



Innovative Applications of O.R.

The impact of voluntary disclosure on a firm's investment policy

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ABSTRACT

In this paper we provide a model which describes how voluntary disclosure impacts on the timing of a firm's investment decisions. A manager chooses a time to invest in a project and a time to disclose the investment return in order to maximise his monetary payoff. We assume that this payoff is linked to the level of the firm's stock price. Prior to investing, the profitability of the project and the market reaction to the disclosure of the investment return are uncertain, but the manager receives signals at random points in time which assist in resolving some of this uncertainty. We find that a manager whose objective can only be achieved through voluntarily disclosing the return is motivated to invest at a time that would be sub-optimal for an identical manager with a profit maximising objective.

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1. Introduction

The purpose of this paper is to investigate the influence of corporate voluntary disclosure on the timing of a firm's investment decision when the manager of the firm has incomplete information regarding the true profitability of the investment and the true market response to the investment strategy. Voluntary disclosures relate to those announcements willingly made by firms outside of their legal and regulatory requirements. We develop a theoretical model of investment whereby the manager of a firm acquires an *option* to disclose the return arising from some investment venture only after the investment has been undertaken. The real options methodology is used to develop the model. This technique has been widely applied to investment decisions (see Dixit & Pindyck, 1994 for a general presentation of real options and investment), but the use of real options methodology in relation to voluntary disclosure has been relatively scant (see Dempster, 2006). This is surprising given that voluntary disclosure decisions share three important characteristics with many investment decisions; i.e., they are irreversible, the payoff is uncertain, and the decision-maker has some leeway over deciding when to disclose.

In our model, the manager of a firm has the option to invest in some risky venture. Once he exercises this investment option, he acquires another separate option which is to voluntarily disclose to the market the return acquired from investing. He only acquires the disclosure option *after* having invested, and the value of his option to invest is dependent upon the value of his option to disclose. So,

we view investment and disclosure as a compound option, which is a novel viewpoint. A related paper to ours is Mittendorf (2004) who considers the issue of information revelation in a real options framework. However, in that paper the information is revealed via an action taken by the manager which serves as a signal to outsiders about the potential profitability of the project in which the manager chooses to invest. In our paper, we interpret information disclosure as the direct communication to outsiders via some medium such as a press release, the company website, or annual and quarterly reports.

In order for the disclosure option to have value, we assume that the manager's remuneration is dependent on the level of his firm's stock price. This is motivated by the fact that the manager's disclosure of investment returns is unexpected information to market participants (henceforth referred to as the "investors"), who subsequently respond by altering their demand for the firm's shares. This impacts positively or negatively on the firm's pre-disclosure stock price level and, hence, on the manager's compensation. If the manager's remuneration was not linked in some way to the impact from disclosure, then the option to disclose would have no value and the manager's investment policy would be formed with a profit maximising objective. Indeed, this is the benchmark scenario against which we compare our results.

The manner in which we deal with uncertainty differs from standard real options models (for example, Dixit & Pindyck, 1994; McDonald & Siegel, 1986) where uncertainty is constant over time. In our model, uncertainty is resolved over time because the manager receives signals at irregular intervals about the expected profitability of the investment and the associated market response, similar to the approach of Thijssen, Huisman, and Kort (2004). However, their model pertains to a stand-alone investment timing decision whereas our model incorporates the voluntary disclosure option into the optimal stopping problem.

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The problem of adjusting the standard real options model of complete information to one of incomplete information has become popular in the operations research literature. For example, Hsu and Lambrecht (2007) and Nishihara and Fukushima (2008) consider the problem, but in the context of strategic games. Our paper is somewhat related to Shibata (2008) who also considers a real options model of incomplete information where uncertainty is resolved over time. However, the purpose of his paper differs from ours in that his aim is to examine the impact of state variable uncertainty on the real options value and its trigger. To achieve this objective, the set-up of his model is more closely related to the standard approach in that he formulates the underlying state variable as a stochastic process, whereas we formulate it as a random variable since this is a more appropriate approach to achieve our objective. In his model, learning occurs via a Kalman filtering procedure whereas in our model, information uncertainty is resolved via the arrival of irregular signals.

Our contribution provides a theoretical framework for the growing body of survey, anecdotal, and empirical evidence which finds that managers of corporations take real economic actions (for example, postpone undertaking profitable investments) which could have negative long-term consequences on firm value in an attempt to manage their reported earnings. For example, Graham, Harvey, and Rajgopal (2005) survey and interview more than 400 executives and find that 78 percent of their sample admits to sacrificing long-term value to smooth reported earnings, while over half of survey respondents (55.3 percent) state that they would delay starting a new project to meet a reported earnings target, even if such a delay entailed a small sacrifice to value. In support of the evidence provided by Graham et al. (2005), Roychowdhury (2006) argues that firms overinvest and give sales discounts to meet their reporting targets.

We consider two separate scenarios. In one scenario the market fully observes the investment timing strategy of the manager, but does not observe the investment return. We refer to this as the observable investment decision. In the other scenario, the market does not observe if and when the manager invests and, thus, cannot determine whether or not the manager has undertaken an investment until he opts to disclose the investment return. We refer to this as the unobservable investment decision.

We find that when a disclosure option holds value for a firm's manager his investment strategy can become sub-optimal. In particular, the manager will invest too early relative to an identical profit-maximising manager (i.e., one for whom the disclosure option holds no value) if the positive stock price impact is expected to be high relative to the negative stock price impact, and he will invest too late if the positive stock price impact is expected to be low relative to the negative stock price impact. Furthermore, the manager may even risk investing in a negative net present value (NPV) venture if the expected positive stock price impact is sufficiently high relative to the expected negative stock price impact and if, simultaneously, the signals which the manager receives are not very informative.

Moreover, we show that when the investment decision is unobservable, the manager will invest but withhold disclosing the return acquired until at a later date. A possible motivation for this behaviour is that the manager may consider the investment to be a worthwhile venture for the firm, but expects that if the market participants were to learn of it at the time of investment they may not fully appreciate its potential. Therefore, the investors may need to be prepared for the product before its existence is revealed. That way, when the manager does disclose, the likelihood of a positive stock price impact is greater.¹

¹ The launch of Apple's iPad can provide some anecdotal evidence on this issue. At a technology conference in Los Angeles in June 2010, CEO of Apple, Steve Jobs, admitted that the company had developed the iPad before the iPhone, but the announcement of its development was postponed until almost three years after the iPhone was launched (FoxNews, 2010). Jobs's justification for this strategy was that the ideas on which the

Even though the objective of this paper is to understand the determinants of firms' investment decisions, rather than a firm's disclosure policy, our paper is related at some level to the voluntary disclosure literature. One of the earliest findings in this literature, provided by Grossman and Hart (1980) and Grossman (1981), has become known as the "unraveling result". If the managers of firms holding private information choose not to disclose their information to outside investors, then the investors will discount the value of the firm to the lowest possible value consistent with whatever firm-specific information they have. Once the managers realise this, they will have an incentive to make full disclosure.

The unraveling argument is relevant to our model when the manager's investment strategy is fully observed by the market. However, when the investment strategy is not observed by the market, the unraveling argument will not hold because we assume that the manager cannot communicate his lack of investment. This implies that when the investment decision is not observed by investors until the manager discloses, the firm is indistinguishable from a firm which has not invested. Since our objective is not to investigate a firm's equilibrium disclosure policies, we do not consider how non-disclosure impacts on investment timing. Therefore, in the unobservable investment case, we assume that the investors observing non-disclosure do not infer anything about a firm's investment strategy, and thus, non-disclosure implies that the impact on the stock price is zero. By making this assumption we are able to isolate and identify how disclosure *per se* affects a firm's investment timing policy.

The remainder of the paper is organised as follows: In Section 2, we describe the economic environment from both the manager's perspective and the market's perspective. In Section 3 we focus on the situation whereby the investment strategy is fully observed by the market while in Section 4 we consider the case whereby the investment strategy is not known until the disclosure option is exercised. In Section 5 we present the benchmark model of investment against which our results are compared and in Section 6 we present the results that emerge from our model. Finally, in Section 7 we discuss the implications of these results for corporate policy and outline some possible directions for future research. All proofs are placed in Appendices A–D.

2. An embedded options model for investment and disclosure

2.1. The manager's perspective

Consider a risk-neutral manager who has the opportunity to undertake some risky investment. The payoff from the investment is uncertain; it can be high, denoted by U^P , or low, denoted by U^N . We assume without loss of generality that $U^N = 0$. Once the investment option is exercised, its return is assumed to be immediately observed by the manager. We denote the sunk costs of investing by $I > 0$, where it is assumed that $I \leq U^P$.²

We assume that the realisation of the investment return is private information to the manager. This implies that upon investment he acquires another option to voluntarily disclose the return to the market. If the disclosure option is then subsequently exercised, the market reacts to the manager's disclosure by altering its demand for the firm's shares which, thus, impacts on the firm's stock price level.

iPad is based "work just as well on a mobile phone". However, at that time, the iPad was unknown and something that Jobs suspected the market did not realise it had a use for, whereas a mobile phone was something that everybody used.

² We assume, as is standard in the real options literature, that the manager has all the resources necessary to invest. There is a body of literature which deals with projects where this is not the case. For example, in Sabarwal (2005), the manager finances part of the sunk investment cost with debt. However, that paper examines the issue about whether a firm's capital structure affects his investment timing decision. For analytical convenience we use the standard assumption of sufficient funds.

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