Capital Structure and Dividend Irrelevance with Asymmetric Information

Philip H. Dybvig
Washington University in St. Louis

Jaime F. Zender
University of Utah

The Modigliani and Miller propositions on the irrelevancy of capital structure and dividends are shown to be valid in a large class of models with asymmetric information. The main assumption is that managerial compensation is chosen optimally. This differs from most of the recent articles on this topic, which impose by fiat a suboptimal contract. Even when imperfections internal to the firm preclude optimal investment, there is a separation between incentives and financing. We conclude that corporations should move toward contracts with better incentives, and that new models should be built that recognize the limitations to optimal contracting.

The Modigliani and Miller (1958, 1963; Miller and Modigliani, 1961) irrelevancy propositions imply that capital structure and dividend policy are matters of irrelevance in the absence of transaction costs, taxes, and informational asymmetries. If the irrelevancy propositions accurately explain the world, then we cannot hope to develop any model that can predict

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or prescribe capital structure or dividend policy. More interestingly, irrelevancy propositions indicate where not to look for predictive and prescriptive models. Furthermore, irrelevancy propositions provide a framework for classifying different potential models in which capital structure or dividend policy is relevant, based on how the assumptions of the irrelevancy propositions have been violated. For these reasons, the irrelevancy propositions have been the benchmark against which models of capital structure and dividend policy have been evaluated. The purpose of this article is to extend the irrelevancy propositions to a large class of models with asymmetric information.

The irrelevancy propositions in this article may seem to be logically inconsistent with a number of articles presenting models in which asymmetric information does make capital structure or dividend policy matter.[1] The main difference between this article and most of the existing literature is in the manager's assumed incentives: while we determine the manager's incentives as an optimal choice, most articles in the literature assume suboptimal incentives. Some of these articles also assume implicitly that it is useful for managers to signal information about the firm to the market. In fact, if the information possessed by managers is firm-specific, this implicit assumption is probably incorrect.[2]

The starting point for our analysis is Myers and Majluf (1984), a distinguished representative of the literature we are criticizing. Myers and Majluf consider several suboptimal objectives for managers, but we will focus on their leading case of a manager who is assumed to act on behalf of existing shareholders who hold their investment until the end, when the firm is liquidated. While this may sound like a reasonable managerial objective, Myers and Majluf demonstrate that it implies suboptimal investment. Specifically, suppose that the manager has private information about existing assets and about a potential new project. A manager who observes very good news about the existing projects would refrain from taking on a new project that is only modestly profitable, because a stock offering at a price based

[1] Some examples of important articles in this literature are Bhattacharya (1980), Miller and Rock (1985), Myers and Majluf (1984), Harris and Raviv (1985), and Ross (1977). This article is closest in spirit to the Ross article, since the optimal incentive contract is discussed (but not derived) in that article. The article by Myers and Majluf also recognizes this issue, and explores several incentive contracts that seem "natural," but does not examine an optimal contract.

[2] Earlier drafts of the article contained a section on the value of early release of information by a firm. That analysis showed that earlier release of information does not, in itself, make shareholders better off or the firm more valuable ex ante. The section also contained a very simple and general proof of the resolution uncertainty result of Ross (1989) on which our analysis is based. It also included an example that shows that learning about a firm's beta is idiosyncratic risk. That entire analysis can be found in Dybvig and Zender (1990).

on public information would imply too much of a dilution of the existing shares. Of course, this suboptimal behavior is anticipated by investors and results in an initial offering price that is lower than it would be under an optimal investment policy.

We develop a series of models based on the framework of Myers and Majluf but solving for optimal contracts using the approach to agency theory pioneered by Ross (1973). In these models, we show that investment is optimal, while capital structure and dividend policy are irrelevant. The optimality of investment is due to the special feature of Myers and Majluf's model: there are no imperfections within the firm related to agency problems of costly managerial effort. We also derive the more general result of separation of financing and incentives: financing does not affect the value of the firm in the presence of imperfect information, provided that the market does not generate information (in its valuation of the firm's obligations) that is valuable to the manager or to those agents evaluating the manager, and provided that costly information gathering does not depress the market price.[3] All these results are in Section 1.

An important implicit assumption of our analysis is that financial claims and control rights can be assigned equally well to different outside claimants. This assumption seems to be reasonable for a firm with publicly traded claims, provided that the law does not include arbitrary restrictions to contracting. For example, it would be inconsistent with our assumptions to have a legal system in which the equityholders can always fire the manager at will and introduce a new manager with a new incentive contract. It seems reasonable that it is possible for equityholders to commit not to do this because of restrictions or incentives built into the corporate charter, bond indentures, offering statements, and other contracts entered into by the firm. (One interesting potential reason for having a particular type of claim is to make sure that some agent has a vested interest in making sure that contracts are enforced, although this concept is outside of our model, which assumes that contracting on observables is not a problem.) Note that if managerial incentives or actions by equity's representatives are simply unobservable, it is unclear how the holders of publicly traded equity can verify that the manager has an incentive to act on their behalf in the first place. If we were to consider a sole proprietorship, however, the assignability of control rights seems much less obvious: for example, the manager may also be the main equityholder.

[3] Several information economists have suggested to us that the real surprise is not that there is a separation of financing and incentives, but rather that anyone would ever think otherwise. [See, e.g., Hart and Hölmstrom (1987, p. 90).] Our analysis shows how and under what circumstances the information economists' perspective applies to existing models in finance.

This is why we think of our model as being most clearly applicable to publicly traded firms.

To tie our analysis to the empirical literature, we present an example showing that the Modigliani–Miller irrelevancy propositions are consistent with the stylized empirical facts. The idea behind the example is that in very good states, the existing project generates the funds needed to undertake any new project, and therefore a new issue is bad news. If the manager has good news about the new project but bad news about the old project, the manager raises debt, which is only slightly bad news. If the manager has bad news about both new and old projects, the manager raises equity, which is very bad news. All of this is consistent with optimal investment. Therefore, even if the empirical evidence agrees more or less with Myers and Majluf, this agreement is not convincing proof that their story is correct; the same empirical evidence is consistent with optimal investment in a world in which the Modigliani and Miller irrelevancy propositions hold. The example is in Section 2.

1. The Model

In the simplest model of Myers and Majluf (1984), the manager is assumed to act on behalf of original shareholders who plan to hold their stock until liquidation of the firm. The manager has private information both about the value of existing assets in place and about the value of a new potential investment. When the new project is marginally profitable and the existing asset is sufficiently more profitable than is typical, the manager knows that the issue price of the new shares will be significantly less than their intrinsic value. Because of the manager's assumed objective, the manager will perceive a loss due to the underpricing of new shares. If this perceived loss is larger than the profitability of the investment, the manager will refrain from making the new investment. The perceived loss is not an economic loss (it is a transfer), which is why a profitable project may be passed by. This rejection of profitable projects is the inefficiency in the Myers and Majluf model.

1.1 Optimal investment

Our first model follows Myers and Majluf's first model very closely, except that the manager's incentive contract is chosen endogenously.[4] We study a single firm existing over three periods (0, 1, and 2). In period 0, the firm is established by an entrepreneur who invests an

[4] As mentioned in note 1, Myers and Majluf did consider several alternative managerial contracts, but not any optimal contract.

amount I^a in the firm's initial project, hires a manager, and chooses the manager's contract $s(\cdot)$, anticipating the manager's reactions to the incentives created by the contract. In this initial period, all agents have the same information, which includes knowledge of the distributions of the exogenous random variables ($\tilde{a}$ and $\tilde{b}$, to be introduced shortly) and the structure of the problems faced by all agents. At the end of this initial period, the entrepreneur sells the new firm by making an equity issue (an initial public offering or IPO).[5] In period 1, the manager learns two pieces of private information: the realization a of the profit $\tilde{a}$ (payoff in excess of I^a) to capital in place, and the realization b of the prospective profit $\tilde{b}$ (payoff in excess of I^b) of a prospective investment opportunity requiring an investment I^b. After observing a and b, the manager chooses whether to undertake the new investment project. We code the manager's choice as d: $d = 1$ if the manager undertakes the new investment, and $d = 0$ if not. The manager's choice is made known to the public, and if the new investment is undertaken, the firm issues new equity worth I^b to finance the project. (We consider later the possibility that the manager may choose to issue debt instead.) In period 2, all payoffs are realized, and the public learns the total profit $a + bd$. It is reasonable that the public learns $a + bd$ but not a and b separately, because we think of the new project as being inextricably tied to the original project. For example, the new project may be an upgrading of the capital used in the original project. (If the payoffs were ultimately separable, there is no reason in the model why the new project could not be spun off with separate accounting.) At the end of period 2, the manager is compensated and the residual goes to the shareholders.[6]

We retain Myers and Majluf's assumptions that all agents are risk-neutral and that there is no discounting. End-of-period prices of the original equity issue, denoted by P_0, P_1, and P_2, are formed rationally. The price at each time can depend only on the public's information at that time; therefore, we can write the equilibrium pricing functions as P_0 (there is "no" public information at 0), $P_1(d)$, and $P_2(d, a +$

[5] It is only a matter of convenience that we are looking at an initial public offering. An ongoing firm with bad incentives in place may not find it desirable to move instantly to the optimal contract (because of potential information asymmetries), but should be able to plan such a change at some time in the future when the usefulness of most information now available will have evaporated. Because of the prospective efficiency gain, there are some terms on which this arrangement will be attractive to all interested parties.

[6] Taken literally, the formal statements of the choice problems imply that shareholders are also assessed for any shortfall. This is an inessential feature of the model. We could assume instead that $I^a + \tilde{a}$ and $I^b + \tilde{b}$ are never negative and that $s(\cdot)$ is constrained to leave nonnegative residual, and none of this would change the optimal value of our problem (and a nonempty subset of the set of optimal solutions would remain feasible), provided the manager's reservation utility level is not too large.

bd).[7] The manager's choice of d is based on the manager's information at time 1, namely, a and b, and therefore we write the decision rule as $d(a, b)$. The agent's compensation scheme (sharing rule) $s(a + bd, d, P_1, P_2)$ is permitted to depend on all information that is publicly available at the end of time 2.[8] As in Myers and Majluf, the manager cannot trade on his own account to undo the incentive contract with the firm, and the incentive contract is common knowledge. Rents extracted from the manager are limited by the agent's reservation utility level $U^* > 0$. We assume that $U^* < E[a]$, which is sufficient to ensure that it is optimal to form the firm in the first place. We also assume that a and b both have compact support; to avoid discussions of ties, we assume that the probability that $b = 0$ is zero.

The entrepreneur faces Problem 1, given in Table 1. An informal representation of the decision problem is as follows: Choose a compensation scheme, an equilibrium investment decision rule, and prices to maximize the initial value of the IPO subject to (i) the manager's equilibrium payoff (just a definition), (ii) the rationality of stock prices, (iii) the incentive compatibility of the investment decision rule, and (iv) the manager's reservation utility constraint. The main difference between our model and that of Myers and Majluf is that the manager's objective [here embodied in the contract $s(a + bd, d, P_1, P_2)$] is determined endogenously. The objective most emphasized by Myers and Majluf is to act on behalf of shareholders who plan to hold to the end, which amounts to taking $s(a + bd, d, P_1, P_2)$ to be equal to a constant plus a tiny proportion of P_2. Another difference between our model and that of Myers and Majluf is that we assume that the profit levels a and b are not separately observable by the public at the end, or else we could trivially obtain the first best directly using a forcing contract to induce the manager to follow the first-best decision rule. On a related point, Myers and Majluf assume that $b \geq 0$ with probability 1. We want to relax this assumption (to allow $b < 0$ with positive probability), or else the first best would obtain trivially under a forcing contract enforcing $d = 1$.

For simplicity, it is assumed that the entrepreneur retains no equity. The issue price P_0 for the initial public offering is the sunk investment I^a in place plus the expectation of profit $a + bd(a, b)$, less the

[7] We could make P_2 depend on P_1 as well, but this is redundant, because there are no game-theoretic issues of perfection.

[8] As with P_2, it is formally redundant to include P_1 and P_2. In fact, this simple observation is one theme of the article: optimal contracting is independent of financing because using market prices cannot improve on contracts that already exploit the public information on which the market prices are based. (Of course, it is possible that the market price aggregates information not available within the firm, but it seems like a good approximation that the value of this information in evaluating the manager is small.) Including P_1 and P_2 *is* required, if we want to admit explicitly the contracts implicit in Myers and Majluf's model.

Table 1
Entrepreneur's choice problem 1

Choose $s(a + bd, d, P_1, P_2)$, $d^*(a, b)$, $P_1(d)$, and $P_2(d, a + bd)$, to maximize $P_0 = E[I^a + a + bd^*(a, b) - s^*(a, b)]$, subject to

(i) $s^*(a, b) = s(a + bd^*(a, b), d^*(a, b), P_1(d^*(a, b)), P_2(d^*(a, b), a + bd^*(a, b)))$

(iia) $P_1(d) = E[I^a + a + bd - s^*(a, b) \mid d^*(a, b) = d]$

(iib) $$P_2(d, a + bd) = \frac{P_1(d)}{P_1(d) + I^b d}[I^a + I^b d + (a + bd) - s(a + bd, d, P_1(d), P_2(d, a + bd))]$$

(iii) $d^*(a, b)$ uniquely solves:
Choose $d(a, b)$ to
$\max E[s(a + bd(a, b), d(a, b), P_1(d(a, b)), P_2(d(a, b), a + bd(a, b)))]$
s.t. $(\forall a, b) d(a, b) = 0$ or 1
$(\forall a, b) s(a + bd(a, b), d(a, b), P_1(d(a, b)), P_2(d(a, b), a + bd(a, b))) \geq 0$

(iv) $E[s^*(a, b)] \geq U^*$

expectation of manager's compensation $s^*(a, b)$. This is because the issue price of stock in a competitive market includes a rational assessment of all net rents (including an allowance for any inefficiency of investment). Also, we assume that the firm has no financial slack, because the existence of slack does not affect our results.

The first constraint in Problem 1 simply defines the manager's equilibrium payoff, which is based on equilibrium prices and the equilibrium decision rule. The first rationality-of-prices constraint (iia) follows directly from competitive risk-neutral pricing in the securities market. This expression is the same as the expression for P_0, except conditioned on public information at time 1. The second rationality-of-prices constraint (iib) takes into account the liquidation value of the firm and the dilution from the share issue (if any) at time 1. The factor $P_1(d)/(P_1(d) + I^b d)$ is the fraction of terminal firm ownership represented by the original shares. This factor multiplies the realized total value of investments less the manager's compensation.

The third constraint is the standard incentive-compatibility constraint for the manager. In this constraint, the requirement of a unique optimum rules out paying a constant and assuming the manager (who is therefore indifferent) follows a first-best investment rule. This requirement of a strict incentive is an imperfect substitute for the costly effort (see Problem 4) that would rule out paying a constant in a more complete model than that of Myers and Majluf. Finally, the reservation utility constraint ensures that the manager is paid enough to accept the position.

The first-best optimum is the solution to the entrepreneur's problem in the absence of incentive problems. In other words, we would maximize the offering price, subject to constraints (i), (ii), and (iv), and the *constraints* to the incentive compatibility problem [$d(a, b)$

$= 0$ or 1 and $s \geq 0$]. Because of risk neutrality, the solution to this problem is trivial, since the form of the sharing rule does not matter so long as the reservation-utility constraint holds with equality. Therefore, the first-best choice problem reduces to

$$\text{Choose } d(a, b) \text{ to maximize } P_0 = E[I^a + a + bd(a, b)] - U^*.$$

Only the third term in the expectation is not a constant; therefore, the optimal strategy is to maximize the third term—that is, to take $d(a, b) = 1$ whenever $b > 0$, and to take $d(a, b) = 0$ whenever $b < 0$. To fill out a solution, we must choose a compensation scheme and equilibrium pricing rules. However, we can simply choose $s(\cdot) \equiv U^*$, defining the price function by the rationality constraints. In other words, the first-best optimum is characterized by efficient production: profitable new projects are always undertaken and money-losing projects are never undertaken.

Our first result is that we can obtain the first-best solution as the solution to the second-best problem, Problem 1 (including the incentive compatibility constraint), if we choose the sharing rule

$$s(a + bd, d, P_1, P_2) = \alpha + \beta(a + bd), \tag{1}$$

where α and $\beta > 0$ are constants chosen to make the reservation-utility constraint an equality and $s^*(a, b) > 0$. (This is feasible for β sufficiently small because a and b both have compact support.) This sharing rule clearly gives the manager a strict incentive to undertake the optimal investment rule

$$d^*(a, b) = \begin{cases} 1, & \text{for } b > 0, \\ 0, & \text{otherwise.} \end{cases} \tag{2}$$

Together with rationally determined prices $P_1(d)$ and $P_2(d, a + bd)$ [given by (iia) and (iib) in Problem 1], we have a solution to Problem 1 that implements the first best.

Because we can use P_1 and P_2 to measure $a + bd$ indirectly, the form of the optimal contract is indeterminant [beyond the choice of β in (1)]. One economically interesting alternative is to take

$$s(a + bd, d, P_1, P_2) = \alpha' + \beta'\left(P_2 + I^b d\frac{P_2 - P_1}{P_1}\right), \tag{3}$$

which also implements the optimal investment rule (2) as a solution of Problem 1, given rational pricing and provided α' and $\beta' > 0$ are chosen to maintain positivity and the reservation-utility constraint. Contract (3) is equivalent to (1) with $\beta = \beta'/(1 + \beta')$ and $\alpha = (\alpha' + \beta' I^a)/(1 + \beta')$, as can be seen by substituting constraint (iib) of

Problem 1 into (3) and solving for s. Therefore, the incentives are the same. The interpretation of contract (3) is that the manager is paid a constant plus a term proportional to the portfolio of the initial stock plus a pro rata purchase and participation in new issues. In this way, if P_1 is out of line (based on the manager's information), the effect on compensation of any mispricing of existing shares is exactly offset by the effect on the pro rata purchase of new shares. For example, if the manager knows that a is very large, the prospective capital loss on the existing shares (the dilution effect) is exactly offset by the windfall gain on the implicit purchase of underpriced new shares. The net effect is to make the manager indifferent about the price at which the new issue is made, and to care only about the fundamental value of the firm. The share price is correct on average, but does not fully reflect the manager's information in each state of nature.[9]

How does this solution relate to that of Myers and Majluf? The main difference is that Myers and Majluf assume by fiat the objective function of the manager. The objective function assumed by Myers and Majluf is consistent with the compensation scheme

$$s(a + bd, d, P_1, P_2) = \alpha'' + \beta'' P_2, \tag{4}$$

for α'' and sufficiently small $\beta'' > 0$, chosen to satisfy positivity and the reservation-utility constraint. This rule is compared most simply to the optimal rule of the form given in (3), with $\alpha' = \alpha''$ and $\beta' = \beta''$. The term that differs is the term $\beta' I^b d(P_2 - P_1)/P_1$, which neutralizes the manager's preferences over mispricing in the middle period. Without this term, the manager has an incentive to forgo investment (set $d = 0$) when b is small and an offer would imply a price $P_1(d = 1)$ significantly less than the manager's assessment $P_2(1, a + b)$.

1.2 Capital structure

In Problem 1, we assumed that the manager financed all new investments using equity exclusively. In this section, we look at an analogous problem (Problem 2), which allows the manager to finance new investments using a mix of debt and equity selected by the manager. Problem 2 is contained in Table 2. The introduction of debt is the main change from Problem 1. This corresponds to the introduction of a new choice variable, F, which is the face value of debt issued at the end of period 1. Rational bond prices are formed as conditional expectations given all public information, just as stock prices are, only all public information now includes the size of the

[9] It may surprise the reader that this informational inefficiency of prices does not represent an economic (Pareto) inefficiency that is reflected in the price of the firm. Intuitively, this is because the timing of resolution of idiosyncratic risk does not matter when investors are equally informed.

Table 2
Entrepreneur's choice problem 2

Choose $s(a + bd, d, F, P_1, P_2, B_1, B_2)$, $d^*(a, b)$, $F^*(a, b)$, $P_1(d, F)$, $P_2(d, F, a + bd)$, $B_1(d, F)$, and $B_2(d, F, a + bd)$, to maximize $P_0 = E[I^a + a + bd^*(a, b) - s^*(a, b)]$, subject to

(i) $s^*(a, b) = s(a + bd^*(a, b), d^*(a, b), F^*(a, b), P_1(d^*(a, b), F^*(a, b)), P_2(d^*(a, b), F^*(a, b), a + bd^*(a, b)), B_1(d^*(a, b), F^*(a, b)), B_2(d^*(a, b), F^*(a, b), a + bd^*(a, b)))$

(iia) $P_1(d, F) = E[I^a + a + bd - s^*(a, b) \mid d^*(a, b) = d, F^*(a, b) = F]$

(iib) $$P_2(d, F, a + bd) = \frac{P_1(d, F)}{P_1(d, F) + I^b d - B_1(d, F)}[\max(0, I^a + I^b d + (a + bd) - F - s(a + bd, d, F, P_1(d, F), P_2(d, F, a + bd), B_1(d, F), B_2(d, F, a + bd)))]$$

(iic) $B_1(d, F) = E[\min(F, I^a + I^b d + a + bd - s^*(a, b)) \mid d^*(a, b) = d, F^*(a, b) = F]$

(iid) $B_2(d, F, a + bd) = \min(F, I^a + I^b d + (a + bd) - s(a + bd, d, F, P_1(d, F), P_2(d, F, a + bd), B_1(d, F), B_2(d, F, a + bd)))$

(iii) Together, $d^*(a, b)$ and $F^*(a, b)$ uniquely solve:
Choose $d(a, b)$ and $F(a, b)$ to
$\max E[s(a + bd(a, b), d(a, b), F(a, b), P_1(d(a, b), F(a, b)), P_2(d(a, b), F(a, b), a + bd(a, b)), B_1(d(a, b), F(a, b)), B_2(d(a, b), F(a, b), a + bd(a, b)))]$
s.t. $(\forall a, b) d(a, b) = 0$ or 1
$(\forall a, b) s(a + bd(a, b), d(a, b), F(a, b), P_1(d(a, b), F(a, b)), P_2(d(a, b), F(a, b), a + bd(a, b)), B_1(d(a, b), F(a, b)), B_2(d(a, b), F(a, b), a + bd(a, b))) \geq 0$

(iv) $E[s^*(a, b)] \geq U^*$

(v) $(\forall a, b) B_1(d^*(a, b), F^*(a, b)) < P_1(d^*(a, b), F^*(a, b)) + I^b d^*(a, b)$

debt issue. Furthermore, we include the effect of leverage on the stock price, and a constraint (v) that the size of the bond issue does not exceed the value of the firm.[10]

Other features of the new choice problem represent an attempt to avoid unneeded complexity. For example, we have not precluded a "short" bond issue—that is, issuing equity to buy bonds—nor have we precluded a swap of equity for debt. (We *have* precluded a swap of debt for equity, but only "accidentally," since we start with an all-equity firm.) These assumptions keep the choice problem from becoming even messier without affecting the economic message.

As before, the first-best solution (i.e., the solution in the absence of the incentive-compatibility constraint) includes an investment policy of undertaking only the new projects that are economically profitable, while paying the manager the reservation utility in expectation. Subject to the constraint of leaving some equity in the firm (which we have imposed a priori), capital structure is irrelevant to the value of this problem. Given any capital structure, we can solve out the remaining constraints of the problem (with reservation utility as an

[10] As a technical aside, there is in principle an issue of how the conditional expectation in (iia) should be formed if the choice of debt issue is not in the support of the set of values anticipated by shareholders. In game-theoretic terms, this is an issue of perfection, which deals with the equation of how to form expectations on events thought to be impossible [see Rasmusen (1989, chap. 5) for an introductory discussion of perfection]. However, this whole problem is not an issue given the optimal contract, since the manager does not care about the market price in the middle period.

equality) to obtain an expression that is the expected value of the firm, net of the reservation utility and expected investment expenditure. This is essentially the irrelevancy of capital structure in the absence of informational asymmetries, because the first-best solution is what arises if all information is shared.

As in Problem 1, if we did not require uniqueness for the solution to Problem 2, we would obtain a trivial solution with a constant salary and directions to follow the optimal strategy. Given our requirement of uniqueness, it is necessary for the debt issue $F^*(a, b)$ to depend on a and b only through d and $a + bd$, which is the information that can be verified ex post by the market.[11] In any first-best solution, knowing d tells us precisely whether $b \gtrless 0$. Therefore, we can obtain positive incentives for no issue, equity, or debt when $b < 0$. We also can simultaneously provide positive incentives to issue equity only when $a + bd < 0$, and debt only when $a + bd \geq 0$. This policy (with optimal investment and the asset prices then implied by rationality of pricing) is supported by the compensation scheme

$$\begin{aligned} s(a + bd, d, F, P_1, P_2, B_1, B_2) \\ = \alpha + \beta(a + bd) - d\delta(d, a + bd, F), \end{aligned} \tag{5}$$

where

$$\delta(d, a + bd, F) = \begin{cases} 0, & \begin{cases} \text{if } a + bd < 0 \text{ and } B_1(d, F) = 0, \text{ or} \\ \text{if } a + bd \geq 0 \text{ and } B_1(d, F) = I^b, \end{cases} \\ k, & \text{otherwise,} \end{cases} \tag{6}$$

$B_1(\cdot)$ is the rational bond price under the stated policy, and the constants are chosen for feasibility (β and k chosen small enough for positivity, and α chosen to make the reservation-utility constraint an equality). Of course, this is not the only optimal scheme: "any" rule for issue of debt and equity as a function of the optimal d and $a + bd$ can be implemented in an equilibrium with first-best investment (where "any" means subject only to nonnegative equity and rational pricing).

While the formal analysis in this section applies only to a split between debt and equity, it should be clear by now that the same arguments will work for many sorts of financial issues, including not only straight debt and equity but also subordinated debt, preferred stock, warrants, convertible bonds, and the like.

[11] The restrictions to functions of d and $a + bd$ are not needed if we are willing to forgo uniqueness of the capital-structure choice in the incentive-compatibility constraint.

Table 3
Entrepreneur's choice problem 3

Choose $s(a + bd, d, D, P_1, P_2)$, $d^*(a, b)$, $D^*(a, b)$, $P_1(d, D)$ (ex-dividend), and $P_2(d, D, a + bd)$, to maximize $P_0 = E[I^a + a + bd^*(a, b) - s^*(a, b)]$, subject to

(i) $s^*(a, b) = s(a + bd^*(a, b), d^*(a, b), D^*(a, b), P_1(d^*(a, b), D^*(a, b)), P_2(d^*(a, b), D^*(a, b), a + bd^*(a, b)))$

(iia) $P_1(d, D) = E[I^a + a + bd - s^*(a, b) \mid d^*(a, b) = d, D^*(a, b) = D]$

(iib) $$P_2(d, D, a + bd) = \frac{P_1(d, D)}{P_1(d, D) + I^b d + D}[I^a + I^b d + (a + bd) - s(a + bd, d, D, P_1(d, D), P_2(d, D, a + bd))]$$

(iii) Together, $d^*(a, b)$ and $D^*(a, b)$ uniquely solve:
Choose $d(a, b)$ and $D(a, b)$ to
$\max E[s(a + bd(a, b), d(a, b), D(a, b), P_1(d(a, b), D(a, b)), P_2(d(a, b), D(a, b), a + bd(a, b)))]$
s.t. $(\forall a, b) d(a, b) = 0$ or 1
$(\forall a, b) D(a, b) \geq 0$
$(\forall a, b) s(a + bd(a, b), d(a, b), D(a, b), P_1(d(a, b), D(a, b)), P_2(d(a, b), D(a, b), a + bd(a, b))) \geq 0$

(iv) $E[s^*(a, b)] \geq U^*$

(v) $(\forall a, b) P_1(d^*(a, b), D^*(a, b)) > 0$

1.3 Dividend policy

Problem 3 deviates from Problem 1 in giving the informed manager a choice of dividend policy. To avoid unneeded complexity, we restrict the manager to issuing only equity, although irrelevancy of dividend policy is obviously not dependent on this assumption. The formal statement of the problem appears in Table 3. The problem is solved by the sharing rule given in (1) but modified to punish inappropriate dividend policy, optimal investment, and any dividend strategy restricted to depend on a and b only through d and $a + bd$, which is the information that can be verified ex post by the market.[12] An optimal sharing rule based on market prices, similar to (3), can easily be derived. This sharing rule differs from (3) in that the manager receives a pro rata share of any dividends paid.

1.4 Separation of incentives and financing

In previous subsections, we have studied models in which equilibrium investment is optimal. This feature is special to the Myers and Majluf framework we have considered. One degenerate feature of the Myers and Majluf model is that there is no costly effort. If the model included costly effort on the part of a risk-averse manager, we would have the traditional trade-off between incentives and risk-sharing that occurs in all significant agency problems. This trade-off would imply

[12] The restrictions to functions of d and $a + bd$ are not needed if we are willing to forgo uniqueness of the dividend-policy choice in the incentive-compatibility constraint.

a second-best solution in which there is suboptimal investment. Nonetheless, financing would not matter in the sense that the degree of suboptimality of investment does not depend on financing. The reason is that the "real" set of feasible contracts to the manager does not depend on financing.

To obtain the general result, we assume there are no taxes or transaction costs (to avoid the traditional violations of Modigliani and Miller), and the additional assumption that the information available to the public (and potentially revealed through the stock price) is a function of information known by the manager and those evaluating the manager. (Or, more generally, we could assume that the public information is not marginally useful to the manager for making investment decisions or to the people evaluating the manager, given their information sets.) In the absence of this assumption, capital structure may influence the usefulness of the information revealed through prices. Once this assumption is satisfied, separation of incentives and financing is quite generally valid.

Because of risk-neutrality, it is implicitly assumed there are no imperfections in the capital market and no risk premium or liquidity premium. The results would be robust to competitive risk-pricing and discounting, provided the manager's information is idiosyncratic and not significantly predictive of market returns (as only seems reasonable). The results are not generally robust to the existence of a liquidity premium. In principle, anticipated information revelation by the manager could make the stock more liquid in the middle period and increase its initial offering price [see Diamond (1985)]. These issues were explored in more detail in an earlier draft (see note 2).

Here is the idea behind the proof, which uses composition of functions just like the proof of the revelation principle. Suppose a manager's compensation depends on market prices, the manager's actions, information that is publicly available (at some date), and fundamentals within the firm. We know that market prices depend only on the publicly available information in a known way. Therefore, we can "see through" the dependence of the compensation on market price, understanding that this is just an alternative way of introducing dependence on publicly available information. Furthermore, the manager's real actions can be retained, and the actions about financing can be changed to announcements. Once we realize this, we can rewrite the compensation directly as a function of publicly available information, the manager's actions and announcements, and fundamentals within the firm. This form of the compensation schedule is completely independent of the financial structure of the firm. Therefore, real choices (and consequently any market values) that are fea-

Table 4
Entrepreneur's choice problem 4

Choose $s(a + bd, d, \theta, P_1, P_2)$, $d^*(\eta, \theta)$, $x^*(\eta, \theta)$, $P_1(d, \theta)$, and $P_2(d, \theta, a + bd)$, to maximize $P_0 = E[I^a + a^* + b^* d^*(\eta, \theta) - s^*(\eta, \theta)]$, subject to

(i) $s^*(\eta, \theta) = s(a^* + b^* d^*(\eta, \theta), d^*(\eta, \theta), \theta, P_1(d^*(\eta, \theta), \theta), P_2(d^*(\eta, \theta), \theta, a^* + b^* d^*(\eta, \theta)))$

(ii) $a^* = a(x^*(\eta, \theta), \eta, \theta)$ and $b^* = b(x^*(\eta, \theta), \eta, \theta)$

(iiia) $P_1(d, \theta) = E[I^a + a^* + b^* d - s^*(\eta, \theta) \mid \theta, d^*(\eta, \theta) = d]$

(iiib) $$P_2(d, \theta, a + bd) = \frac{P_1(d, \theta)}{P_1(d, \theta) + I^b d}[I^a + I^b d + (a(x, \eta, \theta) + b(x, \eta, \theta)d) - s(a(x, \eta, \theta) + b(x, \eta, \theta)d, d, \theta, P_1(d, \theta), P_2(d, \theta, a(x, \eta, \theta) + b(x, \eta, \theta)d))]$$

(iv) $d^*(\eta, \theta)$ and $x^*(\eta, \theta)$ solve:
Choose $d(\eta, \theta)$ and $x(\eta, \theta)$ to
$\max E[U(s(a(x(\eta, \theta), \eta, \theta) + b(x(\eta, \theta), \eta, \theta)d(\eta, \theta), d(\eta, \theta), \theta, P_1(d(\eta,\theta), \theta), P_2(d(\eta, \theta), \theta, a(x(\eta, \theta), \eta, \theta) + b(x(\eta, \theta), \eta, \theta)d(\eta, \theta))), x(\eta, \theta))]$
s.t. $(\forall \eta, \theta) d(\eta, \theta) = 0$ or 1
$(\forall \eta, \theta) s(a(x(\eta, \theta), \eta, \theta) + b(x(\eta, \theta), \eta, \theta)d(\eta, \theta), d(\eta, \theta), \theta, P_1(d(\eta, \theta), \theta), P_2(d(\eta, \theta), \theta, a(x(\eta, \theta), \eta, \theta) + b(x(\eta, \theta), \eta, \theta)d(\eta, \theta))) \geq 0$
$(\forall \eta, \theta) x(\eta, \theta) \geq 0$

(v) $E[U(s^*(\eta, \theta), x^*(\eta, \theta))] \geq U^*$

sible under one financial policy are also feasible under all other financial policies.

Problem 4 (in Table 4) presents the entrepreneur's choice problem for a case that involves costly effort by a risk-averse manager. Problem 4 is a variation on Problem 1, with the following differences. Now, in addition to the investment decision that the manager must make on behalf of the shareholders, the manager must also choose a level of effort. The manager's effort is assumed to increase the profitability of the projects a and b, and the effectiveness of effort is allowed to depend upon the state of nature. The problem includes a public signal θ observed by all agents in the economy at time 1, and a private signal η observed only by the manager. These signals are interpreted as indicators of the realized state of nature (i.e., they contain information on the productivity of effort.)[13] In this problem, the manager chooses an investment policy $d(\eta, \theta)$ and effort policy $x(\eta, \theta)$ in order to maximize expected utility. We write the manager's utility generally as $U(s(\cdot), x(\cdot))$, and interpret $U(\cdot)$ as increasing in $s(\cdot)$ and decreasing in $x(\cdot)$.[14]

[13] The choice problem in Table 4 actually assumes that η and θ represent all the exogenous noise in the model, but this is convenience only. More generally, we could add another random argument ϵ to the functions $a(\cdot)$ and $b(\cdot)$ and our economic arguments would be unchanged (although the choice problem would be even messier).

[14] Much more structure is required to ensure the existence of a solution to Problem 4. As in most agency problems, even the usual concavity and Inada conditions are not enough to ensure the existence or even to make the agent's first-order conditions necessary and sufficient, since the endogenous choice of sharing function may undo the concavity of the agent's objective function. Formally, our results say that *if* there is a solution, it is independent of capital structure.

Demonstration of the irrelevance of the firm's capital structure in this problem follows the argument given above. The optimal sharing rule in this case can be written contingent on any of the publicly observable variables. This naturally includes P_1 and P_2. However, P_1 and P_2 are themselves known functions of other publicly available information. Therefore, any action that can be implemented using a sharing rule of the form $s(a + bd, d, \theta, P_1, P_2)$ can also be implemented by a contract of the form $s(a + bd, d, \theta)$, and the potential value of the firm is not affected by capital structure.

Note that in this problem efficient, or "first-best," investment is not generally achieved. The usual agency-model trade-offs between incentives and risk-sharing imply that the manager will not, at the entrepreneur's optimum, expend a first-best level of effort. New projects that would be profitable under the first-best rule will not be undertaken in this world. Therefore, we have shown irrelevance of capital structure and dividend policy, even when there are agency problems that prevent attainment of the first-best investment policy. This irrelevance is due to the separation between incentives and financing: the real choices (and, in particular, investment) implemented using an optimal contract are the same, independent of financing.

2. Reaction of Stock Prices to New Issues: Theory and Empirics

In this section we demonstrate, through the use of a simple numerical example, that the existing empirical evidence is consistent with the model presented here. The existing evidence on stock-price reaction to issues of new securities can be summarized as follows.[15] New security issues, in general, seem to be interpreted by the market to indicate bad news. The stock price of firms seeking new financing appears to drop at the announcement date of the new issues. The size (and statistical significance) of this drop is related to the type of security offered. Seasoned offerings of equity appear to be particularly bad news, whereas new issues of debt have a less negative (and statistically less significant or insignificant) impact on the stock price of the issuing firm.

Our example shows that the observed price reactions are consistent with optimal investment. We are not claiming that the story in this article is necessarily *the* correct story. Rather, we are pointing out that the existing empirical evidence does not discriminate between

[15] See, for example, Asquith and Mullins (1984), Dann (1981), Dann and Mikkelson (1984), Eckbo (1986), Masulis and Korwar (1986), and Mikkelson and Partch (1986).

a Myers–Majluf world and a world with efficient investment. In other words, interpretation of the empirical evidence should be in the context of a well-specified alternative against which the empirical test has power.

One idea behind the example is that, in very good states, the existing project generates the funds needed to undertake any new project; therefore, the fact that a firm requires new financing is bad news. In order to stay within the existing outline of our model, our example assumes that no new project is available in the very good state. (Another way of thinking of this is that in the very good state there is no new project *that requires outside financing.*)

The example follows. We assume there are three realizations to the value of the asset in place (project a) and the new project (b), if any. The three equally probable realizations of a and b are given by

State	a	b
1	1000	−100
2	100	100
3	100	300.

Recall that in our model, at time 1, the manager is assumed to observe the realizations of a and b. This is equivalent to observing the realized state of nature. The ex ante expectations of these random variables are given by $\bar{a} = 400$ and $\bar{b} = 100$. We assume that the manager is given a compensation scheme that is similar to that given in Equations (5) and (6). Specifically, $s(\cdot)$ is given by

$$s(a + bd, d, F, P_1, P_2, B_1, B_2) = \alpha + \beta(a + bd) - d\delta(d, a + bd, F), \tag{7}$$

where

$$\delta(d, a + bd, F) = \begin{cases} 0, & \begin{cases} \text{if } a + bd = 200 \text{ and } B_1(d, F) = 0, \text{ or} \\ \text{if } a + bd = 400 \text{ and } B_1(d, F) = I^b, \end{cases} \\ k, & \text{otherwise.} \end{cases} \tag{8}$$

This contract gives the manager incentives to invest only in profitable new projects and to issue debt in state 3 and equity in state 2. We can interpret this as a financing strategy that aims to stabilize the debt/equity ratio of the firm or move it toward an industry average. Stabilizing the debt/equity ratio or moving toward the industry average is an arbitrary policy, but that is what many of today's managers have been taught to do; moreover, under the assumptions of this article, the policy is harmless.

Under the optimal investment policy, $d = 1$ if $b > 0$ and $d = 0$ otherwise (since there are no ties), and $E[a + bd] = 533.33$. Therefore, we can write the time 0 price of the original equity offering as $P_0 = I^a + 533.33$, where we have ignored the manager's compensation, which we think of as being negligible compared to the size of the firm. Now, consider the market-price reaction to issues of new securities. Under this contract, if the market, at time 1, observes a new issue being made by the firm, the market expects that state 2 or 3 has been realized. The new issue is bad news. If debt is offered by the firm at time 1, the market expects that state 3 has been realized and the time 1 price of the original equity becomes $P_1^D = I^a + 400$. If equity is offered by the firm at time 1, the market price of the original equity becomes $P_1^E = I^a + 200$. On the other hand, if no new financing is sought by the firm at time 1, the market price of the shares is given by $P_1^n = I^a + 1000$.[16]

We have shown that the existing empirical evidence on the price impact of security issues is consistent with a model in which investment is optimal. In this model, having to issue securities is bad news because it indicates an inability to generate funds internally. Equity issues are particularly bad news, while debt issues are only slightly bad news (or, under a slightly different choice of parameters, would be neutral or slightly good news). Therefore, although the evidence is roughly consistent with the story told by Myers and Majluf, the empirical evidence is not convincing proof that Myers and Majluf are correct. This same empirical evidence is consistent with an optimal (endogenous) investment policy in a world with asymmetric information in which the Modigliani and Miller irrelevancy propositions hold. In fact, it seems that this type of example can be used to explain any rational price process.

3. Conclusion

This article has shown that the Modigliani and Miller irrelevancy propositions hold for a large class of models with asymmetric information and endogenous investment. This type of irrelevancy result is important primarily because it tells where *not* to look for reasons for optimal capital structure. In light of this article, many (or most)

[16] It might seem that there would be an upward jump in the stock price in the absence of a new issue, and that this has not been documented in the data. However, there is no single date on which the public learns that there will not be a new issue and, consequently, there is a small increase (in addition to the usual noise) on each of a large number of days.

of the existing articles in theoretical corporate finance tell us why it is not efficient to have managers act on behalf of shareholders.

The research in this article suggests two directions. One direction is to accept provisionally that the type of model in this article is useful, and to conclude that we should advocate corporate charters, corporate law, and contractual structures that will give better incentives to managers. Another direction is to view the models in this article as unrealistic, and to conclude that we should build models that make explicit whatever practical limitations exist that prevent us from achieving the optimal contracts described here.[17] Ideally, any attempt to describe these limitations should also derive, from fundamentals, what securities (debt and equity or whatever) should be offered. This derivation should determine not only the state-contingent cash flows accruing to each claimant but also the allocation of control rights. This second approach does not generally bring us back to the models in which managers act on behalf of a specific claimant (e.g., shareholders), since it hardly seems possible that the practical limitations that rule out our efficient contracts do not also rule out contracts that induce managers to act on behalf of shareholders.

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[17] Some examples of such limitations may be an inability to precommit to a particular managerial incentive contract; restrictions on indentured servitude, which make it hard to ensure a manager will stay with the firm in bad states; and corporate governance rules that make firms that do not maximize the value of equity subject to takeovers. Another model that implies a violation of our model in a different direction is given by Diamond (1985), who points out that the amount of information released can be relevant beyond the cash flows if there is a liquidity premium based on the degree of investors' information asymmetry.

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