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An analysis of airport–airline vertical relationships with risk sharing contracts under asymmetric information structures

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A B S T R A C T

We analyze the double moral hazard problem at the joint venture type airport–airline vertical relationship, where two parties both contribute efforts to the joint venture but neither of them can see the other's efforts. With the continuous-time stochastic dynamic programming model, we show that by the de-centralized utility maximizations of two parties under very strict conditions, i.e., optimal efforts' cost being negligible and their risk averse parameters both asymptotically approaching to zero, the vertical contract could be agreed as the optimal sharing rule, which is the linear function of the final state with the slope being the product of their productivity difference and uncertainty (diffusion rate) level index.

If both parties' productivities are same, or the diffusion rate of the underlying process is unity, optimal linear sharing rule do not depend on the final state. If their conditions not dependent on final state are symmetric as well, then risk sharing disappears completely. In numerical examples, we illustrate the complex impact of uncertainty increase and end-of-period load factor improvement on the optimal sharing rule, and the relatively simple impact on total utility levels.

1. Introduction

Faced with revenue and profit level fluctuations, some airports (local governments) and airlines serving the airports are forming vertical contractual relationship to share their risk and stabilize their financial conditions so that air transport services by those airlines to/from the airports could be created or kept. Hihara (2008) and Hihara (2012) reports that Noto Airport, one of rural airports in Japan, agreed on a contract with one airline group to share the demand fluctuation risk so as to derive the commitment of airline's service to the airport. They used load factor as a key indicator.[1] So the mechanism of the contract is called load factor guarantee mechanism. Also Hihara (2012) analyzed by using incomplete contract framework to show that when such vertical risk sharing contract satisfy proper conditions, such contract can overcome the under-effort problem and improve the utilities levels of both parties.

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[1] The air craft size is fixed in the load factor contract. So airline cannot manipulate load factor by changing aircraft size during the contract period. Landing charge is also fixed in the airport's rule for a year. In most negotiations between airport and airline of whether the air route is to be opened/maintained or not, load factor is the common indicator to be used in Japan. This may be because competition of domestic market is not so tense until 2012, when LCCs are finally entering Japanese domestic markets.

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2. Literature review

Risk sharing study dates back to Borch (1962). He showed that under pure risk sharing situation without any efforts, the optimal sharing rule stipulates that the ratio of marginal utility of two participating parties in different state are constant and the results hold for any probability distribution.

The risk sharing is also the subject of moral hazard analysis, since the principal is paying to the agent based on the realization of uncertain state. The essence of risk sharing is to share the outcome depend on the realization of contingencies by paying from one party to the other(s) based on some rule. The moral hazard case, the effort of the agent is involved and the principal is optimizing his utilities by controlling payment and also agent's efforts indirectly through the payment structure.

There are two approaches to model the uncertainty in the moral hazard situation. First is that random variable with some probability distribution is assigned to the state itself. This approach dates back to Mirrlees (for example, Mirrlees (1979)) and Rogerson (1985) prove that under this settings, the first order approach is permissible if and only if monotone likelihood ratio condition (MLRC) and the convexity of distribution function condition (CDFC) are satisfied for the probability function with the condition of the agent's action.

But remember the first approach is not a dynamic approach. The random variable is assigned to state contingency and the maximization is about all the possible outcomes at one time only.

The second approach is that the difference of the state is modeled by the stochastic differential equation with the usual Wiener process. This is pioneered by Holmstrom and Milgrom (1987). They showed that if the agent has great action space, the optimal reward contract is simple linear function of the final state (But they did not prove the sufficient conditions).

Then Schaettler and Sung (1993) proved the general cases with necessary and sufficient conditions in the second approach case. Also Schaettler and Sung (1997) studied the connection between discrete models and continuous model in the second approach case.

Mueller (1996) and Mueller (1998), based on these studies, showed that if the principal can see the agent action, in the first best situation according to his words, the linear optimal contract is structured by the risk aversion parameters of both principal and agent.

These literatures are about the traditional moral hazard situation where one principal pay to one agent for his efforts that the principal cannot observe. The efforts are performed only by agent.

If both principal and agent are making efforts, which cannot be observed from the other party, the situation is so-called double moral hazard problem. In the first approach case on the double moral hazard problems, some authors are analyzing the problems. The recent examples are Bhattacharyya and Lafontaine (1995) and Kim and Wang (1998a). About the second approach, to our knowledge, there are no literatures yet to model the double moral hazard situation using the stochastic differential equation, either in air transport economics, or any other field.

In the air transport studies, there are a number of studies on vertical relationship between airport and airline. Recent examples are Oum and Fu (2009), Barbot (2009), Feng et al. (2010), Zhang et al. (2010). The airport–airline vertical relationship could contain some double moral hazard problems, since one cannot directly observe the other's efforts in the relationship.

To our knowledge, however, there are no literatures yet to model the double moral hazard situation between airport and airline, in the air transport economics field, using either the first approach (state random variable) or the second approach (stochastic differential equation with Weiner process).

In this study, we use the second approach (stochastic differential equation with Weiner process) to analyze the double hidden action/moral hazard problems in airport–airline vertical relationships.

3. Double hidden action/moral hazard situation

As stated in Hihara (2012), airport (=AP) and airline (=AL) are engaging in a joint-venture type project, in which both AP and AL are independently making efforts to pro-vide air transport service to the passengers using the air route to/from the airport.

We believe air transport service at one airport cannot be provided by airline or airport alone. Only the combination of airline side and airport side can provide the service to passengers/cargo service users.

In this sense, airport's service and airline's service are closely connected with each other and they are not just a bundle of two different services. For example, if airport make more effort to improve the quality of service, this affects the quality of airline and enhance the contribution of airline's service to the joint-venture type project.

Usually in moral hazard problem, only one party's efforts cannot be seen from the other party. But in the case of airport–airline relationship, neither of the parties' efforts can be seen from the other parties. Hence the double moral hazard situation. This type of situation can be found in not only in other transport supply chains (e.g., sea line operators and port authority) but also commercial property business chains (commercial developers and retail shop owners). And the analysis of this double moral hazard situation is becoming more important as the supply-chain enters more risk sharing ventures.

Here we try to use the stochastic differential equation approach to model the double moral hazard situation. Namely neither airport nor airline can see the efforts of the other side. The contingent variable is according to the usual stochastic differential equation as in the single moral hazard studies.