# RISK ALLOCATION: THEORETICAL AND EMPIRICAL EVIDENCES.

# APPLICATION TO THE DEFENSE PROCUREMENT SECTOR

**Jean-Michel OUDOT**[*]


University of Paris I Panthéon – Sorbonne

Centre for Analytical Theory of Organizations and Markets (ATOM)

106-112 boulevard de l'Hôpital

75 647 Paris cedex 13 – France

Tel: (+33) 1 44 07 83 21

Fax: (+33) 1 44 07 83 20

E-Mail: oudot@univ-paris1.fr

June 2006

**Abstract**

This article addresses the question of how to allocate risks between transaction partners in procurement contracts so as to favor efficiency. The Principal-Agent Theory is mobilized to comply with this matter. Foundations of the theoretical hypothesis are pointed out. Then, these hypotheses are applied to the defense procurement and tested through the analysis of original contractual data constructed in this sector. This test emphasizes the necessity to partly modify current practices in the French defense procurement sector as far as risk allocation is concerned. Eventually, I suggest managerial implications.

**INTRODUCTION**

The procurement process in complex systems implies a lapse of time between the signing of the contract and its implementation. The time between the development and the production of the equipment could be very long. In this context, risks that occurred during the implementation of 48 French defense procurement contracts, signed between 1994 and 2005, represent an average of 4.48% of the reference price contract while the value of these contracts is usually several hundreds of millions of euros. In addition, the importance of cost overruns during contracts implementation is common to many different sectors (Gerardin & Stefanello, 2005). Thus, risks cannot be overlooked. I regard a risk as being "any factor, event or influence that threatens the successful completion of a project in terms of time, cost or quality"[1] (European Commission, March 2003: 50).

Besides, risk allocation refers to any decision that influences the sharing of cost overruns between the transaction partners. Risk allocation decisions directly affect the price that will eventually be paid by determining the precise implementation conditions of the contract. Several works have emphasized the importance of risk allocation when explaining the performance of procurement contracts (Private Finance Treasury Taskforce, 1997; European Commission, March 2003). Furthermore, in the French defense procurement sector, a difference in ex-ante risk allocation and ex-post risk allocation decision can be noted since firm-fixed-price contracts are signed and are sometimes enforced as cost-plus contracts. This observation reveals an incompleteness of contracts and difficulties in decision making concerning risk allocation. Then, the question is how to allocate risks between transaction

---

[1] In this article, I do not distinguish risk from uncertainty (Knight, 1921) since the difference between these two concepts does not intervene in the theoretical hypothesis suggested by the theoretical framework used here, the Principal-Agent Theory. Indeed, the knowledge of the probability of risk occurrence is not included in these hypotheses. Besides, I focus the developments on negative risks and especially, moral hazards. Events causing unexpected benefits to the transaction partners are not included in the scope of this article.

partners so as to favor efficiency. In this article, I deal with this question and to do so, I resort to the Principal-Agent Theory.

Agency theoreticians analyze risk allocation through the choice of the contract type (Laffont & Tirole, 1993; Tirole, 1999). In this article, I suggest an extension of the theoretical propositions on the choice of contract type by enouncing hypotheses focused on contractual choices within a context of fixed-price contracts. These refined hypotheses are in line with the contract type propositions of the Principal-Agent Theory. The hypotheses are applied in the defense procurement sector, and then tested empirically. I attempt to put forth a theoretical contribution with testable hypotheses, which is uncommon under the Principal-Agent Theory (Stiglitz, 1974; Allen & Lueck, 2001; and Olsen & Osmundsen, 2005 among others).

In addition, from an empirical point of view, I reveal some specific features of the defense procurement sector. For reasons developed in this article, these features are expected to influence risk allocation decisions, therefore justifying the need for specific risk allocation as compared to other sectors. I proceed with a testing of the theoretical hypotheses using an original database constructed in the French defense procurement sector, representing all weapon systems. The database is comprised of 48 outsourcing procurement contracts that were accurately analyzed through both a questionnaire sent to the French defense procurement agency and interviews. The test reveals both similarities and differences between the theoretical hypotheses and factual observations.

This article contains three sections. The first section presents theoretical developments justifying the testable hypotheses, while the application and testing of these hypotheses are the basis for the second section. The third section concludes on managerial implications.

## 1. PRINCIPAL-AGENT THEORY HYPOTHESES ON RISK ALLOCATION

As opposed to Skromme-Baird & Thomas, 1985; March & Shapira, 1987; and Kirat, 2003; I develop normative prescriptions on risk allocation through an examination of the Principal–Agent Theory (henceforth PAT) literature. The positions of both transaction partners are taken into account with the analysis of the optimization program followed by the PAT to the extent that following this program must improve the situations of both partners, compared to a case in which the constraints would not have been taken into account (Wilson, 1968). In this section, I show that the PAT hypotheses on risk allocation come from the constraints within the optimization program.

This section is composed of three subsections; each one is devoted to the analysis of one specific constraint. The first subsection presents developments on the incentive constraint, while the second describes the role of the participation constraint. In the first two subsections, I assume symmetric information. I recall the sensitivity of risk allocation in this assumption and provide further details in the third subsection. The latter is devoted to the development of a specific constraint in the defense procurement sector: the autonomy constraint. In all subsections, the Principal is assumed to be risk neutral while the Agent is regarded as risk averse. In addition, I focus on the developments in hidden action models, not hidden information.

## 1.1 The incentive constraint

The objective of this subsection is to present the role of the incentive constraint in the determination of the risk allocation hypothesis within the framework defined by the PAT. Principal-Agent theoreticians resort to the allocation of cost-overruns on partners as an incentive device. The payment the Agent receives from the Principal depends on its performance. "The Agent is punished for outcomes that revise beliefs about H (hard work)

downward and rewarded for outcomes that revise beliefs upward" (Hart & Holmström, 1987: 79). When the random factor is not crucial in explaining the Agent's performance, then the following process is expected: the less the Agent's efforts, the more risks materialize, the higher the costs, the less the performance, and the less the Agent is paid; all things being equal.

Incentive pay serves to allocate risks so as to motivate the Agent to perform. This rule comes from the responsibility principle expressed by the PAT (in Holmström & Milgrom, 1991: 27). Therefore, the risk is expected to be allocated to the Agent to the extent that it controls the source of the risk. Similarly, if the Principal is responsible for one type of risk, the PAT suggests that the Principal must bear this risk. I derive the first hypothesis from these developments.

**Hypothesis 1. If a source of risk is under the exclusive control of one partner, then this partner is expected to support that risk.**

Several studies (Domberger, 1998; Klein, 1998; Tirole 1999; Hood & MacGarvey, 2002; European commission, March 2003; Lewis, 2001; Guasch, 2004; Medda, 2004) support this hypothesis, although its theoretical foundations have not been summarized. Let us now analyze the second constraint in the optimization program.

## 1.2 The participation constraint

This constraint requires that the Principal grants the Agent as many benefits as it would receive in another relationship. The benefits are equal to the income minus the costs. The market determines the reserve income. The remainder of the Agent's benefits is explained by the costs it supports.

According to Principal-Agent theoreticians, costs reflect both the implementation cost of work as well as the cost of risk-bearing (Holmström & Milgrom, 1991). As far as risk allocation is concerned, the PAT highlights the cost of risk bearing[2]. To minimize costs, the Principal is expected to minimize the risk-bearing cost. "Principal-Agent relationships should reflect efficient organization of information and risk-bearing costs" (Eisenhardt, 1989: 59). Within this risk-bearing cost, PAT authors point out the importance of agents' attitudes towards risk (Stiglitz, 1974; Harris & Raviv, 1978; Barney & Hesterly, 1996; Allen & Lueck, 2001; Olsen & Osmundsen, 2005). These authors stipulate that the higher the risk aversion, the higher the risk-bearing cost and the tighter the participation constraint; all things being equal. Agency theoreticians regard the attitude towards risks as the central variable determining the risk allocation decision. Here, I situate the attitude towards risks within the general argument presented by the PAT to draw testable hypothesis on risk allocation. I deduce that risks are expected to be allocated to the least risk averse partner in order to minimize the overall risk-bearing cost. In the PAT, the Agent is often supposed to be risk averse whereas the principal is supposed to be risk neutral. In this article, I support the same assumption. To minimize the overall risk-bearing cost, Agents are not expected to support risks that are beyond their control. I deduce from these developments the second hypothesis.

**Hypothesis 2. If a source of risk is not under the control of any of the partners, then the Principal is expected to support that risk.**

Whereas hypothesis 1 is focused on incentives to perform, hypothesis 2 highlights insurance. The incentive / insurance trade-off still exists but, in this analysis, it is placed on a more

---

[2] The risk-bearing cost is the cost a partner supports when he is due to bear the consequences of the risk occurrence. This component of the total cost is mainly illustrated by the risk premium. The insurer demands the insured collaborate to ensure the latter against the financial consequences, should risks occur. Transaction costs induced by the efforts to design and settle organizational or contractual guarantees aiming at the reduction of the probability of risk occurrence is also included within the risk bearing cost variable.

precise scale than the contract type choice by focusing on contractual clauses exclusively devoted to the risk allocation determination within a fixed price context. Such a contractual strategy is expected to respond to the reduction in incentives coming from the incentive / insurance trade-off.

In the last two subsections, I assumed symmetric information. Both partners were supposed to observe, objectively and without mistake, the risks that occurred as well as their sources and impacts (cost overruns in particular). I relax this assumption in the next subsection which is devoted to a specific constraint existing in the defense procurement sector.

## 1.3 The defense procurement sector: Autonomy matters

The objective of this subsection is to adapt the general hypotheses on risk allocation to the defense procurement sector. I suggest that, to a certain extent, the industrial policy might trump other considerations of economic incentives and efficiency. Here, the specificity of this sector relies on the Principal's particular objectives.

In the defense procurement sector, the Principal follows two main objectives. In the short term, its primary objective is to obtain weapon systems as cheap as possible (acquisition target), as set out in the optimization program detailed by the PAT. Both hypotheses presented earlier support the realization of this objective.

The Principal has also a long-term objective: being independent from other (foreign) Principals, as far as the armament procurement is concerned. This is justified by strategic and political reasons. The Principal does not want to make its decisions dependent on other Principals' point of view. Indeed, the procurement of one crucial defense system could be traded against a military intervention in a specific theatre of military operations for instance.

To be self-governing, the Principal must rely on a large and competitive national Agent. The more developed the national Agent, the higher its ability to realize complex defense systems, the more likely the Principal is able to procure defense abilities without resorting to foreign Agents; all things being equal. That is why the principal may decide to support the Agent's development.

Several industrial policy tools are available to support the Agent's development. In this article, I tend to suggest that risk allocation is one of the elements that sustains the Agent. As a matter of fact, the less risks the Agent supports, the better its financial situation, the greater its investment abilities, the better its realization skills; all things being equal. Thus, the Principal may decide to support risks as an industrial policy advice. This is a discretionary decision that the Principal can make to sustain the Agent's development.

As in the last subsections, the Principal's objective is translated as being a constraint within the optimization program. Previously, the incentive constraint represented the procurement cost minimization objective while the participation constraint responded to the necessity of procuring equipments. In line with the autonomy objective, I call the third constraint the autonomy constraint. Let us note that the latter is not binding for all contracts. According to the Agent's features (small or large for instance) and the features of technologies introduced in the defense equipment (whether obsolescence is likely or not, use of specific technologies in different crucial defense systems in particular), the Principal is more or less subject to the autonomy constraint. Thus, according to the transaction features, the Principal is more or less likely to favor the Agent's development.

The autonomy constraint, added to the asymmetric information assumption, the developments previously presented and the necessity that the first two hypotheses not be contradicted, leads to the next hypothesis.

**Hypothesis 3. If a source of risk is either blurred or shared by both partners, then the Principal may decide to support that risk.**

Let us note that these three hypotheses favor the determination of the risk allocation regardless of the ex-post contingencies. The procurement contract is theoretically complete as far as risk allocation is concerned, which corroborates the complete contract approach presented by the PAT. Now that the theoretical developments have been presented, the analysis now focuses on their applications and tests.

## 2. APPLICATION CASE: THE DEFENSE PROCUREMENT SECTOR

Two objectives are pursued in this section: applying the theoretical hypotheses stated previously (section 2.1) and comparing them with empirical observations (section 2.2). I regard the Defense Procurement Agency (henceforth DPA) as being the Principal. The Agent is the defense industrial base[3].

### 2.1 Applying the theoretical hypotheses

In order to apply the theoretical hypotheses in the defense procurement sector, I must resort to a typology of risks existing in this sector. I base my demonstration in this section on a large and precise risk assessment realized in a previous work (Oudot, 2006). This analysis points out the risks that exist in the French defense procurement sector.

---

[3] Dunne defines the defense industrial base as being "a sector or groups of industries that are dependent to some degree on defense spending and upon which the state is dependent to some degree on self-sufficiency in the production of the means of defense and war" (1995: 401). This is made up of firms that manufacture the equipment and/or deliver the service.

In this previous work, I identified - thanks to a tight collaboration of French defense firms and the French DPA - five main risk categories in the defense procurement sector. First, I noted the existence of a technological risk that has been defined as a technical or technological event that, directly or indirectly, reduces the performance of the contractual relation. Second, a contractual risk exists that concerns all events related to the negotiation, drafting, notification and implementation of a contract. This includes for instance the partners' opportunism. The third risk category is the industrial risk: failure of the firm's industrial organization or of its subcontractors. The fourth category is the direct financial risk, which is defined as an event that modifies the initial equilibrium between receipts and outlays. This financial event corresponds to two contingencies: receipts inferior than expected or delayed receipts (1); cost overruns higher than the capital set aside to cover them (2). Eventually, the calendar risk was perceived, described as an event, directly or indirectly, causing delays longer than expected when the reference contract was signed. This last risk is generated by the other risk categories (technological, contractual, industrial and direct financial).

The application of the first two hypotheses is presented in the table 1. The 3$^{rd}$ hypothesis is not introduced in this table since its application resorts to a DPA's discretionary decision. The latter cannot be regarded as a general result, while the purpose of this table is to present general implications of the PAT hypotheses on risk allocation in the defense procurement sector.

**Table 1: application of the PAT's hypotheses on risk allocation**

The five risk categories are represented in this table (column 1). For each of them, some of their potential sources are highlighted (column 2). The theoretical hypotheses are applied on these specific sources of risks, not on categories of risks. For each source of risks, I point out

the effect of hypothesis 1 first (column 3). When risks are not under the control of any of the partners, this hypothesis does not apply. Then, I focus on the impact of hypothesis 2 on risk allocation (column 4). The last column of table 1 combines columns 3 and 4 by specifying the risk allocation deduced from the PAT.

In this table, the word "depends" refers to specific circumstances of the implementation of transactions. It indicates that it is not possible to draw an ex-ante general result through the application of the first hypothesis. The "NR" means "not relevant". It indicates that hypothesis 1 is useless in determining the risk allocation, regardless of the precise transaction conditions. These origins are exogenous.

The asterisk indicates that a problem of endogeneity exists concerning the source of the risk. The source of these risks are mainly controlled by one partner but the second transaction party also has an influence (technophile bias), or can influence it (reaching the technological state of the art) or should be able to influence it (obsolescence). This endogeneity leads to the necessity of precisely analyzing each specific procurement case so as to determine the risk allocation.

This table shows that the application of the theoretical propositions induces an equilibrated risk sharing between transaction partners. Each of them is expected to support the financial consequences of the risks and any of them may bear most of the risks. No transaction partner will support entirely the financial consequences of a risk category. This equilibrated risk sharing comes from using strict decision rules (hypotheses) based on a diversified factor (the source of risks). The following section is devoted to the test of the theoretical hypotheses.


**2.2 Testing the theoretical hypotheses**

I proceed with a test of the theoretical hypotheses by comparing them with factual observations. For this purpose, I first present the data used, then the statistical results followed by the econometric regressions.

### A. The data

I constructed an original data base composed of 51 defense procurement contracts signed by the French DPA. The latter represents all defense systems and all possible contract objects (research, production, maintenance and global contracts). For each of these contracts, I collected the text of the reference contracts, their supplemental agreements, and addressed questionnaires to the persons responsible for the given contracts within the French DPA. The objective of this questionnaire was to assess the overall performance and to collect information on risks that occur during the implementation of contracts and on the way risks have been allocated. Generally, my goal was to understand what happened in these contracts and the role the contractual terms played in the implementation of these contracts.

This questionnaire was composed of 364 variables. Two kinds of data were collected. First, information on the contract object, the respondent and the overall contract performance: price, notification and end-date years, attribution process, confidence degree in the contractor abilities, cooperation of different contractors, cooperation of different buyers, the contract object (research, production, maintenance, global), type of equipment (plane, missile, vehicle,…), respondent's name and overall contract performance (price overrun, cost overrun, technical maladaptation and delays). Second, for each risk category that occurred during the implementation of the contract, the following information was asked: anticipated probability of risk occurrence, the sources of risks in this contract (a list of potential sources was submitted, which explains the large number of variables), the most critical source of risk (i.e.

the most important in the explanation of the risk occurrence), responsibilities for these risks, the impacts and importance of the risk category occurrence (in terms of cost overrun, technical maladaptation, delays, and an overall qualitative indicator) and eventually risk allocation decisions.

I checked the 51 answers collected using a qualitative analysis completed by systematic phone interviews with respondents. The combination of questionnaire answers and interviews led to a precise understanding of all case studies. Of the entire database, I rejected 3 answers for validity or reliability reasons. Thus, 48 questionnaires were selected. The following descriptive statistics concern these 48 cases.

The contracts were signed between 1994 and 2005 (with the average in 2002) and come to an end between 2000 and 2013 (with the average in 2007). The average price of contracts was € 134.7 million. The mean cost overrun was € 6.03 million, which represents 4.48% of the mean contract price. In these 48 contracts, 133 risks occurred. The financial consequences of those risks were supported either by the DPA, or by the contractor or by both transaction partners[4].

Testing the theoretical hypotheses on risk allocation implies a verification of the relationship between the responsibility of the sources of the risks and the decisions for risk allocation. For this purpose, I coded each source of occurred risk according to the responsibility group it belongs to: DPA, contractor (and subcontractors), responsibility shared by both transaction partners, department of defense[5] (government furnished equipment in particular), contractor

---

[4] The DPA supported the financial consequences of these risks in 28.57% of cases, the contractor(s) in 44.36% of cases, while both partners supported risks in 27.07% of cases (50-50 most of time). This result differs from Florens & Naffrichoux (1992)'s. Their analysis of cost overrun allocation in the civil aerospace industry pointed out that the public buyer supported 80% of cost overruns suggesting that cost plus contracts prevail in this sector. The situation seems to be different in the defense procurement sector.

[5] Contingencies included within this group are all events caused by partners belonging to the department of defense: the DPA (but not exclusively), the armed forces (they deliver most of the government furnished equipment) and the public try centers. This is a hybrid category, between sole DPA responsibility and the exogenous events (exterior to both transaction partners).

and exogenous forces (obsolescence for instance), all possible factors (DPA, contractor and exogenous) and last, exogenous factors (i.e. events that cannot be controlled by any partner: natural hazards, import ban of intermediary consumptions, department of Treasury's decisions for instance). I proceed to the test of the theoretical hypotheses by presenting dynamic crossed tables.

### B. Dynamic crossed tables

In table 2, I emphasize the role of the responsibility for the events causing the risk occurrence in the explanation of risk allocation decisions. Comments follow.

**Table 2: the responsibility of the events causing risks and risk allocation decisions**

The table can be read by line and by column as follows: out of the 133 risks that occurred, 38 risks are supported by the DPA. For these 38 risks, the sources of events causing the risk occurrence are the responsibility of the DPA in 10 cases. 26.32% of risks supported by the DPA are caused by the DPA (reading by line). In addition, 90.91% of risks caused by the DPA are supported by the DPA (reading by column). The remaining risks caused by the DPA are supported by the contractor (in 9.09% of cases). 30.83% of the 133 risks emerged because of the ministry of defense's actions during the contract life.

Comments are focused successively on the different hypotheses. When the DPA is responsible for the events explaining the risk occurrence, it supports the financial consequences of these risks in 90.91% of cases. Symmetrically, 100% of risks exclusively

caused by the contractor are supported by the contractor. Hypothesis 1 is not rejected in table 2. Therefore, the incentives to perform are expected to be high for both transaction partners.

In addition, when all risk sources are exogenous forces, the contractor supports the financial consequences of these risks in 50% of cases, whereas the DPA supports them only in 25% of cases and both partners are charged in the remaining 25% of cases. Furthermore, the contractor supports 9.09% of risks caused by the DPA, 20% of risks emerged because of both the DPA and the contractor's actions, 24.4% of risks emerged from the department of defense's behavior, 72.22% of risks caused both by the contractor and exogenous forces, and 21.74% of risks explained by all possible factors. Although, these observations can be explained by several factors (DPA opportunism, the occasional low level of the financial consequences of risks and/or the fixed price contract), the following conclusion prevails in table 2: the contractors support financial consequences of events that are clearly beyond its control. From a theoretical perspective, I can conclude that hypothesis 2 is rejected in the French defense procurement sector. Therefore, contractors are expected to introduce a risk premium in the defense procurement contracts to cover potential cost overruns in case events that they are not able to control were to emerge ex-post, which causes an increase in the procurement price. The biding participation constraint justifies such a behavior. Thus, the DPA is expected to pay more in all defense procurement contracts as compared to a situation in which the risk allocation policy would have been closer to the PAT hypotheses.

Table 2 also shows that shared responsibilities lead to shared risk allocations, 50-50 most of time. 70% of risks caused by both transaction partners are jointly supported by the DPA and the contractor, while 65.22% of risks caused by all factors are also shared. Thus, hypothesis 3 is not rejected in the French defense procurement sector. However, the interviews with the DPA managers, responsible for the implementation of the procurement contracts, reveal that the motivation for such practices relies on the responsibility principle: the DPA managers

attempt to render the transaction partners responsible for the financial consequences of their actions. The industrial policy objective, sustaining the defense industrial base, is not taken into account in the risk allocation decisions.

In summary, statistical results show that hypotheses 1 and 3 are not rejected in the French defense procurement sector. The motivation for risk allocation decisions relies on the responsibility principle. The industrial policy objective, sustaining the defense industrial base, is not an explanatory factor of the risk allocation decisions. Also, hypothesis 2 is rejected, which is likely to justify the introduction of a risk premium in the contract price, causing an increase in the procurement price.

## 3. MANAGERIAL IMPLICATIONS

The results presented in the last section suggest that a change in risk allocation practices would be a bridge for performance improvement of defense procurement contracts, through the reduction in the risk premium introduced by contractors in the reference price contract. The purposes of the section 3 are to emphasize application conditions of the theoretical hypotheses (section 3.1), to point out the existence of exceptions in their applications (section 3.2) and to suggest a contractual strategy to design risk allocation clauses in practice (section 3.3).

### 3.1 Application conditions of the theoretical hypotheses

As stipulated previously, risk allocation decisions are important since they directly determine the implementation conditions of the procurement contract. Modifying the risk allocation practices implies to analyze the other factors influencing these implementation conditions,

mainly here the contract price. I also expect that the assumptions enounced by the Principal-Agent framework be taken into account. The following four application conditions result from such an analysis.

The first condition is a strict correlation between the risk allocation and the procurement price. If the DPA is due to support a risk, the price paid by the contractor is expected to be reduced compared to a transaction in which the contractor was due to support this risk, all things being equal. During the negotiation of the contract, the DPA is expected to demand a price reduction if it supports risks that were previously supported by the contractor.

The second application condition relies in the necessity to avoid a too large uncertainty on the DPA's procurement price. Indeed, the administrative procurement process demands the DPA to determine a certain budget for each contract. It is difficult to get more money ex-post than expected. Thus, the DPA needs to minimize the uncertainty on the price it pays. On the other hand, if the DPA is due to support risks (in line with the theoretical hypotheses), then an uncertainty on the procurement price emerges. This contradiction can be solved by using responsibility limitation clauses. Such clauses define the limit until which a partner is due to support the financial consequences of risks. The cost overrun that goes beyond this limit can either be supported by the other partner or be externalized to an insurer for instance. Thus, I expect that the application of the theoretical hypotheses is allied to DPA's responsibility limitation clauses.

The third application condition of the risk allocation hypotheses is the stability of the risk allocation during the contract implementation. Principal – Agent theoreticians stipulate that contract should not be renegotiated ex-post and parties should not anticipate such a change (Laffont & Martimort, 2002). Otherwise, the incentive effect of contractual clauses is cancelled. Therefore, the DPA is expected to credibly commit itself not to renegotiate the risk

allocation defined in the reference contract. If a party is due to support a risk, as stated in the reference contract, then it should really bear the risk ex-post in case this risk occurs.

A fourth application condition relies in the DPA's ability to objectively identify the precise sources of risks and to precisely evaluate their financial impacts, since the theoretical hypotheses enounced by the PAT are based on the sources of risks. The information asymmetry in favor of the contractor is the main factor preventing the DPA to realize such an identification and assessment. Although the problem of information asymmetry appears not to be a crucial matter in risk allocation decisions in the French defense procurement sector, the DPA is nonetheless expected to pay attention to the contractor's potential opportunism coming from the information asymmetry[6]. The following figure emphasizes the analytical steps of the risk allocation determination in practice. The information asymmetry matter leads to one of them.

---

**Figure 1. The analytical steps of the risk allocation determination in practice**

---

The first question I expect to be asked is whether the event(s) causing the risk can be controlled by one of the transaction partners. If this event is exogenous to the relation, then the DPA is expected to support its financial consequences for reasons explained previously. On the other hand, if this event is endogenous, then a second question prevails: Does the contractor control this event? If yes, then the contractor is expected to support its financial consequences. If no, the DPA is likely to support them. Afterwhile, comes the third question:

---

[6] As a matter of fact, when the contract comes to an end, the DPA's managers (responsible for the implementation of procurement contracts) are aware of the sources of the risks and their financial impacts. The reason why the information asymmetry is not so wide in practice relies in the features of the defense procurement sector: complex process implying a large and regular information-sharing between the transaction partners. As a consequence, the partners are able to appreciate the consistency and reliability of information they receive. On the other hand, the DPA's managers do not know the financial impact of risks whose responsibility belongs to the contractor, when the latter supports these consequences. Indeed, the DPA's knowledge on the contractor's production costs is perfectible. Thus, the information asymmetry cannot be utterly overlooked in the French defense procurement sector.

has the DPA the ability to objectively observe the source(s) of the risk and to assess its financial consequences? I suggest that the DPA follows a wise decision rule: if the DPA's manager is not sure on either the source of the risk or its financial consequences, then it is expected to transfer the risk to the contractor. Thus, in case of established information asymmetry, I expect that the contractor supports the financial consequences of the risk. Such a decision rule is likely to favor the information-sharing during the contract implementation, which reduces the information asymmetry, all things being equal.

## 3.2 The exceptions to the rules

The theoretical hypotheses enounced by the PAT are not intended to be applied to all transactions in the defense procurement sector. As a matter of fact, I note two exceptions in their applications. These exceptions are focused on the transactions in which the DPA absolutely needs a perfect realization of both technical performance and calendar objectives.

The first case concerns nuclear equipments. A failure in the quality of the equipment would have uncountable social and political consequences for obvious reasons. These consequences would be much higher than the procurement price of the contract. The second case in which the DPA demands a strict realization of the technical and calendar objectives is when the equipment procured is destined to be introduced within a larger defense system. If the equipment is late or procured with a different specification as expected, then the cost overrun for the DPA could be much higher than the value of the procurement contract.

In these two cases, the non realization of the transaction (technical or calendar) objectives would impose the DPA cost overruns that are much higher than the procurement price. The DPA is very dependent on the contractor concerning the realization of the technical and calendar objectives. From a theoretical point of view, these remarks can be linked to the

concept of probity enounced by Williamson, 1999. Through this concept, Williamson emphasizes the specificity of some extreme transactions including sovereign tasks: "foreign affairs, the military, foreign intelligence, managing the money supply, and, possibly, the judiciary" (1999: 321). The author adds that "What distinguishes probity transactions are their needs for loyalty (to the leadership and to the mission) and process integrity" (1999: 324). In such transactions, the DPA needs a large confidence and professional excellence from the contractor.

The contractual implications caused by "probity transactions" are as follows: the DPA cannot demand the contractor too much on the procurement price. Indeed, in these specific transactions, the DPA is not credible in demanding high incentives to perform since the DPA is constrained to pay for cost overrun in case they occur. Otherwise, the contractor could decide to breach the contract by putting forward technical impossibilities for instance. As Williamson stipulates "Because breach of contract/lapse of probity can place the system at risk, probity represents a condition of contractual hazard the mitigation of which cannot be realized through pecuniary penalty" (1999: 324). As a consequence, the fixed price contract does not make sense in such transactions. In the same vein, the DPA cannot credibly commit to transfer risks to the contractor. As soon as the outsourcing decision has been taken, the cost-plus contract seems to prevail in "probity transactions".

## 3.3 The design of risk allocation contractual clauses in practice

The previous developments presented in this article point out theoretical hypotheses on risk allocation, their application conditions and two exception cases. The purpose of this last section is to emphasize a design of risk allocation contractual clauses in practice. I suggest the following two propositions in that perspective.

**Proposition 1: if, ex-ante, a risk source clearly resorts to one partner (regardless the ex-post implementation conditions), then his responsibility is expected to be clearly written in the reference contract.**

The purpose of the first proposition is to establish clear responsibilities during the contract implementation. I expect the renegotiation costs be minimized this manner. However, the contingencies corresponding to this proposition are far from representing all possible contingencies in the defense procurement sector. Indeed, the procurement process is complex, implies the participation of different actors (the contractor, the DPA, the department of defense and the department of finance) and is often a long term process. Thus, it may be impossible to attribute ex-ante clear responsibilities regardless the ex-post contingencies. That is why I suggest the following proposition to make the contract complete as far as the risk allocation is concerned.

**Proposition 2: if a responsibility cannot be clearly ex-ante determined, then the risk allocation rules that will be used ex-post are expected to be defined in the reference contract.**

Proposition 2 suggests the introduction of a default rule in the procurement contract. Such a rule stipulates the decision rules that are expected to be followed when any other clause indicates the behavior to undertake. For instance, I expect that the hypotheses 1 and 2 are written in the reference contract, as default rules.

**CONCLUSION**

In this paper, I began by pointing out the Principal-Agent hypotheses on risk allocation and their theoretical foundations. These hypotheses are derived from the propositions on the choice of contract type and are supposed to be applied on specific contractual clauses, exclusively devoted to the determination of the risk allocation, within a (non pure) fixed price contract.

The first hypothesis, explained by the incentive constraint within the optimization program, stipulates that if a source of risk is under the exclusive control of one partner, then this partner is expected to support the financial consequences of that risk. Its application is likely to exploit the transaction partners' relative abilities to control risks. The second hypothesis is as follows: if a source of risk is not under the control of any of the partners, then the Principal is expected to support that risk. The origin of this hypothesis is the participation constraint. The objective here is to attempt to exploit the risk-bearing cost differential between partners. By relaxing the symmetric information assumption, the third hypothesis reveals the following decision rule: if a source of risk is either blurred or shared by both partners, then the Principal may decide to support that risk. The motivation for such a hypothesis relies on the necessity of developing the Agent in order to respond to the Principal's autonomy constraint. Whereas the first two hypotheses are common to all economic sectors, the third hypothesis is specific to defense procurement (and other sectors aware of the autonomy constraint).

These theoretical hypotheses have been applied to the defense procurement sector. This application opened the opportunity to compare the theoretical hypotheses to factual observations. In order to proceed with a testing of these hypotheses, I constructed an original database composed of 48 French defense procurement contracts. A statistics analysis provided several results.

First, hypothesis 1 is not rejected in the French defense procurement sector. Thus, the incentives to perform are expected to be strong for both transaction partners, although in some cases, the defense procurement agency managed to transfer part of its responsibility to the contractor. Second, hypothesis 2 is rejected in the data analyzed. The contractor supports financial consequences caused by events that are beyond his control, the result being that the contractor is expected to introduce a risk premium in the reference price contract to cover such contingencies. Thus, a higher structural price can be expected because of the risk allocation practices in the French defense procurement sector, revealing that a change in these practices is necessary. Third, hypothesis 3 appears not be rejected in this sector. However, the motivations behind the risk allocation decisions, when the responsibility is shared, rely on the responsibility principle rather than the desire to develop the defense industrial base. This objective is not taken into account in risk allocation decisions in the French defense procurement sector.

These results call for a change in the risk allocation practices in the French defense procurement sector. The section 3 addressed the managerial implications of these developments. I pointed out four application conditions. The latter suggest completing the theoretical hypothesis with contractual safeguards, mainly DPA's responsibility limitation clauses and a strong commitment not to renegotiate risk allocation decisions ex-post. I also emphasized the information asymmetry matter and three analytical steps to follow to determine risk allocation in practice. In addition, I identified two exceptions in which the theoretical hypotheses are not expected to apply. These two cases refer to the concept of "probity transactions" enounced by Williamson, 1999. Eventually, I suggested two propositions to design risk allocation clauses in practice, aiming at making the procurement contract complete as far as risk allocation is concerned.

# REFERENCES

Allen, D.W., & Lueck, D. 2001. The Role of Risk in Contract Choice. **Journal of Law, Economics & Organization**, 15(3): 704-736.

Arrow, K.J. 1970. **Essays in the Theory of Risk-Bearing**. Amsterdam: North-Holland.

Barney, J.B., & Hesterly, W. 1996. Organizational Economics: Understanding the Relationship between Organizations and Economic Analysis. In S.R. Clegg, C. Hardy & W.R. Nord (Eds.), **Handbook of Organization Studies:** 115-47. London, Sage.

Bellais R., & Guichard R. 2006. Defense innovation, Technology Transfers and Public Policy. **Defence and Peace Economics**, 17(3): 273-286.

Cheung, S.N.S. 1969. Transaction Costs, Risk Aversion and the Choice of Contractual Arrangements. **Journal of Law and Economics**, 12: 23-42.

Domberger, S. 1998. **The Contracting Organization. A Strategic Guide to Outsourcing**. Oxford: Oxford University Press.

Dunne, J.P. 1995. The Defense Industrial Base. In K. Hartley & T. Sandler (Eds.), **Handbook of Defense Economics**, vol. 1: 399-430.

Eisenhardt, K.M. 1989. Agency Theory: An Assessment and Review. **The Academy of Management Review**, 14(1): 57-74.

European commission, general direction for the regional policy. March 2003. **Guidelines for Successful Public Private Partnerships**.

Florens, J-P., & Naffrichoux, N. 1992. Estimation du taux de partage des risques dans les contrats Etat - industries spatiales. **Revue Economique**, 43(5): 851-869.

Gerardin, E., & Stefanello, E., 2005. **Le pilotage des grands projets par les risques**. Paris: Botega.

Glaister, S. 1999. Past Abuses and Future Uses of Private Finance and Public Private Partnerships in Transport. **Public Money & Management**, 19(3): 29-36.

Guasch, J. L. 2004. **Granting and Negotiating Infrastructure Concessions. Doing it Right.** Washington: World Bank Institute, Development Studies.

Harris, M., & Raviv, A. 1978. Some Results on Incentive Contracts with Applications to Education and Employment, Health Insurance and Law Enforcement. **The American Economic Review**, 68(1): 20-30.

Hart, O., & Holmström, B. 1987. The Theory of Contracts. In T.F. Bewley, **Advances in Economic Theory, Fifth World Congress**: 71-155. Cambridge: Cambridge University Press.

Holmström, B., & Milgrom, P. 1991. Multitask Principal-Agent Analyses: Incentive Contracts, Asset Ownership and Job Design. **Journal of Law, Economics & Organization**, 7, special issue: 24-52.

Hood, J., & MacGarvey, N. 2002. Managing the Risks of Public-Private Partnerships in Scottish Local Government, **Policy Studies**, 23(1): 21-35.

Kirat, T. 2003. L'allocation des risques dans les contrats: de l'économie des contrats 'incomplets' à la pratique des contrats administratifs. **Revue internationale de droit économique**, 17(1): 11-46.

Klein, M. 1998. **Bidding for Concessions**. Washington: The World Bank.

Knight, F.H. 1921. **Risk, Uncertainty and Profit.** Chicago: University of Chicago Press.

Laffont, J-J., & Martimort, D. 2002. **The Theory of Incentives. The Principal – Agent Model**. Princeton: Princeton University Press.

Laffont, J-J., & Tirole, J. 1993. **A Theory of Incentives in Procurement and Regulation**. Cambridge: the MIT Press.

Lewis, M.K. 2001. **Risk Management in Public-Private Partnerships**. Discussion paper n°12, Center for Globalization and Europeanization of the Economy, University of Gôttingen.

Lyons, B.R. 1996. Empirical Relevance of Efficient Contract Theory: Inter-Firm Contracts. **Oxford Review of Economic Policy**, 12(4): 27-52.

March, J.G., & Shapira, Z. 1987. Managerial Perspectives on Risk and Risk Taking. **Management Science**, 33(11): 1404-1418.

Martimort, D., & Sand-Zantman, W. 2005. **Signaling and the Design of Delegated Management Contracts for Public Utilities**. Working paper n°289, University of Toulouse: IDEI.

Medda, F. 2004. **The Allocation of Political and Regulatory Risks in Public Private Partnerships**. Working paper, London: University College.

Olsen, T.E., & Osmundsen, P. 2005. Sharing of Endogenous Risk in Construction. **Journal of Economic Behavior & Organization**, 58(4): 511-526.

Oudot, J-M. 2003. **Evaluation de la politique publique de soutien aux exportations d'armements. Le cas américain.** University of Paris I, master dissertation.

Oudot, J-M. 2006. **Risks in the Defense Procurement Process: A Measure**. Working paper, University of Paris I: centre ATOM.

Skromme-Baird, I, & Thomas, H. 1985. Toward a Contingency Model of Strategic Risk-Taking. **Academy of Management Review**, 10(2): 230-243.

Stiglitz, J.E. 1974. Incentives and Risk Sharing in Sharecropping. **Review of Economic Studies**, 41(2): 219-255.

Tirole, J. 1999. Concessions, concurrence et incitations. **Revue d'économie financière**, 51: 79-92.

Williamson, O.E 1999. Public and Private Bureaucracies: A Transaction Cost Economics Perspective. **Journal of Law, Economics and Organization**, 15(1): 306-342.

Wilson, R. 1968. The Theory of Syndicates. **Econometrica**, 36(1): 119-132.

# TABLES

| RISK CATEGORY | SOURCES OF RISKS | HYP. 1 APPLICATION | HYP. 2 APPLICATION | RISK ALLOCATION INDUCED BY THE PAT |
|---|---|---|---|---|
| **Techno-logical** | Reaching the tec. state of the art level | NR∗ | DPA | DPA |
| | Technophile bias | DPA∗ | | DPA |
| | Obsolescence | Contractor* | | Contractor |
| | Appearance of new tec. innovations | NR∗ | DPA | DPA |
| | Interface | Depends∗ | | Depends |
| | Non mastering technology | Contractor | | Contractor |
| **Contractual** | | | | |
| | Contractor's opportunism | Contractor | | Contractor |
| | Buyer's opportunism | DPA | | DPA |
| | Human factors within the DPA | DPA | | DPA |
| | Inconsistent demand | DPA | | DPA |
| | Demand modification | Depends | | Depends |
| | Government's entries | DPA | | DPA |
| | Budget constraint | NR | DPA | DPA |
| | Contract mal adaptation | Depends | | Depends |
| **Industrial** | | | | |
| | Contractor's failure | Contractor | | Contractor |
| | Subcontractor's failure (insufficient tec. abilities) | Contractor | | Contractor |
| | Lack of coordination | Depends | | Depends |
| **Direct financial** | | | | |
| | Political factors | NR | DPA | DPA |
| | DPA's procurement strategy | DPA | | DPA |
| | Contractor's opportunism | Contractor | | Contractor |
| | Buyer's opportunism | DPA | | DPA |
| | Change in inflation rate | NR | DPA | DPA |
| | Change in exchange rate | NR | DPA | DPA |
| **Calendar** | | | | |
| | Technological risk | Depends | | Depends |
| | Contractual risk | Depends | | Depends |
| | Industrial risk | Depends | | Depends |
| | Direct financial risk | Depends | | Depends |
| | Acquisition strategy | DPA | | DPA |
| | DPA's human factors | DPA | | DPA |

**Table 1: application of the PAT's hypotheses on risk allocation**

| RISK BEARER | | RESPONSIBILITY OF EVENTS CAUSING RISK OCCURRENCES | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | | DPA | Contractor | DPA & contractor | Depart. of defense | Contractor & exogenous | All | Exoge nous | Total |
| DPA | Nb. of obs. | **10** | 0 | 1 | 23 | 0 | 3 | 1 | **38** |
| | Line % | **26.32** | 0 | 2.63 | 60.53 | 0 | 7.89 | 2.63 | 100 |
| | Col. % | **90.91** | 0 | 10 | 56.1 | 0 | 13.04 | **25** | -- |
| | | | | | | | | | |
| DPA & CONTRAC TOR | Nb. of obs. | 0 | 0 | 7 | 8 | 5 | 15 | 1 | 36 |
| | Line % | 0 | 0 | 19.44 | 22.22 | 13.89 | 41.67 | 2.78 | 100 |
| | Col. % | 0 | 0 | **70** | 19.51 | 27.78 | **65.22** | 25 | -- |
| | | | | | | | | | |
| CONTRAC TOR | Nb. of obs. | 1 | 26 | 2 | 10 | 13 | 5 | 2 | 59 |
| | Line % | 1.69 | 44.07 | 3.39 | 16.95 | 22.03 | 8.47 | 3.39 | 100 |
| | Col. % | **9.09** | **100** | **20** | **24.4** | **72.22** | **21.74** | **50** | -- |
| | | | | | | | | | |
| TOTAL | Nb. of obs. | 11 | 26 | 10 | 41 | 18 | 23 | 4 | **133** |
| | Line % | 8.27 | 19.55 | 7.52 | **30.83** | 13.53 | 17.29 | 3.01 | 100 |
| | Col. % | 100 | 100 | 100 | 100 | 100 | 100 | 100 | -- |

**Table 2: the responsibility of the events causing risks and risk allocation decisions**

**FIGURE**

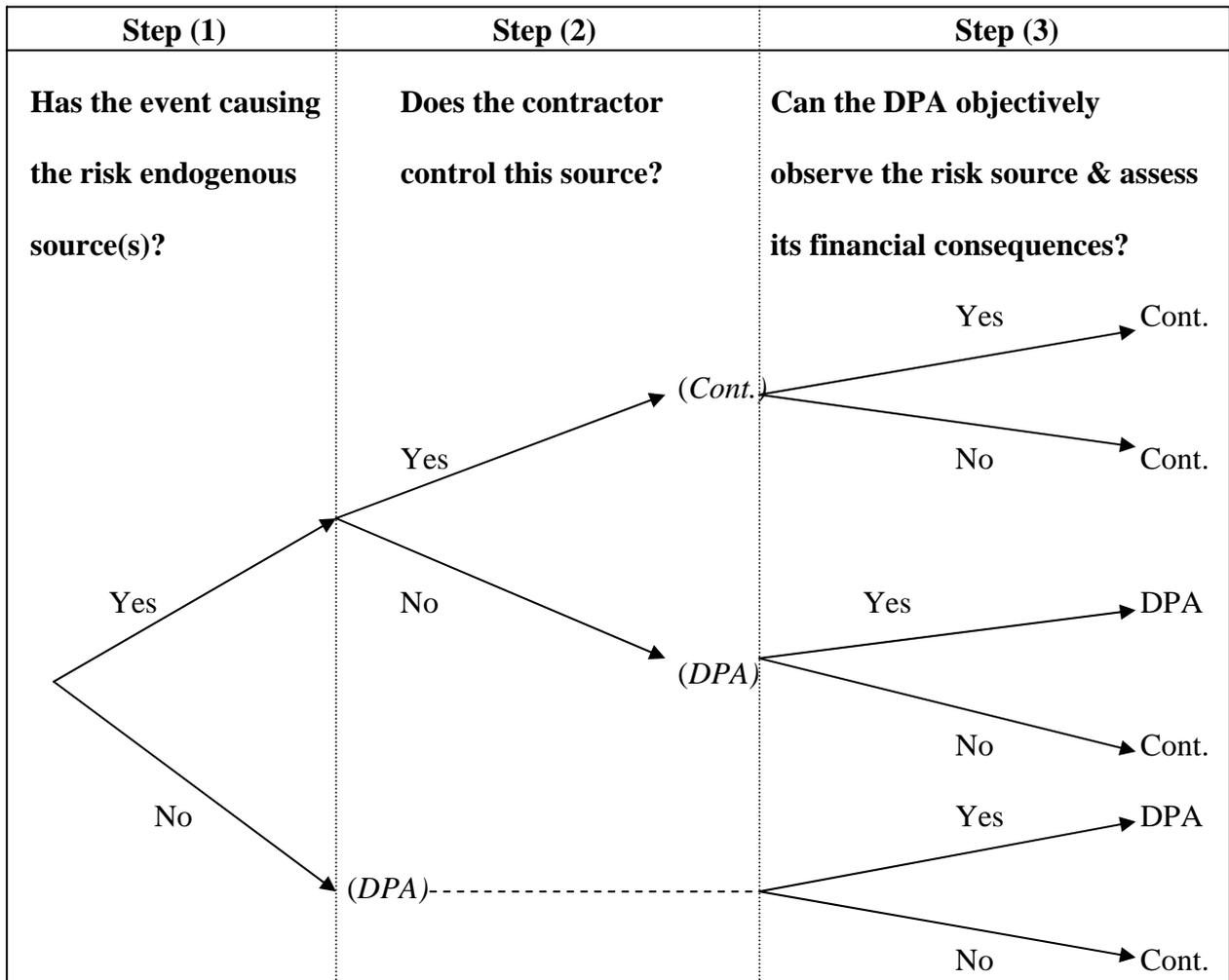| Step (1) | Step (2) | Step (3) |
|---|---|---|
| **Has the event causing the risk endogenous source(s)?** | **Does the contractor control this source?** | **Can the DPA objectively observe the risk source & assess its financial consequences?** |



**Figure 1. The analytical steps of the risk allocation determination in practice**