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Incentive systems for risky investment decisions under unknown preferences

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ABSTRACT

Our paper examines how to design incentive systems for managers making multi-period risky investment decisions. We show how compensation functions and performance measures must be designed to ensure that managers implement the expected value-maximizing set of projects. The Relative Benefit Cost Allocation (RBCA) Scheme[1] and its extensions revealed in literature on unknown time preferences generally fail to do so under unknown time and risk preferences. We illustrate that when coping with such unknown preferences in a risky setting, a specific state-dependent allocation rule is required. We introduce such an allocation scheme, which we refer to as the State-Contingent RBCA Scheme, and reveal that specific knowledge of the time and risk structure of the cash flows is needed to apply it.

1. Introduction

A frequently expressed concern in literature and practice is that managers make investment decisions in their own interest and not in the interest of the owners. Reasons for this behavior may be private interests of the manager (e.g. power, prestige, low exertion of effort) and/or a current compensation system giving financial incentives, which are not in line with the financial interests of the owners. Such poorly designed compensation systems have been blamed to incentivize too short-termed and too risky investments, especially in the context of the financial crisis (see e.g. Bebchuk et al., 2010; Samuelson and Stout, 2009). In order to avoid such value destroying decision-making, incentive systems should align the financial interests of both parties. However, the design of such incentive systems turns out to be challenging, especially if – as in practice – the preferences of the managers are unknown. In this paper, we show how to design incentive systems, which align the financial interests of both parties without knowledge of the time and risk preferences for multi-period risky investment decisions. The analysis reveals that in order to construct adequate performance measures, in addition to the specific inter-temporal cost allocation revealed in the literature (i.e. the Relative Benefit Cost Allocation (RBCA) Scheme), a state-dependent cost allocation is crucial under risk. We introduce such a new cost allocation scheme, which we refer to as the *State-Contingent (Robust) Relative Benefit Cost Allocation Scheme*. The proposed allocation scheme ensures time and statewise dominant performance measures and compensation for the desired investment strategy (i.e. the implementation of the value-maximizing set of projects). Furthermore, we analyze the information requirements to construct such performance measures.

We conduct our formal analysis within the following general theoretic framework: The owner of a firm delegates risky investment decisions to a manager who is better informed about all future project cash flows. The interest of the risk neutral owner is to maximize the expected firm value. The interest of the manager can be composed of financial and private interests. To ensure that the manager acts in the interest of the owner, an incentive system is established. This incentive system is composed of compensation functions and performance measures for each period.

In Literature, such principal agent relationships are analyzed within two main approaches, the *standard agency approach* and the *consistency approach*. The standard agency approach (Grossman and Hart, 1983; Holmström, 1979; Mirrlees, 1976; Shavell, 1979)

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[1] The Relative Benefit Cost Allocation (RBCA) Scheme has been introduced by Rogerson (1997). It ensures the performance measure of every single period to be a linear function of the net present value (NPV) of the project. All further literature on unknown time preferences is based on this approach.

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explicitly considers both private and financial interests of the manager and focuses on *optimal incentive system design*. To be able to derive such optimal incentive systems, it is necessary to assume well-specified scopes of action, corresponding probability distributions and (dis-)utility functions. The derived optimal incentive systems are not robust, i.e. the solution depends crucially on the specific assumptions of the model. If either the relationship between effort and the cash flow distribution or the utility function of the manager is unknown – as in most practical situations – this approach is very limited. The second approach, which is the basis of our analysis, aims to derive so-called *consistent incentive systems*. It assumes that the relationship between effort and the cash flow distribution is unknown and only focuses on explicitly aligning the *financial* interest of the manager and the owner with regard to any cash flow distribution. Consistent incentive systems ensure that if any investment decision has a financial advantage for the owner, it will also provide the manager with a financial advantage. Although non-financial interests are not considered explicitly, they can be addressed by exploiting the remaining degrees of freedom within the requirements for consistent incentive system design.

The *consistency approach* itself encompasses two incentive concepts: *Goal congruence* (GC) and *preference similarity* (PS) (Dutta and Reichelstein, 2005; Reichelstein, 1997; Rogerson, 1997; Solomons, 1965 resp. Pratt, 2000; Ross, 1974, 1973; Wilson, 1969, 1968). The difference relates to the concrete financial interest of the risk neutral owner: Whereas under GC it is to maximize the expected net present value (NPV) of the investments, under PS the NPV after managerial compensation is considered for maximization. Within both concepts, consistency can be achieved by designing appropriate performance measures and compensation functions. If the *utility function of the manager is known*, potential differences in financial preferences can be counterbalanced by adjusting the compensation functions. Then any complete performance measure, i.e. fulfilling NPV-identity,[2] will ensure consistent investment decisions (Pfeiffer and Velthuis, 2009). As such, any *residual income* measure is in general appropriate. However, if the utility function of the manager and as such his *time and/or risk preferences are unknown* to the owner, the only possibility to achieve consistent investment decisions persists in a specific design of the performance measures. For *unknown time preferences* prior analyses revealed that such performance measures can be constructed by means of the so-called *Relative Benefit Cost Allocation (RBCA) Scheme* (Reichelstein, 1997; Rogerson, 1997) and its extension (Mohnen and Bareket, 2007). These allocation schemes ensure that a specific portion of the NPV is reflected in the performance measure in each period. As such, NPV-maximizing investment decisions will result in *timewise dominant* performance measures and compensation for the manager.

We expand existing accounting research by focusing on *unknown time and risk preferences*. By analyzing the implications of unknown risk and time preference in a setting with risky investment projects, we relax the most restricting assumption of the prevalent models on GC and PS (i.e. risk neutrality of the manager or certainty). Within this setting, prevalent allocation schemes derived under unknown time preferences fail to induce consistency. The reason for this deficit is that whereas risk-neutral decision makers only consider expected values in their decision process, risk-averse decision makers also care about the distribution across different states in each period. As such, consistent performance measures must portray stronger properties to induce the desired investment decisions regardless of managers' risk preferences. Our findings are based on the preliminary work of Wollscheid (2013) and contribute to existing literature by introducing an allocation scheme, which we refer to as *State-Contingent (Robust) RBCA Scheme*. It ensures both *GC and PS* for *risky investment decisions* despite *unknown time and risk preferences* of the manager. Our *State-Contingent (Robust) RBCA Scheme* leads to *state- and timewise dominant* performance measures, distributing a specific portion of the expected NPV in every state in each period. As such, *dominant compensation pay-offs* for the desired investment decisions are ensured, while using positive marginal compensation for all states, periods and projects.

This paper is organized as follows: The next section introduces the formal model. In Section 3, consistent incentive systems for risky investment decisions under unknown time and risk preferences are derived. We first focus on a single-project setting (3.1) and then analyze the multi-project case (3.2). Section 4 finally discusses the implications of our findings.

2. The basic model

In line with prior investigations (e.g. Mohnen and Bareket, 2007; Pfeiffer and Velthuis, 2009; Reichelstein, 1997; Rogerson, 1997), we analyze a principal agent relationship, in which a firm owner (principal P) delegates investment decisions to a better-informed manager (agent A). These investment decisions accrue at time $t = 0$. If the manager decides to invest, the investment requires an initial investment expenditure I in $t = 0$ and subsequently generates risky cash flows c_{ts} (or riskless cash flows c_t) in state s at times $1 \leq t \leq T$. The probability of state s at time t is denoted by p_{ts} with $\sum_{s=1}^{S} p_{ts} = 1\ \forall t$. The initial investment expenditure as well as the cash flows in each state s at each point in time t may contain cash flow components (I_i resp. c_{its}) from one or several projects i, i.e. $I = \sum_{i=1}^{n} I_i$ resp. $c_{ts} = \sum_{i=1}^{n} c_{its}$.

To capture the risk and time structure of cash flows we further assume, without loss of generality, that the state specific cash flows (resp. their components) can be represented as:

$$c_{ts}(I) = \psi_{ts} \cdot E(c_t(I)) = \psi_{ts} \cdot x_t \cdot y(I) \quad \text{with} \quad E\left(\psi_t\right) = 1. \tag{1}$$

The *variation factor* ψ_{ts} depicts the state specific variation of cash flows with respect to its expected value. The expected periodic cash flow $E(c_t(I))$ is the product of a *temporal growth factor* x_t and a *profitability factor* $y(I)$.

Only the manager has complete information of possible investment projects, i.e. only he knows the investment expenditures, possible future periodic cash flows c_{ts} in the different states and the probability of each environmental state p_{ts}. The realized initial investment expenditure I, and all realized cash flows c_{ts} are observable by the owner.

To align their financial interests, the owner establishes an *incentive system* by designing *performance measures* π_{ts} and by specifying the *functional relationship* between the performance measures and the variable compensation of the manager ω_t at each point in time $1 \leq t \leq T$:

$$\omega_t = \omega_t(\pi_{ts}). \tag{2}$$

We focus on incentive systems ensuring $\omega_t(\pi_{ts}) = 0\ \forall t, s$ for cases in which the manager does not invest at all.[3] The performance measures considered in this analysis are accrual accounting measures,

[2] NPV-identity states that the present value of the performance measures equals the present value of the cash flows.

[3] As such, we do not consider a fixed compensation component resp. a base performance level in the performance measures. Furthermore, the compensation at time t is solely a function of the performance measure π_{ts}. Hence, the function $\omega_t(\pi_{ts})$ is neither state nor project dependent.

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