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# Capital budgeting, information timing, and the value of abandonment options

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ABSTRACT

This paper investigates how an abandonment option influences the optimal timing of information in a sequential adverse selection capital budgeting model. While the divisional manager has imperfect private pre-contract information, headquarters can time whether the manager obtains perfect project information before (timely information) or after (delayed information) the contract is signed. In the absence of the abandonment option, headquarters favors timely (delayed) information if the investment costs are high (low). The presence of the abandonment option favors delayed information because under the timely information regime the value of the abandonment option is zero, whereas under the delayed information regime the value of the option is positive.



## 1. Introduction

### 1.1. Motivation

Capital budgeting serves to plan, coordinate, and motivate activities throughout an organisation. The budgeting process defines a set of rules to govern the way in which managers at different levels of the hierarchy produce and share information about investment projects. It is well-known that the timing and the conditions under which information is shared in an organisation are highly critical for the outcome of the budgeting process (e.g., Anthony et al., 1992). As outlined by the real options literature, capital budgeting decisions are dynamic and flexible rather than static. Typically the budgeting process entails real options, including abandonment options. Abandonment options play a crucial role in capital intensive industries, in financial services, and for R&D projects (e.g., Trigeorgis, 1996).

In this paper, we investigate how an abandonment option influences the optimal timing of information and therefore the value of information in a sequential adverse selection model. In particular, we analyse a capital budgeting setting consisting of risk-neutral headquarters and a risk-neutral divisional manager who has pre-contract information about an investment project's profitability. We extend a variant of Antle and Eppen's (1985) capital budgeting model incorporating the timing of information and an abandonment option (e.g., Antle and Fellingham, 1997; Rajan and Reichelstein, 2004, for an overview of related budgeting models). Headquarters can grant the manager additional information that only the manager as an expert can interpret (e.g., Hart and Moore, 1988). As such, only the manager's assessment of the data through a verifiable report makes the information contractible (e.g., Baiman and Evans, 1983; Baiman and Sivaramakrishnan, 1991). We analyse the optimal timing of information for the following two information regimes:

(i) under the timely information regime, the manager obtains access to additional information about the project's profitability before signing the contract. Hence, the initial investment and abandonment

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decisions can be made under perfect information about the project's profitability if the manager truthfully reports his private information to headquarters.

(ii) under the delayed information regime, the manager obtains access to additional information about the project's profitability after signing the contract and after the initial investment decision has been undertaken, but before the abandonment option can be exercised. Consequently, the initial investment decision has to be made under imperfect information about the project's productivity, whereas the abandonment decision can be made under perfect information.

To analyse the interaction between the optimal timing of information and the value of the abandonment option, we first consider as a benchmark the case without the real option. The following trade-off arises: headquarters only has to pay the manager information rents for his private pre-contract information, but not for his post-contract information. Accordingly, delaying project information has the advantage of reducing the manager's information rents. However, headquarters has to make the initial investment decision under imperfect information. Since high investment costs indicate a need for more precise project information, the timely information regime dominates the delayed information regime for high investment costs. In contrast, lower investment costs increase headquarters' willingness to invest, increasing the need to handle the agency problem more efficiently. Accordingly, our result reverses. The delayed information regime dominates the timely information regime for low investment costs. At a first glance our finding seems to contrast with Farlee's (1998) result that headquarters always prefers timely to delayed information. However, unlike in our model, in Farlee (1998) the notion of timely versus delayed refers not to the point in time at which the manager gains the information but rather to the point in time at which the manager reports his information to headquarters.

Starting from this basic trade-off, we investigate the role of the abandonment option. Since the manager does not receive any information rents if the project is abandoned, the real option can be used as an additional control instrument to elicit the manager's information rents more efficiently. Under the timely information regime the real option's value is zero because the entire project information is incorporated in the initial investment decision. Accordingly, there is no need to revise the initial investment decision and to abandon the once initiated project. In contrast, under delayed information headquarters can reassess the initial investment decision exploiting the new information. Depending on the new information, it can be optimal to exercise the abandonment option. Since the expected firm's profit with the real option equals the value of the real option plus the expected firm's profit without the real option, the presence of the abandonment option favors the delayed information regime.

### 1.2. Related literature

Our analysis is related to two streams of literature. First, it is connected to the literature on the value and timing of information. As mentioned, the analysis of our benchmark case is related to Farlee (1998) who assumes, like in our delayed information regime, that the manager has pre-contract and post-contract information. He compares two communication schemes: (i) timely reporting, where the manager reports his pre-contract information immediately, as analysed in our delayed information setting, and (ii) delayed reporting, where the manager delays communication and reports the entire project information later ex-post. Farlee (1998) finds that headquarters prefers timely compared to delayed reporting. In particular, as mentioned before, the notion of delayed information refers to a delayed information transfer of the manager's pre-contract information. Furthermore, in the delayed information case the manager reports both his pre- and his post-contract information at the same time. This leads to a multi-dimensional reporting problem and makes the transfer of information more costly for headquarters. Accordingly, timely information is always superior in Farlee (1998). In contrast, in our analysis delayed information implies that the manager gains his private information after contracting takes place. Therefore, in contrast to Farlee (1998), delayed information mitigates the agency conflict.

Several one-dimensional agency-theoretical studies have shown that finer pre-decision information can discourage agents from exerting effort if they are risk-averse (Christensen, 1981; Demski and Sappington, 1986). Our work differs from these one-dimensional papers in that in our setting the agent has access to multiple (timely) sources of information in the case of early information and has access to one source in the case of delayed information. Additionally, the mentioned literature does not focus on the role of flexibility on the optimal timing of information. Other studies have shown that delayed information may serve as an imperfect substitute for commitment (Cremer, 1995; Arya et al., 1997, 2000). For example, Arya et al. (2000) have shown that when commitment is limited, receipt of earlier information may be undesirable. These papers differ to the present work in that we assume full commitment. Our results are not driven by a lack of commitment.

Second, our paper complements the few papers that analyse the interaction of real options and agency conflicts. Abstracting from the optimal timing of information, Pfeiffer and Schneider (2007) analyse how to implement with residual income-based contracts decentralized sequential investment decisions. Exogenously assuming the delayed information regime, their research question focuses on how to design proper accounting adjustments for residual income-based contracts. We add to Pfeiffer and Schneider's (2007) analysis the timing of information as an essential design variable for the capital budgeting process. Neglecting residual income adjustment and implementation issues, we focus in contrast on the trade-off between timely and delayed information and the real option's influence on this trade-off.

Our analysis is also related to Arya and Glover (2003) who examine abandonment options and information system design for a moral hazard problem. Unlike in our setting, in Arya and Glover (2003) headquarters cannot