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Paying for performance: Uncertainty, asymmetric information and the payment model

Louise Hooper

Institute of Transport and Logistics Studies, Faculty of Economics and Business, The University of Sydney, NSW 2006, Australia

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ABSTRACT

Privatisation has led to a growing interest in more complex contractual forms designed to give public transport operators the incentives for effort that maximise value for money. Contract theory provides a rich research basis for selecting an appropriate contractual form, with an emphasis on the effects of uncertainty and asymmetric information. To date, however, there have been few applications of contract theory in the field of transport. This paper identifies the key empirical results from the multi-disciplinary literature to help transport researchers and practitioners place contractual decision-making in the broader theoretical context, suggesting aspects of transport contracting that merit future research.

1. Introduction

Interest in optimal contracts has grown in recent years as governments look for new ways to maximise value for money in the provision of transport services. While debate continues about choice of mechanism (for example, negotiated contracts or competitive tender) to procure these services (see Hensher & Wallis, 2006 for discussion of this important issue), this paper abstracts from this debate to examine another tactical element of the STO framework[1] (see Macario, 2001; van de Velde, 1999): the payment model.

Consider two parties, a principal (say, a regulator) and an agent (an operator) who have chosen to do business together. What type of payment model should the regulator offer? Wallis (2003) defines and describes the range of payment models that are commonly applied in the urban public transport sector (summarised in Table 1), including performance-based contracts (PBCs). The optimal use of PBCs in public transport has been the focus of some important research in recent years (e.g. Fearnley, Bekken, & Norheim, 2005; Hensher & Houghton, 2004, 2005; Hensher & Stanley, 2003).

The choice of an optimal payment model is more complex than it may at first appear; it is specific to the situation at hand, and in most cases involves complex trade-offs. A rich body of theoretical and empirical literature, broadly known as *contract theory*, can help us make optimal, or at least informed, payment model decisions.

The paper is divided in two parts. In Section 2, the key tenets of contract theory are briefly sketched, giving us some basic tools for analysis of the ‘real life’ contracts observed in public transport. Section 3 turns to the application of the theory in transport and other contexts, examining how well theory predicts the contractual forms that we actually observe. Section 4 concludes the paper with some suggestions for future research.

2. Contract theory

The term *contract theory* generally refers to ideas about incentives, information and economic institutions. These ideas transcend disciplinary boundaries, finding particular relevance in economics, finance, management and corporate law. Contract theory began with the classic ‘Edgeworth box’, extended in the 1950s to explicitly consider situations involving uncertainty. In the 1970s, contractual situations involving asymmetric (or hidden) information were introduced, leading to a rich theory of incentive contracting. The 1980s saw a focus on issues of repeated or dynamic contracting, together with the development of transaction-cost-economics, a departure from the classical microeconomic framework.

The literature is vast, and this paper's treatment of it will be brief. For simplicity we focus on bilateral contracting situations without reference to externalities that the contract may impose on other parties (such as competitors). For discussion of contracting in

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E-mail address: louiseh@itls.usyd.edu.au

[1] Macario (2001, p 16) defines the Strategic, Tactical and Operational levels of public transport service as follows:
- Strategic: definition of mobility policy reflecting the needs of citizens, which is usually performed by political authorities.
- Tactical: design of the transport system and defining the respective policies by translating the strategic goals into operational specifications.
- Operational: production and consumption of transport services.

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Table 1
Commonly used payment models

Payment model	Model summary	Outcomes summary
Cost-plus	► Operator is paid a fixed fee in addition to their reported costs	► Cost risk: government ► Revenue risk: government ► Incentives for effort: none
Gross cost	► Contract payments are based on the gross cost of providing the services; all fare revenue is returned to the government authority.	► Cost risk: operator ► Revenue risk: government ► Incentives for effort: low
Net cost	► Contract payments are based on the net costs (i.e. gross costs less fare revenue of providing the services); the operator retains fare revenue.	► Cost risk: operator ► Revenue risk: operator ► Incentives for effort: medium
Incentive (PBC)	► Contract payments include a performance element (i.e. direct financial payments, contract termination/renewal, evaluation of future tenders, publication of performance).	► Cost risk: operator ► Revenue risk: shared ► Incentives for effort: medium
Commercial	► Operator retains fare revenue and receives no subsidy; may pay a fee to the government.	► Cost risk: operator ► Revenue risk: operator ► Incentives for effort: high

a multilateral setting see Bolton and Dewatripont (2005). The most general implications for application of the theory to the development of real payment models are highlighted in this section.

2.1. Choice under uncertainty

The framework introduced by von Neumann and Morgenstern (1944) remains the starting point for analysis of optimal contracting under uncertainty. At its simplest, the utility derived by a principal and an agent from the consumption of t is optimised given two states of nature (say, low and high) and a probability distribution p that the states of nature will occur. Ex ante utility functions for principal and agent are defined as the expectation over ex post utility outcomes $U(\cdot)$ and $u(\cdot)$ respectively:

$$V(t_{1L}, t_{1H}) = p_L U(t_{1L}) + p_H U(t_{1H})$$

and

$$v(t_{2L}, t_{2H}) = p_L u(t_{2L}) + p_H u(t_{2H})$$

In this framework, an individual's attitude toward risk is characterised by the curvature of his ex post utility function. The Borch (1962) rule states that optimal insurance requires the equalisation of the ratio of marginal utilities of money across states of nature; a risk-neutral individual has a constant marginal utility of money, and so must ensure that a risk-averse contracting party also has a constant marginal utility by providing them with perfect insurance. If both parties are risk-averse they will optimally share business risk, and the distribution of this risk will depend on the shape of the utility functions of both parties. An individual's attitude toward risk is driven in part by initial wealth holdings, and it is generally accepted that absolute risk aversion tends to decrease with wealth.

How does this help us choose the optimal payment model in a transport situation? Risk preferences should drive the type of payment model offered. A risk-neutral regulator should offer a risk-averse operator a cost-plus contract; if both parties are risk-averse, risks should be shared as dictated by the utility functions. As risk preferences are not directly observable, proxies such as wealth or size of firm are often used in practice.

It is important to note that this result is achieved under stringent assumptions, and this limits application in actual contractual situations. The assumption of rational behaviour is less plausible in environments with uncertainty, as in practice it is possible that contracting parties will be unable to agree on a complete description of the state space and that, as a consequence, insurance contracts will be incomplete. Perfect enforceability of contracts is also assumed, however, uncertainty imposes limitations on the courts' understanding of the original intentions of the contracting parties. Research has focused, in particular, on relaxing the assumptions relating to symmetric information and the static contracting environment, as described in the rest of this section.

2.2. Adverse selection

One or both parties to the contract may have private information that is not shared with the other party (for instance, an operator's willingness to undertake certain tasks). This information asymmetry gives the parties the ability to lie about their type (say, low-productivity or high-productivity) in order to obtain informational rents, leading to distributive inefficiency.

The payment model can mitigate distributive inefficiency using the powerful *revelation principle*: a principal wishing to optimise a contract under asymmetric information should offer multiple contracts, one contract for each type of information that the informed party may have, making sure that each type has an incentive to select 'from the menu' only the contract that is destined for them.

For example, a regulator might contract with both high-productivity and low-productivity operators, but might have no way of distinguishing which type an individual operator is. A low-productivity operator may obtain informational rents by pretending to be high-productivity. Under the revelation principle, it is optimal for the regulator to offer two contracts – one destined for the high-productivity type and one for the low-productivity type – applying incentive and individual rationality constraints that ensure that each type chooses the correct contract. Thus, the payment model offered to each type is optimally structured to elicit truth-telling.

This example describes a screening model, where the uninformed party moves first and solves an optimisaton problem constrained by a set of incentive constraints. If the informed party moves first, it becomes a signalling model, which involves more sophisticated game-theoretic arguments. Multiple equilibria are possible because many conditional beliefs of the uninformed party can be self-fulfilling. A large literature has developed to refine equilibrium outcomes (see Cho & Kreps, 1987; Maskin & Tirole 1992; Spence, 1973, 1974).

The payment model now has two roles: allocate risk efficiently, while limiting informational rents. In general, optimal contracts under asymmetric information will be second-best contracts, which do not achieve simultaneously optimal allocative and distributive efficiency.