = \underline{m}$	107.1	110.5	110.7
A Firm value	119.5	117.5	114.0
Equity value	19.5	19.4	19.0
P(Violation)	0.757	0.813	0.803
P(Continue)	0.560	0.603	0.322
B Firm value	119.6	117.6	114.2
Equity value	17.5	17.6	17.7
P(Violation)	0.792	0.844	0.830
P(Continue)	0.561	0.606	0.318
C Firm value	119.8	117.8	115.0
Equity value	12.8	12.9	15.0
P(Violation)	0.823	0.866	0.852
P(Continue)	0.561	0.612	0.328

Panel C: Continuation covenants $v_1 < \underline{v}_1$

Project assumed	Project chosen		
	A	B	C
Face value	133.6	141.5	161.4
Threshold \underline{v}_1	109.8	111.4	123.6
A Firm value	119.7	117.6	115.0
Equity value	19.7	19.7	20.1
P(Violation)	0.573	0.573	0.670
P(Continue)	0.540	0.588	0.346
B Firm value	119.7	117.7	115.0
Equity value	17.6	17.7	18.6
P(Violation)	0.587	0.587	0.678
P(Continue)	0.546	0.596	0.344
C Firm value	119.9	117.8	115.2
Equity value	13.2	13.4	15.2
P(Violation)	0.684	0.684	0.738
P(Continue)	0.539	0.597	0.316