OPTIMAL DEBT MATURITY STRUCTURE AND NEGOTIATION TACTICS*

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Abstract

We examine the optimal structure of corporate debt maturity in a multiperiod context. Three debt issuance strategies are examined: simultaneously issuing short-term and long-term debt, sequentially issuing short-term debt followed by long-term debt, and sequentially issuing long-term debt followed by short-term debt. In a model with stylized benefits and costs of debt with symmetric information, the optimal debt maturity mix for each strategy is derived, as are implications for the optimal order of debt negotiation. The effects of asymmetric information between management and investors are discussed.

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Introduction

The purpose of this paper is to provide a multiperiod analysis of the optimal corporate debt maturity structure. The paper focuses on the dynamic nature of the structure, as the firm selects levels for both short-term and long-term debt. Considerable attention has been devoted in recent years to studying the incentives that may lead corporations to prefer a certain debt maturity over other maturity terms.[1] Several papers advance arguments for non-trivial debt maturity choices that are based on information or moral hazard. Flannery (1986) shows that the choice of risky debt maturity can signal insiders' information about future cash flows. In the presence of transaction costs, long-term debt will be optimally used by firms which do not anticipate improvement in future cash flows. On the other hand, the use of short-term debt can signal more favorable values in the next period. Diamond (1991, 1993) and Sharpe (1991) also propose that firms with favorable private information about future credit terms will prefer issuing short-term debt. In Diamond's model, short-term debt gives rise to liquidity risk, which results from the borrower's loss of control rents in the event of default. Short-term debt may trigger default at an intermediate date because lenders might favor asset liquidation over refinancing. Sharpe attributes the cost of short-term debt to a distorted perquisite consumption after the short-term debt matures, in the form of reduced effort. Houston and Venkataraman (1994) obtain an optimal mix of debt maturity in the presence of costly renegotiation between bondholders and equityholders. Finally, Goswami, Noe and Rebello (1995) and Almazan (1997) derive an optimal design of debt maturity and dividend covenants depending on the distribution of the asymmetry of

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[1] For a review of the theory and empirical evidence, see Barclay and Smith (1995), Guedes and Opler (1996) and Stohs and Mauer (1996).

information across time.[2] In contrast with the existing literature, the current paper offers a model set in a symmetric information framework. It does not require the presence of either transaction costs, liquidation costs, or perk consumption to motivate the relevance of debt maturity.

The paper constructs a multiperiod model of a long-lived firm with endogenous determination of the capital structure. Information is completely symmetric. The benefit and cost of debt, although stylized, may be interpreted as corporate tax benefits and agency costs. Implications are found for the optimal debt maturity structure. We are able to make normative statements regarding the optimal debt negotiation tactics; that is, the optimal order in which various debt issues should be negotiated.

The paper is organized as follows. Section 1 presents the basic structure of the model and the optimal debt decision in a single-period context. Section 2 extends the model into two periods, with the manager able to simultaneously choose both short-term and long-term debt levels. The optimal debt structure is derived. Section 3 considers the situation when the manager issues short-term and long-term debt sequentially. Both issuance orders are considered, issuing short-term debt first, and issuing long-term debt first. The optimal debt structures in each case are derived, and the outcomes are shown to be different. Section 4 compares these three issuance scenarios. Section 5 presents the analogous scenario using only short-term debt that is rolled over across time. Comparisons with the other three scenarios are made, and it is shown that in the presence of asymmetric information between managers and potential debtholders, the signaling properties of short-term debt may make it undesirable. Section 6 concludes the paper.

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[2] In general, all the literature on debt maturity assumes that the selection of the underlying assets is exogenous. Somewhat of an exception are Sharpe (1991) and Almazan (1997) in which the agency cost, manifested through the choice of effort, appears as an argument in the production function. Debt maturity therefore affects the level of investment made, but abstracts in these models from risk considerations.

1. The single-period model

We first consider a firm with a lifetime of a single period, to illustrate the basic nature of the model before developing the multi-period version. The manager faces a single corporate capital structure decision, selecting a level of debt payment $d \geq 0$. Debt generates a benefit (which may be interpreted as a corporate income tax benefit) of amount $t \cdot d$, with $t > 0$. The benefit of the debt accrues to the equityholders. Debt also generates a cost (which may be interpreted as arising from agency issues) of amount $c \cdot d^2$, with $c > 0$. The cost of the debt is imposed upon the debtholders. A linear benefit of debt is chosen keeping in the spirit of Modigliani and Miller (1963), and a quadratic cost function is chosen to guarantee an interior optimal tradeoff between benefit and cost of debt.[3]

Although the cost of the debt is imposed on debtholders, both equityholders and debtholders recognize this effect before the debt issuance occurs. Therefore, the debt-related cost is reflected in the price of the debt at the time of issuance. Debtholders are thus compensated in advance, and the debt-related cost is ultimately borne by equityholders. Debtholders therefore face no *ex-post* buyer regret. The manager is assumed to optimize value for equityholders. Thus, the manager faces the optimization problem of choosing a debt level d to maximize the benefit of debt (accruing to equityholders) less its cost (passed on to equityholders at the pricing of the debt). Denoting the net value of the debt, its benefit less cost, by V,

$$\max_{d \geq 0} \quad V = td - cd^2 , \tag{1}$$

[3] An earlier version of this paper, with a model featuring a capital project with a risky payoff, an explicit corporate income tax calculation, and an explicit asset substitution problem endogenously derives a linear benefit function and a quadratic agency cost function.

which implies an optimal debt level $d = t / 2c$. Note that a higher debt level results from a higher benefit t or lower cost c associated with debt.

2. The two-period model with simultaneous debt choice

We now consider a firm with a lifetime of two periods. The manager has two capital structure choice variables, a debt level for each of the two periods. The debt levels are respectively denoted by d_1 and d_2, and will be referred to as short-term and long-term debt. (These can be interpreted as zero-coupon debt.) There is a benefit and a cost associated with debt in each of the two periods. Debt generates a benefit t_1d_1 in the first period, and a benefit t_2d_2 in the second period, with $t_1 > 0$, $t_2 > 0$. (Note that the periodic benefit associated with debt depends upon the debt payment made that period, consistent with a tax-related benefit.) Debt generates a cost $c_1(d_1 + d_2)^2$ in the first period, and a cost $c_2(d_2)^2$ in the second period, with $c_1 > 0$, $c_2 > 0$. (Note that the periodic cost associated with debt depends upon the remaining debt payments at that time, consistent with agency costs imposed upon debtholders.) Note that the benefit coefficients t_1 and t_2 need not be identical; different t's could be interpreted either as a tax rate varying over time, or underlying operational cash flows varying over time.[4] Similarly, the cost coefficients c_1 and c_2 need not be identical; different c's can be interpreted as variation in agency costs over a corporate ot project life cycle (for example, a project constructing tangible assets over time may preclude opportunities for asset substitution.) For the convenience of the analysis, define $T = t_2 / t_1$, which measures the relative level of benefits associated with debt across the periods, and $C = c_2 / c_1$, which measures the relative levels of cost associated with debt across the periods.

[4] If underlying operational cash flows vary over time, it is natural to interpret d_1 and d_2 as debt payments relative to the underlying cash flows. Higher (dollar) tax benefits associated with higher cash flows (thus greater tax shielding opportunities) for a period then translates to a higher t coefficient for that period.

This scenario assumes that the manager simultaneously issues short-term and long-term debt. Debtholders fully recognize the (future) costs generated by the debt and therefore price the costs into the purchase price of the debt, passing the cost on to equityholders at the time of issuance. Maximizing equityholder value, the manager faces the optimization problem

$$\max_{d_1,\, d_2 \geq 0} \quad V_{SIM} = t_1 d_1 + t_2 d_2 - c_1(d_1 + d_2)^2 - c_2(d_2)^2. \qquad (2)$$

The solution, with the optimal debt choice, has three cases:

Case 1. If $T \leq 1$, then $d_1 = (t_1/2c_1)$, $d_2 = 0$, $V_{SIM} = (t_1^2/4c_1)$. For these parameters, the benefits of debt are much higher in the first period than the second period. However, long-term debt imposes costs on debtholders in both periods. Consequently, the firm issues no long-term debt: the manager optimally prefers to utilize short-term debt to capture desired debt-related benefits in the first period, while avoiding the relatively high cost associated with long-term debt.

Case 2. If $1 \leq T \leq 1 + C$, then $d_1 = (t_1/2c_1)[1 + (1 - T)/C]$, $d_2 = (t_1/2c_1)[(T - 1)/C]$, $V_{SIM} = (t_1^2/4c_1)[1 + (T - 1)^2/C]$. For these parameters, both short-term and long-term debt are issued. At the margin, long-term debt has higher associated costs than short-term debt, but it also generates higher benefits.

Case 3. If $T \geq 1 + C$, then $d_1 = 0$, $d_2 = (t_1/2c_1)[T/(1 + C)]$, $V_{SIM} = (t_1^2/4c_1)[T^2/(1 + C)]$. For these parameters, the benefits of debt are much higher in the second period thn in the first. As a consequence, no short-term debt is issued.

INSERT FIGURE 1 HERE

As the benefits associated with short-term or long-debt increase, the firm uses more of that type of debt in its capital structure (possibly substituting away from the other type): short-term debt d_1 is weakly increasing in t_1 and weakly decreasing in t_2, while long-term debt d_2 is weakly increasing in t_2 and weakly decreasing in t_1 (when the firm issues both short-term and long-term debt, these are all strictly increasing or decreasing). Figure 1 illustrates the debt levels as a function of T, the relative debt benefit across time.

Optimal debt usage is also sensitive to the debt-related costs. Both short-term and long-term debt are weakly decreasing in c_1, reflecting that both types of debt generate a cost in the first period. However, long-term debt is weakly decreasing, while short-term debt is weakly increasing in c_2, reflecting that only long-term debt generates a cost in the second period. Therefore, an increase in debt-related cost in the second period gives the firm incentive to substitute short-term debt in place of long-term debt.

3. The two-period model with sequential debt choice

The firm may not always be able to issue its entire capital structure simultaneously. We therefore consider the outcome where the firm issues short-term and long-term debt sequentially. There are obviously two possible scenarios here: issuing short-term debt first and long-term debt second, or issuing long-term debt first and short-term debt second. Both scenarios will be considered. Either way, there are no events occurring between the dates of issuance in the model. (This precludes any release of relevant information about corporate creditworthiness in the interim, as in Flannery (1986), for example.) Nevertheless, the results differ from the case of simultaneous debt issuance when management fully commits to one type of issue before issuing the other type of debt.

Relative to a firm with simultaneous debt issuance, an additional level of moral hazard is possible with sequential debt issuance. Debtholders fully recognize future costs that the debt will impose upon them, and will price the debt in order to pass the cost on to equityholders at the time of issuance. With sequential issuance, one type of debt (the first issue) has already been committed to at the time of the second issue. Therefore, only the cost imposed on the second set of debtholders by the second debt issue will be priced and passed on to the equityholders at that time. This introduces a moral hazard not found is the simultaneous issuance scenario: the cost that the second debt issue imposes on the first set of debtholders is not reflected in the price of the second debt issue. Naturally, when both types of debt are issued simultaneously, all costs imposed on all debtholders will be priced into the debt and passed on to the equityholders.[5]

Of course, earlier, when the first debt was issued, the above-described moral hazard problem was recognized by the first set of debtholders, and the cost expected to be generated by the moral hazard was passed on to the equityholders then. Therefore, sequential debt issuance leads to a moral hazard relative to simultaneous debt issuance, and, since investors recognize this moral hazard, its cost is ultimately borne by the equityholders.

This implies not just that the outcome of simultaneous and sequential issuance scenarios may differ, but that the order of issuance may make a difference under the sequential scenario. That is, the moral hazard generated by issuing short-term debt first may differ from the moral hazard generated by issuing long-term debt first. Therefore, both sequential scenarios must be examined: issuing short-term debt before long-term debt, and issuing long-term debt before short-term debt.

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[5] Implicitly, under simultaneous issuance, potential debtholders price the debt, and thus pass costs on to equityholders conditional on the quantity of both types of debt; the manager chooses the quantities. Under sequential issuance, at the first issuance, potential debtholders can condition only upon the quantity of the first type of debt issued (and their expectations of the quantity of the second type to be issued in the future).

3.1. Issuing short-term debt, then long-term debt

It is further assumed at this point that, when both types of debt are outstanding, that the costs imposed on the two types of debtholders are symmetric, in the sense that the costs imposed on each debtholder class is proportional to the total amount of that debt outstanding. Therefore, in the first period, with d_1 short-term debt and d_2 long-term debt, the short-term debtholders bear a fraction $d_1/(d_1 + d_2)$ of the debt-related costs, while the long-term debtholders bear a fraction $d_2/(d_1 + d_2)$ of the debt-related costs. Since the total debt-related costs are $c_1(d_1 + d_2)^2$ in the first period, this implies that the short-term debtholders face costs $c_1d_1(d_1 + d_2)$ while the long-term debtholders face costs $c_1d_2(d_1 + d_2)$ in the first period.

With short-term debt issued before long-term debt, the manager faces the optimization problem

$$\max_{d_1 \geq 0} \quad V_{ST\text{-}LT} = t_1d_1 + t_2d_2 - c_1(d_1 + d_2)^2 - c_2(d_2)^2, \tag{3}$$

$$\text{subject to } d_2 = \underset{d_2 \geq 0}{\text{Argmax}} \quad t_2d_2 - c_1d_2(d_1 + d_2) - c_2(d_2)^2 \tag{4}$$

At the time the short-term debt is issued (first), the manager recognizes the benefits and costs of both current and future debt issuance. However, at the time the long-term debt is issued (second), the short-term debt is already committed. Furthermore, the costs $c_1d_1(d_1 + d_2)$ will be faced by the *short-term* debtholders, not the long-term debtholders. As such, since these costs are not faced by the long-term debtholders, they will not charge the equityholders for bearing these costs. Since the earlier issuance price of the short-term debt already reflected these costs, when the short-term debt was issued, the short-term debtholders do not face buyer's remorse. Of course, the costs $c_1d_2(d_1 + d_2)$ that will be faced by the long-term debtholders are recognized in equation (4), so they will charge the equityholders for bearing these costs, and thus pass on the costs at this time.

INSERT FIGURE 2 HERE

The solution, with the optimal debt choice, has four cases (see Figure 2):

Case 1. If $T \leq 0.5$, then $d_1 = (t_1/2c_1)$, $d_2 = 0$, $V_{ST\text{-}LT} = (t_1^2/4c_1)$. Here, the second-period benefit of debt is relatively low, so no long-term debt is issued. This coincides with the simultaneous issuance solution. Although the moral hazard is here, for these parameters, it does not affect the optimal choice.

Case 2. If $0.5 \leq T \leq (2 + 2C)/(3 + 4C)$, then $d_1 = T(t_1/c_1)$, $d_2 = 0$, $V_{ST\text{-}LT} = (t_1^2/4c_1)[4T(1 - T)]$. Here, the second-period benefit of debt is still low, and no long-term debt is issued. However, more short-term debt is issued than in the simultaneous issuance scenario.

Case 3. If $(2 + 2C)/(3 + 4C) \leq T \leq 1 + C$, then $d_1 = 2[(1 + C - T)/(1 + 4C)](t_1/c_1)$, $d_2 = (t_1/2c_1)[(3 + 4C)T - (2 + 2C)]/[(1 + C)(1 + 4C)]$, $V_{ST\text{-}LT} = (t_1^2/4c_1)[T^2/(1 + C) + 4(1 + C - T)^2/(1 + C)(1 + 4C)]$. Here, both short-term and long-term debt are issued. More long-term debt is issued here, relative to the simultaneous issuance scenario. More or less short-term debt may be issued here, relative to the simultaneous issuance scenario.

Case 4. If $T \geq 1 + C$, then $d_1 = 0$, $d_2 = (t_1/2c_1)[T/(1 + C)]$, $V_{ST\text{-}LT} = (t_1^2/4c_1)[T^2/(1 + C)]$. Here, the first-period benefit of debt is relatively low, so no short-term debt is issued. This coincides with the simultaneous issuance solution.

Similar to the simultaneous issuance scenario, long-term debt d_2 is weakly increasing in the second-period benefit parameter t_2 and weakly decreasing in t_1. Although short-term debt d_1 is weakly increasing in the first-period benefit parameter t_1, it is not weakly decreasing in t_2: clearly, there is more here than just a simple substitution between the two types of debts as the relative benefits vary.

For the extreme cases with very different values of t_1 and t_2 (Cases 1 and 4), only one type of debt is issued, the type with the relatively high benefit associated with it, and the outcome coincides with the simultaneous issuance case. For parameters with less extreme values of t_1 and t_2 (Cases 2 and 3), issuing short-term debt first and issuing simultaneously lead to different optimal outcomes.

Consider the region where positive amounts of both short-term and long-term debt are issued under the simultaneous issuance scenario ($1 < T < 1 + C$, a subset of Case 3 above). The moral hazard of issuing short-term before long-term debt (relative to simultaneous issuance) affects both the long-term issue and the short-term issue. At the time the long-term debt is issued, costs imposed upon short-term debtholders are not taken into account, since short-term debt is already in place. Relative to the simultaneous debt issuance scenario, the apparent cost associated with long-term debt issuance is lower; more long-term debt is issued than under the simultaneous issuance scenario.

At the time of the short-term issue, all parties recognize the tendency of the manager to "overissue" long-term debt later, to the detriment of the short-term debtholders. This tendency arises from the lack of the managerial incentive to take into account the costs of the second debt issue impacting on the first set of debtholders. Furthermore, the more short-term debt that is issued first, the larger the moral hazard is when the long-term debt is issued second. In order to control the magnitude of the moral hazard problem for long-term debt, the manager has a tendency to reduce the size of the short-term debt issue, relative to the simultaneous issuance scenario. Thus, in this region, less short-term debt and more long-term debt is issued relative to the simultaneous issue scenario.

For $T \geq 1 + C$, (Case 4), no short-term debt is issued under simultaneous issuance, so no moral hazard comes into play when short-term debt is issued first: there is no outstanding short-term debt to create a negative impact on long-term debt at the second issuance. Thus, under sequential issuance (with short-term issued before long-term), the same pair of debt levels are selected as with sequential issuance.

As short-term debt becomes more valuable (for smaller values of T), the moral hazard problem becomes intensified, as the manager prefers to use more long-term debt, and therefore less short-term debt.

For $T \leq 1$, with simultaneous issue, the short-term debt is limited because the non-negativity constraint on long-term debt binds. When short-term debt is issued first, the moral hazard increases the long-term debt issued, so the non-negativity constraint on long-term debt binds only for even smaller values of T, $T \leq (2 + 2C)/(3 + 4C) < 1$. Thus, not faced with a binding non-negativity constraint on long-term debt, it is possible for short-term debt to rise above the corresponding level under simultaneous issue (the parameters $1/2 \leq T \leq 3/4$, Case 2 and a subset of Case 3). For the extreme case $T \leq 1/2$, (Case 1), the benefit associated with long-term debt is so low that, even with the moral hazard, the manager will not want to issue any long-term debt for a second issuance, so the outcome under simultaneous issuance and short-term issued first coincide.

Therefore, depending on the parameters, issuing short-term debt first, relative to simultaneous debt issuance, can lead to: less short-term and more long-term debt, more short-term and more long-term debt, more short-term and equal long-term debt, equal short-term and more long-term debt, or an equal amount of both short-term and long-term debt.

3.2. Issuing long-term debt, then short-term debt

Next analyzed is the other order of sequential debt issuance, issuing long-term debt first and short-term debt second. The moral hazard arising here due to the sequential issuance is similar to that discussed in the previous section. It will not be perfectly symmetric, however, because there is an asymmetry in the costs generated by the two types of debt;

short-term debt generates a cost to first-period debtholders only, but long-term debt generates a cost to both short-term and long-term debtholders.

If long-term debt is issued first, and short-term debt is issued second, the manager faces the optimization problem

$$\max_{d_2 \geq 0} \quad V_{LT\text{-}ST} = t_1 d_1 + t_2 d_2 - c_1(d_1 + d_2)^2 - c_2(d_2)^2 \qquad (5)$$

$$\text{subject to } d_1 = \underset{d_1 \geq 0}{\text{Argmax}} \quad t_1 d_1 - c_1 d_1(d_1 + d_2) \qquad (6)$$

Similar to the other sequential issuance scenario, at the time of the first issuance (here, the long-term debt), the manager recognizes the benefits and costs of both current and future debt issuance. At the time of the second issuance (here, short-term debt), the first issuance is already committed. Thus, in choosing a level of short-term debt, the costs $c_1 d_1(d_1 + d_2)$ faced by the short-term debtholders are included, since they are incorporated into the price of the short-term debt, while the costs imposed on the long-term debtholders are not reflected in the price of the short-term debt, since the long-term debt is already committed.

INSERT FIGURE 3 HERE

The solution, with the optimal debt choice, has four cases (see Figure 3):

Case 1. If $T \leq 1$, then $d_1 = (t_1/2c_1)$, $d_2 = 0$, $V_{LT\text{-}ST} = (t_1^2/4c_1)$. Here, the second-period benefit of debt is relatively low, so no long-term debt is issued. This coincides with the simultaneous issuance scenario.

Case 2. If $1 \leq T \leq 1.5 + 2C$, then $d_1 = (t_1/2c_1)[1 - 2(T - 1)/(1 + 4C)]$, $d_2 = 4[(T - 1)/(1 + 4C](t_1/2c_1)$, $V_{LT\text{-}ST} = (t_1^2/4c_1)[1 + 4(T - 1)^2/(1 + 4C)]$. Both types of debt are issued. More short-term debt is issued than under simultaneous issuance.

Case 3. If $1.5 + 2C \leq T \leq 2 + 2C$, then $d_1 = 0$, $d_2 = (t_1/c_1)$, $V_{LT\text{-}ST} = (t_1^2/4c_1)4[T - (1 + C)]$. No short-term debt is issued. More long-term debt than under simultaneous issuance.

Case 4. If $T \geq 2 + 2C$, then $d_1 = 0$, $d_2 = (t_1/2c_1)[T/(1 + C)]$, $V_{LT\text{-}ST} = (t_1^2/4c_1)[T^2/(1 + C)]$. The first-period benefit of debt is relatively low, so no short-term debt is issued. This coincides with the simultaneous issuance scenario.

Comparing issuing long-term debt first with simultaneous issuance is similar to the comparison of the previous section. Short-term debt d_1 is weakly increasing in t_1 and weakly decreasing in t_2. Long-term debt d_2 is weakly increasing in t_2, but not weakly decreasing in t_1. The moral hazard tends to increase short-term debt, which is issued second, and tends to make the manager restrict the use of long-term debt (issued first) to avoid the moral hazard at the second issuance.

When the benefit of second-period debt is low, for $T \leq 1$, no long-term debt is used under simultaneous issuance, so no additional moral hazard cost on short-term debt is created by issuing short-term debt later (Case 1).

For $1 < T < 1 + C$, both short-term and long-term debt are issued in the simultaneous scenario; more short-term and less long-term are issued in the long-term first scenario (part of Case 2).

For $T \geq 1 + C$, with simultaneous issue, long-term debt is limited because the non-negativity constraint on short-term debt binds. When long-term debt is issued first, the moral hazard increases the amount of short-term debt issued, so the non-negativity constraint on short-term debt binds only for $T \geq 1.5 + 2C$. Not facing a binding non-negativity constraint on short-term debt, it is possible for long-term debt to be higher than under simultaneous issue (parameters $4(1 + C)/3 \leq T \leq 2(1 + C)$; Case 3 and part of Case 2). For the extreme case $T \geq 4$, (Case 4), the benefit of debt in the first period is so low that no short-term debt is issued and the outcome coincides with that of simultaneous issuance.

Therefore, depending on the parameters, issuing long-term debt first, relative to simultaneous debt issuance, can lead to: more short-term and less long-term debt, more short-term and more long-term debt, more short-term and equal long-term debt, equal short-term and more long-term debt, or an equal amount of both short-term and long-term debt.

Similarly, comparison of the two sequential debt issuance strategies shows that no strict ranking of the amounts of debt issued exists: depending on the parameters, the levels of short-term and long-term debt can be either greater, lesser, or equal under the sequential short-term-first issuance or sequential long-term-first issuance scenarios (see Figure 4.) In fact, all nine pairwise comparisons between levels of short-term debt and long-term debt arise excepting only one (issuing short-term debt first will not lead to both more short-term and less long-term than issuing long-term debt first.)

INSERT FIGURE 4 HERE

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4. Negotiation Tactics

Since each of the two sequential debt issuance scenarios generate a moral hazard not present with simultaneous debt issuance, the net value (benefit less cost, accruing to equityholders) from debt issuance are weakly greater under simultaneous issuance.[6] The additional cost of the moral hazard varies with the parameters: at extreme values of T, for example, the outcome of both sequential issaunces coincide with the simultaneous issuance, so the extra moral hazard causes no harm. Figure 5 illustrates the difference between net

[6] An alternative interpretation is that the issuance of coupon debt is a combination of short-term and long-term debt, and thus may be akin to a simultaneous issuance. Thus, a motivation for the issuance of ordinary coupon debt over zero coupon debt is to avoid the additional moral hazard problem associated with sequential issuance. We thank Ron Singer for pointing this out.

values associated with debt financing under the various issuance strategies, specifically, the differences (V_{SIM} - $V_{ST\text{-}LT}$) and (V_{SIM} - $V_{LT\text{-}ST}$). Although neither of the two sequential issuance scenarios dominates the other for all parameters, relative statements of the magnitude of the moral hazard cost can still be made. (As the model of benefits and costs is quadratic, the differences in the net values across issuance scenarios in Figure 5 are piecewise quadratic with continuous first partial derivatives with respect to the parameters.)

INSERT FIGURE 5 HERE

The difference (V_{SIM} - $V_{ST\text{-}LT}$) is at its greatest at T = 4(1 + C)/(5 + 4C), where it reaches a value of $(t_1^2/4c_1)/(5 + 4C)$, while the difference (V_{SIM} - $V_{LT\text{-}ST}$) is at its greatest at T = 4(1 + C)/3, where it reaches a value of $(t_1^2/4c_1)/3$. Thus, the peak cost of moral hazard when long-term debt is issued first is greater than the peak cost when short-term debt is issued first.

In the regions $T \leq 1/2$ and $T \geq 2 + 2C$, short-term first, long-term first, and simultaneous issuance are all equally effective. In the region $1/2 < T < (1 + C)^{1/2}$, long-term first is more effective than short-term first, while in the region $(1 + C)^{1/2} < T < 2 + 2C$, short-term first is more effective than long-term first. [7] Thus, in making a selection about which type of debt to issue first (which we label "negotiation tactics"), not all choices are equal.

Finally, a comment on the optimal debt policy. In light of the above results, it must be noted that optimal financial policy is no longer fully characterized by an optimal debt level

[7] Although it appears from Figure 5 that long-term first is an inferior issuance strategy for a larger set of parameters, this is because it is illustrated with $T = t_2/t_1$ on the horizontal axis. If we had used $1/T = t_1/t_2$ on that axis, short-term first would appear to be inferior more often. Either way, long-term first has the highest peak.

and a maturity structure; different strategic timings of debt issues yield different optimal mixes of short-term and long-term debt.

5. The two-period model with rolled-over short-term debt

In this model, if the manager could easily substitute multiple issuances of short-term debt for long-term debt, not only the moral hazard problem arising from sequential issuance, but the entire negative impact of one debt type on another could be avoided, obviously lowering the cost of debt issuance. If the firm can issue short-term debt d_1 before the first period, and then, after the first period is over, so that debt d_1 is retired, issue another short-term debt D_2 for the second period, the cost of debt issuance should be able to be lowered because the firm has no "second period" debt outstanding during the first period.

In this scenario, the manager faces the optimization problem

$$\max_{d_1,\, D_2 \geq 0} \quad V_{ROLL} = t_1 d_1 + t_2 D_2 - c_1(d_1)^2 - c_2(D_2)^2. \tag{7}$$

The optimal debt choice is $d_1 = t_1/2c_1$ and $D_2 = t_2/2c_2$, with $V_{ROLL} = (t_1^2/4c_1)[1 + T^2/C]$. Unsurprisingly, $V_{ROLL} > V_{SIM}$ for all parameters.

The observation that agency costs could be avoided by decreasing the life of utilized debt to be shorter than the time required for managers to adversely affect debtholders, then continually rolling over the debt is not new to us. It is found, for example, in Myers (1977). However, this leaves open the question of why a firm should use anything but rolled-over short-term debt. Of course, there are certain practical considerations outside the scope of our model that inhibit the desirability of rolling over short-term debt. These may include recapitalization costs as modeled by Flannery (1986) and Fischer, Heinkel and Zechner (1989), liquidity risk (Diamond 1991, 1993 and Myers and Rajan 1998), and credit market imperfections as in Froot, Scharfstein and Stein (1993).

Another approach is taken in a model presented in the Appendix. The model features a simplified structure for the costs of debt, variable benefits and costs of debt across firms, and asymmetric information between management and potential debtholders about the firm's cost parameters. The choice of the size of debt payments potentially signals firm type. Higher quality (lower debt-related cost) firms are more effectively able to signal their type under the simultaneous issuance scenario than under the rolled-over short-term debt scenario. Using rolled-over short-term debt allows for two signals (two short-term debt issues), one before the first period and one before the second period. Using simultaneous debt issuance allows two signals (short-term and long-term debt), both before the first period. This allows for more separation in equilibrium, and higher quality firms are better off under simultaneous issuance than with rolling over short-term debt. (Note that this result differs from Flannery (1986), where information about the firm is revealed in the interim between the two short-term debt issuance dates. Here, it is the signal from the debt choice that carries information.)

6. Conclusion

This paper examines the effects associated with the timing of multiple issuances of debt in a multiperiod framework. The model assumes symmetric information, perfect liquidity, no transaction costs, and risk neutrality. The benefits and costs associated with debt may be the traditional benefits and costs of the tradeoff theory of capital structure (corporate income tax benefits and agency costs), although the model does not require them to be specified. Benefits accrue directly to equityholders, while the costs accrue to the debtholders. Since the costs are fully recognized by all parties before debt issuance, they are ultimately borne by equityholders.

When the firm engages in multiple issuances of debt, a moral hazard problem arises wherein managers working to benefit equityholders may make decisions that do not benefit holders of currently outstanding debt. We show how the nature and magnitude of this moral hazard depends upon the negotiation tactics, or the order in which various maturities of debt are issued. From this, we show how the optimal amount of various maturities of debt to issue also depends upon the negotiation tactics chosen. Furthermore, we make statements about the optimal negotiation tactics to employ to optimize corporate value. The analysis also indicates an advantage of coupon debt over separately issued short-term and long-term discount bonds.

Although utilizing rolled-over short-term debt has been proposed elsewhere as a solution to agency costs associated with debt financing, a model we present in the Appendix shows how, in the context of signalling firm type (in the model, level of debt-related costs imposed upon debtholders), such an approach may be inferior to issuing both short-term and long-term debt. By issuing multiple maturities of debt, a manager is able to send multiple signals about firm type, helping to separate firm types in equilibrium. Higher quality firms may find such multiple maturity issuance, with associated revelation of quality, to be more valuable than utilization of short-term debt only.

References.

Almazan, A. 1997, "A Model of Debt Maturity: Determinants and evolution," working paper, University of Illinois at Urbana-Champaign, November.

Barclay, M. J., and C. W. Smith, 1995, "The Maturity Structure of Corporate Debt," *Journal of Finance*, 50, 609-631.

Diamond, D. W., 1991, "Debt Maturity Structure and Liquidity Risk," *Quarterly Journal of Economics*, 106, 709-737.

_______, 1993, "Seniority and Maturity of Debt Contracts," *Journal of Financial Economics*, 33, 341-368.

Fischer, E. O., R. Heinkel, and J. Zechner, 1989, "Dynamic Recapitalization Policies and the Role of Call Premia and Issue Discounts," *Journal of Financial and Quantitative Analysis*, 24, 427-446.

Flannery, M. J., 1986, "Asymmetric Information and Risky Debt Maturity Choice," *Journal of Finance*, 41, 19-37.

Froot, K. A., D. S. Scharfstein, and J. C. Stein, 1993, "Risk Management: Coordinating Corporate Investment and Financing Policies," *Journal of Finance*, 48, 1629-1658.

Goswami, G., T. Noe, and M. Rebello, 1995, "Debt Financing under Asymmetric Information," *Journal of Finance*, 50, 633-659.

Guedes, J., and T. Opler, 1996, "The Determinants of the Maturity of Corporate Debt Issues," *Journal of Finance*, 51, 1809-1833.

Houston, J. F., and S. Venkataraman, "Optimal Maturity Structure with Multiple Debt Claims," *Journal of Financial and Quantitative Analysis*, 29, 179-197.

Modigliani, F., and M. Miller, 1963, "Corporate Income Taxes and the Cost of Capital: A Correction," *American Economic Review*, 53, 433-443.

Myers, S. C., 1977, "Determinants of Corporate Borrowing," *Journal of Financial Economics*, 5, 147-175.

_______, and R. G. Rajan, 1998, "The Paradox of Liquidity," *Quarterly Journal of Economics*, 113, 733-771.

Sharpe, S. A., 1991, "Credit Rationing, Concessionary Lending, and Debt Maturity," *Journal of Banking and Finance*, 15, 581-604.

Stohs, M. H., and D. C. Mauer, 1996, "The Determinants of Corporate Debt Maturity Structure," *Journal of Business*, 69, 279-312.

Appendix

This appendix presents an asymmetric information model with a benefit/cost structure of debt simplified from that in the body of this paper. Different firm types impose different (agency) costs on the debtholders. The choice of debt level potentially signals the firm type to debtholders. It is shown that simultaneous issuance may be more effective than using rolled-over short-term debt here. Simultaneous issuance allows the high-quality firm to signal their type to the marketplace more quickly, thus allowing the high-quality firm more advantageous pricing of both first-period and second-period debt. Rolled-over short-term debt only allows separation of firm types at the rolling-over date, after the first period is concluded; thus, when short-term debt is rolled-over, high and low quality firms are pooled together in the first period.

The model has two firm types, distinguished in their benefit and cost parameters. Type H (high-cost) has benefit parameters t_1 in the first period and t_{2H} in the second period, and cost parameter c_H in both periods. Type L (low-cost) has benefit parameters t_1 in the first period and t_{2L} in the second period, and cost parameter c_L in both periods. Note that the two types have an equal benefit parameter for the first period, but may differ in their benefit parameter for the second period. Without loss of generality, $c_H > c_L$ is assumed; no assumption on the relative size of t_{2H} and t_{2L} is made.

As this appendix concentrates on the role of asymmetric information, the cost structure associated with debt financing is simplified. For first-period and second-period debt levels of d_1 and d_2, the cost borne by first-period and second-period debtholders is $c_i(d_1)^2$ and $c_i(d_2)^2$, where i = H or L, depending upon the firm type. Note that, under symmetric information, with this simplified cost structure, the optimal capital structure is identical no matter what issuance scenario is considered (simultaneous issuance, short-term first, long-term first, or rolled-over short-term debt): first-period debt is $t_1/2c_i$, second-period debt is $t_{2i}/2c_i$. Thus, any differences in the outcomes across issuance strategies under asymmetric information must arise purely from the information asymmetry.

As the debtholders bear the cost associated with debt, they prefer to own debt of the type L firm, *ceteris paribus*. Depending on parameters, either a pooling or separating equilibrium can potentially arise. In a separating equilibrium, a type L manager must choose a debt issuance which is not worthwhile for a type H manager to mimic, even if debtholders then believe that the type H is really type L. Sequential issuance of short-term and long-term debt is examined first, followed by rolled-over short-term debt.

As noted above, there are three cases to consider in solving for the equilibrium under simultaneous debt issuance: debt issuance for a type H firm (believed to be type H by investors), debt issuance for a type L firm (believed to be type H by investors), and debt issuance for a type L firm (believed to be type L by investors). In the latter case, the type H firm cannot, in equilibrium, find it profitable to mimic the type L firm issuance.

The manager of a type H firm (believed to be type H) faces the maximization

$$\max_{d_1,\, d_2 \geq 0} \quad V_H = t_1 d_1 + t_H d_2 - c_H d_1^2 - c_H d_2^2, \tag{A1}$$

with optimal issuance $d_1 = t_1/2c_H$, $d_2 = t_H/2c_H$, and $V_H = (t_1^2 + t_H^2)/4c_H$.

Similarly, the manager of a type L firm, that is believed by investors to be of type H, faces the maximization

$$\max_{d_1,\, d_2 \geq 0} \quad V_{L/H} = t_1 d_1 + t_L d_2 - c_H d_1^2 - c_H d_2^2, \tag{A2}$$

with optimal issuance $d_1 = t_1/2c_H$, $d_2 = t_L/2c_H$, and $V_{L/H} = (t_1^2 + t_L^2)/4c_H$. Note that the costs that potential debtholders believe they will face in owning the debt are reflected in the price equityholders receive for issued debt.

Finally, the manager of a type L firm, who finds it worthwhile to choose a debt issuance that will convince investors her firm is of type L, faces a maximization problem with two constraints. The first constraint is that the type H firm not find it profitable to fool investors by mimicking a type L firm. The second constraint is that the type L firm finds it profitable to separate from the type H firm (this incorporates the calculation from the previous paragraph).

$$\max_{d_1,\, d_2 \geq 0} \quad V_{L/L} = t_1d_1 + t_Ld_2 - c_Ld_1^2 - c_Ld_2^2, \tag{A3}$$

$$\text{subject to} \quad t_1d_1 + t_Hd_2 - c_Ld_1^2 - c_Ld_2^2 \leq (t_1^2 + t_H^2)/4c_H,$$

$$t_1d_1 + t_Ld_2 - c_Ld_1^2 - c_Ld_2^2 \geq (t_1^2 + t_L^2)/4c_H.$$

The optimum is unconstrained, with $d_1 = t_1/2c_L$, $d_2 = t_L/2c_L$, and $V_{L/L} = (t_1^2 + t_L^2)/4c_L$ if the first constraint is nonbinding, which holds if the parameters satisfy $t_L > t_H + [(1 - c_L/c_H)(t_1^2 + t_H^2)]^{1/2}$ or $t_L < t_H - [(1 - c_L/c_H)(t_1^2 + t_H^2)]^{1/2}$.

The optimum is constrained if the first constraint is binding. Here, there are two regions. If $t_H < t_L \leq t_H + [(1 - c_L/c_H)(t_1^2 + t_H^2)]^{1/2}$, then the optimum involves debt issuance of $d_1 = t_1/2c_L$, $d_2 = t_H/2c_L + [(1 - c_L/c_H)(t_1^2 + t_H^2)]^{1/2}/2c_L$, with $V_{L/L} = (t_L - t_H)(t_H + [(1 - c_L/c_H)(t_1^2 + t_H^2)]^{1/2})/2c_L + (t_1^2 + t_H^2)/4c_H$.

In the other region, with $t_H - [(1 - c_L/c_H)(t_1^2 + t_H^2)]^{1/2} \leq t_L < t_H$, the optimum involves debt issuance of $d_1 = t_1/2c_L$, $d_2 = t_H/2c_L - [(1 - c_L/c_H)(t_1^2 + t_H^2)]^{1/2}/2c_L$, with $V_{L/L} = (t_L - t_H)(t_H - [(1 - c_L/c_H)(t_1^2 + t_H^2)]^{1/2})/2c_L + (t_1^2 + t_H^2)/4c_H$.

We now turn to the equilibrium under rolled-over short-term debt issuance. Here no separating equilibrium is possible until the second issuance stage (since both types share the same benefits in the first period).

As noted above, there are three cases to consider in solving for equilibrium debt issuance: debt issuance for a type H firm (believed to be type H by investors), debt issuance for a type L firm (believed to be type H by investors), and debt issuance for a type L firm (believed to be type L by investors). In the latter case, the type H firm cannot, in equilibrium, find it profitable to mimic the type L firm issuance.

As in the simultaneous issuance scenario, the manager of a type H firm (believed to be type H) faces the maximization

$$\max_{d_1,\, d_2 \geq 0} \quad V_H = t_1 d_1 + t_H d_2 - c_H d_1^2 - c_H d_2^2, \tag{A4}$$

with optimal issuance $d_1 = t_1/2c_H$, $d_2 = t_H/2c_H$, and $V_H = (t_1^2 + t_H^2)/4c_H$.

Similarly, the manager of a type L firm, that is believed by investors to be of type H, faces the maximization

$$\max_{d_1,\, d_2 \geq 0} \quad V_{L/H} = t_1 d_1 + t_L d_2 - c_H d_1^2 - c_H d_2^2, \tag{A5}$$

with optimal issuance $d_1 = t_1/2c_H$, $d_2 = t_L/2c_H$, and $V_{L/H} = (t_1^2 + t_L^2)/4c_H$. Again, the price equityholders receive for issued debt reflects the costs potential debtholders believe they will incur in owning the debt.

Finally, the manager of a type L firm will not be able to convince investors her firm is of type L based on the first issuance alone, and only after the second issuance. Thus, at the first stage, she will be pooled with type H firms. She faces maximization

$$\max_{d_1,\, d_2 \geq 0} \quad V_{L/L} = t_1 d_1 + t_L d_2 - c_H d_1^2 - c_L d_2^2, \tag{A6}$$

$$\text{subject to} \quad t_1 d_1 + t_H d_2 - c_H d_1^2 - c_L d_2^2 \leq (t_1^2 + t_H^2)/4c_H,$$

$$t_1 d_1 + t_L d_2 - c_H d_1^2 - c_L d_2^2 \geq (t_1^2 + t_L^2)/4c_H.$$

The optimum is unconstrained, with $d_1 = t_1/2c_H$, $d_2 = t_L/2c_L$, and $V_{L/L} = t_1^2/4c_H + t_L^2/4c_L$ if the first constraint is nonbinding, which holds if the parameters satisfy $t_L > t_H + t_H(1 - c_L/c_H)^{1/2}$ or $t_L < t_H - t_H(1 - c_L/c_H)^{1/2}$.

The optimum is constrained if the first constraint is binding. Similar to the simultaneous issuance case, there are two regions. If $t_H < t_L \leq t_H + t_H(1 - c_L/c_H)^{1/2}$, the optimum involves debt issuance of $d_1 = t_1/2c_H$, $d_2 = (t_H/2c_L)[1 + (1 - c_L/c_H)^{1/2}]$, with $V_{L/L} = (t_L - t_H)(t_H/2c_L)[1 + (1 - c_L/c_H)^{1/2}] + (t_1^2 + t_H^2)/4c_H$.

In the other region, with $t_H - t_H(1 - c_L/c_H)^{1/2} \leq t_L < t_H$, the optimum involves debt issuance of $d_1 = t_1/2c_H$, $d_2 = (t_H/2c_L)[1 - (1 - c_L/c_H)^{1/2}]$, with $V_{L/L} = (t_L - t_H)(t_H/2c_L)[1 - (1 - c_L/c_H)^{1/2}] + (t_1^2 + t_H^2)/4c_H$.

In all cases, the first-period debt issued is $d_1 = t_1/2c_H$; thus, no separation information is revealed at the first stage of debt issuance. This puts rolled-over debt issuance at a disadvantage relative to simultaneous debt issuance, as the latter allows valuable price-relevant information about the firm (the firm's cost parameter) to be revealed more quickly. Comparing $V_{L/L}$ for the rolled-over and the simultaneous issuance case, a higher value is achieved under simultaneous issuance for all $t_L \neq t_H$.

Note that the rolled-over short-term debt scenario is formally identical to one sequential issuance (short-term debt first) scenario, as no relevant information is revealed during the first period. In contrast, the simultaneous issuance scenario is not formally identical to the other sequential (long-term debt first) scenario, as both d_1 and d_2 are used by high-quality firms to distinguish themselves from low-quality firms in the sequential scenario.

Figure 1. Debt payments under simultaneous issuance

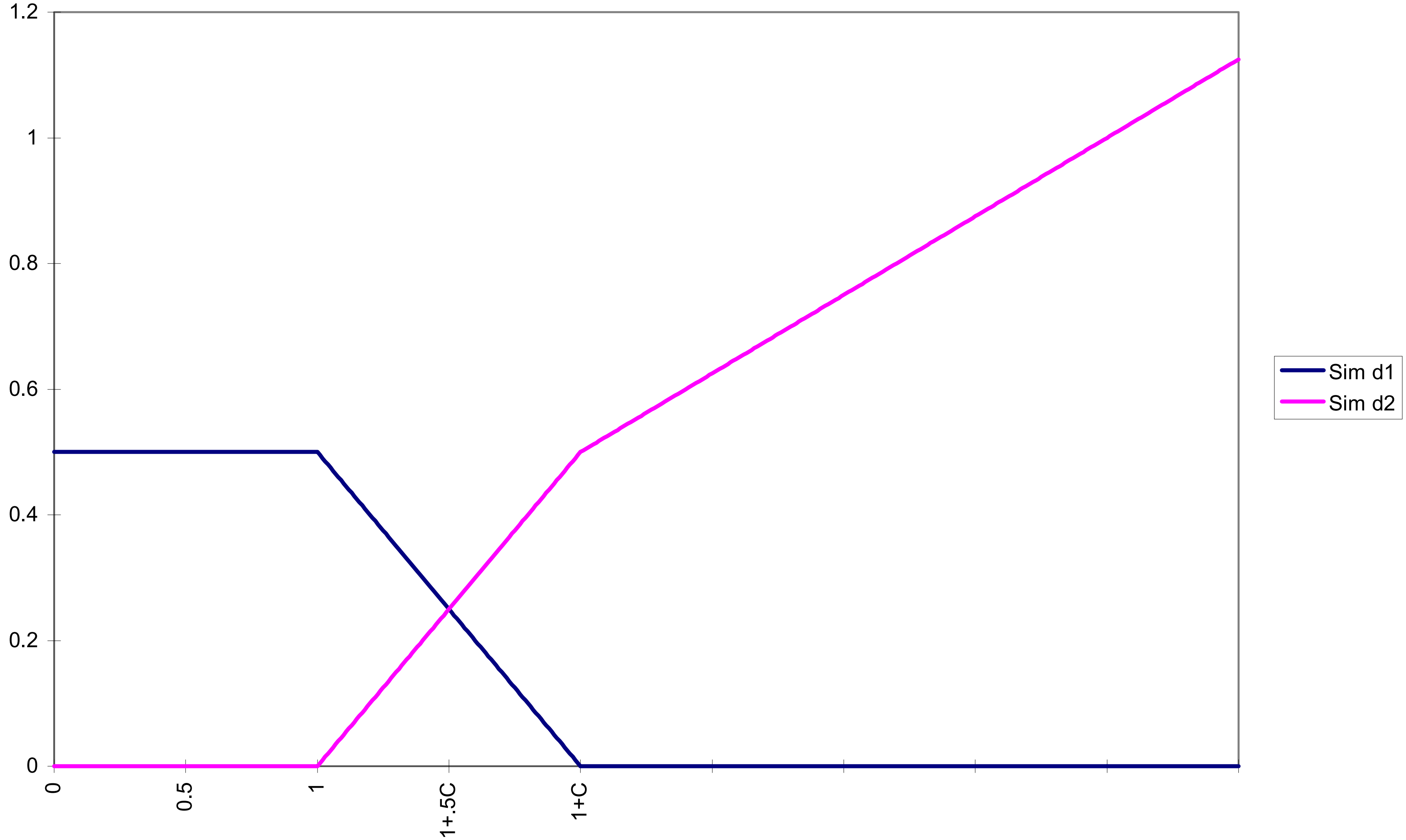

Figure 2. Debt payments under sequential issuance (short-term first) vs. simultaneous

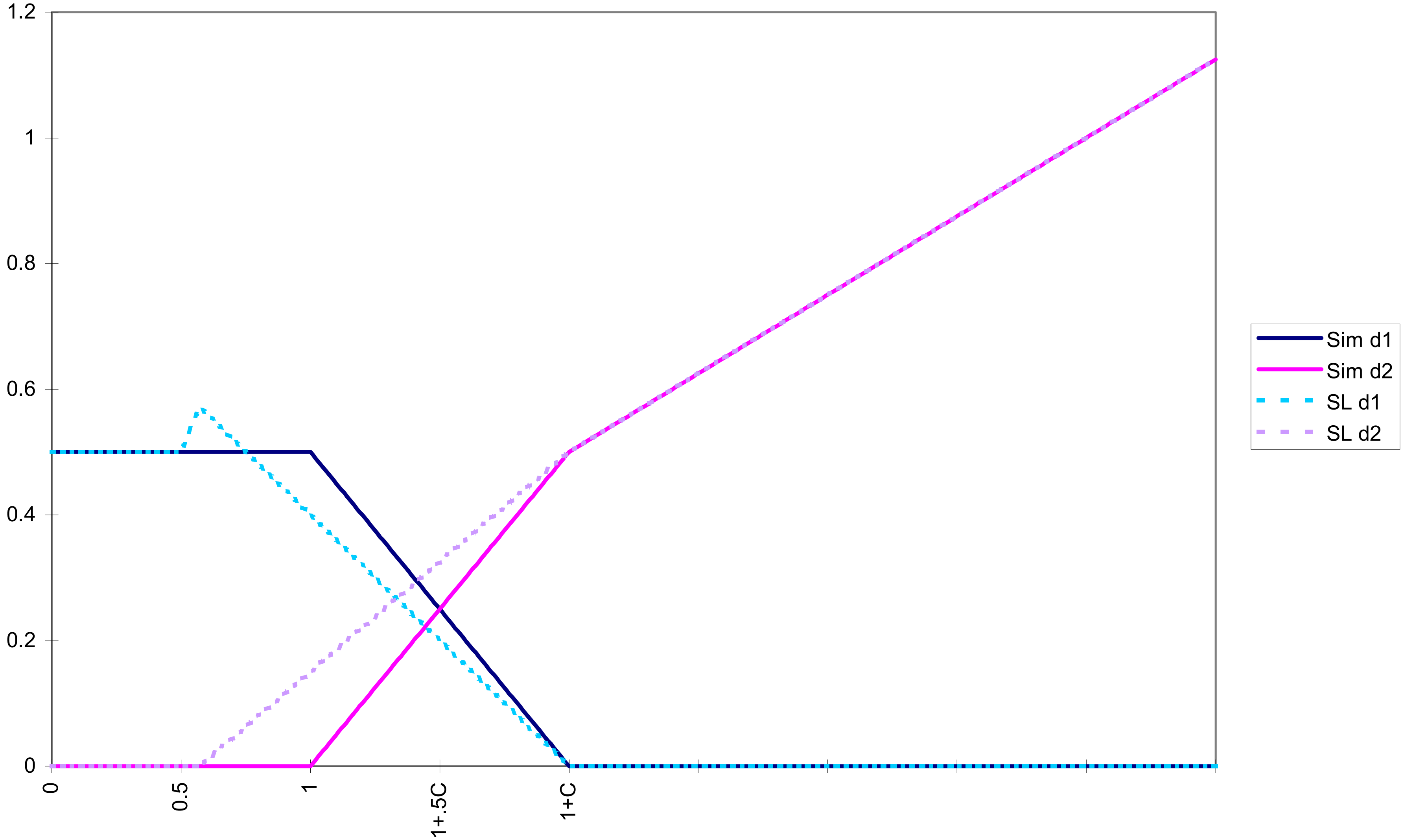

Figure 3. Debt payments under sequential issuance (long-term first) vs. simultaneous

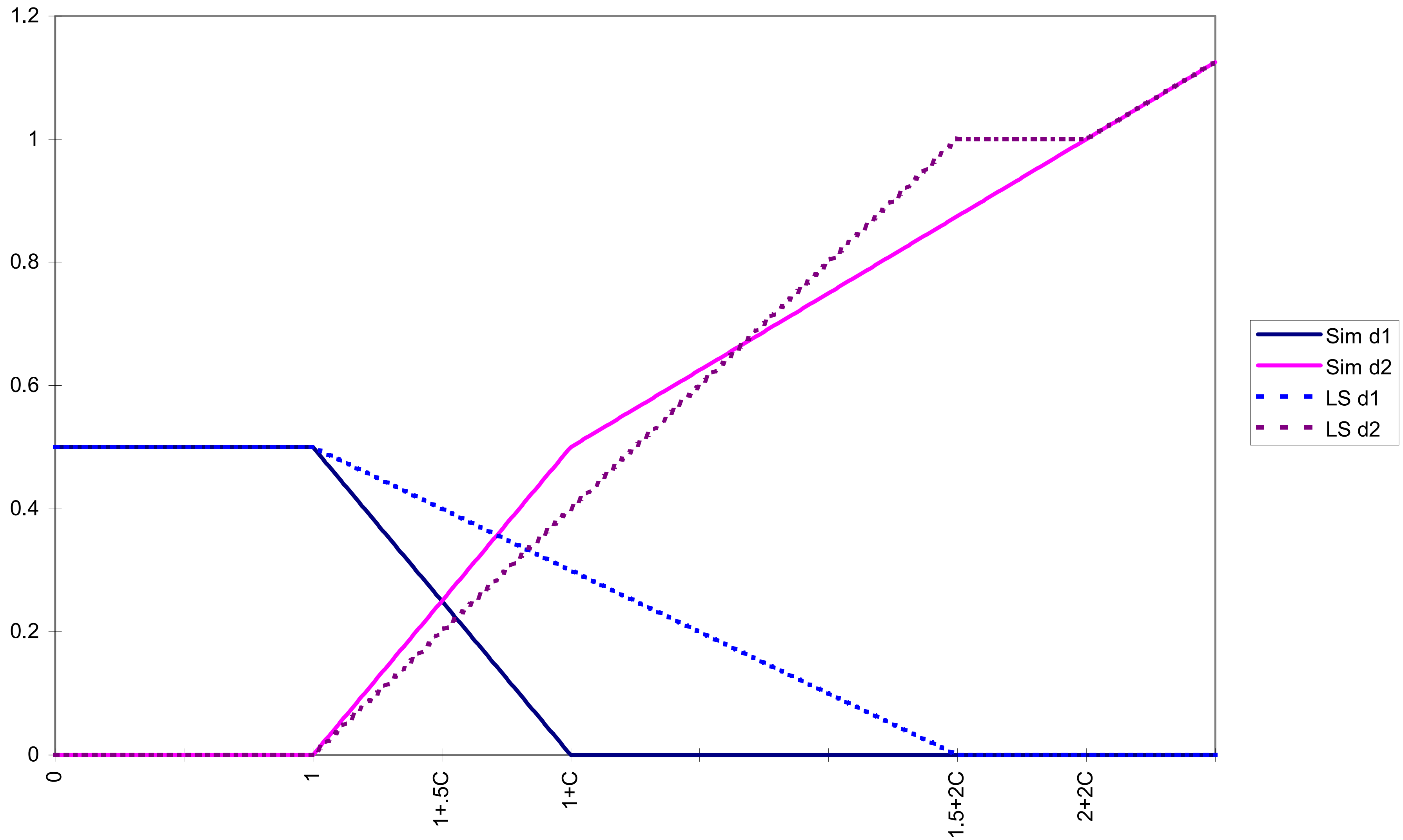

Figure 4. Debt payments under three issuance scenarios

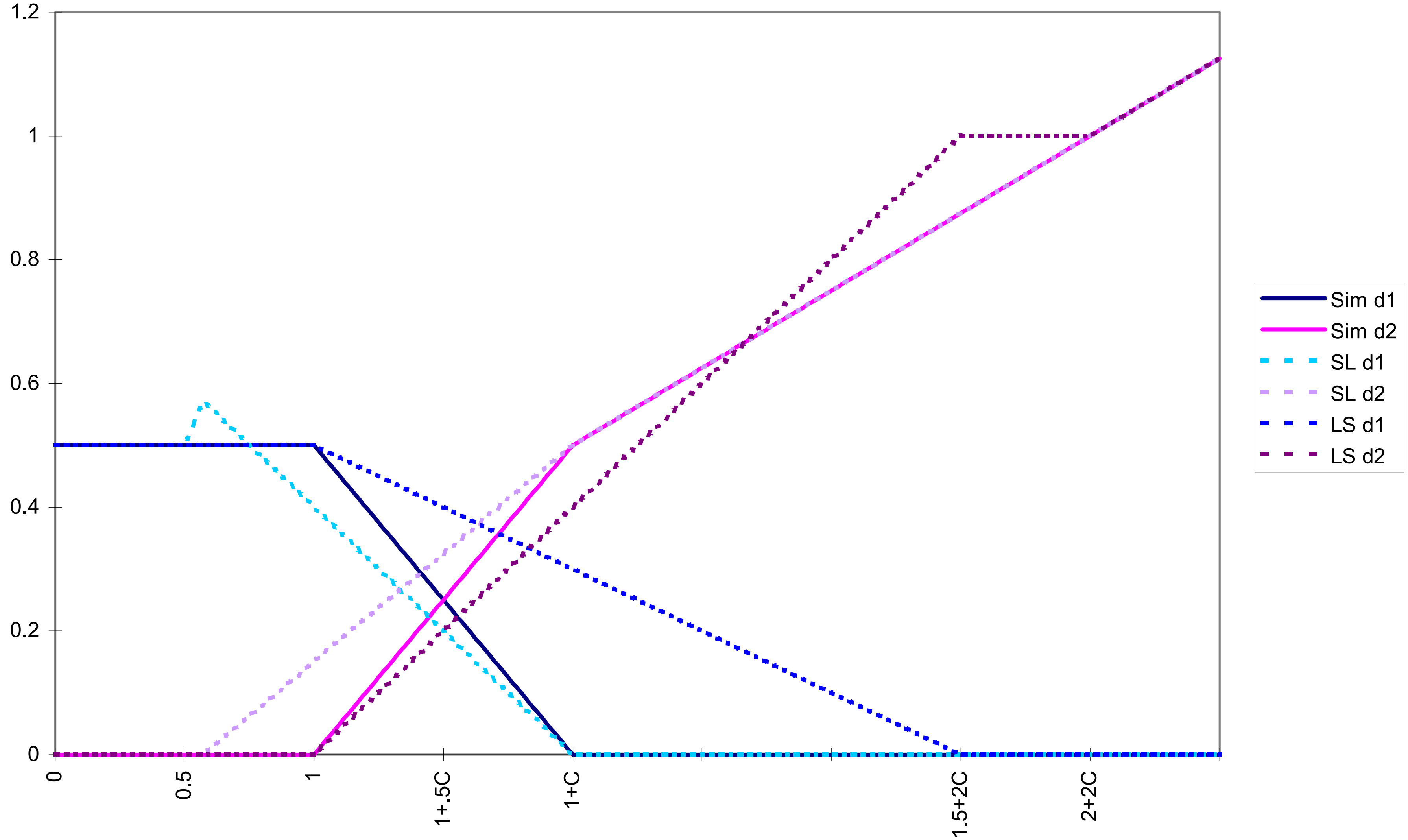

Figure 5. Moral hazard cost of sequential issuances, relative to simultaneous