

Reporting incentives in organizations

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Abstract

This teaching note uses the Antle and Eppen (1985) model to illustrate reporting incentives in the context of capital budgeting in organizations. The note is appropriate for both undergraduate and graduate students. In the model a management control problem arises because a manager has private information about characteristics of a project that requires funding from the owner and because the manager has taste for slack. This gives the manager incentives and opportunity to overstate the cost of the project. This in turn puts upward pressure on the manager's budget request. The owner efficiently deals with this problem by restricting production with the intention of reducing the manager's slack. Optimally, the owner trades off lost production and slack. An implication of the model is the observation of slack and capital rationing in an organization does not imply the organization is acting irrationally.

Introduction

One feature of an organization is the degree to which it is decentralized. In a decentralized organization, managers learn more about the firm's investment opportunities and are either delegated the decision or report what they know to central who then decides whether to make the investment based on the reports. The advantage of the decentralized form is it facilitates learning and specialization; the disadvantage is managers' possession of private information may lead to a control problem. That is, managers may have incentives to make decisions other than those that would be made by owners, or managers may have incentives to report less than what they know. The firm has many devices at its disposal for mitigating these control problems, such as internal audits, incentive contracts, variance analysis and post-audits of capital budgeting projects.

The purpose of this note is to investigate how private information induces incentives to "pad the budget" and why management control systems might optimally react by distorting capital budgeting decisions. We characterize the decision as capital budgeting, but many other interpretations are appropriate.

We construct a simple model of the firm wherein a manager knows more than the owner about the cost of a potential investment opportunity. If the manager could guarantee the owner would approve the investment, he would have incentives to overstate the cost. That way he could consume any excess funds in the form of perquisites or slack.

The owner is aware of the manager's motives, and knows she can reduce the manager's slack by rationing capital, i.e., by committing to turn down a profitable investment. It turns out that both slack and capital rationing may be *ex ante* best responses to the manager's private information.¹ This is an important lesson: capital rationing may be a useful substitute for project auditing and other costly management control devices. Thus, the organization's investment decisions can be viewed as one of many elements in its portfolio of management control devices.

A Little Perspective

When markets are perfect (no transaction costs) and complete (any desired commodity can be traded, including managerial inputs) management control is not an issue. All transactions can be efficiently carried out in the market. In this situation, however, it is hard to imagine there would be a demand for accounting.² And there is certainly no need to spend costly resources to verify managerial inputs. The market price would contain all necessary information about the commodity of interest.

Further, in the absence of market frictions, organizational form would be a moot point. All trading could take place in the

¹ A more general version of this model has been used to present a rationale for why firms tend to discount capital investments at a rate that is larger than their risk-adjusted cost of capital (Antle and Eppen, 1985). The model is also related to Arya et al. (1996).

² Valuing the firm using accounting data is very simple (although not useful) without market imperfections. Seminal works exploring income measurement and valuation are: E. Edwards and P. Bell (1950), Paton (1922), and Paton Littleton (1970). See also, Demski (1992),

commodity market. There would be no reason for an organization to orchestrate activities. There would be no reason to carry out costly and time consuming budgeting procedures to elicit *ex ante* projections from managers. There would be reason to conduct project audits to verify whether *ex post* costs or sales met their targets. There would be no reason to design elaborate incentive schemes based on market and non-market data such as employee stock options and accounting-based performance plans. There would be no demand for auditors. In order to understand the existence of many accounting and auditing activities it is important to explicitly model market frictions.

A Simple Model of the Decentralized Organization

We model a firm composed of one manager and one owner who jointly make an investment decision. Both the owner and manager agree that the investment will provide \$100 in revenue. Both the owner and the manager are initially unsure about the cost necessary to undertake the project. To keep things simple, let us assume that they agree that the cost will be \$90 (high) with probability .5, and \$78 (low) with probability .5.

Three features of the model combine to create an interesting management control problem. First, prior to investment the manager alone learns the cost. Second, the manager must receive the funds for investment from the owner.³ That is,

Fellingham et al. (1997), Ohlson (1995), and Preinrich (1932).

³ One way to explain this is that the manager may not be as wealthy as the owner, and so cannot borrow as cheaply (in itself this is a market imperfection).

the manager's wealth cannot be negative.⁴ Third, the manager can consume any extra funds provided by the owner, which we shall refer to as slack, in the form of perquisites. The manager maximizes his expected slack, and the owner maximizes her expected profit (revenue minus payment to the manager). This sets up a conflict between the owner and manager. Of course, conflict is essential for the existence of a control problem.

The Importance Of The Three Features

Before proceeding to analyze the complete model, let us first consider the role of the three assumptions. First, if the owner as well as the manager learned the cost, she would know how much to invest, and would never provide the manager with slack, so she obtains:

$$.5(100 - 78) + .5(100 - 90) = 16.$$

Second, suppose the manager had enough wealth to invest on his own. Then the owner could sell the investment opportunity to the manager for \$16, and let the privately informed manager bear the cost. Of course the manager would always invest, and receive:

$$.5(100 - 78 - 16) + .5(100 - 90 - 16) = 0.$$

Both the manager and owner are equally as well off as if the manager were not privately informed. Notice that under this arrangement the manager's wealth would be negative if the cost turned out to be 90, which violates the second assumption.

The third assumption is easy. If the manager has no taste for perquisites he would be willing to disclose the cost without

⁴ One could generalize to the case where the manager's liability was

any disciplining, so again the solution described above would be achieved.

Thus, without all three assumptions there would be no real control problem. Since the purpose of this note is to explore an interesting control problem and its solution, we will proceed with all three assumptions in place.

The Effects of Decentralization

We assume the owner can make a commitment by offering an enforceable contingent contract, as long as it is based on information or events that are publicly observed. In this way the manager can rely on the owner honoring her commitments. Within our model, a contract is comprised of:

- (1) the amount of money the owner will provide to the manager,
and
- (2) the amount of revenue returned to the owner.

Because the owner knows the manager will learn the cost prior to making the investment decision, it is natural for her to ask the manager to issue a report regarding the cost. The owner can make the amounts specified in the contract contingent on the cost report of the manager. However, the owner realizes that the manager will choose a cost report that is in his own best interest, i.e., that maximizes his slack.

Summarizing, the owner offers a contract to the manager stating that:

set at some level other than zero.

"If you report the cost is low, I provide you with
\$ _____ and require revenue of \$ _____"

"If you report the cost is high, I provide you with
\$ _____ and require revenue of \$ _____"

Eventually we wish to find the best contract from the owner's perspective. But for now assume that the owner writes a contract wherein she pays the manager whatever amount he requests and invests. That is, if the manager asks for \$78 she will provide \$78 and request \$100 in revenue; if the manager asks for \$90 she will provide \$90 and request \$100 in revenue.

How will the manager behave, given this contract? Recall that the manager privately learns the cost, and the owner has no means of checking up on the manager.⁵ Because the owner has no verifiable source of cost information, the manager cannot be caught if he over-reports the cost. Thus, the self-interested manager maximizes his slack by claiming the cost is high whether in fact it is low or high.⁶ Because the owner knows the manager is going to report high, and the contract specifies that she pay \$90 when the manager reports high, the owner and manager obtain:

$$\begin{array}{l} \text{Owner:} \quad .5(100 - 90) + .5(100 - 90) \quad = \quad 10 \\ \text{Manager} \quad .5(90 - 78) + .5(90 - 90) \quad = \quad \underline{6} \end{array}$$

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⁵ The assumption that there is no way to detect mis-reporting is useful in computing the value of auditing. If auditing cost were greater than this value one would not audit.

⁶ Notice we have portrayed the manager as a ruthlessly self-interested individual. There is no intention to condone this type of behavior.

Note that, due to the inability to verify the manager's report, the manager is able to extract from the owner \$6 in expected slack. However, note further that the contract leads to efficient investment decisions – investment in profitable projects occurs with certainty.

We note that the manager is over-reporting the cost with probability .5. The ethical dilemma for the manager is apparent. However, it is possible to rewrite the contract so as to remove the manager's incentive to lie and still provide the same expected profit and slack to the owner and manager. Such a contract, which we shall refer to as a SLACK contract, appears as follows.

<p>"If you report the cost is low, I provide you with \$ 90 and require revenue of \$ 100"</p> <p>"If you report the cost is high, I provide you with \$ 90 and require revenue of \$ 100"</p>
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SLACK CONTRACT

In the SLACK contract the owner promises to provide \$90, whether the manager reports high or low. We assume that, when indifferent, the manager is willing to report honestly.⁷ For this contract to be viable, of course, the owner must be able to commit to pay the high amount, even in the event the manager has reported the cost is low. Of course, the owner would be tempted

Rather, this assumption guarantees the existence of an interesting control problem.

⁷ The manager is not a pathological liar – he only lies if it is to his benefit.

to go back on her word in that case – hence the importance of the owner’s ability to commit as to how she will use the report.

Ponder what we have done. We first proposed a contract, and derived equilibrium behavior -- the manager always reports high. Then we rewrote the contract so that the owner and the manager received the same expected utility, and the manager no longer had incentives to over-report via the SLACK contract. It turns out that in settings such as this, one can rewrite any contract that induces lying in equilibrium so as to remove the incentive to lie and retain the same expected utilities for the parties. Thus, it is without loss of generality that one can restrict our search for optimal contracts to those that induce truthful reporting. This idea is often referred to as the *revelation principle*.⁸ This idea is of sufficient importance that it led to a Nobel Prize in economics being awarded to Leonid Hurwicz, Eric Maskin and Roger Myerson in 2007. We emphasize that an important feature of our model that allows invocation of the revelation principle is the owner's ability to commit how she will use the manager's report.⁹

Let us see if the owner can improve upon the SLACK contract. It turns out that if the owner commits to ration capital investment the manager's slack can be reduced. To see this, consider the following alternative contract:

⁸ Note that there is no benefit from receiving the truth other than its help in searching for optimal contracts. Restricting attention to truth-telling costs can be thought of as a clever but harmless trick.

⁹ We have not endowed the manager with the same commitment ability. More will be said about this later.

"If you report the cost is low, I provide you
with \$ 78 and require revenue of \$ 100"

"If you report the cost is high, I provide you
with \$ 0 and require revenue of \$ 0."

RATIONING CONTRACT

Under this RATIONING contract, how will the manager behave? Assume the cost is really low, will the manager report low (the truth) or will he report high? If the cost is low and the manager reports low, he obtains slack equal to $78 - 78 = 0$; if he reports high he obtains no money from the owner and so also gets slack equal to 0. Thus, in this case the manager is indifferent between reporting honestly and mis-reporting. Inspection will reveal that the manager strictly prefers to report honestly in the case where the cost is high.

Now the owner anticipates that the manager reports honestly, so the probability that the manager reports low is .5; the probability that he reports high is .5. Notice first that in this contract the manager receives no slack, and second that the owner has committed to turn down a profitable project when the manager reports high. Thus we shall refer to this contract as a RATIONING contract.

Let us now consider how the owner and manager evaluate the RATIONING contract.

Owner:	$.5 (100 - 78) + .5 (0 - 0)$	=	11
Manager:	$.5 (78 - 78) + .5 (0 - 0)$	=	<u>0</u>

Note two things. First, with these parameters the owner is better off under the RATIONING contract than she would be under the SLACK contract, but the manager is worse off. The reason the owner is better off is she is able to remove the manager's slack by restricting production.¹⁰ By offering a RATIONING contract in place of a SLACK contract, the owner gives up $.5 (100 - 90) = 5$. but gains $.5 (90 - 78) = 6$ in reduced slack.

Recall that the source of the restricted production is that the owner cannot rely on the manager's report of the cost. If the owner were to monitor the manager and learn the cost of the investment, she would not have to pay slack to obtain production when the cost is high. For example, if the owner could obtain verifiable information by paying \$1, she would obtain:

$$.5(100 - 78) + .5(100 - 90) - 1 = 15.$$

The owner would only obtain \$11 without the ability to verify the cost, so she is better off. In fact, the maximum amount the owner would pay for verifiable information is found by solving the following equation for C.

¹⁰ Coase's Theorem implies that if contingent contracts can be written and optimal decisions are independent of wealth levels, then production decisions do not depend on property or decision rights, or more precisely, on who has the bargaining power (See P. Milgrom and J. Roberts, 1992).) Note that this example illustrates a case where the conclusion of Coase's Theorem doesn't go through. The owner has the bargaining power, in the sense that she can commit to a take-it-or-leave-it offer. In order to improve her welfare, the owner finds it optimal to commit to a socially inefficient production decision, i.e., to ration capital. This is because a contract cannot be written on the cost, is disclosed with moral hazard, and the manager has limited liability. If, on the other hand, the manager had the bargaining power, he would choose to invest always. So who has the bargaining power affects social welfare.

$$.5(100 - 78) + .5(100 - 90) - C = 11$$

Therefore, the maximum the owner would pay for the audit is 5.¹¹ However, an even more efficient approach to extracting the manager's information would be to audit the cost only if the manager reports the cost is 90, because only then is the manager motivated to over-report the cost. With such a *conditional* audit approach, where the owner would pay for an audit only if the manager reported the cost is 90, the maximum the owner would pay for the audit is found by solving the following equation for C.

$$.5(100 - 78) + .5(100 - 90 - C) = 11$$

Therefore, the maximum the owner would pay for the *conditional* audit is 10.¹²

Reflection

Now is a good time to reflect on what we have done. In cases where a RATIONING contract is optimal, one may ask why the owner would honor her agreement and turn down a profitable project once the manager issues a report of 90. You can see that it is important that the owner be able to convince the manager that she will honor the terms of the contract, or the contracting solution unravels.¹³ Here is one place where the reputation a

¹¹ Given the owner's risk neutrality, to compute the maximum amount the owner would pay for verification one would take the difference between her expected profit with the costly audit and the maximum expected profit she would obtain if she had to rely solely on the manager's report. In this example the RATIONING contract was optimal without the audit, but for other parameter values the SLACK contract may be optimal. (See the last section of this note.)

¹² Some would call this "management by exception".

¹³ Such confidence is assumed in most every transaction. You hand the clerk your money before they hand you the sack of groceries. Exceptions might include kidnapping and blackmail (which are illegal

firm can carry with it for honoring its agreements arises, something that is difficult for a market transactor to accomplish. Recently it has been proposed that the major advantage of firms over markets is firms are better able to develop a reputation for honoring their implicit and explicit contracts with employees.¹⁴ In many cases (but not all) a firm would have an advantage over an individual in establishing and maintaining a reputation, perhaps because of its going concern nature and because of the publicity it receives in the media.

The above analysis has implications for organizational design. Where organizations are large and managers have significant private information the potential for extracting slack may be a serious problem. In such organizations we would expect to see more elaborate budgeting and monitoring procedures, and perhaps more capital rationing. Notice that the degree to which each is used would depend on their cost: budgeting and monitoring lead to out of pocket costs, capital rationing involves paying an opportunity cost.

A More General Analysis

This section generalizes the result above. Above we considered two states and a particular set of parameters. We introduce the following notation: c_2 = high cost, c_1 = low cost, p_2 = probability of c_2 , p_1 = probability of low cost, X = revenue.

transactions).

¹⁴ See D. Kreps (1990).

One can show that one of the two contract types described above must be optimal.¹⁵ Using the notation, these contracts provide the owner with an expected profit as follows:

$$\textbf{SLACK:} \quad X - c_2$$

$$\textbf{RATIONING:} \quad p_1(X - c_1)$$

Thus a RATIONING contract is preferred if and only if:

$p_1(X - c_1) \geq X - c_2$. In order to explore the forces at work, it is useful to think in terms of the opportunity cost of the RATIONING contract. Under a RATIONING contract there is a benefit equal to the expected slack savings, which is equal to $p_1(c_2 - c_1)$. Under a RATIONING contract, there is a cost equal to the profit foregone by turning down the investment when the manager budgets a high cost, which is equal to

$p_2(X - c_2)$. Thus, another way to express conditions under which the rationing contract is preferred is:

$$p_1(c_2 - c_1) \geq p_2(X - c_2).$$

One can see from inspection of this relationship that the rationing contract becomes less desirable as:

- (1) the high cost gets closer to the low cost,
- (2) the probability of a low cost decreases, and
- (3) the revenue obtained by investing increases.

Of course, other management control devices (such as post audits and variance analysis) are also viable alternatives to either rationing capital or simply allowing the manager to obtain

¹⁵ See Antle and Eppen (1985).

slack. The question is whether they are more or less cost effective.

One characteristic of the two-cost settings described above is either no slack is paid, or no rationing occurs. However, if there are more than two possible costs an optimal contract may be characterized by both slack and rationing (see the Appendix).

APPENDIX

This appendix explains how linear programming techniques can be used to derive optimal contracts when there are n possible costs (n can be two or greater). In such cases it is possible that the optimal contract involves both rationing and slack.

Denote by X the level of revenue generated by full production, and denote the incremental cost of producing \$1 of revenue by c_i , where $0 < c_1 < c_2 < \dots < c_n < 1$. (To allow for a linear programming approach, we assume the incremental cost is a constant.) Let x_i denote the level of production undertaken conditional on the manager's report that the cost is c_i ($0 \leq x_i \leq X$). Denote by p_i the probability that the cost is c_i ($0 \leq p_i \leq 1$). Finally, let y_i denote the owner's payment (transfer) given the manager reports the cost is i .

The owner's contracting problem is to choose revenue levels (x_i) and payments (y_i) that maximize her expected wealth and satisfy the participation, limited liability, truth-telling and output feasibility constraints. The participation constraint (P) ensures that the contract provides the manager with non-negative expected wealth. The limited liability constraint (LL1- i) ensures that if the cost is i the manager's wealth (slack) is non-negative. The truth-telling constraints (TT) ensure that if the cost is i the manager wants to report truthfully. The output feasibility constraint (OF) reflects the bounds on the investment level.

The linear program to solve for an optimal contract appears below. Recall that X and the p_i 's and c_i 's are given parameters, and the program solves for the payments (the y_i 's) and revenue levels (the x_i 's).

$$\text{Maximize } p_1(x_1 - y_1) + p_2(x_2 - y_2) + \dots + p_n(x_n - y_n)$$

$$x_i, y_i$$

subject to:

$$p_1(y_1 - c_1 x_1) + p_2(y_2 - c_2 x_2) + \dots + p_n(y_n - c_n x_n) \geq 0 \quad (\text{P})$$

$$y_i - c_i x_i \geq 0, \quad i = 1, \dots, n \quad (\text{LL})$$

$$y_i - c_i x_i \geq y_j - c_j x_j, \quad i, j = 1, \dots, n \quad (\text{TT})$$

$$0 \leq x_i \leq X, \quad i = 1, \dots, n \quad (\text{OF})$$

Antle and Eppen (1985) prove the solution to the above program is a hurdle rate contract, wherein: (1) the manager is paid $c_i X$ for all cost reports less than or equal to c_i and full production occurs and (2) the manager is paid zero for all cost reports greater than c_i and no production occurs.

To generate a numerical solution one may use a spreadsheet's numerical optimizer. For example, in the case where $X = 90$, $c_1 = 60$, $c_2 = 72$ and $c_3 = 84$, with $p_1 = p_2 = p_3 = 1/3$. The solution is as follows: $x_1 = x_2 = 90$, $x_3 = 0$, $y_1 = y_2 = 72$, $t_3 = 0$. Thus the manager is paid 72 if he reports the cost is 72 or 60 and full production occurs, but if the manager reports the cost is 84 he receives nothing and no production occurs.

To verify that the above contract is optimal, the other possible hurdle rates are: (1) 84, in which case the owner

obtains expected profit of 6 and the manager obtains expected slack of 12, and (2) 60, in which case the owner obtains 10 and the manager 0. Interestingly, because the optimal hurdle rate is interior (equal to the middle cost of 72), both slack and capital rationing appear in equilibrium in this example, a result that cannot occur in a two-cost setting.

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