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On the Good News in Equity Carve-Outs

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ABSTRACT

The announcement of the sale of equity in a wholly owned subsidiary of a corporation is received by the market as good news about the value of the existing equity in the parent corporation. This is in stark contrast to announcements of other forms of public equity financing. We show that the apparent inconsistency between the market response to equity carve-out announcements and other forms of equity financing can be easily understood in the Myers and Majluf (1984) framework. It is shown that firms that resort to an equity carve-out will be firms that, on average, are being undervalued by the market.

THE ANNOUNCEMENT OF THE sale of equity in a wholly owned subsidiary of a corporation, known as an "equity carve-out,"[1] appears to be received by investors as good news about the value of the existing equity in the parent corporation. For a sample of announcement of equity carve-outs by corporations, Schipper and Smith (1986)[2] document that such announcements are associated with an average market adjusted positive return to the stock of the parent corporation of about 2%.

As Schipper and Smith point out, this positive market reaction is in stark contrast to the well documented[3] evidence that announcements of issues of seasoned equity are treated by the market as unfavorable news about the value of a company's stock price. Masulis and Korwar (1986) and others have documented that announcements of equity issues by U.S. industrial firms are associated with an average negative abnormal return of around -3%. Not only are sales of seasoned equity viewed unfavorably by the market, but the empirical evidence indicates that even sales of convertible debt are associated with statistically significant negative average abnormal returns (see Dann

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[1]Also known as a "partial public offering." An example is Ecodyne which was a wholly owned subsidiary of Trans Union until 15% of its stock was sold to the public in mid-1972. It was stated at the time that this was intended to improve public recognition of Ecodyne as one of the largest water and water treating companies in the country (from Trans Union's 1972 annual report and referenced in Schipper and Smith (1986)).

[2]Schipper and Smith study a sample of 76 equity carve-out announcements by NYSE and AMEX companies over the period 1965–1983.

[3]See Masulis and Korwar (1986), Asquith and Mullins (1986), Mikkelson and Partch (1986), and Kalay and Shimrat (1987).

and Mikkelson (1984)). Schipper and Smith point out that equity carve-outs appear to represent the only form of new public equity financing by companies which results, on average, in an increase in shareholder wealth. Somehow, the fact that the equity is being issued with a claim on only part of the corporation's assets, rather than on its total assets, has the effect of reversing the usual pessimism about the value of the corporation with which equity issue announcements are received.

Why are announcements of equity carve-outs received favorably by the market? A "popular" argument, listed in Schipper and Smith, appears to be that investors are somehow attracted to subsidiary growth opportunities when these are isolated from the rest of the corporation. The argument relies upon the notion that equity carve-outs create securities that have scarcity value. Schipper and Smith[4] advance several alternative reasons as to why there might be differences in the market's reaction to an equity carve-out compared to parent equity offerings. For instance, they point out that the carve-out commits the subsidiary to supply audited financial statements. Most models with asymmetric information about firm assets will imply that firms that choose to get monitored more intensely are likely to be of higher value than average quality firms. In addition, the restructuring of asset management and incentive contracts that is found to be associated with carve-outs may have positive information content. It is also suggested that separate financing for subsidiary investments may have a positive share price effect if: (1) information is released about the subsidiary's planned investment in a positive NPV project without negative implications about the value of other assets in the consolidated firm; and (2) separate financing implies that management will not forgo future positive NPV projects. With respect to this last explanation, however, it is not obvious why similar arguments should not be applicable to announcements of other forms of equity financing that are clearly received unfavorably by the market.

This paper was motivated by the desire to find a common framework that could reconcile the seeming inconsistency between the response of the market to equity carve-outs and other forms of equity financing. We show that the Myers and Majluf (1984) framework, which has proven so useful in interpreting the negative reactions to seasoned equity announcements, can be extended in a straightforward manner to provide an explanation for the positive price reactions to equity carve-outs.[5] In our model we allow firms to choose to finance projects by selling equity in the parent corporation, engage in an equity carve-out, or simply forgo their projects. There is asymmetric information about the value of subsidiary assets in place as well as asymmetric information about the value of the assets in place in the rest of the

[4]For more details, see Schipper and Smith (1989).

[5]Schipper and Smith note that a rather interesting distinction between equity carve-outs and "conventional" IPOs is that in equity carve-outs there is no significant underpricing of the offering. We believe this lends support to our view that the information environment in which equity carve-outs are undertaken is closer to that of seasoned equity issues rather than that associated with "conventional" IPOs. We would like to thank the referee for pointing this out.

corporation. Any misvaluation by the market in the value of the subsidiary's assets in place is taken to be uncorrelated with misvaluation in the value of the assets in place for the rest of the corporation. In this situation we find that some firm types resort to equity carve-outs to fund subsidiary projects, while other types prefer to issue equity in the consolidated corporation. For example, if the consolidated corporation is being undervalued by the market and yet has a subsidiary that is being overvalued, such a firm prefers to issue equity in the subsidiary rather than equity in the consolidated corporation. Hence, by their financing decisions, firms reveal information *not just about the value of assets in place of the subsidiary but also about the value of the assets in place in the rest of the corporation.* We show that the firms that typically choose to go in for an equity carve-out will be firms that have, on average, been undervalued by the market. In contrast, firms that choose to issue equity in the parent corporation will be those that have, on average, been overvalued by the market.

Following Myers and Majluf, the standard assumption in models with equity financing is to assume that the class of firms under consideration are unable to use debt or other modes of external financing for reasons exogenous to the model. While it would be desirable to formally model equity financing in a framework that permitted a wider array of financing possibilities, the difficulty with introducing financing options such as debt have been amply demonstrated elsewhere in the literature.[6] Despite the lack of general models that allow for both debt and equity financing, it is possible to envision scenarios in which it is less costly to use equity or even to forgo a project rather than to use debt financing. The costs associated with debt financing are well known. Debt holders may require severe restrictions on the operations of the firm; the agency costs of debt and the consequences for firm value have been studied extensively in theoretical models. Debt can result in large bankruptcy costs. In this paper, we follow Myers and Majluf and assume that for one or more of these reasons, debt financing is not a viable alternative for the class of firms in the model. This assumption enables us to focus more sharply on the issues involved in choosing to finance subsidiary projects through selling equity in the consolidated corporation as compared to selling equity in the subsidiary.

Given asymmetric information, a firm with insufficient financial slack may choose to forgo some valuable investment opportunities. Myers and Majluf suggest that one way for slack-poor firms to counter this underinvestment problem may be through merger with slack-rich firms. We show that the ability to fund subsidiary projects through equity carve-outs can, in some cases, help overcome this underinvestment problem. However, the ability to

[6]Bagnoli and Khanna (1988) have proposed a model in which firms choose between debt or equity to finance projects. Their results are largely dependent on the assumption that debt financing involves greater fixed costs than equity financing. Noe (1988) provides an example in which some firm types resort to equity financing and other types to debt financing. The example requires assumptions about the variance of cash flows, as well as the distribution of firm types.

use equity carve-outs as a financing possibility appears to have ambiguous implications for the underinvestment problem overall. While the firm that resorts to the carve-out clearly stands to benefit, there are scenarios in which the overall underinvestment problem would be less if all firm types were obliged to sell equity in the consolidated corporation. We provide examples to illustrate the ambiguous nature of effects of equity carve-outs on the overall underinvestment problem.

The paper is organized as follows. In Section I, the model is developed. The relation between the various equilibria is discussed in Section II. Section III discusses the effect of carve-outs on the underinvestment problem. Section IV concludes.

I. The Model

We consider a class of corporations with a wholly owned subsidiary. The equity of the parent corporation is publicly traded. In the discussion below all market participants, including firm managers, are assumed to be risk neutral. In addition, for ease of exposition, we assume there to be no discounting of future cash flows. The subsidiary is publicly observed to receive a project and it is public knowledge that the project has a payoff of B next period for an investment of I by the subsidiary this period. The project has positive net present value, i.e., $B > I$. After receiving the project, the firm decides whether or not to engage in raising external financing to undertake the project.

Following the assumptions in Myers and Majluf (1984), the value of assets in place of the corporations is taken to be information private to the managers of the corporation.[7] Managers act in the best interest of the *current* equity owners of the firms, who are assumed to be passive investors, i.e., they do not alter their holdings until the liquidation of the firm.

While investors in the market do not have precise information about the value of the firm's assets in place, they have the following priors on the values of these assets. The value of the assets in place of the nonsubsidiary part of the corporation are known to be either V_H^1 or V_L^1 with equal probability,[8] where $V_H^1 > V_L^1$. The assets in place of the subsidiary are similarly known to be worth either V_H^2 or V_L^2 with equal probability, where $V_H^2 > V_L^2$. The assets in place of the subsidiary, on average, account for less than half the total assets of the corporation.[9] We assume that there is no correlation between the value of the assets in place of the subsidiary and the

[7]The results in Myers and Majluf are entirely driven by the existence of information asymmetry about assets in place and not about the value of the new project. We lose little economic intuition and greatly simplify the exposition by assuming that there is no information asymmetry regarding the new project.

[8]The arguments in the paper would not be affected by changing the equal probability assumption. It is made only for expositional ease.

[9]That is $\dfrac{V_H^1 + V_L^1}{V_H^2 + V_L^2} > 1$. We believe that this is in line with the Schipper and Smith sample.

rest of the assets of the corporation.[10] Hence, there are effectively four types of corporations that can occur with equal probability. The total value of the assets in place of these four types are $V_H^1 + V_H^2$, $V_H^1 + V_L^2$, $V_L^1 + V_H^2$ and $V_L^1 + V_L^2$. We designate these four types as stated in Table I.

Firms have no internal funds or "slack" capital available to finance the project. For the reasons discussed above, we assume that the only means available to the firm to finance the subsidiary project is by selling new stock. However, firms have the choice of either selling stock in the consolidated corporation or else selling stock in the subsidiary alone. So the firm can take one of three possible actions:

- O: Do not issue equity and forgo the project.
- S: Sell stock in subsidiary, i.e., do an equity carve-out.
- C: Sell stock in the consolidated corporation.

In order to determine and analyze possible equilibria, we need a convention to specify the strategies of different firm types. We write a possible equilibrium as a set with four elements, each element representing the strategy of one of the types. The first element represents the action of type HH, the second the action of type IH, and so on. As an example, the situation in which types HH and LL choose C, while type HL chooses S and LH chooses O will be written as CSOC. We will use * to denote that any of the three possible actions is allowed.

In any equilibrium, if a firm with assets in place of value of V_i^1 (for nonsubsidiary assets) and V_j^2 (for subsidiary assets) moves S and investors value the expected cash flows to the subsidiary at P_2,[11] then the value of the

Table I

Assets in Place of the Four Firm Types

There are two possible values each for subsidiary and nonsubsidiary assets in place, giving rise to a total of four firm types, denoted by HH, HL, LH, and LL. Assets in place are denoted by V_j^i. The superscript i refers to whether the assets in place are nonsubsidiary ($i = 1$) or subsidiary ($i = 2$). The subscript refers to whether the assets in place are of high value ($j = H$) or are of low value ($j = L$).

Firm Type	Nonsubsidiary Asset	Subsidiary Assets
HH	V_H^1	V_H^2
HL	V_H^1	V_L^2
LH	V_L^1	V_H^2
LL	V_L^1	V_L^2

[10] It is only critical to the model that misvaluations by the market of assets in place of the subsidiary and the rest of the corporation not be perfectly positively correlated.

[11] This represents the expected value of the cash flows to the subsidiary and includes the cash flows from the new project.

firm to the current owners of the firm will be:

$$V_i^1 + \left(1 - \frac{I}{P_2}\right)(V_j^2 + B).$$

This results from the fact the firm is selling new equity worth I in the subsidiary.[12] For this to be desirable, it must at least be true that the firm cannot do better by taking action O, i.e., foregoing the project. This implies the following:

$$V_i^1 + \left(1 - \frac{I}{P_2}\right)(V_j^2 + B) \geq V_i^1 + V_j^2.$$

If in equilibrium the firm takes action C, and the expected cash flows to the consolidated firm are valued by investors at P_1,[13] then the value to the current owners of the firm will be:

$$\left(1 - \frac{I}{P_1}\right)(V_i^1 + V_j^2 + B).$$

Again, at a minimum, it must be true that the current owners of the firm are not worse off than if they do not undertake the project.

To simplify the analysis we take the extent of uncertainty about the values of the subsidiary and nonsubsidiary assets in place to be similar by making the following assumption:

$$\frac{V_H^1}{V_L^1} = \frac{V_H^2}{V_L^2} = \mu > 1.$$

We write the ratio of the assets in place as γ, i.e., $\frac{V_H^1}{V_H^2} = \frac{V_L^1}{V_L^2} = \gamma$. Here, $\gamma > 1$, i.e., the assets of the subsidiary on the average account for less than half the value of the corporation's total assets. By these assumptions, types HH and HL are being undervalued by the market, while types LH and LL are being overvalued. Also let us define $B/V_L^2 = \theta$.

A. Determining the Equilibria

We limit our analysis to pure strategy equilibria. In principle there are a possible 3^4 (i.e., 81) candidate equilibria to consider since each type of firm can take each of three types actions and there are four firm types. However, we can quickly rule out many possibilities.

Type LL will always finance the project, i.e., move either C or S, since its true value is the lowest and the project is a positive NPV project. Also

[12] If there is asymmetric information, it is not in the interest of undervalued firms to sell more equity than is strictly required to undertake the project. Hence, any equilibrium will be characterized by the selling of new equity worth only I.

[13] This represents the expected value of the total cash flows of the consolidated corporation and includes the cash flows from the new project.

type HL has a subsidiary whose assets in place have the lowest value; hence, it will always receive at least a fair price for selling equity in the subsidiary, i.e., taking action S, and investing in the project. Hence, combinations of moves of the sort *O** and ***O cannot be equilibria. If type HH finds it optimal to accept the project, all other types will also find it optimal to finance the project. This follows from the fact that type HH is the highest true value type (i.e., the most undervalued)—if it finds it optimal to issue equity, lower value types can only do better by mimicking type HH.

Hence, in order to determine possible equilibria, we can limit ourselves to the following combinations of actions by the different types: (1) A maximum of 12 sets if type HH moves O.[14] (2) A maximum of 16 sets if type HH does not move O.[15] We should note here that, since we are considering all possible combinations of actions by firms, we will be analyzing all the possible pure strategy equilibria that can exist. The issue of whether for any choice of parameter values from the allowed set, there exists at least one of these pure strategy equilibria is discussed later. In order to organize the discussion, we have chosen to discuss first the situation in which all types undertake the project, then when only three types do so, and finally the situation in which only types HL and LL take on the project. As mentioned above, types HL and LL will always undertake a positive NPV project.

B. Equilibria with All Types Undertaking the Project

As mentioned above, with all types choosing to finance the project, there may be a maximum of 16 combinations of moves to consider in order to determine the possible equilibria. We begin by ruling out further combinations of moves as possible equilibria. In the discussion below, we will rely heavily upon the Cho-Kreps Intuitive Criterion (1987) in order to rule out certain candidate equilibria.[16]

[14]Since types HL and LL can take actions C or S and type LH can take actions O, C, or S.

[15]Since each of the types can move C or S.

[16]The Cho-Kreps criterion is a "refinement" of the Nash equilibrium concept and is used to decide whether a candidate equilibrium is robust to out-of-equilibrium moves by players. An informal description of the criterion is as follows. Consider a game with asymmetric information between player 1 and player 2. Player 1 has private information about its type, while player 2 knows the probability with which the different types can occur. On observing a move by player 1, player 2 updates his beliefs about player 1's type. The Cho-Kreps criterion imposes restrictions on the manner in which these beliefs are updated in the event that an out-of-equilibrium move is observed. The criterion requires that if an out of equilibrium move is observed, then player 2 must believe that the move could not possibly have come from any of the types that would do better by not deviating from the candidate equilibrium. Hence, the criterion is applied in the following steps: (1) specify a candidate equilibrium and (2) examine whether there are out-of-equilibrium moves that any of the types could make so as to do better by deviating from the candidate equilibrium, given the restrictions on the way player 2's beliefs are to be updated. If there are no such moves, then the candidate equilibrium is said to satisfy the criterion.

Lemma 1: *SSSS and CCCC cannot be equilibria on the basis of the Cho-Kreps criterion.*

Proof: In the appendix.

We now show that certain other combinations of moves can be ruled out as possible equilibria.

Lemma 2: (*a*) *If type HH finds it optimal to take action C, so will type LH.* (*b*) *If type HH finds it optimal to take action S then so will type HL.*

Proof: (a) In any equilibrium, let P_1 be the price at which equity can be sold in the consolidated corporation and let P_2 be the price at which equity can be sold in the subsidiary. If type HH prefers action C to action S, then the following weak inequality must hold:

$$\left(1 - \frac{I}{P_1}\right)\left(V_H^1 + V_H^2 + B\right) \geq V_H^1 + \left(1 - \frac{I}{P_2}\right)\left(V_H^2 + B\right)$$

or,

$$\frac{V_H^1 + V_H^2 + B}{P_1} \leq \frac{V_H^2 + B}{P_2}. \tag{1}$$

Since type LH is characterized by assets in place worth V_L^1 and V_H^2, the weak inequality above will hold as a strict inequality for type LH and it too will prefer action C to S.

(b) If type HH finds it optimal to choose action S, then we can show, as above, that the following condition holds:

$$\frac{V_H^1 + V_H^2 + B}{P_1} \geq \frac{V_H^2 + B}{P_2}. \tag{2}$$

It follows that if (2) is satisfied, type HL with assets in place of V_H^1, V_L^2 will allow find it optimal to move S.

Using these two lemmas we have been able to reduce our candidate equilibria to the following six: (1) CSCS; (2) CCCS; (3) CSCC; (4) SSCS; (5) SSSC; (6) SSCC. However, it is immediately apparent that (2) and (5) cannot be equilibria since they both involve the firm with the lowest value moving in a fashion that identifies its type. This firm will always do better by deviating from this move and pooling with the other higher value firms. Also (1) cannot be an equilibrium since it can be verified that type LL does better by deviating and moving C. Similarly (6) cannot be an equilibrium since in this situation type LL again has the incentive to deviate and will move S rather than C.

We are left with two candidate equilibria for the case in which all types undertake the project. As we discuss below, while there are parameter values for which one of two equilibria is unique, in general we have a situation with multiple equilibria. It turns out, however, that for either of the equilibria,

the price reactions to announcements of equity issues is similar and consistent with the empirical observations. We now discuss these two equilibria.

B.1. Equilibrium CSCC

We first find the conditions for this equilibrium to exist. If this combination of moves is an equilibrium, then the price P_1 at which equity in the consolidated corporation can be sold will reflect the types of firms that move C and will be given by:

$$P_1 = \frac{1}{3}\left(V_H^1 + 2V_L^1 + V_L^2 + 2V_H^2 + 3B\right).$$

Similarly, the price P_2 at which equity in the subsidiary can be sold will be given by:

$$P_2 = V_L^2 + B.$$

For type HH to not want to deviate from the equilibrium, he must prefer C to O or S. The condition that type HH prefers moving C to foregoing the project is:

$$\left(1 - \frac{I}{P_1}\right)\left(V_H^1 + V_H^2 + B\right) \geq V_H^1 + V_H^2 \tag{3}$$

and the condition that type HH prefers action C to S is:

$$\left(1 - \frac{I}{P_1}\right)\left(V_H^1 + V_H^2 + B\right) \geq V_H^1 + \left(1 - \frac{I}{P_2}\right)\left(V_H^2 + B\right). \tag{4}$$

The latter condition can be shown to be equivalent to the following:

$$\frac{\theta}{\mu} \leq \frac{\gamma + 2}{2(\gamma - 1)}.$$

The relationship between the conditions for equilibrium CSCC and equilibrium SSCS are discussed later. If the two conditions (3) and (4) are satisfied and type HH finds it optimal to move C, then by lemma 2 so does type LH. Also type HL has no incentive to deviate from moving S, since it would be undervalued by investors if it moved C rather than S. It is also optimal for type LL to pool with higher valued firms and move C rather than to move S and sell stock in the subsidiary at P_2. Hence, if conditions (3) and (4) are satisfied, CSCC will be an equilibrium.

Let us see the effect of the announcement of selling equity in the consolidated corporation compared to the effect of the announcement to sell equity in the subsidiary. Since, in this equilibrium, all types choose to undertake the project, the pre-announcement value P of the outstanding equity is:

$$P = \frac{1}{2}\left(V_H^1 + V_L^1 + V_H^2 + V_L^2\right) + B - I. \tag{5}$$

If the firm announces that it will finance by selling equity in the subsidiary, investors will identify the firm as being of type HL after such an announcement, the value to the investors of the outstanding equity is given by:

$$P^* = V_H^1 + V_L^2 + B - I. \tag{6}$$

Since, $P^* > P$, the announcement of S causes an upward revision in the price of the outstanding equity in the parent corporation. Similarly, we can see that the announcement of action C causes a downward revision in the value of the outstanding equity in the parent corporation. We now discuss the other equilibrium that can exist.

B.2. Equilibrium SSCS

We find the conditions for this equilibrium to exist. The price P_1 at which equity in the consolidated corporation can be sold (reflecting the value of the total expected cash flows) is given by:

$$P_1 = V_L^1 + V_H^2 + B.$$

The price at which equity in the subsidiary corporation can be sold is given by

$$P_2 = \frac{1}{3}\left(V_H^2 + 2V_L^2 + 3B\right).$$

As above, the conditions for type HH to not deviate from this equilibrium are as follows:

$$\left(1 - \frac{I}{P_2}\right)\left(V_H^2 + B\right) \geq V_H^2 \tag{7}$$

and

$$V_H^1 + \left(1 - \frac{I}{P_2}\right)\left(V_H^2 + B\right) \geq \left(1 - \frac{I}{V_L^1 + V_H^2 + B}\right)\left(V_H^1 + V_H^2 + B\right). \tag{8}$$

Conditions (7) and (8) are necessary to ensure that type HH prefers to move S to moving O or C, respectively. The second condition can be shown to be equivalent to the following:

$$\gamma \geq \frac{2\left(1 + \dfrac{\theta}{\mu}\right)}{1 + 3\dfrac{\theta}{\mu}}.$$

If type HH finds it optimal to move S, we know from lemma 2 that it is optimal for type HL to also move S. It is straightforward to verify that types LL and LH will similarly not want to deviate from this equilibrium.

As before we see that the announcement to issue equity in the consolidated corporation identifies the firm to have assets in place such that the market

reaction is negative. This is since only type LH is moving C in this equilibrium. The announcement of an equity carve-out is associated with an upward revision in the price of the outstanding equity in the parent corporation since the average value of assets in place of the three types HH, HL, and LL is greater than the average value of assets in place for all four types.

Based on the discussion above, we can state:

PROPOSITION 1: *In either of the two equilibria in which all firm types finance the project, the announcement to issue equity in the consolidated corporation is associated with a negative return to the outstanding equity. The announcement of an equity carve-out is associated with a positive return to the outstanding equity in the consolidated corporation.*

C. Equilibria in Which Type HH Forgoes Project

Now let us consider equilibria of the type O***, where * denotes any of the three possible moves O, C, or S. We can rule out as equilibria combinations of moves such as OC**. This is because type HL always faces adverse selection costs if it engages in the sale of equity in the consolidated corporation if type HH is not participating. Hence, type HL always sells equity in the subsidiary, i.e., move S, if type HH moves O. We can further state:

Lemma 3: *The only equilibrium in which type HH forgoes the project while types HL, LH, and LL accept is OSCC.*

Proof: As mentioned above, combinations of moves of the type OC** cannot be equilibria. Also we can rule out OSCS and OSSC as possible equilibria since in each case type LL has the incentive to deviate. In the case of OSSS, using an argument similar to that used in lemma 1 to rule out SSSS, we can show that type LH has the incentive to deviate and move C and that there exists an out-of-equilibrium move to which OSSS is not robust. Finally we are left only with OSCC.

C.1. Equilibrium OSCC

In this equilibrium, the only type of firm that is facing adverse selection costs is type LH. Hence, for this equilibrium to exist, it must be the case that type LH prefers moving C to staying out. Also it must be the case that type HH prefers to stay out to financing the project. Let P_1 be investors' expectation of the total value of the cash flows to the consolidated firm for a firm that moves C. Then we have:

$$P_1 = V_L^1 + \frac{1}{2}\left(V_H^2 + V_L^2\right) + B.$$

Similarly, let P_2 be the investors' expectation for the cash flows to the subsidiary for the firm that moves S. Then we have:

$$P_2 = V_L^2 + B.$$

The condition that a type LH firm prefer to move C to foregoing the project can be expressed as:

$$\left(1 - \frac{I}{P_1}\right)\left(V_L^1 + V_H^2 + B\right) \geq V_L^1 + V_H^2. \tag{9}$$

The conditions[17] that a type HH firm prefer to forgo the project can be expressed as:

$$V_H^1 + \left(1 - \frac{I}{P_2}\right)\left(V_H^2 + B\right) \leq V_H^1 + V_H^2, \tag{10}$$

$$\left(1 - \frac{I}{P_1}\right)\left(V_H^1 + V_H^2 + B\right) \leq V_H^1 + V_H^2. \tag{11}$$

The other types HL and LL will not have the incentive to deviate from this equilibrium if the conditions (9), (10), and (11) are satisfied.

As in the earlier cases, given the types resorting to an equity carve-out, this equilibrium is associated with a positive price reaction to the outstanding equity in the parent corporation equity at the announcement of an equity carve-out. Similarly, the announcement of an equity issue in the consolidated corporation is associated with a negative price reaction in the outstanding equity. We can state:

PROPOSITION 2: *In the equilibrium in which type HH forgoes the project, the announcement of an equity carve-out is associated with an upward revision in investor valuation of the parent corporation. The announcement of sale of equity in the parent corporation is associated with a downward revision in the investor valuation of the parent corporation.*

D. Equilibria in Which Types HL and LL Finance the Project

This situation exists only if the NPV of the new project is so low that only the firm types with the lowest value of assets in place in either the subsidiary or the consolidated corporation have the incentive to undertake the project. As discussed above, types HL and LL never want to forgo the project given that they are always able to sell equity at least at a fair price. We can have two equilibria in this situation: OSOS and OSOC. If the latter equilibrium exists, then the announcement of an equity carve-out identifies the firm as having a high value of nonsubsidiary assets in place and a low value of subsidiary assets in place, and this is associated with an upward revision of the price of equity in the parent corporation. Conversely, the announcement of an equity issue in the parent identifies the firm to be the type LL and leads

[17] Both conditions (10) and (11) are necessary since neither of the moves C or S dominates the other in general.

to a downward revision in the equity price. Sufficient conditions for the equilibrium to exist are that type LH prefers to forgo the project, i.e.,

$$\left(1 - \frac{I}{V_L^1 + V_L^2 + B}\right)(V_L^1 + V_H^2 + B) < V_L^1 + V_H^2, \tag{12}$$

$$\left(1 - \frac{I}{V_L^2 + B}\right)(V_H^2 + B) < V_H^2. \tag{13}$$

These conditions are related, however, and if condition (12) is satisfied, so is (13).

However, if OSOS is the equilibrium, then the announcement of an equity carve-out leads to a decline in the value of the equity in the parent corporation, given that only types HL and LL are undertaking the project. This is the only equilibrium in which the equity carve-out announcement leads to a negative price reaction in our model. Condition (12) is sufficient to ensure that this equilibrium exists. However, as mentioned, this equilibrium only holds if the projects are not profitable enough to induce types HH and LH to undertake the project.

II. Relation between the Different Equilibria

The type of equilibrium that exists depends on the return on the investment opportunity, measured by $B/I - 1$, as well as the relation between the assets in place of the different firm types, measured by γ and μ. Recall that μ, the ratio of high value to low value assets in place, is given by $\mu = \frac{V_H^1}{V_H^2} = \frac{V_H^2}{V_L^2}$. γ is the ratio of nonsubsidiary to subsidiary assets in place, i.e., $\gamma = \frac{V_H^1}{V_H^2} = \frac{V_L^1}{V_L^2}$. θ was defined to be the ratio B/V_L^2. As observed earlier, in general there does not exist a unique pure strategy equilibrium for a particular set of parameter values. We are, however, able to show that at least one of the pure strategy equilibria always exists for any choice of parameter values from the allowed set. The proof of this statement is provided in the appendix.

To help illustrate the effect of B/I and other parameters on the existence of the different equilibria, we rely on Table II below which gives the ranges for B/I over which the different equilibria can exist for several possible parameter values. The first number in a column is the smallest value of B/I and the second number the largest value of B/I for which a particular equilibrium will exist. For Table II, the value of μ has been kept constant at 1.5.

Consider the ranges of B/I over which the equilibria OSOS and OSOC can exist. Since firm types HL and LL do not face any adverse selection cost, the project will be undertaken by these types as long as $B/I \geq 1$; hence, in each

Table II

Ranges of B/I over Which the Different Equilibria Exist for Various Parameter Values

The investment of I in the new investment opportunity yields a total payoff of B next period. The first value in a column is the *smallest* value of B/I (i.e., 1 + return on investment) for which a particular equilibrium exists; the second value is the *largest* for which that equilibrium exists. A firm can take one of three possible actions S, C, or O where S denotes an equity carve-out, C the selling of stock in the consolidated corporation, and O the decision to forgo the project. An equilibrium is written as an ordered set of four elements, each element representing the strategy (i.e., O, S, or C) of one of the four firm types. The ordering is in terms of declining total assets in place. Therefore, the first element represents the strategy of firm type HH, the second that of type HL, and so on. The ratio of the nonsubsidiary and subsidiary assets in place is denoted by γ (i.e., $\gamma = \frac{V_H^1}{V_H^2} = \frac{V_L^1}{V_L^2}$). θ is defined to be the ratio B/V_L^2, where V_L^2 is the value for the assets in place for a subsidiary of low value. μ is the ratio of the values of the high type to the low type subsidiary as well as nonsubsidiary assets in place (i.e., $\mu = \frac{V_H^1}{V_L^1} = \frac{V_H^2}{V_L^2}$). For the table μ has been kept constant at 1.5.

Equilibrium	$\frac{\theta}{\mu}$	$\gamma = 1.05$	$\gamma = 2.0$	$\gamma = 8.0$
OSOS/OSOC	.25	1.00, 1.21	1.00, 1.15	1.00, 1.05
	.75	1.00, 1.16	1.00, 1.12	1.00, 1.05
	1.5	1.00, 1.12	1.00, 1.10	1.00, 1.04
OSCC	.25	1.09, 1.29	1.07, 1.34	1.03, 1.36
	.75	1.07, 1.23	1.06, 1.24	1.02, 1.24
	1.5	1.05, 1.15	1.04, 1.15	1.02, 1.15
CSCC	.25	$\geq$ 1.18	$\geq$ 1.20	$\geq$ 1.26
	.75	$\geq$ 1.14	$\geq$ 1.17	—
	1.5	$\geq$ 1.11	$\geq$ 1.14	—
SSCS	.25	—	$\geq$ 1.22	$\geq$ 1.22
	.75	—	$\geq$ 1.15	$\geq$ 1.15
	1.5	$\geq$ 1.10	$\geq$ 1.10	$\geq$ 1.10

case $B/I = 1$ is the lower end of the range. Table II indicates that, as θ/μ increases, the range over which these equilibria can exist shrinks. This can be interpreted as follows. The NPV of the investment opportunity is $B - I$ or $I(B/I - 1)$. For a given rate of return on the investment, i.e., $(B/I - 1)$, the investment I can be viewed as a measure of project size and $\theta/\mu = B/V_H^2 = (B/I)(I/V_H^2)$, as a measure of project size to the assets in place. Obviously, for a given rate of return, project NPV is increasing in the size of the project. Hence, as project size in increased, a type LH firm will be willing to bear adverse selection costs and move C even for a lower rate of return on the investment, i.e., a lower value of B/I.[18] Similarly, as γ is increased the

[18]Recall that the value of μ is fixed for the discussion. Hence, for a given value of V_H^2, the magnitude of the adverse selection cost that a type LH faces is kept fixed. Therefore, if the project size is increased, as measured by θ/μ, type LH firms will be willing to enter even if the rate of return on the project is lower.

range of B/I over which these equilibria can exist shrinks. The reason for this follows from the fact that as $\gamma = \frac{V_L^1}{V_L^2}$ increases, firms of type LH in moving C face a relatively smaller extent of adverse selection cost since the subsidiary assets in place (which are undervalued in their case) account for a relatively smaller proportion of the total assets in place. Hence, type LH firms will enter for lower values of B/I as γ increases.

Consider the ranges of B/I over which the equilibrium OSCC exists. As θ/μ increases, both the lower as well as the upper end of the range decreases. The reason for this, as discussed above, is that as the scale of the project increases, firm types that face adverse selection costs will be willing to enter for lower values of B/I. As γ increases, the lower end of the range decreases, as expected, since type LH firms face the adverse selection cost only for the subsidiary assets in place. If subsidiary assets in place account for a lower proportion of the total assets in place, firms of type LH will be willing to enter for lower values of B/I. This is not the case for type HH firms, however, and increasing γ may make it less desirable for them to enter since these firm types are being undervalued in both subsidiary and nonsubsidiary assets in place. This accounts for the increase in the upper end of the range for B/I in several of the cases for this equilibrium as γ increases.

Finally, consider the two equilibria in which all firm types undertake the project. As expected, an increase in the scale of the project, indicated by θ/μ, decreases the lower end of the range of B/I at which either of the equilibria can exist. While, in general, both equilibria can exist for large enough values of B/I, it turns out that for some ranges of parameter values there will be a unique equilibrium. As γ increases, the extent of the adverse selection cost faced by type HH firms in the CSCC equilibrium increases since these firm types are undervalued in both subsidiary as well as nonsubsidiary assets in place. For large values of γ, type HH firms will prefer to move S rather than C. It can be verified from conditions (4) and (8) that if $1 > \frac{\theta}{\mu} > 1/2$ (i.e., a condition on the scale of the project) and $\gamma > 7$, then SSCS will be the unique equilibrium. For low values of γ and θ/μ, it turns out that the equilibrium CSCC may be unique. This is because, if the scale of the project is smaller and the magnitudes of the subsidiary and nonsubsidiary assets in place is close, type HH firms do better moving C and pooling with firm types LH and LL.

III. Carve-Outs and the Underinvestment Problem

The fact that firms have an additional degree of freedom in the manner in which they can finance subsidiary projects may help some firms to overcome the type of underinvestment problem identified by Myers and Majluf. Compared to a situation in which firms could only issue equity in the consolidated corporation, the possibility of an equity carve-out can in some cases allow undervalued firms to take on investments that would otherwise have been

forgone. Consider the following example below:

Example 1: Let $V_H^1 = 10$, $V_L^1 = 5$, $V_H^2 = 4$, and $V_L^2 = 2$. Hence, the assets in place for the four types of firms are valued at 14, 12, 9, and 7. Let the project be such that $B = 1.1$ and $I = 1$. If firms can issue equity only in the consolidated corporation, only firm types LH and LL will undertake the project. The total cash flows of firms that choose to issue equity will be valued at 9.1. Hence, the stock price for firms that announce an equity issue will drop to reflect this information.

If firms also have the choice of an equity carve-out, the resulting equilibrium has type HL resorting to an equity carve-out, while types LH and LL issue equity in the consolidated corporation (the OSCC equilibrium). Hence, the possibility of an equity carve-out has the beneficial effect of allowing a larger set of firms to undertake valuable projects. The firm that announces a carve-out will be valued at 12.1, while the firms that choose to sell equity in the consolidated corporation will be valued at 8.1. The price of the firms before the announcement will be 10.575 to reflect the various outcomes; hence, an equity carve-out will result in the stock price appreciating, while selling equity in the consolidated corporation will lead to a decline in the stock price.

The ability of firms to resort to equity carve-outs on the overall underinvestment problem is, however, somewhat ambiguous. Clearly the firms that resort to an equity carve-out stand to benefit from this financing option. However, since the types of firms that will resort to carve-outs are typically undervalued firms, by leaving the pool of undervalued firms, they may make the adverse selection problem even worse for other types of undervalued firms that do not find it optimal to resort to a carve-out. We provide an example below of a situation in which the overall underinvestment problem becomes worse because firms have the ability to resort to equity carve-outs. In this example, more types of firms would have accepted the project if equity could have only been issued in the consolidated corporation:

Example 2: Let the values of the assets in place be the same as in Example 1, but let the project have $B = 1.3$ and $I = 1$ instead. For this case, if firms can only issue equity in the consolidated corporation, then the project is valuable enough that all four types of firms will choose to undertake the project. Hence, the announcement of an equity issue releases no new information in this case. Total equity of a firm after the equity financing will be valued at 11.8 (this is the sum of the average assets in place and the cash flow from the project).

If firms can also resort to equity carve-outs, then the resulting equilibrium is OSCC. This happens since type HL finds it optimal to issue equity in the subsidiary given that its subsidiary is overvalued, while the firm as a whole is being undervalued. This, however, affects the price that type HH can get for issuing equity. It can be verified that conditions (3) and (7) fail to be satisfied and, hence, there is no equilibrium in which type HH accepts the project. Therefore, even though type HL benefits from the possibility of a

carve-out, it makes the adverse selection problem worse for type HH. In this example the effect is large enough to induce type HH to forgo the project.

IV. Conclusion

In this paper we have provided a possible explanation that can resolve the seeming inconsistency between the market response to equity carve-out announcements and announcements of other forms of equity financing. We have argued that the choice of financing decision may provide information not just about the subsidiary's assets in place but also about the value of the assets in place of the rest of the corporation. In equilibrium, firms that choose an equity carve-out will typically be those that have been undervalued by the market. The fact that firms have the option of resorting to equity carve-outs, in some cases, allows firms to take on subsidiary projects that might otherwise have been forgone. The overall effects of the equity carve-out option on the underinvestment problem are, however, ambiguous.

Appendix

Proof of Lemma 1: We argue that CCCC cannot be an equilibrium since a firm of type HL always has the incentive to make an out-of-equilibrium move of S.[19] The reasoning is a follows. If CCCC were the equilibrium, investors would value the expected cash flows of the consolidated corporation at the pooling value:

$$P_0 = \frac{1}{2}\left(V_H^1 + V_L^1 + V_H^2 + V_L^2\right) + B.$$

Therefore, by taking action C, firm type HL is selling its equity for less than its worth—since by construction $V_H^1 + V_L^2 > \frac{1}{2}(V_H^1 + V_L^1 + V_H^2 + V_L^2)$. Suppose instead that type HL sells equity in the subsidiary and offers it for a price consistent with the value of subsidiary assets in place of V_L^2. Investors, given their priors, know that subsidiary assets in place are worth at least V_L^2 and will be willing to buy equity in the subsidiary for a price consistent with this. Type HL is certainly better off because it does not face any adverse selection costs in selling equity in the subsidiary. We show this to be the case. By taking action C, the current equity owners of firm type HL receive:

$$\left(1 - \frac{I}{P_0}\right)\left(V_H^1 + V_L^2 + B\right). \tag{14}$$

[19]This and similar arguments below are based on the Cho-Kreps criterion.

By selling equity in the subsidiary, the current equity owners of firm type HL can receive:

$$V_H^1 + \left(1 - \frac{I}{V_L^2 + B}\right)(V_L^2 + B). \tag{15}$$

The value of expression (15) is greater than the value of expression (14) under our assumptions regarding μ and γ. Type HL will always deviate and move S and its offer will be accepted by investors in the market. Hence, CCCC cannot be an equilibrium.

Similarly SSSS will not survive out-of-equilibrium moves by type LH. If this set of moves is an equilibrium, it involves the selling of equity in the subsidiary at the pooling price:

$$P = \frac{1}{2}(V_H^2 + V_L^2) + B.$$

Hence, in this situation, type LH with subsidiary assets in place worth V_H^2 is being undervalued by the market. Suppose instead that type LH takes action C and offers equity in the consolidated corporation for sale at a price consistent with total assets in place worth $V_L^1 + \frac{V_H^2 + V_L^2}{2}$. We verify that type LL (the only type with assets in place for the consolidated corporation worth less than type LH) will never have the incentive to make such an offer since it does better by not deviating from the candidate equilibrium SSSS. This is since:

$$\left(1 - \frac{I}{V_L^1 + \frac{V_H^2 + V_L^2}{2} + B}\right)(V_L^1 + V_L^2 + B) < V_L^1 + \left(1 - \frac{I}{P}\right)(V_L^2 + B).$$

On the other hand, if investors are willing to accept the equity at a price of $V_L^1 + \frac{V_H^2 + V_L^2}{2} + B$, then type LH does better by deviating. This is since:

$$\left(1 - \frac{I}{V_L^1 + \frac{V_H^2 + V_L^2}{2} + B}\right)(V_L^1 + V_H^2 + B) > V_L^1 + \left(1 - \frac{I}{P}\right)(V_H^2 + B).$$

Hence, on observing such an out-of-equilibrium offer, investors should be convinced that type LL never has the incentive to make such a move and will, therefore, be willing to accept the offer. Hence, by this argument, SSSS cannot be an equilibrium.

Existence of a Pure Strategy Equilibrium

We show that for any value of the parameters within the allowed set, the conditions for the existence of at least one of the pure strategy equilibria will

be satisfied. According to the discussion in the text, the parameters must satisfy the following conditions: μ, γ, $B/I \geq 1$; also θ, $V_L^2 > 0$. We proceed by defining two values $\frac{B^1}{I}$ and $\frac{B^2}{I}$.

Given a particular choice of μ, γ, θ, and V_L^2, let $\frac{B^1}{I}$ be the value of $\frac{B}{I}$ such that condition (12) is just satisfied, i.e., $\frac{B^1}{I} = \frac{V_L^1 + V_H^2 + B}{V_L^1 + V_L^2 + B} = \frac{\gamma + \mu + \theta}{\gamma + 1 + \theta}$. For a value of $\frac{B}{I}$ such that $\frac{B^1}{I} > \frac{B}{I} \geq 1$, the equilibria OSOS and OSOC will exist. We consider below the cases in which $\frac{B}{I} \geq \frac{B^1}{I}$.

Now consider the range of $\frac{B}{I}$ in which all four types undertake the project. It is easy to show that of the two conditions (4) and (8) that apply to the equilibria CSCC and SSCS respectively, at least one is always satisfied. This is because for (8) to be satisfied, it is sufficient that either $\theta/\mu \geq 1$ or else $\gamma \geq 2$. However, it is immediate that if $2 > \gamma \geq 1$ and $\theta/\mu < 1$, then condition (4) will always be satisfied.

Now define the following:

$$\frac{B^2}{I} = \text{Min}\left[\frac{B^*}{I}, \frac{B^{**}}{I}\right]$$

where,

$$\frac{B^*}{I} = \begin{cases} \infty, & \text{if (4) is not satisfied,} \\ \dfrac{V_H^1 + V_H^2 + B}{1/3\left(V_H^1 + 2V_L^1 + V_L^2 + 2V_H^2 + 3B\right)}, & \text{if (4) is satisfied} \end{cases}$$

and,

$$\frac{B^{**}}{I} = \begin{cases} \infty, & \text{if (8) is not satisfied,} \\ \dfrac{V_H^2 + B}{1/3\left(V_H^2 + 2V_L^2 + 3B\right)}, & \text{if (8) is satisfied.} \end{cases}$$

Since, at least one of the conditions (4) or (8) is satisfied, $\frac{B^2}{I}$ is well defined and finite. For $\frac{B}{I} \geq \frac{B^2}{I}$, it is easy to verify that the conditions for the existence of at least one of the equilibria CSCC or SSCS will be satisfied.

We now consider the remaining possible values of $\frac{B}{I}$. There are two possibilities:

I. If $\frac{B^1}{I} > \frac{B^2}{I}$, then, from above, for $\frac{B^2}{I} > \frac{B}{I}$, the equilibria OSOS and OSOC will exist. Hence, in this case there exists at least one pure strategy equilibrium for any value of $\frac{B}{I} \geq 1$.

II. If $\frac{B^2}{I} \geq \frac{B^1}{I}$, we show that the equilibrium OSCC will exist for $\frac{B}{I}$ in the range $\frac{B^2}{I} \geq \frac{B}{I} \geq \frac{B^1}{I}$. For OSCC to exist, the conditions (9), (10), and (11) must be satisfied. Now, it is easy to verify that for $\frac{B}{I} \geq \frac{B^1}{I}$, condition (9) is always satisfied. For the other conditions, we argue as follows. By the definition of $\frac{B}{I} \geq \frac{B^1}{I}$, condition (9) is always satisfied. For the other conditions, we argue as follows. By the definition of $\frac{B^2}{I}$, for $\frac{B}{I} \geq \frac{B^2}{I}$, at least one of the equilibria CSCC, SSCS will exist. Suppose it is CSCC that exists for $\frac{B}{I} \geq \frac{B^2}{I}$. Then, for $\frac{B}{I} < \frac{B^2}{I}$, it must be true that condition (3) does not hold. Therefore, it must be the case that:

$$V_H^1 + V_H^2 > \left(1 - \frac{I}{1/3\left(V_H^1 + 2V_L^1 + V_L^2 + 2V_H^2 + 3B\right)}\right) \cdot \left(V_H^1 + V_H^2 + B\right) \geq V_H^1 + \left(1 - \frac{I}{V_L^2 + B}\right)\left(V_H^2 + B\right).$$

It can be verified that this implies that conditions (10) and (11) hold. Hence OSCC will exist in the region under consideration.

Similarly, suppose it is SSCS that exists for $\frac{B}{I} \geq \frac{B^2}{I}$. Then, for $\frac{B}{I} < \frac{B^2}{I}$, it must be true that condition (7) does not hold. Therefore, it must be the case that:

$$V_H^1 + V_H^2 > V_H^1 + \left(1 - \frac{I}{1/3\left(V_H^2 + 2V_L^2 + 3B\right)}\right)\left(V_H^2 + B\right) \geq \left(1 - \frac{I}{V_L^1 + V_H^2 + B}\right)\left(V_H^1 + V_H^2 + B\right).$$

It can similarly be verified that this implies that conditions (10) and (11) hold. Hence, the conditions for OSCC to exist are satisfied in the region $\frac{B^2}{I} \geq \frac{B}{I} \geq \frac{B^1}{I}$.

We have shown, therefore, that for any arbitrary values of V_L^2, μ, θ, γ, and B/I, there will exist at least pure strategy equilibrium.

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