Research Proposal
Firm innovation in the Defense Industry, and Spill-over Effect

1. Introduction

This research proposal aims at understanding better the innovation system that sustains the French military sector in its autonomy, but also contributes to the French national industry in both military and civilian activities.

2. Project A : Defense R&D and Private R&D : mechanisms of crowding-in

This first work has for objective to develop a detailed analysis of the mechanisms of crowding-in of the defense R&D. Indeed, if the importance of military investment in R&D has long been discussed in the literature, like (Pallante, Russo, and Roventini 2023; Moretti, Steinwender, and Van Reenen 2025) for the crowding-in effect of direct government subsidies on private R&D, or jump-start effect of military investment on growth and innovation (Draca 2013; Mazzucato and Penna 2015; Gross and Sampat 2023), much less attention has been provided to the exact mechanisms at play in the innovation system. Therefore, we propose a quantified assessment of the role of differents innovations channels through which the French military innovation systems spills over various industries.

A first step of this paper, would be to provide rich descriptives facts about the structure of the French innovation system. For that we would use patenting on the most consistent set of companies in France. The main objective would be to recover the channels of knowledge transmissions in the French innovation sector. The idea would be to isolate the scientific content of defense companies (being purely defense or dual) patents and then measure back the provenance of these knowledge. It would clarify the scientific quality and use of scientific inputs in the French military industry while providing a first assessment of which companies integrate the most scientific knowledge and generate the most innovation[1].

In a second time, we could map the innovation connection between the three key actors of the innovation systems as coined by Serfati (2008) in this milestone study: the DGA (*Direction Générale de l'Armement*), the scientific labs (ONERA, CEA, ESA), and the large defense companies (LDC)[2], we propose to add an actor with the subcontracting firms which can bear important innovations when LDC mainly serve as "technological integrator" (Fauconnet 2020).

Once we have reconstitued the FIS, the following step, would be to measure the impact on patenting activities and R&D activities of firms benefitting directly and indirectly of public R&D funds. The broad idea is just to obtain a measure of publicly funded R&D on crowding-in. This first empirical metrics would be a valuable milestone by providing an estimate at the firm and industry level of the crowdin-in/out effects[3] of French R&D investment.

[1]The closest exercise has been done by Acosta et al. (2018) on the 100th biggest defense firm in the world, finding that industries operating in both civilian and military activites are the more likely to produce patents, and Fauconnet (2020) on the scientific contents of Europe largest firms, including the defense ones, she found that they are less likely to incorporate scientific knowledge

[2]These companies have been remarkly stable for the last 60 years: Nexter-KNDS, ADS, MBDA, Naval Group, Dassault, Thales, Safran, Ariane Group, Arquus, Technicatom.

[3]We are aware of the work of Moretti, Steinwender, and Van Reenen (2025), their paper does not provide a clear analysis of the channels through which spillover effects occur in the French industry—an aspect that this study aims to unpack. Moreover, their findings are substantially larger than those reported in the rest of the literature, and their instrument is likely fragile to demand anticipation, potentially leading to an upward bias.

Following, the methods developped by Bergeaud et al. (2025) to distinguish the impact of public research lab on patenting and innovation activities in LDC and SMDE. We decompose our analysis in different channels :

- A first aspect would be to distinguish direct **funding of publics labs vs private companies**. It would have at least two advantages over the current methodology used : first, it would control for the "anticipated demand effect" (Belenzon and Cioaca 2024) — firms who obtain important government grants expect to win future procurement and then invest top-up public investment to secure future gains. This channel is important to understand and exploit but can bias upward our estimation. The second advantages of this approach would be to avoid "inverse causality" effects, firms that participate to public procurements may need to invest ex-ante in R&D which would once again bias upward the average crowdin-in effect. Examining the effects of funding public laboratories in defense-related industries would also yield valuable insights into the broader impact of public research funding on primarily industrial firms. It could shed light on the unequal access to frontier innovations across firms of different sizes, as well as the trade-off between supporting firms directly through tax credits (such as the *Crédit Impôt Recherche*) versus allocating direct public funds. Moreover, it would help determine whether small firms benefit more from research conducted in public laboratories or from that carried out within the large defense contractors (LDCs) for which they work.
- A second channel is the **local spillover effect**. Firms operating within clusters tend to agglomerate and innovate more intensively following the receipt of government grants. Industries collaborating with innovative firms may, in turn, benefit from these firms' innovations—either by investing to secure their own market position or by integrating external innovations into their products or production processes. In such cases, local spillover effects arising from technological clustering are to be expected. The transformative impact of defense R&D is well documented in the U.S. context, particularly its crucial role in fostering technological clusters and steering American innovation toward initially military-oriented products—commonly referred to as spin-offs (Gross and Sampat 2023).
- A third channel involves **dual-use goods** produced by both defense firms and civilian industries. Most firms operating in the military sector also engage in civilian production, and the high level of R&D they conduct for military purposes may spill over into the development of civilian good (Ruttan 2006; Mazzucato and Penna 2015). Distinguishing between the two provides valuable insights into which firms and industries the state can expect to generate spillover effects. If civilian industries operating in closely related technological patent classes do not benefit from defense R&D funding, this would suggest that most of the effects are concentrated in dual-use goods[4]. In that case, the crowding-in effect may result from the additional research required to convert military technologies into marketable goods. Finally, the spillover effects of public R&D could be assessed through scientific citation measures, using the funding of military projects across different industries as a clear indicator of public support for private research.

2.1. Valuable outputs

Academic outputs:

- Clean decomposition of different channels through which the public R&D in the defense industry might foster public investment
- Contribution to the debate on the optimal way of funding R&D

[4]Except if we consider that competition with dual production firms may encourage investment from fully civilian firms.

Professional outputs:

- Analysis on the respective roles of different institutions and private companies in the French Defense Innovation Network
- The impact of public funds on economic and scientific outputs

2.2. Data

1. Patents Data
2. Firm level data on contract with the army to build a defense expenditure shock & balance sheet.
3. MESRI : to recompose the innovation network.
3. Data on firm employment of scientist (complementary to MESRI data)

3. Project B : Credit Constraint, R&D, and firm's growth in the Defense Industry

A recurring comment on the French military industry (FMI) is its remarkably stable sets of actors, being public scientific agencies or LDC. The DGA, in charge of military procurement and technological guidance, often underscores the difficulty to let new actors emerge from its current procurement procedure. Indeed, SME have a difficult access to medium and large market (over 100K) given European regulation imposes open competition and high military standards tends to considerably increase the cost of participating to this open competition. These two factors, coupled with a difficult access to credit (Belin and Guille 2006) limits development capacities of SME in the Defense industry and then both production and innovation capacities.

We propose to develop a dynamic model of firm growth featuring endogenous credit constraints that arise from limited access to larger markets, itself driven by exogenous entry costs shaping firms' growth trajectories. The model serves primarily as a conceptual framework to guide the empirical analysis and to formalize the underlying mechanisms constraining the development of the FMI. Specifically, it aims to elucidate the potential trade-off between market access barriers induced by entry costs and the financial frictions associated with credit constraints.

For the empirical part of the paper, a promising approach could be to identify credit constrained firms, its impact on their investment and growth strategy (R&D investment and firm dynamics). Following Garicano and Steinwender (2016) we may use the difficulty to obtain credits for future investments and the obtention of a grant from BPI France as an exogeneous shock on credit constraint. Firms more constrained would shift part of their investment to more long-term or R&D investment now that their credit constrained is relaxed.

Depending on the findings we could see if the credit relaxed firms increase their probability of participating to public procurement, increase their production or export, or if the small size of the French military market is a more binding constraints that the credit one. We can test this last hypothesis by using a second natural experiment, the surge in military spending following the Russian invasion of Ukraine in 2022. We could then identify the demand effects of firms that benefited from credit relax in 2021, those who did not, and the pure magnitude of the demand effect. A natural concern with this last step would be that firms benefiting of credits are also different in nature in their production and then benefit even more of the demand shock since what they produce is more tailored to the operational need of the French armies. However, at this stage, we can reasonably argue that the invasion was a shock, largely unexpected, and that

the need of the French armies have probably been reconsidered following the invasion[5].

3.1. Data

1. Firm level data on balance sheets & military contracts
2. Patents
3. Level of R&D
4. Data on firm employment of scientist (complementary to MESRI data)

4. Project C : Anticipated Demand, Investment and Growth in the Military Industry

An important aspect of the question is **anticipated demand** that firm will face in their investment choice. If firms obtaining government grant consider it as a future signal of demand for a specific good from the MoD then winning government fund is the same as facing "guaranteed demand". They are incentivize to top-up government fund to secure future procurement contract (Belenzon and Cioaca 2024). Further research have showed that demand for experimental product is crucial so that new technology can grow to maturity and survive against more mature incumbant technology. Historically the MoD by their procurement in innovative equipments has played this "consumer in first resort" role to forster innovation (Malerba et al. 2007; Mowery 2010). Theoretical results from (Belenzon and Cioaca 2024) showed that larger firms with production capacities and upstream in the innovation channel are more likely to benefit from "guaranteed demand" mechanisms. Recent reforms of R&D funding that separate demand from R&D might lead to growth of SME.

Possibility to use *Fonds Innovation Défense* comme expérience naturelle d'allégement de la contrainte financière.

4.1. Data

1. Data on firm innovation expenditures : Enquête sur les dépenses de R&D des entreprises (MESRI)
2. Data on Credit constraints & firm financial situation : FARE
3. Data on workers of those firms to control for change in employment structure : BTS
4. Data on MoD procurement to control for potential demand : Chorus

[5]The French military doctrine specified in the 2023 "Livre Blanc" is a global reconduction of the previous one, with the nuclear deterence being at the core of the French military doctrine, though in practice incremental changes were implemented and are acknowledge and theorised in the last "Livre Blanc" published in 2025.

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