

**RISK-ALLOCATION: THEORETICAL AND EMPIRICAL EVIDENCES. Application to Public-Private Partnerships in the defence sector.**

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**Abstract.**

Using a Principal – Agent framework, we start by pointing out two normative risk allocation criteria. We show that the risk allocation criteria come from the incentive and participation constraints within the maximization program. The first criterion is expressed as follows: risk should be allocated to the partner best able to manage it. The second criterion stipulates that risk should be allocated to the least risk-bearing cost partner. A third constraint is introduced to complete the theoretical criteria: The procurement autonomy. We deduct from it a third criterion: the Principal can support some risks in order to support the Agent's development. The underlying economic mechanisms of risk allocation are presented.

The second part of this article is dedicated to the application case. We first aim to apply the theoretical propositions to the case of the public-private partnerships in the French defence procurement sector. To that purpose, we extend the theoretical propositions and enounce three application propositions. We base our analysis on a large qualitative risk assessment recently realised in this sector in France. Then, we compare the theoretical risk allocation to what is envisaged in the French defence procurement sector for public – private partnerships and to the current practices in public market contracts.

## **Introduction.**

As soon as the period during which the contract is signed and enforced is different, risks<sup>1</sup> exist in the transaction. At the same time, risk-allocation is an important factor to take into account in the explanation of the procurement contract performance (Private Finance Treasury Taskforce [1997] p.9; European Commission [March 2003] p.55) and in the understanding of the transactions undertaken (Gollier [1991] p.4). Then, how to allocate risks between partners in order to favour efficiency? We tackle this question in this article.

Despite the importance of this question, the allocation criteria are sometimes unknown. In this case, authors use general risk allocation criteria such as “appropriate risk transfer” (Grimsey & Lewis [2004]) or “risk should be allocated to the party that is best placed to manage it at the least cost” (European commission [March 2003] p.50; Hood & MacGarvey [2002] p.26<sup>2</sup>). The latter quotation expresses a general target (the cost minimisation) but does not precise the means to reach it. Sometimes, only one -out of the two theoretical criteria- is acknowledged and applied (by the French ministry of the economy for instance<sup>3</sup>). When the criteria are known, their theoretical origins are never detailed (Domberger [1998] p.125; Klein [1998] p.5; Medda [2004] p.2).

Besides, the full understanding of the risk allocation principles is fundamental to draw efficient recommendations as far as risk bearing is concerned. That is why we aim to precisely explain the theoretical foundations of the risk allocation criteria. To our knowledge, this is the first article doing so. Our purpose is to highlight the best practice(s) concerning the risk allocation. As opposed to Kirat [2003], March & Shapira [1987] and Skromme-Baird & Thomas [1985], we use a normative approach on risk bearing. We identify first what should be done (according to the economic theory) in order to maximise the partners’ joint profit. We concentrate our theoretical approach on the Principal-Agent theory for reasons explained in the first part of this paper.

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<sup>1</sup> We regard risk as being “any factor, event or influence that threatens the successful completion of a project in terms of time, cost or quality” (European Commission [March 2003] p.50).

Let us note that sharing (potential) costs is different from sharing (potential) gains. Indeed, the agents’ behaviour in face of costs and in face of gains differs (Wiseman & Gomez-Mejia [1998] p.136-7). However, the optimal solutions to share risks are the same in both cases (Polinsky [1983]).

<sup>2</sup> These authors precise that “risk transfer is, at best, a very unclear and poorly understood concept and, at worst, weighted in favour of the private sector” (p.26).

<sup>3</sup> Its position is expressed in the web site : <http://www.ppp.minefi.gouv.fr>

Once the theoretical propositions are clearly presented, we apply these results to the case of public-private partnership<sup>4</sup> (PPP) contracts in the defence procurement sector. This application case is justified by the fact that the stakes behind the risk allocation are particularly important in such contracts and sector. PPP has been first regarded as a mean to transfer all risks to the private partner. This induced the operators to increase prices. One example is the Herkules contract in Germany negotiated between EADS and the German ministry of defence in 2004. Negotiations failed because of an excessive risk transfer towards the consortium of firms. Risk transfer is often regarded as being at the heart of an effective PPP design (Grimsey & Lewis [2004] p.97). That is why we apply our research on risk allocation to the case of PPP contracts.

To do so, we extend the Principal – Agent theory criteria by enouncing application propositions. Besides, we base our work on a large risk assessment in the French defence procurement sector (Oudot [2005]) realised with the collaboration of both the defence firms and the French ministry of defence. Then, we compare the risk allocation proposed by the Principal – Agent theory to what is envisaged in the PPP in the defence procurement and to the current practices in public market contracts in France. We base this part on the propositions enounced by the French ministry of the economy, the French ministry of defence and on procurement contracts signed between the general delegation to the armament (the French defence procurement agency) and defence firms. This comparison enables us to assess the feasible potential improvements in the defence procurement process.

## **1. The Principal – Agent theory propositions on risk-allocation**

Among the various theoretical literatures dealing with risk allocation (Law & Economics, the economic theory of insurance, the Principal – Agent theory), we use here the Principal – Agent framework. The main reason is the specific nature of risks existing in the defence sector. Most of these risks are uninsurable. Indeed, the probability of risk materialization

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<sup>4</sup> A PPP arrangement is specified by three main specificities. First, it is a global contract. It aims to assure the conception, realisation, exploitation, and the maintenance of services to the public sector. Second, this administrative contract links a public administration to a private partner. Third, the public administration (or the user) pays when the service is delivered, according to performance criteria specified in the reference contract. The contract duration of such an arrangement is often long (25-30 years) because of the amount of specific assets in the defence sector. Several types of PPP contracts exist: BOT (build, operate, transfer: a private firm finances, operates, and transfers a service to the public sector), BLT (Build, Lease, Transfer: the private sector build, finance and the public sector operates the service), BOO (Build, Own, Transfer), DBFO (design, build, finance, operate) mainly.

directly depends on the partners' behaviour<sup>5</sup>. Consequently, the risk allocation should be treated within the transaction. A third partner is not usable to spread the risk. Therefore, the economic theory of insurance is not as central in our topic as it could be in other sectors. To analyse such a bilateral relation, we choose to use contract theories. Among these theories, the Principal – Agent Theory (PAT) deals the most with the risk allocation topic. That is why we concentrate on the PAT.

By modelling the relation between an informed person (the Agent) and an uninformed one (the Principal), the PAT highlights two problems rising from the information asymmetry: adverse selection and moral hazard. Both of them lead to higher risk in the realisation of the program outcome. The question is how to allocate efficiently these risks between partners<sup>6</sup> in the reference (complete) contract.

The target followed in the determination of risk allocation criteria is the total cost minimization. This must maximize the Principal's utility<sup>7</sup>. The analytical process followed by the PAT consists in maximising the Principal's utility subject to the Agent's participation and incentive constraints<sup>8</sup> (Hart & Holmström [1987] p.78; Laffont & Tirole [1993]). The respect of these two constraints must permit both partners to improve their situation, compared to a situation in which only one constraint would have been taken into account<sup>9</sup>. As Laffont & Martimort [2002] precise, "incentive and participation constraints define the set of incentive feasible allocations" (p.30). We show here that both risk allocation criteria enounced by the PAT come from these two constraints. Let us analyse these constraints one by one.

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<sup>5</sup> Moureau & Rivaud-Danset [2004] precise that for a risk to be insurable, it should respect the following conditions: risk should be assessable, this assessment should be observable by all partners, and risk should be independent of partners' actions (p.105).

<sup>6</sup> Let us note that we analyse the relation between a buyer and a seller. The risk should be allocated between these two partners. If we introduce within the analysis the existence of several co-contractors, then other solutions are possible to allocate risks, compared to the criteria presented latter on. In such a case, redistribution effects intervene between the different co-contractors.

<sup>7</sup> Let us note that this aim perfectly coincides with the situation in the defence procurement sector. Indeed, the government, one way or another eventually supports all production and transaction costs. The analysis of risk allocation is a device to reduce costs.

<sup>8</sup> In some articles, a third constraint is introduced: the liability constraint, as in Laffont et Martimort [2002] p.147 for instance.

<sup>9</sup> The Pareto criterion is applied in the PAT. As Wilson [1968] puts it: "our criterion for choosing a sharing rule is that it must be Pareto optimal" (p.123). A sharing rule is Pareto optimal if there is no alternative sharing rule that would increase the expected utility of some member(s) without decreasing the expected utility of any other member.

In the PAT framework, the Agent's effort is not observable<sup>10</sup>. At the same time, the Agent's behaviour is at the root of the performance. In order to assure a certain level of performance, the Principal should give the Agent incentives to perform. The incentive constraint should be tackled. The authors belonging to the PAT concentrate on the imposing of potential cost overruns on partners<sup>11</sup> as an incentive device. The payment the Agent receives from the Principal depends on his 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] p.79). The more risks materialize, the higher the costs, the less the performance, the less the Agent is paid. Incentive pay serves to allocate risks so as to motivate the Agent to perform. This rule comes from the principle of responsibility expressed by the PAT (in Holmström & Milgrom [1991] p.27 for instance). We draw a first conclusion from the PAT:

**First intermediary conclusion:** the risk should be allocated to the Agent to the extent he does manage the risk

Let us note one limit to this conclusion. Some PAT scholars highlight the existence of a trade-off between incentive and insurance. This is the case for instance of Cheung [1969], Holmström [1979] and Lyons [1996]. In the first conclusion, the incentive effect is the only dimension considered whereas the insurance dimension should also be taken into account, following the incentive-insurance trade-off. The Principal should support a part of the risk, even when the Agent controls its materialization. The underlying idea is to insure the Agent a certain amount of income. The origin of this trade-off is the Agent's participation constraint. However, the underlying idea behind the first conclusion remains unchanged.

More precisely, the Agent should support the risk it controls. Similarly, if the Principal is responsible for one kind of risk, the PAT would<sup>12</sup> suggest that the Principal should bear this risk. We deduct the first risk allocation criterion:

**Criterion 1: the risk should be allocated to the party best able to manage it.**

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<sup>10</sup> More precisely, the PAT presents two kinds of models: hidden action and hidden knowledge. We are here concerned with the hidden action models. Within these models, the action is specified as being not observable and/or not verifiable.

<sup>11</sup> One mean to allocate incentives to reduce costs is to choose adequately the contract type (cost-plus or price cap and their derivatives). That is why so many Principal-Agent articles dealt with the contract type choice (Arrow [1970]; Baron & Besanko [1987]; MacAfee & MacMillan [1986]; Weitzman [1980]). Let us also note that cost overrun is only a component of one risk category (the direct financial risk) out of five. We generalise the PAT proposition to the other risk categories.

<sup>12</sup> The PAT does not consider the case in which the Principal would have an impact on the performance. We extrapolate the result presented from the PAT's way of thinking.

By assigning incentive to control risks, such a risk allocation criterion must lead to a reduced probability of risk occurrence. Let us now analyse the second constraint in the maximization program: The participation constraint.

This constraint imposes the Principal to grant the Agent as much benefits as he would get in another relation, which is mainly determined by the market. The benefits are equal to the income minus the costs. The market determines the reserve income<sup>13</sup>. The other part of the Agent's benefit is explained by the costs he supports. According to the Principal-Agent theoreticians, the implementation cost reflects both the direct cost of work as well as the cost of risk-bearing (Holmström & Milgrom [1991] p.45). The PAT highlights the cost of risk bearing. As Eisenhardt [1989] states "Principal-Agent relationships should reflect efficient organization of information and risk-bearing costs" (p.59). Within this risk-bearing cost, PAT authors point out the importance of agents' attitudes towards risk<sup>14</sup> (Harris & Raviv [1978]). The higher the risk aversion, the more tight the participation constraint, the higher the risk-bearing cost. To assure the cost minimization, the Principal should minimize the risk-bearing cost. The agents' attitude towards risk should influence the contractual choices concerned with risk allocation. We deduct a second conclusion.

**Second intermediary conclusion:** risk should be allocated to the least risk averse partner in order to minimize the overall risk-bearing cost<sup>15</sup>.

In the Principal-Agent literature, the Agent is most of time supposed to be risk averse whereas the principal is supposed to be risk neutral<sup>16</sup>. Several authors justify this point. Arrow [1970] explains for instance that: "The government invests in a greater number of diverse projects and is able to pool risks to a much greater extent than private investors" (p.240). Wiseman & Gomez-Mejia [1998] add "Principals are considered risk neutral in their preferences for individual firm actions, since they can diversify their shareholdings across multiple firms.

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<sup>13</sup> As consequence, the price of the contract should be introduced in the analysis. The authors highlighting the incentive-insurance trade-off point out the necessity for the Agent to stabilize this income.

<sup>14</sup> "Agency Theory ... [is characterized] by its emphasis on the risk attitudes of principals and agents (Barney & Hesterly [1996] p.124). The Principal Agent literature hypothesizes either a risk aversion or neutrality in face of risk. Let us note that risk preferences are not analysed (Wiseman & Gomez-Mejia [1998] p.133-4).

<sup>15</sup> Consequently, the risk bearing cost and the magnitude of the materialised risk must be reduced.

<sup>16</sup> The reverse case is also analysed in order to highlight the results sensibility to the hypothesis. Chavas [2004] shows for instance that "when the Agent is risk neutral [like the Principal], it remains efficient to shift all the risk to the agent" (p.193).

Conversely, since agents employment security and income are inextricably tied to one firm, agents are assumed to exhibit risk aversion in decisions regarding the firm in order to lower risk to personal wealth” (p.133). Consequently, the government is presented as having a lower risk-bearing cost. Glaister [1999] does precise for instance that “Governments can bear some risks at less cost than the private sector because of their greater opportunities for risk spreading and risk pooling. This may be reflected in lower cost of borrowing for the public sector” (p.30). We draw a third conclusion.

**Third intermediary conclusion:** The Principal should support risk in order to minimize the overall risk-bearing cost.

A formalization of this PAT reasoning is the following:

$C = f(\text{Implementation, Risk Bearing})$ $+ \qquad \qquad +$ $RB = g(\text{Aversion Towards Risk})$ $+ \qquad \qquad +$ $ATR = h(\text{diversification ability})$ $- \qquad \qquad -$	<p>The PAT points successively out the importance of the risk bearing cost within the total cost, the aversion towards risk within the risk bearing cost, and the diversification ability within the aversion towards risk.</p>
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We draw from this reasoning the second risk allocation criterion:

**Criterion 2: the risk should be allocated to the least risk-bearing cost partner. The latter is the partner with the largest diversification ability.**

According to the PAT, this partner is the Principal.

At this stage of the analysis, we can note one functioning condition for these normative risk allocation criteria: They should be stable over time. If a party has to support a category of risk, as stated in the reference contract, then it should really bear the risk ex-post. Contract should not be modified ex-post and parties should not anticipate such a change (Agency theory result). Otherwise, the incentive effect is cancelled.

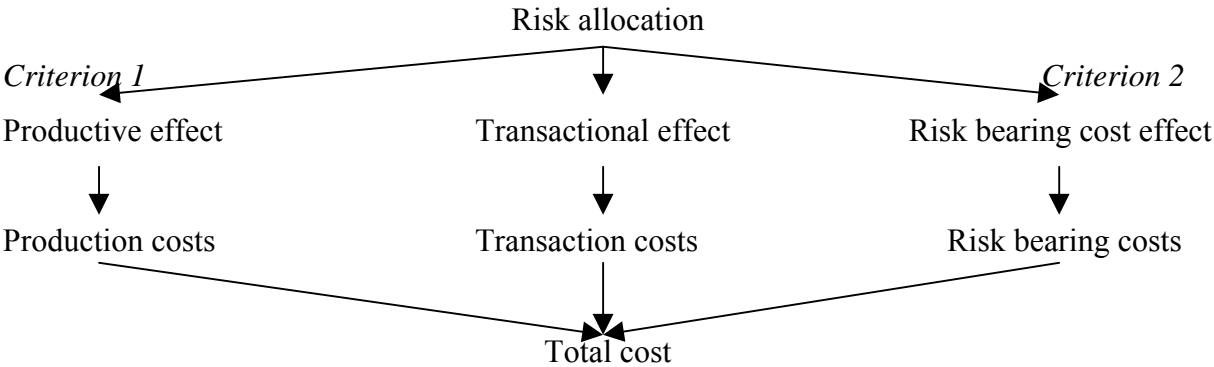
These two criteria are applicable to all economic sectors. They are not focused on the defence procurement at all. The latter sector is specific for one reason as far as the risk allocation is concerned. It permits the partners to introduce a third criterion. Indeed, the government follows two main targets in this sector. It aims to get weapon systems as cheap as possible (acquisition target). This target corresponds to the maximization program detailed by the PAT. Consequently, the two criteria enounced by the PAT participate to realize this aim. The government has an industrial policy purpose too: developing the national defence industrial

base<sup>17</sup> (DIB). This target is not taken into account in the PAT. From a theoretical point of view, the specificity of the procurement sector leads to the introduction of a third constraint in the maximization program. This constraint is the procurement autonomy. This constraint comes from the government’s goal to be independent as far as the armament procurement is concerned. This is justified by strategic and political reasons. The government does not want to make its political decisions dependent on other countries’ point of view. So as to fit the defence sector features, it is necessary to complete the theoretical propositions. One way to support the DIB is to bear risks. Therefore, the Principal may decide to support this risk as an industrial support decision. This is a discretionary decision that the Principal can take to support the Agent’s development. We draw a third criterion:

**Criterion 3: the Principal can support some risks in order to support the Agent’s development.**

The functioning condition is that such a criterion should not reduce the incentive effect initiated by the first criterion.

Now that the theoretical foundations of these criteria have been presented, let us point out the economic mechanisms illustrating these foundations. The following scheme permits us to point out the impact of the risk allocation on the contract performance<sup>18</sup>.



The impact of risk allocation on the program total cost can be justified by three effects: The productive effect, the transactional effect and the risk-bearing cost effect. The productive

<sup>17</sup> Dunne [1995] defines the DIB as being “a sector or groups of industries that are dependent to some degree on defense spending and upon which the state is dependent for some degree of self sufficiency in the production of the means of defense and war” (p.401).

<sup>18</sup> The contract performance is here regarded as the total cost of the project (following the PAT). We may consider other dimensions as the delay and the technical performance.

effect highlights the incentives to control risk (Triantis [2000] p.101). If contract terms make a partner to support the risk, he will try to avoid the risk. As a consequence, the probability of risk occurring will be lower, which directly and indirectly (through avoiding delays for instance) reduce the production costs. Theoreticians and practitioners commonly acknowledge the productive effect. The first criterion highlights and exploits this effect.

The transactional effect points out the transaction costs induced by the risk allocation. When a partner is due to support risks, he will try to introduce contractual and organizational guaranties to avoid their materializations. This effort leads to higher ex-ante transaction costs. Besides, if the risk allocation criteria are well acknowledged and if their efficiency is recognized, then partners will spend less time to allocate risks in the contract. Besides, partners will not renegotiate the risk allocation. Consequently, the ex-ante and ex-post transaction costs are reduced by using clear risk allocation criteria. Overall, the impact of risk allocation on the transaction costs is ambiguous; it depends on the risk allocation used.

The risk-bearing cost effect highlights the costs supported by the partners once the risk materializes. As each partner has different risk-bearing cost, allocating risks to one partner or another lead to a different overall risk-bearing cost. The risk premium illustrates this effect. The second criterion aims to take into account this risk bearing cost effect.

We now understand why transferring either too much or too little potential costs to the private partner leads to higher costs for the buyer. As the Private Finance Panel [1995] puts it: “as a general rule, value for money can be expected to increase initially as risk is transferred to the private sector until the optimum point is reached at which all risks have been allocated to the partner best able to manage them. Any further risk transfer will lead to a decline in value for money” (p.15). Thus, the purpose should be to optimise the risk transfer, not to maximise it. The risk allocation criteria proposed by the PAT may permit the partners to reduce the total cost of the project. Now that the risk allocation criteria are clear and their origins presented, we can analyze the application of these criteria in the French defence procurement sector.

## **2. Application case: Public-private partnerships in the French defence procurement sector.**

The purpose of this part is to apply the normative risk allocation criteria to the PPP contracts in the defence sector. This is a necessary intermediary step to be able to compare the risk allocation proposed by the PAT and the risk allocation existing in this sector. We regard the

the procurement agency (DGA: Délégation Générale pour l'Armement) as being the Principal. The defence firm producing the equipment and delivering the service is the Agent. We base this part on a large and precise risk assessment realised in a previous work (Oudot [2005]). This analysis points out the risks existing in the defence procurement sector. Oudot identified -thanks to a tight collaboration of French defence firms and the French ministry of defence- five main risk categories in the defence procurement sector. First, the author noticed the existence of a technological risk. It 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. This risk category concerns all events related to the partner selection, the contract negotiation, the contract redaction, its notification and its enforcement control. This includes for instance the opportunism case. The third risk category is the industrial risk: unintentional failure of the firm's industrial organisation or of its subcontractors. The fourth category is the direct financial risk, which is defined as an event that modifies the initial equilibrium between recipes and outlays. This financial event triggers cost overrun, recipes inferior than expected or delayed recipes. Eventually, the delay lengthening risk was noticed. Such a risk is an event causing, directly or indirectly, delays longer than expected when the reference contract was signed.

This risk assessment focused on risks existing in the traditional public market procurement process (whose French name is "marché public"), not on PPP arrangements. Indeed, PPP contracts are still not used in the French defence procurement sector. The first PPP contract is being negotiated. It is a procurement contract for the acquisition of helicopters for a military school in the south of France. Therefore, it is not possible to get empirical evidence from PPP experiences. However, we believe that risks existing in the PPP contracts are not as much different as those in a public market process within the defence procurement sector. In fact, the French ministry of defence is used to sign long-term global contracts, including R&T, R&D, production and maintenance activities.

However, PPP contracts present one specificity: new activities are introduced within the contractual relation whereas these activities were not previously formalized by contract in a public market framework. These activities are related to the operational phase. Activities like insuring the staff training and security or problem such as the asset damage are introduced within a PPP contract. The origins of all potential problems occurring during this phase are related either to the technological, contractual, industrial, financial or to delay dimensions. That is why the risk typology is not modified.

Let us now apply the criteria enounced by the PAT on the PPP arrangements in the defence procurement sector. We face several difficulties to do so. First, let us note the partial incompatibility of both criteria enounced by the PAT. Indeed, the partner managing the risk could also be the highest risk-bearing cost partner. To resolve this problem, we advocate applying the following three application propositions.

**Proposition 1: When the origin of risk is internal to the relation, the first criterion should be applied.**

The application of the proposition one must permit the Principal to maximise the incentive effect. When one of the partner can influence the risk materialization, then he should support the consequences of this risk.

**Proposition 2: When the origin of risk is external to the relation, the second criterion should be applied.**

When the origin of risk is uncontrollable by either partner, the incentive effect is useless. The participation constraint is then the only constraint to take into account in the maximization program. Consequently, we advocate applying the second criterion in such a case.

**Proposition 3: When the origin of risk is either blurred or ambivalent, the third criterion can be applied.**

In such a situation, the Principal may decide to support the risk to favour the development of the defence industrial base (DIB). This last rule must favour the development of the DIB and reduce the ex-post transaction costs to allocate risks whose origin is unclear.

A second problem to apply the PAT propositions relies on the assessment of the partners' attitude towards risk. Such an evaluation is problematic (Goldberg [1990]<sup>19</sup>). We assume here that the government has a lower risk-bearing cost than the firms (following the PAT propositions).

A third and main problem is the identification of the precise origin of risks. Several phenomena make this identification more difficult in the defence sector. This is the complexity of the weapon systems, the information asymmetry in favour of the firm and huge financial stakes for each transaction. Consequently, the precise origins of risk are difficult to identify and to check. A tight collaboration of partners can be regarded as a favourable factor,

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<sup>19</sup> Goldberg [1990] does precise, p.216, that the introduction of the agents' position in face of risks in models implies the introduction of other simplifying hypothesis, in order to make these models workable. Moreover, it would be necessary to differentiate the large and smaller suppliers because they are likely to have different attitudes towards risk (Okamuro [2001] p.362).

but the very high financial stakes limit such collaboration. Developing the audit system could be a partial solution, but it does not resolve the problem related to the complexity. The following propositions depend on the objective identification of the precise origin, which is problematic. All results are summarized in the table 1.

<b>RISK CATEGORY</b>	<b>RISK ORIGINS</b>	<b>CRITERION 1 APPLICATION</b>	<b>CRITERION 2 APPLICATION</b>	<b>PAT RISK ALLOCATION</b>
<b>Techno-logical</b>				<b>Depends</b>
	Reaching the tec. state of the art level	?	DGA	DGA
	Obsolescence	Firm		Firm
	Appearance of new tec. innovations	?	DGA	DGA
	Interface	Depends		Depends
	Non mastering technology	Firm		Firm
<b>Contractual</b>				<b>Depends</b>
	Firm's opportunism	Firm		Firm
	Buyer's opportunism	DGA		DGA
	Demand modification	Depends		Depends
	Government's entries	DGA		DGA
	Contract mal adaptation	Depends		Depends
<b>Industrial</b>				<b>Depends</b>
	Firm's failure	Firm		Firm
	Subcontractor's failure	Depends		Depends
	Lack of coordination	?	DGA	DGA
<b>Direct financial</b>				<b>Depends</b>
	<b>Reduced financial recopies</b>			DGA
	Political factors	?	DGA	DGA
	Acquisition strategy	DGA		DGA
	<b>Production cost overrun</b>	Depends		Depends
	<b>Transaction cost overrun</b>	Depends		Depends
	<b>Financial cost overrun</b>	Depends		Depends
<b>Delay leng-thening</b>				<b>Depends</b>
	Technological risk	Depends		Depends
	Contractual risk	Depends		Depends
	Industrial risk	Depends		Depends
	Direct financial risk	Depends		Depends
	Acquisition strategy	DGA		DGA
	DGA's human factors	DGA		DGA

**Table 1: Application of the Principal – Agent theory risk allocation criteria**

In this table, the word “depends” does reference to specific circumstances of the transactions enforcement. It indicates that it is not possible to draw a general result through the application of the first criterion. The “?” does indicate that the criterion one is useless to determine the normative risk allocation, whatever the precise transactions condition might be. These risks

are exogenous. The criterion three application is not presented because its enforcement relies on the good will of the DGA.

All risk origins are not introduced in this table, it would have been too long. We only precised the main risk origins. Most of them do not present an ambiguity as far as the allocation criteria application is concerned. However, a deep discussion with practitioners would be necessary to fix the final risk allocation. In particular, it would have been interesting to understand the clear status of each risk origin. For instance, the obsolescence problem can be first regarded as resorting to the firm control. That is why this risk origin is allocated to the firm in the table 1. However, the firm cannot control all factors. The consequences caused by the obsolescence could then be allocated to the DGA, following the second or the third risk allocation criterion.

We observe in this table that most of the risk origins are allocable through the first criterion. That does mean that most of the risks have an internal origin. This confirms the uninsurable specificity of these risks and the necessity to use a contractual theory to propose a risk sharing arrangement.

Once the theoretical risk allocation has been determined, a question remains unresolved: How introducing risk allocation within the contract? We can anticipate two situations and draw two other propositions.

**Proposition 4: If a risk category or risk origin resorts clearly ex-ante to one partner (whatever the ex-post enforcement conditions might be), then this responsibility will be clearly precise in the reference contract.**

For instance, it can be precised in the contract that the DGA will support the consequences of the modifications in the exchange rate.

**Proposition 5: If a responsibility cannot be clearly ex-ante determined, then the risk allocation criteria that will be used ex-post should be precised in the reference contract.**

This situation represents most of cases. The application of such a proposition is equivalent to determine ex-ante the decision rule used ex-post. This introduces a default rule<sup>20</sup> in the contract.

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<sup>20</sup> A default rule is defined as a “rule that defines the parties’ obligations in the absence of any explicit agreement to the contrary” (Craswell [2000] p.1)

Let us now compare the risk allocation suggested by the PAT to what is envisaged in PPP contracts in the French defence procurement sector and to what is the risk allocation practices in the public market contracts. To do so, we propose to highlight first the risk allocation policy within the French Ministry of Economy (MOE) and the French Ministry of Defence (MOD). The MOE is responsible in France for advising the ministries to implement PPP contracts. Second, we use procurement contracts signed between the DGA and defence firms to make such a comparison. We show that the MOE and the MOD is not clear at all on the way risks should be allocated. Consequently, this paper is more an analysis of the application condition of the PAT propositions than a test of these propositions.

The French MOE has recently started an analysis on the risk allocation. It implements such an analysis since the French government wishes to implement PPP contracts. The commission<sup>21</sup> responsible for the implementation of PPP contracts points out one criterion to allocate risks: risk should be allocated to the partner best able to manage the risk materialization. It is in full line with the first criterion enounced by the PAT. However, three problems remain. First, none criterion is identified to allocate risks emerging during the operational phase, whereas these risks are the specificity of the PPP contracts. Second, the risk-bearing cost is not considered as an allocation criteria. This dimension appears to be acknowledged<sup>22</sup>, without leading to a risk allocation criterion. The only effect of this dimension introduction seems to blur the application of the single risk allocation criterion. We may wonder whether this choice has been intentionally done, or unintentionally. Third, the results highlighted by this commission are not planned to be applied to the public market contracts. Such contracts are not submitted to any risk allocation analysis. The government's public market commission told us: "None criterion is really followed to allocate risks [...] Some contracts do not even precise the risk sharing". Why progress in the risk allocation is limited to PPP contracts whereas the public market contract types are not as different as PPP as far as the risk dimension is concerned? The question remains open.

We point out the French MOD position thanks to a document edited by the DGA in 2004. Although some problems are noticeable in their risk typology<sup>23</sup>, we can identify several

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<sup>21</sup> Its point of view is expressed in the following web site: <http://www.ppp.minefi.gouv.fr>

<sup>22</sup> "The cost associated to each risk is different according to the party bearing it" (PPP commission, [March 2005] p.2)

<sup>23</sup> This typology is incomplete (the delay lengthening risk does not appear for instance) and above all partially inconsistent. Indeed, the risk categories are based on the period risk materializes (operational risk for instance), the type of problem posed (funding and finance) and the risk origin (technological obsolescence). Consequently, one risk can be situated in several risk categories.

results from this document. The French MOD has a propensity to maximise the risk allocation to the firm not to optimise it. For instance, exogenous risks (such as the exchange rate changes) and security matters are allocated to the firm whereas the firm do not control these risks. The firm should also support the consequences of changes in usage due to a greater demand for service, whereas such a change fully resorts to the DGA. The latter is due to support only very few problems (affordability, voluntary termination and discriminatory changes). These results do indicate that the criteria two and three are not taken into account by the MOD. It would be necessary to understand why in order to assess such a decision.

The procurement contracts<sup>24</sup> we have in hand show that the risk analysis is quite poor in the French defence procurement sector. The question of the risk allocation is almost not treated in the contract. Two main points can be pointed out. First, only a few categories of risks are introduced in the contract. The only risk included in the contract is the delay lengthening risk through imposing delay penalties, the possibility of cost overruns through the price formulae, and the technological risks (during the risk reviews realised in the enforcement period). Second, no risk allocation criterion is precised in the contract. The documents<sup>25</sup> aiming to help the DGA workers to determinate the contractual clauses do not precise any risk allocation criterion neither. The partners cannot rely on any decision rule to allocate risks. Practitioners miss decision rules to determinate the allocation of risks.

These weaknesses are partially explained by the inheritance of history. The DGA only starts analysing risks under the budgetary constraint, emerging since the end of the cold war. The risk analysis is extending since 2000. However, the DGA relies on the private partner to establish the risk portfolio. The DGA is not really able to assess the validity of information given by the firm. That is why an internal risk assessment is necessary in this sector.

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<sup>24</sup> Our database is composed of armaments procurement contracts signed by the DGA and defence firms since the beginning of the 1990's.

<sup>25</sup> The generic management specification and the guide for the establishment of government's management plans for instance.

## **Conclusion.**

In this paper, we started by identifying the Principal – Agent theory propositions as far as risk allocation is concerned. We have shown that these propositions come from the incentive and participation constraints in the maximization program. The criteria enounced by the Principal-Agent framework aim to explore two features. First, the criterion one focuses on the relative partners' ability to manage risks. According to this criterion, the risk should be allocated to the partner best able to manage it. The foundation of this criterion is the incentive constraint. The second criterion tends to exploit the risk bearing cost differential between partners. It stipulates that risk should be allocated to the least risk-bearing cost partner. This criterion has been identified through the analysis of the participation constraint. We also suggested a third criterion applicable in the defence procurement sector: The Principal can support some risks in order to support the Agent's development. This criterion has been deduced from the analysis of a third constraint: The procurement autonomy.

After pointing out these risk allocation criteria, we analysed the application conditions of such criteria. This is an extension of the Principal – Agent theory. We proposed three application propositions. The first proposition stipulates that the first criterion should be applied when the origin of risk is internal to the relation. The second proposition advocates the application of the second criterion when the origin of risk is external to the relation. The third proposition precise the condition application of the government's discriminatory power. When the origin of risk is either blurred or ambivalent, the third criterion can be applied.

Then, we applied these propositions to the case of PPP in the French defence procurement sector. This permitted us to compare this risk allocation to what is envisaged in practice for PPP contracts and to the current practices in the public market contracts. We have shown that practitioners miss decision rules to determinate the risk allocation. Our paper might help practitioners to agree for the risk allocation in the contract. We proposed not only risk allocation criteria but also suggested ways to introduce these criteria into the contract. In particular, we advocated the introduction of the risk allocation criteria into the contract and call for precisising the risk allocation ex-ante only for specific cases.

Eventually, we can note several limits to our approach. First, it is necessary to test the impact of the Principal –Agent theory criteria on the overall performance of the contract. Is the contractual performance really better when the theoretical risk allocation proposed by the PAT are applied, compared to the reverse case? It would be very interesting to reply to that question. The empirical test is impossible (or only very partially) because these criteria are not

applied yet. We could only use a theoretical model to make such verification. It is a potential future research program. Second, the objective application of the second criterion implies an estimation of the risk bearing cost. In particular, it would be necessary to assess the degree of the partners' risk aversion, which may be problematic, and the impact of the insurance cost into the risk-bearing cost (Posner & Rosenfield [1977] p.90). This represents another future investigation file. Third, applying the risk allocation criteria enounced by the PAT implies for the partners to be able to determinate the precise origin of risks. However, the complexity of defence systems, the information asymmetry and the huge financial stakes make this identification and verification difficult, but not impossible. Four, the performance criterion used in this paper is the total cost of the project, following the Principal – Agent framework. It would be interesting to determinate the sensibility of the theoretical propositions to the performance criterion used. The latter could be the delay and the technical performance. What are the risk allocation criteria the economic theory could deduct from these performance criteria? The question remains open.

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