Firm Performance in Regulated Markets: The Case of Spanish Defence Industry

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Abstract

This paper studies the effects of legal reforms associated to defence and public procurement on firm performance. With this aim, a theoretical framework for the reaction of defence firms to regulatory changes is developed. Its predictions have been empirically assessed using the last reforms implemented in Spain. Our results suggest that these new regulations have allowed the main defence contractors to outperform the other defence contractors in terms of productivity, having no effect on profitability. These findings are in line with theoretical priors. Therefore, it can be claimed that governmental interventions have had an effect on firm performance. We also provide evidence that, while the procurement procedures and the contract law put into place in 2011 have principally affected the productivity of large firms, the centralization process established in 2014 has exerted a higher influence on SMEs.

Keywords: defence industry, public procurement, regulated markets, firm performance.

JEL classification: H57, K23, L64.

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1 Introduction

Market regulation is generally established to avoid market failures such as the presence of monopolies, externalities or asymmetric information (Den Hertog 1999). Nevertheless, if poorly designed, regulations may affect the degree of competition by raising barriers to entry or granting protection to incumbent special interest groups; and can, in turn, limit firms' incentives to maximise efficiency and innovate, see Arnold, Nicoletti, and Scarpetta (2011). Defence industry is not an exception. As Hartley (2003) points out, defence markets comprise the corresponding ministries and the armed forces that are procurement agencies purchasing equipment from national and/or overseas industries, and hiring military and civil personnel typically from national labour markets. Defence markets are also made up by a set of heterogeneous industries from commodities to tailored-made products which consume the largest part of the acquisition budget. In the latter case, regulation could be explained for both economic (limited demand, complex products and long duration, among others) and strategic (national security) reasons. Actually, regulated procurement systems are supposed to provide incentives for private-sector production and, in many countries, public procurement of military systems has also been used as a tool to achieve industrial objectives and build up domestic industrial and technological capabilities (Molas Gallart 1998). At the same time, defence procurement based on single-sourced contracts has been a widespread phenomenon, in which the absence of competitiveness make the procurement process vulnerable to corruption. In this sense, adequate regulation to grant supervision should be introduced, such as multiple levels of oversight and approval (Pyman, Wilson, and Scott 2009).

The changing geopolitical scenario has called into attention the defence markets in Western countries (Arteaga 2013). The novel nature of conflicts, the new technologies and the growing public opinions' concerns on lack of transparency, democratic oversight and corruption risks has posed a challenge to Western armies and procurement systems to adapt to the new circumstances. Moreover, the recent economic crisis has led to enact austerity measures, including military budget cuts (SIPRI 2012). Accordingly, Western defence industrial sectors have been forced to adapt as their traditional markets change and decrease. For instance, defence companies in the major arms producing countries have evolved into multinational corporations through mergers and acquisitions (Kurç and Neuman 2017). In this setting, the European Union (E.U.) has tried to develop a common defence industrial policy (Hartley 2008). The Six Nation Framework Agreement was signed in 1998 to facilitate defence industry restructuring in Europe and reflected a desire to maintain European industry's relative competitiveness.[1] In 2004, the European Defence Agency (E.D.A.) was created[2] to promote and enhance European armaments cooperation, to strengthen the European defence technological and industrial base,

[1] The countries involved were France, Germany, Italy, Spain, Sweden, and the United Kingdom (U.K.).

[2] 2004/551/CFSP Council Joint Action on the establishment of the European Defence Agency.

and to create a competitive European defence equipment market.[3] Later on, the Directive 2009/81/EC aims at liberalising the supply of defence equipment in the E.U. and ensuring transparency and non-discrimination during the award of defence contracts (Fiott 2017). Still, this directive provides contracting authorities with great flexibility so that it is not clear to what extent national procuring practices could change (Weiner 2012). The European Defence Action Plan, passed in 2016, emphasized the need to reinforce internal defence market by increasing competition and competitiveness and encouraging investment in research and development (R&D).[4] In particular, this plan prompts to reduce the use of article 346 of the Lisbon Treaty, which exempts the vast majority of defence procurement contracts from the rules of the single market and has reduced foreign competition in the past.[5]

The Spanish defence industry has traditionally enjoyed positive economic profits on procurement contracts based on the bargaining power of contractors and non-competitive arrangements (Fonfría and Correa-Borrows 2010).[6] Further, Spanish defence procurement has been characterised by old-fashioned bureaucratic managerial practices (Colom Piella 2016). This discretionary governance has permitted to protect domestic industries from foreign competition. Moreover, the purchases of the Ministry of Defence are concentrated in a very few companies (DGAM 2018a). However, there have been several recent initiatives to adapt the armed forces and the procurement system to the new international scenario. There has been a restructuring of the Ministry of Defence and of the armed forces as well as different laws and directives were passed to respond to the nation's strategic needs (Pérez Muinelo 2015, 173–177). In particular, the traditional planning system based on threats was replaced by a new capability-based strategy through the Ministerial Order 37/2005. In addition, Law 24/2011 and Ministerial Instructions 2/2011 and 67/2011 were approved to increase transparency and accountability in defence contracting, to enhance coordination in industrial relations and to encourage R&D investments within the defence industry. Following the principle of 'centralised management, decentralised execution' (DGAM 2012), these regulatory changes intend to separate producers and end users during the procurement process in order to promote their neutrality as well as to include external financial and operational audits to increase their transparency and effectiveness

[3] In this respect, and on a voluntary basis, a code of conduct on defence procurement was introduced in July 2006. This inter-governmental non-binding regime tried to increase the 'subscribing Member States' commitment to ensure fair and equal opportunities in all defence procurement contracts over one million euros where the conditions for application of article 296 – 346 of the Lisbon Treaty – were met. The exceptions were procurement of research and technology, collaborative procurements, and procurements of nuclear weapons and nuclear propulsion systems, chemical, bacteriological and radiological goods and services, and cryptographic equipment. This code of conduct was subscribed by Spain in July 2007, see https://www.eda.europa.eu/docs/documents/CoC.pdf

[4] COM(2016)950. European Defence Action Plan.

[5] COM(2013)542. Towards a more competitive and efficient defence and security sector.

[6] Contractors are firms that provide procurement service to the Ministry of Defence.

(Arteaga 2014).

The defence budget cuts, that started in 2008 as a consequence of the financial crisis, showed the need for efficiency improvements, especially with respect to major systems' renovation and sustainability (Barco Gorostegui and Calvo González-Requeral 2015). Accordingly, in 2014, 17 armaments and material programmes were centralised both in terms of management and of execution (García Montaño 2015a). This change is justified as a better way to guard procurement contracts and to be able to warn of possible economic deviations that may occur in their execution (García Montaño 2015b). In addition to these changes, the importance of science and technology to future defence capabilities has been acknowledged through the reorganisation of different ministerial offices and institutes related to R&D.[7] It is important to bear in mind that this sort of legal reforms is introduced to improve market performance in tailored-made products' industries which, as highlighted above, represent the largest percentage of the acquisition budgets. Due to their specificities, lack of complete information and uncertainty, this kind of products can be non-existent or exhibit significant problems in the market (Martí Sempere 2019).[8] These public initiatives would require industry efforts to adapt not only technologically and economically, but also from an organizational point of view (Pereira Rueda 2011). Had the new regulatory framework provided firms incentives to enhance their productivity and to upgrade investment in R&D, it would have an impact on allocative efficiency. Consequently, policy implementation may generate the desired improved efficiency by providing armed forces with higher quality and cheaper products, on the one hand, and/or developing a healthier industry, on the other (Martí Sempere 2019). However, policy implementation may also result in new deficiencies and other adverse effects that reduce social welfare. Therefore, ex-post evaluations are needed to assess the outcomes and to provide refinements when necessary (Martí Sempere 2015).

The Spanish defence market is not unique in having experienced such a transformation; the British and French ones have also been subjected to drastic changes (Dowdall 2004; Guichard 2005; Molas Gallart and Tang 2006). In fact, Spanish reforms are in line with the initiatives of the U.K., France, Germany, and Sweden that have looked for the establishment of highly centralised organizations with greater capacities of decision and control (Edwards 2011). In the case of France, Guillou et al. (2009) show that, following the restructuring of the French Direction Générale de l'Armement, contractors were prompted to reduce costs and intensify knowledge practices.[9] Moreover, the firms closely related to the Ministry of Defence through

[7]For an overview, see ministerial orders DEF/1453/2010, that regulates defence R&D projects, and DEF/685/2012, on R&D for weapon systems.

[8]At the same time that these problems are present in this market segment, they can be of small magnitude or even non significant for many commodities required by the armed forces. We are grateful to the referee to draw our attention to this relevant disctintion.

[9]The reform implemented a new purchasing policy inspired by the 'smart procurement' introduced in the

R&D programs are found to be more successful. This evidence suggests that the monitoring and selection carried out by the French Ministry have been quite effective. This paper tries to make a similar contribution for the Spanish case by evaluating the effects of the recent regulatory reforms on the defence industry. In particular, the main goal of the present paper is to analyse whether the legal rules approved in 2011 and 2014 have affected the performance of the firms contracting more with the Ministry of Defence. Provided firm performance has improved, Spanish companies will be better positioned to remain competitive on a global scale or to become attractive partners for cooperation, particularly within the European context. It is worth noting that, although the effects of the reforms on issues such as the type of contracts, product quality, prices or outlays are of interest, they are outside the scope of the present study and, hence, left for future research.

Following Levine, Sen, and Smith (1994), Levine and Smith (1995), and García-Alonso (1999), we develop a theoretical model to analyse the performance of firms in reaction to regulatory reforms. In the first phase of the procurement process, the Ministry of Defence secures the quality of the product by allocating a research subsidy to firms with an attractive proposal. In the second phase, a negotiation determines the price of procurement. Before the change in the regulatory framework, firms enjoy high bargaining power and their profits can be substantial. After the change, transparency and accountability in defence contracting is enhanced, improving the negotiation conditions for the Ministry of Defence, and encouraging R&D investment. The potential effects of the reform are twofold. On the one hand, profits may be lower as firms have less bargaining power. On the other hand, as investment in R&D increases, production costs are reduced, yielding better technology and higher productivity. From an empirical point of view, we exploit the introduction of the legal reforms enacted in 2011 and 2014 to estimate the impact of the new regulatory framework. Our identification strategy relies on the differences-in-differences approach. For that, we use an unbalanced panel data set covering 277 Spanish defence contractors during 2000-2018. In particular, we compare the changes in performance of those contractors more exposed to the new legal rules, main contractors that participate in procurement contracts of tailored-made products (treatment group), with the rest of defence contractors (control group). The sample is completed with financial data as well as other relevant information. Results show that the regulatory reforms have allowed main defence contractors to outperform the rest of defence contractors in terms of productivity. Further, results differ for larger and smaller contractors.

The remainder of the paper is organised as follows. Section 2 outlines some information about the Spanish defence industry and procurement policy. Section 3 lays out the theoretical setup. Section 4 explains the identification strategy and describes the data used. Section 5 presents the results obtained in the empirical analysis, and Section 6 concludes.

U.K.

2 Spanish defence industry and procurement policy

The Spanish defence industry is composed by a set of heterogeneous companies ranging from weapons to textiles, and through electronics to services (Duch-Brown, Fonfría, and Trujillo-Baute 2014). Traditionally, it has been characterised by a high degree of concentration with a few large contractors and an important number of small- and medium-sized enterprises (SMEs) that are usually second-tier contractors (Álvarez and Fonfría 2000). In 2015, 17% of this sector was made up of large companies with over 250 employees and 83% were SMEs (70% of them with less than 50 employees). In this respect, as Agustín Conde Bajén, Secretary of State for Defence stated in 2017, the Ministry has paid attention to develop a more cohesive industry, and to promote and prepare SMEs through R&D and productive investments (IDS 2017, 7). The intention is to modernise industry's production chains so as to increase overall competitiveness (García Montaño 2015b).

The recent transformation of the global defence market has impacted the Spanish industry. The sector has undergone significant changes broadening its product range and incorporating new and more advanced technologies, see García-Estevez and Trujillo-Baute (2014). According to these authors, the explicit defence industrial strategy of the Ministry of Defence to stimulate modernisation and to build a strong technological base has implied relevant efforts in military R&D.[10] At the same time, institutional support to internationalisation through government-to-government accords and the development of the 'defence diplomacy' (Arteaga 2013), as well as the national participation in international organizations, such as E.D.A. or the Organisation for Joint Armament Co-operation, has permitted the industry to be involved in cross-border programmes. All these efforts together have ended up in an important increase in export capacity. In 2014, over 85% of turnover was from international sales. Despite this positive evolution, Duch-Brown, Fonfría, and Trujillo-Baute (2014) show that defence contractors present efficiency problems associated to the lack of realistic financial scenarios and proper procurement management.

As highlighted above, the capability-based Spanish planning system was adopted in 2005 to modernise and rationalise defence planning to improve resource allocation and to integrate the domestic procurement in the international context (Colom Piella 2017). Accordingly, a set of rules and instructions were passed in 2011 to put into practice the rationalisation defined in the Ministerial Order 37/2005. Instructions 2/2011 and 67/2011 established the material and financial resource planning and the military planning, respectively. The military planning must be capable of presenting alternative options to the responsible authorities, at different levels, serving as a tool that supports decision making to provide the necessary equipment to accomplish the military missions established in the national defence policy. Regarding resource

[10] Nonetheless, the 2008 economic crisis has negatively affected R&D defence expenditures (both public and private), see Ortega, Gamella, and Moya (2012).

planning, it is necessary to foster R&D and innovation as well as to maintain operability, along with technological priorities that are the basis for delivering the capabilities needed by the armed forces. Budgetary availability, however, has been the principal conditioning factor on military and resource planning. As a consequence, the main objectives of Instruction 67/2011 were to control costs (especially important in the constrained budget scenario at that time), to develop intense relationship with suppliers to invest in R&D and to monitor the firms once the programs were underway, and to emphasize the use of project engineering techniques that empower managers. This procedure is based on the principles of 'unique client' and 'centralised management and decentralised execution' (DGAM 2012). However, a further control on execution was established for international cooperation initiatives or programmes with special features.[11] Therefore, Instruction 67/2011 opens the way to the centralisation of the procurement process as well as it simplifies the procedures. This centralisation process ended up in 2014 with the approval of Resolution 320/03967/2014, that specifies the contracts and programmes whose execution will be incorporated in the Directorate General of Armament and Material, and the Royal Decree 524/2014, that focuses on a ministerial reorganisation to include the new functions derived from this last reform.

The National Defence and Security Public Contract Law 24/2011, as the transposition of Directive 81/2009/EC, aims at implementing fair and transparent procurement processes while ensuring flexibility in negotiations of complex contracts (Transparency International 2016). A related code of conduct for defence contractors was passed through Instruction 44/2011, with the goals of increasing publicity, guaranteeing equal access to public tenders, and extending the business opportunities of major businesses to SMEs and tier 2- and 3-level subcontractors.[12] Although a positive trend in open tenders is observed between 2008 and 2011 (Fonfría and Martín 2018), this evolution[13] has taken place within a reduction in the overall number of contracts year on year due to budget restrictions. Furthermore, the increase in bidders has shown to reduce the price (González Chapela 2019) and to rise savings (González Chapela, Labeaga, and Medrano 2019) for service procurements during the periods 2012-2016 and 2012-2015, respectively. However, the economic value of open contracts regarding the acquisition budget has not increased during this period (Fonfría and Martín 2018; Soriano Forte 2016). This would indicate that the new rules are increasing transparency and accountability. This is especially relevant as imperfect market conditions have proved to reduce firm incentives to minimise costs, corroborating the so called cost-shifting hypothesis (Rogerson 1989; Smith

[11] Instruction 67/2011, article 9.

[12] Adhering to this code of conduct has been voluntary. Nonetheless, it could become mandatory for any company wishing to enter into a contract with the Ministry of Defence, depending on sector needs and the industrial strategy eventually adopted. Additionally, in accordance with the Directive 2009/81/EC, the main clauses of the code of conduct became compulsory (García Montaño 2015a).

[13] Similarly, Soriano Forte (2016) finds a positive trend in open biddings for the 2008–2015 period.

1990). Together with cost reimbursement systems, this has been shown to positively affect firms profits in different countries (Rogerson 1992).

To sum up, the new procurement framework and contract regulation in the Spanish defence market follows international trends to rationalise the procedures, and to increase transparency and improve market conditions. In this paper we investigate whether the new regulatory framework introduced in 2011, and completed in 2014, has affected firm performance. The following section presents a theoretical model to assess the impact of the reforms on defence firms.

3 Theoretical setup

In constructing the model we use some characteristics described in Levine, Sen, and Smith (1994), Levine and Smith (1995), and García-Alonso (1999). We consider a static economy with firms involved in procuring to the government, which establishes its demand for weapons from the maximization of an utility function:

$$U = U(C, S) \tag{1}$$

where C is aggregate consumption and S is the overall security level. The budget constraint is given by

$$Y = C + PM + I \tag{2}$$

where Y is the national income, M is the procurement level, P is the relative price of arms to consumption goods and I is the government participation in the R&D process of defence firms. The relative price P reflects the way contracts between the government and military firms are arranged and contains negotiation cost.

The level of security depends on the national defence and on the military capability of potential adversaries. We assume that both national and foreign military capability depend on the arms holding and the quality of those arms. Therefore, the overall security level can be formulated as a function of these arguments,

$$S = S(\underset{(+)}{M}, \underset{(+)}{Q}, \underset{(-)}{m}, \underset{(-)}{q}) \tag{3}$$

where Q is the quality of domestic arms, m is the adversary's stock of arms and q is its quality. Signs under the variables reflect those of the corresponding partial derivatives of the security function.

Our model is a simplification of the industrial innovation process described in Martí Sempere (2017), where the Ministry of Defence is choosing a firm with attractive R&D that it is ready to (co)finance. The market is made up by a continuum of firms, some of them being eligible

as government contractors. Firms' cost function is denoted as $c(M)$, such that $c'(M) > 0$. Firms can reduce production costs through technological improvements, i.e. spending more on R&D. The variable R stands for the total amount of resources devoted to R&D. More resources allocated to R&D translate into a higher technological level, $\upsilon(R)$, with $\frac{d\upsilon}{dR} > 0$ and $\frac{d^2\upsilon}{dR^2} \leq 0$.

Firms' profits can be expressed as:

$$\Pi = PM - \frac{1}{\upsilon(R)} c(M) - (1-a)R \tag{4}$$

where $1-a$, with $0 < a \leq 1$, is the fraction of R&D financed by firms and, consequently, a is that by the Ministry of Defence. Therefore, the government participation in the R&D process of defence firms is:

$$I = aR. \tag{5}$$

Quality of arms depends on the total research cost,

$$Q = Q(R) \tag{6}$$

with $\frac{dQ}{dR} > 0$ and $\frac{d^2Q}{dR^2} \leq 0$. Government funding I is sufficient to reach the minimum quality requirements. Each quantity of procured good can be labeled by its quality level, procurement demand being denoted by $M^{(Q)}$, where (5) and (6) indicate how a better quality is achieved. Also, the bigger is the fraction of the total research cost financed by the government, a, the higher are firm's profits.

In this framework, there are two stages of the procurement process. In the first stage, the Ministry of Defence chooses projects that are assigned the R&D funding. In the second stage, the government hires a firm able to satisfy its procurement needs. Such a firm thus becomes a government contractor. Firms are motivated to present attractive proposals in the first phase because financing from the ministry may foster productivity improvements. Also, obtaining successful products will likely open the door to a large production contract in the second step (Rogerson 1995) and/or even foreign or civilian sales (Lichtenberg 1995). The negotiations with the contractor in the second stage evolve under the conditions (legal status) established by the Ministry of Defence. In what follows, we consider two procurement systems: procurement system 1 (ps1) reflects the situation before the reform, and procurement system 2 (ps2) represents the situation after the reform. The model stipulates a simple agenda in which the legal change could affect the conditions imposed by the ministry on the process of procurement and in turn the firm performance.[14]

Procurement system 1 (ps1): Under this system, in the first stage, the ministry assigns a research subsidy I_{ps1} to the chosen firm. In the second stage, bargaining between the ministry and the potential contractor takes place, and a price that implies non-negative profits for

[14] The performance of firms before and after the legal reform can be then tested empirically.

the contractor is set. The chosen winner will satisfy the government demand for arms with the desired minimum quality, $M^{(Q_{\min})}$, for the negotiated price, P_{ps1}. Such a price leads to profits Π_{ps1}. Note that the final procurement demand is related to the negotiated conditions, $M_{\text{ps1}} = M(P_{\text{ps1}}, Q_{\min})$.

Procurement system 2 (ps2): We take into account that the reform aims to improve the supervision of defence firms by the ministry, to foster the relationships between them, and to make the procuring process more transparent. Moreover, it rationalises the costs for the Ministry of Defence. The reform thus brings greater bargaining power for the government over the defence contracts. We assume that the first phase proceeds in the same fashion as in the pre-reform period, R&D funds I_{ps2} are destined to the chosen candidate, and the amount can be the same, $I_{\text{ps2}} = I_{\text{ps1}}$. In the second phase, the requirement over a minimum level of quality is maintained, but due to legal changes in contract accomplishment negotiated prices will decrease, i.e. $P_{\text{ps2}} < P_{\text{ps1}}$. Clearly, this pushes down the profits of the contractor. By accommodating investment in R&D firms can compensate this decrease in profits. If this is the case, research cost may be pushed up to a certain level $R_{\text{ps2}} \geq R_{\text{ps1}}$.[15] Notice that even if the quality of the final product is maintained, the procurement level may be different under the procurement system 1 and 2, $M_{\text{ps2}} = M(P_{\text{ps2}}, Q_{\min}) > M_{\text{ps1}}$.

The final effect of the reform on profits is negative in the absence of firm reaction in terms of R&D improvement. In such a case, the post-reform productivity will not be improved either. On the contrary, provided firms improve their technology, the final effect of the reform on productivity is positive and profit reduction can be neutralised. However, the final effect on profits will depend on firm R&D investment intensity. Therefore, it can be stated that this theoretical setup establishes two testable predictions. First, productivity increases by virtue of technology improvements. Second, there is no clear prior about the influence of the new regulatory framework on profitability.

4 Empirical framework

According to the model presented in the previous section, regulatory changes are expected to affect the productivity and profitability of firms contracting with the Ministry of Defence. To evaluate this potential impact, we adopt a differences-in-differences approach. This method is typically used to estimate the effect of a specific exogenous intervention or treatment – such as a law approval or policy enactment – by comparing the changes in outcomes over time between either a population that is affected by the intervention (treatment group) and a population that is not (control group), see Card and Krueger (1994); or a population that is more exposed

[15] Given the price set by the Ministry of Defence, demand for procurement and the final cost of the product, maximum affordable research cost can be determined by each firm.

to the intervention and a population less exposed, see Duflo (2001), among others. In our case, the more important the contractor is for the Ministry of Defence, the more exposed to the introduction of the new legal framework. Once defined the two groups, we estimate the corresponding outcome differences as a consequence of the laws approval. Therefore, we compare the change in the dependent variable for main contractors (treated), before and after legal reforms were approved, to the change in the same variable among the rest of defence contractors (controls). The difference in these differences can be interpreted as the causal effect of the new legal framework under the assumption that, in the absence of the laws' approval, the effects on performance of the two groups would not have had to be systematically different (Bertrand, Duflo, and Mullainathan 2004).

The sample studied covers 277 Spanish defence firms during 2000–2018. The data have been extracted from several complementary sources. First, we assemble the firms listed in the catalogue of the Spanish defence industry in 2015 published by the Ministry of Defence (2016). Then, we classify firms in two groups: main defence contractors (hereafter main contractors), and the rest of defence contractors (hereafter defence contractors). In doing so, we follow the approach taken by Martin, White, and Hartley (1996) who classify contractors between 'dependent' and 'non-dependent' in their analysis of the U.K. defence industry, to measure their relationship with the Ministry of Defence. In our case, main contractors are the firms that participate in procurement programmes and that account for a relevant share of all purchases by the Ministry of Defence (more important firms in terms of ministerial purchases in 2015 and 2016 and firms that participate in procurement programmes). These companies develop tailored-made, usually innovative products, hence being more exposed to the legal reforms. Further, according to the ministry records, these firms have received R&D financing and/or participated in research collaborations during the period analysed. Our claim rests on the fact that, as stated above, the legal reforms are introduced to improve market performance of these products, which represent the largest percentage of defence acquisition budgets. These are precisely the firms included in our main contractor definition: those that account for a greater share of the ministerial budget and participate in procurement programmes. For that, we use information from the 2015 and 2016 reports on the defence industry elaborated by the Ministry of Defence (DGAM 2018b, 2018c) and actual procurement programmes[16]. By proceeding in this way, 113 firms from our sample have been classified as main contractors, representing more than 90% of the purchases carried out by the Ministry of Defence.

Along these lines, we are able to estimate the impact of the new legal framework, contrasting changes in performance of main contractors, which are more affected by the new procedures, with those firms less exposed to the legal reform, the rest of defence contractors. The identification is based on the assumption that firms do not sort in or out of treatment. That is to say,

[16] https://www.defensa.gob.es/ministerio/organigrama/sedef/dgam/

the firms that represent an important share of ministerial purchases during the years 2014–2016 are considered to be main contractors throughout the eighteen years analysed. Although there might have been some changes during the sample period, we consider them negligible for the purpose of the paper for two reasons. On the one hand, different reports published by the Ministry of Defence (DGAM 2016, 2018a) confirm the classification for the last part of the sample period, and recall long-term and stable relationships with main contractors. On the other hand, the long duration of defence programs is corroborated by the fact that the main procurement programs signed by the governments in the 1990s and the early 2000s have been active along the whole sample period (Colom Piella 2016). Finally, we collect financial information retrieved from the Spanish business register through the System of Analysis of Iberian Balance Sheets (SABI) database, compiled by Bureau van Dijk.

Our baseline regression is defined as:

$$y_{it} = \alpha + \beta X_{it-1} + \delta_0 \; Rank_i + \delta_1 Post_t + \delta_2 (Rank_i \times Post_t) + u_{it}. \tag{7}$$

The dependent variable y_{it} takes the value of the measures of performance of firm i during the year t included in the model: productivity (the operating income to employees, in logarithms to control for skewness) and profitability. The latter has been proxied using the return to sales (hereafter profitability) and the return on assets (ROA). The coefficient α is the intercept and $Rank_i$ is an indicator variable that takes a value of 1 if the firm i is identified as a main contractor, trying to capture the differences with the other defence contractors. The variable $Post_t$ is an indicator that takes a value of 1 after the policy change, zero otherwise. We use two alternative specifications to account for the legal novelties introduced in 2011 and 2014. In the first specification, we consider 2012 as the post-legal reform starting year. The interaction term ($Rank_i \times Post_t$) captures the effects of the regulatory changes on performance measures, being δ_2 our main parameter of interest. In the second specification, we introduce an additional control for the 2014 centralisation regulation in order to disentangle the distinctive influence of the complementary legal changes taken place in 2011 and 2014. Accordingly, two interaction terms are used for these two years.

A set of firm-level control variables (X_{it-1}) has been included to account for other factors not related with the reform that could also affect the performance of firms. These regressors refer to the previous period, trying to mitigate potential simultaneity concerns. Following the related literature analysing firm performance (see Cingano et al. [2010], among others) we include age (difference between the current year and that of firm creation), the size of the firm (number of employees, in logarithms), and the share of intangible assets to proxy for reputation, liquidity/internal resources, and R&D investments/technological progress opportunities, respectively. We also introduce labour costs, measured as the employee cost ratio. Further, firm productivity has been shown to be positively influenced by internationalisation (Fariñas and Martín-Marcos 2007; Aw, Roberts, and Xu 2011) and foreign ownership (Harris and Robinson

2003). As the Spanish defence industry has boosted its exports and has recently been part of international merger waves, two dummy variables to proxy for internationalisation (whether the firm exports) and the presence of foreign capital participation (whether there are international shareholders) have been included. During the period of study, along with the international financial crisis, Spain suffered a deep economic downturn starting in 2008 that put into place constraints to the defence budget. For this reason, an additional dummy variable has been introduced to control for the potential effects of the crisis. The estimations exploit the panel structure of the data to control for non-observable heterogeneity. Industry dummies have also been included to reduce the sampling variability of the estimates.[17] In addition, standard errors have been clustered at the firm level to allow for time-series persistence of the shocks and reduce overestimation of t-statistics and significance levels (Bertrand, Duflo, and Mullainathan 2004).

[Insert Tables 1 and 2 around here]

Tables 1 and 2 report descriptive statistics for the main variables of interest. Table 1 shows that the median firm size is smaller than the average, reflecting that the Spanish defence industry was concentrated in large companies during 2000-2018. Similar evidence is described by Duch-Brown and Fonfría (2014) for a shorter period. More interestingly, Table 2 collects the differences-in-mean test statistics between the main contractors and the other defence contractors. Panel A shows that main contractors are significantly larger, older, present lower labour costs and higher shares of intangible assets, and display a higher labour productivity than defence contractors. Differences in ROA and profitability, however, are not significant at the 5% level. This descriptive evidence is in line with previous studies on the performance of military contractors in Canada (Pepall and Shapiro 1991), the U.K. (Martin, White, and Hartley 1996) and Spain (Fonfría and Correa-Burrows 2010). Panel B reports differences before and after the 2011 legal reform. As in Panel A, the main contractors are significantly older than defence contractors in both subperiods. Differences in size have become significant after the reform as the main contractors show a slight increase in the number of employees while that of the other defence contractors remains almost the same. Labour costs are also significantly lower for the main defence contractors in both subperiods. Looking at the performance measures, labour productivity of the main contractors is significantly higher both before and after the legal changes. Interestingly, while the main contractors become more efficient after the reform, the productivity of the other contractors has been nearly stable. Although the profitability of all contractors worsened after 2011, the decrease was less important for the main contractors. Nonetheless, the differences between the two groups are not statistically significant in any subperiod. Both groups of firms present a decrease in ROA in the second subperiod, reflecting

[17] The classification used is NACE, rev. 2.

the influence of a higher competition or the economic crisis.[18] However, the difference is not significant after 2011. Finally, Panel C presents the differences distinguishing two subperiods after the first reform. The main contractors are older, larger, and more efficient than the other defence contractors, as shown by their higher average labour productivity and lower labour cost. These differences increase after 2014. Regarding the other performance measures, the ROA of the main contractors was higher than that of the other defence contractors before 2014, when it experienced an important reduction. Nevertheless, that of main contractors declined, making the difference with that of the other contractors not statistically significant. This decreasing trend along the second subperiod is also observed in profitability. Summarizing, this descriptive analysis suggests some performance improvements of the main contractors along the sample period. In the next section, we check whether this preliminary evidence is confirmed, and the reforms have had significant effects once industry and firm characteristics are controlled for.

5 Results

Table 3 shows the estimation results of equation (7) considering the effects of the 2011 reform alone. For each dependent variable, the first column (specification) includes firm age, size, labour cost, and intangible assets as covariates. The second column adds dummies for export activity and for the presence of foreign shareholders. The first two columns show that labour costs are inversely related to productivity. As expected, this is also the case of firms with foreign shareholders. The rest of firm characteristics as well as the crisis dummy are not statistically significant. Looking at the variables of interest, the dummy variable that identifies the main contractors has a positive sign. In line with the figures displayed in Table 2, this reflects that they display higher labour productivity. Moreover, the interaction term that captures the differential effects of the regulatory changes on main contractors shows a positive and significant impact of the reform, at the 5% level, on their labour productivity. That is, main contractors have been more positively affected by the reform in 2011 than the other defence contractors, in terms of productivity. This result is independent of the set of control variables introduced.

[Insert Table 3 around here]

Columns 3 to 6 of Table 3 show the results for the profitability proxies. The third and fourth columns present the parameter estimates when ROA is considered as the dependent variable. In this case, the results are milder than those presented above. The estimated coefficient for the indicator of main contractor firms is positive, but not statistically significant. The dummy variable for the period after the reform is negative and highly significant, reflecting a decrease

[18] We are grateful to one anonymous referee referee for drawing our attention to this interpretation.

in the ROA of all defence firms. However, the lack of statistical significance of the interaction term suggests that the general negative trend has not been different for main contractors. This finding can be interpreted as evidence that the new regulations introduced in 2011 have not had a differential effect on those firms that are more exposed to them. Looking at the control variables, it is worth noting that the crisis dummy now presents a negative and significant coefficient at conventional levels. This would indicate that the economic downturn had a negative effect on ROA. Therefore, the downward trend observed in this variable does not seem to be associated to improved market conditions, but to be the impact of the general economic crisis. Similar conclusions can be drawn from the last two columns, that display estimation results obtained when the ratio of sales to assets is used as the dependent variable. These findings do not depend on the control variables included. Altogether, the results displayed in Table 3 suggest that the 2011 reforms did have a positive differential impact on the labour productivity of main contractors, even under the general reduction of profitability.

[Insert Table 4 around here]

As highlighted above, the reforms started in 2011 and concluded in 2014, when the execution of a series of existing programs was also centralised. Table 4 shows the estimation results when both legal reforms are considered. The coefficients for firm characteristics do not meaningfully change with respect to those reported in Table 3. Contrarily, the interaction term for the reform of 2011 is not statistically significant when labour productivity is the dependent variable. More importantly, this is not the case of the term that reflects the differential effect of legal changes in 2014 on the productivity of main contractors. Therefore, it can be stated that the centralisation established in 2014 not only implied an important ministerial reorganization, but also had a significant positive influence on the productivity of those companies more exposed to the regulation. This effect seems to be more important than the mere introduction of the new procurement procedures and the contract law. Further, according to the theoretical model, the absence of significant effects on profitability together with the increase in productivity could be an indication that main contractors are making relevant efforts to improve their technology.

[Insert Table 5 around here]

Given that the Spanish defence industry is concentrated in a few large firms, the sample has been split between large (more than 250 employees) and SMEs (less than 250 employees) to evaluate whether there exists a different impact associated to size. Table 5 collects the results for both subsamples. The method of estimation and the variables included mimic those of Table 4. Results show that splitting the sample enriches the conclusion since the two reforms considered affect differently large firms and SMEs. In particular, these figures suggest that the reform of 2011 had a positive effect on the productivity of large main contractors. That of

smaller main contractors was not affected until the centralisation process of 2014 was put into place. In line with the results reported in tables 3 and 4, distinguishing the firms according to their size does not lead us to find any significant influence of either reform on the profitability of main defence contractors, regardless the measure considered. This may reflect that firms react to the reform in terms of R&D investment.

Therefore, the new regulatory framework introduced in 2011, and completed in 2014, has improved the productivity of main contractors, that is, firms that often provide tailored-made products and represent the largest percentage of the acquisition budgets. These results suggest that the reform implemented is helping to develop a healthier industry which is one of the objectives of policy implementation. Previous findings may be related to the fact that contractors anticipated the 2011 and 2014 reforms when the capability-based planning was introduced in 2005. In order to discard biases and show the robustness of the results we conduct a falsification exercise, which we term 'in-time placebo studies,' following Abadie, Diamond, and Hainmueller (2010, 2014). This exercise allows us to assess whether the estimated effect for the main defence contractors, more exposed to the 2011 and 2014 intervention, is different to the estimated effect for years where the intervention did not take place. Provided the estimated effects for dates when the intervention did not occur are similar or larger than those for the real date, the attribution of the effects found to the legal change itself would greatly diminish or, at most, it would indicate that main contractors anticipated the reforms. In particular, equation (7) has been re-estimated collecting the interaction term from 2003 to 2010. The same exercise has been repeated for large firms and SMEs. Figure 1 plots the estimated interaction terms and their 95% confidence intervals. The results for the complete sample show that there are no significant effects for any of the performance measures analysed, since the confidence band overlaps the zero value. Nonetheless, there is some evidence of anticipation to the legal changes in the productivity of main contractors at the end of the pre-intervention period. It can also be observed that splitting the sample does not provide any additional insight.

[Insert Figure 1 around here]

6 Concluding remarks

The Spanish defence market has experienced many changes in the last two decades, but also continuity due to the coexistence of an increasing number of competitive contracts and enhanced protection to national industry (Fonfría and Martín 2018). In the present paper, the effects on industry performance of recent regulatory reforms – intended to increase efficiency and cost control in the procurement process – have been analysed. To do so, a theoretical framework

to study firm strategic reaction to legal reforms has been presented. The model consists of a comparison between the procurement procedure before and after the new legal scenario is in place. It is shown that improving transparency and alleviating market imperfections encourage defence contractors to reduce their costs and produce more efficiently to offset profitability contraction. The cost reduction is associated with an increase in R&D expenses that improves technology and productivity of contractors. As a consequence, the government may have the possibility of increasing arms demand and, at the same time, enjoying better product quality.

The implications of the model have been tested taking advantage of the approval of legal reforms in 2011 and 2014, aimed at improving market conditions in the tailored-made products' industries, which are the largest part of the Ministry acquisition budgets. The results obtained from the econometric analysis are mostly in line with the theoretical predictions. The legal reforms implemented in 2011 exerted a positive influence on the productivity of main defence contractors, especially large companies. The productivity of smaller firms has been more affected by the centralisation process put into place in 2014. We have not found evidence of significant effects of these legal changes on the profitability of main defence contractors. This may be an indication of the reaction of firms in terms of R&D investments are improving productivity and offsetting the profits contraction. Further, the 'in-time placebo studies' carried out show that there is no clear anticipation behaviour prior to the regulation issuance. There is only some evidence of an effect on productivity at the end of the pre-intervention period.

To sum up, the present study provides additional evidence on the effects that legal reforms can exert on firm performance in the defence sector. In particular, our findings suggest that the changes in the regulatory scenario can induce a positive influence on the established industry. Hence, Spanish government interventions seem to have accomplished some of the expected results, those associated to firm performance. It is worth noting that the effects on market conditions – such as the type of contracts, product quality, prices or outlays – have not been evaluated in this paper, and are left for future research. Therefore, and before promoting further reforms, market conditions should be assessed in order to avoid potential scenarios where efficiency is not improved in either market conditions or firm performance. This finding confirms the relevance of assessing the outcomes of public interventions.

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References

[1] Abadie, Alberto, Alexis Diamond, and Jens Hainmueller. 2010. "Synthetic Control Methods for Comparative Case Studies: Estimating the Effect of California's Tobacco Control Program." *Journal of the American Statistical Association* 105 (490): 493–505. doi:10.1198/jasa.2009.ap08746.

[2] Abadie, Alberto, Alexis Diamond, and Jens Hainmueller. 2014. "Comparative Politics and the Synthetic Control Method." *American Journal of Political Science* 59 (2): 495–510. doi:10.1111/ajps.12116.

[3] Álvarez, Isabel, and Antonio Fonfría. 2000. "Estructura e Innovación en la Industria de Defensa Española." *Economistas* 85: 102–121.

[4] Arnold, Jens, Giuseppe Nicoletti, and Stefano Scarpetta. 2011."Does Anti-Competitive Regulation Matter for Productivity? Evidence from European Firms." Institute for the Study of Labor (IZA) Discussion Paper No 5511.

[5] Arteaga, Félix. 2013. "The Coming Defences: Criteria for the Restructuring of Defence in Spain." Elcano Royal Institute Policy Paper No 3/2013.

[6] Arteaga, Félix. 2014. "A Proposal for Restructuring the Security and Defense Industrial Sector in Spain." *Defence and Peace Economics* 25 (1): 69–83. doi:10.1080/10242694.2013.857463.

[7] Aw, Bee Y., Mark J. Roberts, and Daniel Y. Xu. 2011. "R&D Investment, Exporting, and Productivity Dynamics." *American Economic Review* 101 (4): 1312–1344. doi:10.1257/aer.101.4.1312

[8] Barco Gorostegui, Juan A., and Carlos Calvo González-Requeral. 2015. *La Dirección General de Armamento y Material*. Madrid: Information and Design Solutions.

[9] Bertrand, Marianne, Esther Duflo, and Sendhil Mullainathan. 2004. "How Much Should We Trust Differences-In-Differences Estimates?" *Quarterly Journal of Economics* 119 (1): 249–275. doi:10.1162/003355304772839588.

[10] Card, David, and Alan B. Krueger. 1994. "Wages and Employment: A Case Study of the Fast-Food Industry in New Jersey and Pennsylvania." *American Economic Review* 84 (4): 772–793. doi:10.1257/aer.90.5.1397.

[11] Cingano, Federico, Marco Leonardi, Julian Messina, and Giovanni Pica. 2010. "The Effects of Employment Protection Legislation and Financial Market Imperfections on Investment: Evidence from a Firm-Level Panel of E.U. Countries." *Economic Policy* 25 (61): 117–163. doi:10.1111/j.1468-0327.2009.00235.x.

[12] Colom Piella, Guillem. 2016. "Transforming the Spanish Military." *Defence Studies* 16 (1): 1–19. doi:10.1080/14702436.2016.1146078.

[13] Colom Piella, Guillem. 2017. "Una Revisión del Planeamiento de la Defensa por Capacidades en España (2005–2016)." *Papeles de Europa* 30: 47–68. doi: 10.5209/PADE.56334

[14] Den Hertog, Johan A. 1999. "General Theories of Regulation." In *Encyclopedia of Law and Economics*, edited by Boudewijn Bouckaert and Gerrit De Geest, 223–270. Cheltenham: Edward Edgar.

[15] DGAM (Dirección General de Armamento y Material). 2012. *Estrategia Industrial de Defensa*. Madrid: Catálogo General de Publicaciones Oficiales.

[16] DGAM (Dirección General de Armamento y Material). 2016. *La Industria de Defensa en España. Informe 2014*. Madrid: Catálogo General de Publicaciones Oficiales.

[17] DGAM (Dirección General de Armamento y Material). 2018a. *El sector Industrial de Defensa en España 2010–2016*. Madrid: Catálogo General de Publicaciones Oficiales.

[18] DGAM (Dirección General de Armamento y Material). 2018b. *La Industria de Defensa en España. Informe 2015*. Madrid: Catálogo General de Publicaciones Oficiales.

[19] DGAM (Dirección General de Armamento y Material). 2018c. *La Industria de Defensa en España. Informe 2016*. Madrid: Catálogo General de Publicaciones Oficiales.

[20] Dowdall, Paul. 2004. "Chains, Networks and Shifting Paradigms: The U.K. Defence Industry Supply System." *Defence and Peace Economics* 15 (6): 535–550. doi:10.1080/1024269042000246639.

[21] Duch-Brown, Néstor, and Antonio Fonfría. 2014. "The Spanish Defence Industry: An Introduction to the Special Issue." *Defence and Peace Economics* 25 (1): 1–6. doi:10.1080/10242694.2013.857462.

[22] Duch-Brown, Néstor, Antonio Fonfría, and Elisa Trujillo-Baute. 2014. "Market Structure and Technical Efficiency of Spanish Defense Contractors." *Defence and Peace Economics* 25 (1): 23–38. doi:10.1080/10242694.2013.857461.

[23] Duflo, Esther. 2001. "Schooling and Labor Market Consequences of School Construction in Indonesia: Evidence from an Unusual Policy Experiment." *American Economic Review* 91 (4): 795–813. doi:10.2307/2677813.

[24] Edwards, Jay. 2011. "The E.U. Defence and Security Procurement Directive: A Step Towards Affordability?" Chatam House International Security Programme Paper No 2011/05.

[25] Fariñas, José C., and Ana Martín-Marcos. 2007. "Exporting and Economic Performance: Firm-Level Evidence of Spanish Manufacturing." *The World Economy* 30 (4): 618–646. doi:10.1111/j.1467-9701.2007.01007.x.

[26] Fiott, Daniel. 2017. "The E.U., N.A.T.O. and the European Defence Market: Do Institutional Responses to Defence Globalisation Matter?" *European Security* 26 (3): 398–414. doi:10.1080/09662839.2017.1352582.

[27] Fonfría, Antonio, and Paulina Correa-Burrows. 2010. "Effects of Military Spending of Spanish Defence Contractors." *Defence and Peace Economics* 21 (2): 177–192. doi:10.1080/10242690903569007.

[28] Fonfría, Antonio, and Fernando Martín. 2018. "Efectos de la Crisis Económica en la Contratación en Defensa." *Papeles De Europa* 30 (1): 1-18. doi:10.5209/PADE.56333.

[29] García Montaño, Juan M. 2015a. "La Nueva D.G.A.M." *Revista Española de Defensa* 318: 46–49.

[30] García Montaño, Juan M. 2015b. "La Política Industrial de Defensa." *Cuadernos de Estrategia* 175: 111–142.

[31] García-Alonso, Mary C. 1999. "Price Competition in a Model of Arms Trade." *Defence and Peace Economics* 10 (3): 273–303. doi:10.1080/10430719908404927.

[32] García-Estevez, Javier, and Elisa Trujillo-Baute. 2014. "Drivers of R&D Investment in the Defence Industry: Evidence from Spain." *Defence and Peace Economics* 25 (1): 39–49. doi: 10.1080/10242694.2013.857464.

[33] González Chapela, Jorge. 2019. "Weight Values, Scoring Rules and Abnormally Low Tenders Criteria in Multidimensional Procurement: Effects on Price." *Hacienda Pública Española* 228 (1): 55–81. doi:10.7866/hpe-rpe.19.1.3.

[34] González Chapela, Jorge, José M. Labeaga, and Luis A. Medrano. 2019. "Further Econometric Evidence on the Extent and Sources of Cost Savings in Competitively Tendered Contracts." *Empirical Economics* 56 (2): 679–701. doi:10.1007/s00181-017-1365-8.

[35] Guichard, Renelle. 2005. "Suggested Repositioning of Defence R&D within the French System of Innovation." *Technovation* 25 (3): 195–201. doi:10.1016/S0166-4972(03)00131-7.

[36] Guillou, Sarah, Nathalie Lazaric, Christian Longhi, and Sylvie Rochhia. 2009. "The French Defence Industry in the Knowledge Management Era: A Historical Overview and Evidence from Empirical Data." *Research Policy* 38 (1): 170–180. doi:10.1016/j.respol.2008.10.015.

[37] Harris, Richard, and Catherine Robinson. 2003. "Foreign Ownership and Productivity in the United Kingdom. Estimates for U.K. Manufacturing Using the ARD." *Review of Industrial Organization* 22 (3): 207–223. doi:10.1023/A:1023622407571.

[38] Hartley, Keith. 2003. "The Future of European Defence Policy: An Economic Perspective." *Defence and Peace Economics* 14 (2): 107–115. doi:10.1080/10242690302921.

[39] Hartley, Keith. 2008. "Collaboration and European Defence Industrial Policy." *Defence and Peace Economics* 19 (4): 303–315. doi:10.1080/10242690802221585.

[40] IDS (Information and Design Solutions). 2017. "Spain, Defence and Security Industry: R&D, the Strategic Approach." Information and Design Solutions. Accessed 11 June 2020. https://www.infodefensa.com/archivo/files/spain2017(ing)OK%20.pdf.

[41] Kurç, Çağlar, and Stephanie G. Neuman. 2017. "Defence Industries in the 21st Century: A Comparative Analysis." *Defence Studies* 17 (3): 219–227. doi:10.1080/14702436.2017.1350105.

[42] Levine, Paul, Somnath Sen, and Ron Smith. 1994. "A Model of the International Arms Market." *Defence and Peace Economics* 5 (1): 1–18. doi:10.1080/10430719408404776.

[43] Levine, Paul, and Ron Smith. 1995. "The Arms Trade and Arms Control." *The Economic Journal* 105 (429): 471–484. doi:10.2307/2235505.

[44] Lichtenberg, Frank R. 1995. "Economics of Defense R&D." In *Handbook of Defense Economics Volume 1*, edited by Keith Hartley and Todd Sandler, 431–457. Amsterdam: Elsevier Science.

[45] Martí Sempere, Carlos. 2017. "A Survey of Performance Issues in Defence Innovation." *Defence and Peace Economics* 28 (3): 319–343. doi:10.1080/10242694.2015.1072377.

[46] Martí Sempere, Carlos. 2019. "A Review of Market Failures in the Defence Industry." *Defence and Peace Economics.* Advance online publication. doi:10.1080/10242694.2019.1581981.

[47] Martin, Stephen, Richard White, and Keith Hartley. 1996. "Defence and Firm Performance in the U.K." *Defence and Peace Economics* 7 (4): 325–337. doi:10.1080/10430719608404861.

[48] Ministry of Defence. 2016. *Catalogue Spanish Defence Industry 2015.* Madrid: Catálogo General de Publicaciones Oficiales.

[49] Molas Gallart, Jordi. 1998. "Defence Procurement as an Industrial Policy Tool: The Spanish Experience." *Defence and Peace Economics* 9 (1–2): 63–81. doi:10.1080/10430719808404894.

[50] Molas Gallart, Jordi, and Puay Tang. 2006. "Ownership Matters: Intellectual Property, Privatization and Innovation." *Research Policy* 35 (2): 200–212. doi: 10.1016/j.respol.2005.03.017.

[51] Ortega, Vicente, Manuel Gamella, and María A. Moya. 2012. *Investigación, Desarrollo e Innovación I+D+i en el Sector de la Defensa: Análisis de la Situación (2009-2012).* Madrid: Fundación Rogelio Segovia para el Desarrollo de las Telecomunicaciones.

[52] Pepall, Lynne. M., and Daniel M. Shapiro. 1991. "The Profitability of Canadian Defence Contractors." *International Journal of Industrial Organization* 9 (3): 425–440. doi:10.1016/0167-7187(91)90021-C.

[53] Pereira Rueda, Manuel. 2011. "La Innovación y su Implicación en el Planeamiento de Defensa." *Cuadernos de Estrategia* 154: 67-104.

[54] Pérez Muinelo, Francisco. 2015. *El Gasto de Defensa en España 1946-2015.* Madrid: Ministerio de Defensa.

[55] Pyman, Mark, Regina Wilson, and Dominic Scott. 2009. "The Extent of Single Sourcing in Defence Procurement and its Relevance as a Corruption Risk: A First Look." *Defence and Peace Economics* 20 (3): 215–232. doi:10.1080/10242690802016506.

[56] Rogerson, William P. 1989. "Profit Regulation of Defense Contractors and Prizes for Innovation." *Journal of Political Economy* 97 (6): 1284–1305. doi: 10.1086/261654.

[57] Rogerson, William P. 1992. "Overhead Allocation and Incentives for Cost Minimization in Defense Procurement." *Accounting Review* 67 (4): 671–690. doi: 10.2307/248318.

[58] Rogerson, William P. 1995. "Incentive Models of the Defense Procurement Process." In *Handbook of Defense Economics Volume 1*, edited by Keith Hartley and Todd Sandler, 309–346. Amsterdam: Elsevier Science.

[59] SIPRI (Stockholm International Peace Research Institute). 2012. "Yearbook. Armaments, Disarmament and International Security." Stockholm International Peace Research Institute. Accessed 11 June 2020. https://www.sipri.org/sites/default/files/2016-03/SIPRIYB12Summary.pdf.

[60] Smith, Ron P. 1990. "Defence Procurement and Industrial Structure in the U.K." *International Journal of Industrial Organization* 8 (2): 185–205. doi:10.1016/0167-7187(90)90015-S.

[61] Soriano Forte, Ginés. 2016. *Mapa de la Contratación del Ministerio de Defensa Durante 2015*. Madrid: Information and Design Solutions.

[62] Transparency International. 2016. "Single Sourcing: A Multi-country Analysis of Non-competitive Defence Procurement." Transparency International Defence and Security Program. Accessed 11 June 2020. https://ti-defence.org/wp-content/uploads/2016/03/140910-Single-Sourcing.pdf.

[63] Weiner, Katharina. 2012. "Towards European Preferences? Implications of Directive 2009/81/EC on Domestic Preferences in Defence Procurement." *The Procurement Lawyer* 47: 16–20.

Table 1. Main variables: Definitions and descriptive statistics.

Variable	Mean	SD	P25	P50	P75
Labour Productivity: *Operating income to employees (log)*	4.997	0.899	4.356	4.907	5.516
Profitability: *Returns on sales*	-0.067	4.009	0.016	0.047	0.096
ROA: *Returns on assets*	4.005	36.764	0.790	4.050	9.530
Age: *Number of years*	22.054	15.550	11	19	29
Size: *Number of employees (log)*	4.274	1.869	2.995	4.060	5.356
Labour Cost: *Total labour cost to number of employees*	35.631	41.175	17.370	29.590	48.230
Intangible Assets: *Share of intangible assets to total fixed assets*	0.174	0.238	0.007	0.058	0.252

Data are for 277 Spanish defence firms during the period 2000-2018 from SABI. The number of observations is 2,685.

Table 2. Group descriptive statistics:
Differences between main contractors and defence contractors.

Panel A: Complete sample period, 2000-2018.

	Main contractors		Defence Contractors	
	Mean	Observations	Mean	Observations
Labour Productivity	**5.270**	1,028	**4.827**	1,657
	(0.948)		(0.823)	
Profitability	-0.192	1,028	0.009	1,657
	(6.411)		(0.742)	
ROA	4.609	1,028	3.631	1,657
	(55.984)		(15.700)	
Age	**25.764**	1,023	**19.732**	1,634
	(20.177)		(11.156)	
Size	**4.427**	1,028	**4.180**	1,657
	(2.118)		(1.690)	
Labour Cost	**27.051**	1,028	**40.953**	1,657
	(21.361)		(48.896)	
Intangible Assets	**0.189**	1,028	**0.164**	1,657
	(0.247)		(0.231)	

Data are for 277 Spanish defence firms during the period 2000-2018 from SABI.
Standard deviations in parentheses. A bold number reflects statistical significance at the 5% level.

Table 2. (continued). Group descriptive statistics: Differences between main contractors and defence contractors.

Panel B: Subsamples, 2011 reform.

	2000-2011				2012-2018			
	Main Contractors		Defence Contractors		Main Contractors		Defence Contractors	
	Mean	Obs	Mean	Obs	Mean	Obs	Mean	Obs
Labour Productivity	**5.213**	551	**4.855**	926	**5.337**	477	**4.793**	731
	(0.923)		(0.850)		(0.974)		(0.788)	
Profitability	-0.039	551	0.027	926	-0.369	477	-0.012	731
	(2.266)		(0.700)		(9.094)		(0.792)	
ROA	**7.559**	551	**5.018**	926	1.202	477	1.874	731
	(12.616)		(13.644)		(80.974)		(17.827)	
Age	**22.793**	547	**16.914**	904	**29.179**	476	**23.223**	730
	(20.208)		(10.265)		(19.614)		(11.237)	
Size	4.298	551	4.167	926	**4.577**	477	**4.197**	731
	(2.068)		(1.699)		(2.167)		(1.680)	
Labour Cost	**26.481**	551	**38.780**	926	**27.710**	477	**43.708**	731
	(19.483)		(59.700)		(23.348)		(29.900)	
Intangible Assets	**0.213**	551	**0.182**	926	0.164	477	0.143	731
	(0.261)		(0.236)		(0.229)		(0.251)	

Data are for 277 Spanish defence firms during the period 2000-2018 from SABI.

Standard deviations in parentheses. A bold number reflects statistical significance at the 5% level.

Table 2. (continued). Group descriptive statistics:
Differences between main contractors and defence contractors.

Panel C: Subsamples, 2011 and 2014 reforms.

	2000-2011				2012-2018			
	Main Contractors		Defence Contractors		Main Contractors		Defence Contractors	
	Mean	Obs	Mean	Obs	Mean	Obs	Mean	Obs
Labour Productivity	**5.169**	195	**4.821**	323	**5.453**	282	**4.772**	408
	(0.949)		(0.761)		(0.976)		(0.808)	
Profitability	0.028	195	0.005	323	-0.644	282	-0.025	408
	(0.381)		(0.219)		(11.824)		(1.043)	
ROA	**4.832**	195	**1.555**	323	-1.308	282	2.128	408
	(11.171)		(14.898)		(104.905)		(19.857)	
Age	**26.474**	194	**21.236**	322	**31.039**	282	**24.792**	408
	(19.167)		(11.233)		(19.736)		(11.002)	
Size	4.360	195	4.196	323	**4.727**	282	**4.199**	408
	(2.219)		(1.734)		(2.120)		(1.639)	
Labour Cost	**29.485**	195	**44.350**	323	**26.483**	282	**43.199**	408
	(25.665)		(25.550)		(21.563)		(32.962)	
Intangible Assets	0.173	195	0.156	323	0.157	282	0.132	408
	(0.237)		(0.245)		(0.223)		(0.203)	

Data are for 277 Spanish defence firms during the period 2000-2018 from SABI.

Standard deviations in parentheses. A bold number reflects statistical significance at the 5% level.

Table 3. Differences-in-differences estimation: Effects of the 2011 reform.

	(1)	(2)	(3)	(4)	(5)	(6)
	Labour Productivity	Labour Productivity	ROA	ROA	Profitability	Profitability
Age	0.052	0.029	0.931	0.970	0.119	0.111
	(0.052)	(0.049)	(0.984)	(0.936)	(0.084)	(0.077)
Size	-0.026	-0.043	-0.332	-0.590**	0.009	-0.016
	(0.034)	(0.035)	(0.335)	(0.274)	(0.031)	(0.021)
Labour Cost	-0.324***	-0.296***	-3.353	-3.368	-0.310	-0.326
	(0.050)	(0.047)	(2.639)	(2.774)	(0.301)	(0.319)
Intangible Assets	-0.009	0.041	-3.060	-4.043	-0.332	-0.361
	(0.085)	(0.082)	(3.570)	(3.880)	(0.351)	(0.381)
Export		0.035		1.986		0.185
		(0.113)		(2.473)		(0.245)
Foreign		0.388**		0.621		0.181
		(0.158)		(2.145)		(0.177)
Crisis	-0.015	0.004	-5.815*	-5.814**	-0.391	-0.369
	(0.028)	(0.027)	(3.036)	(2.855)	(0.334)	(0.314)
Rank	0.194*	0.109	0.509	0.333	-0.133	-0.179
	(0.109)	(0.101)	(1.829)	(2.174)	(0.136)	(0.180)
Post	-0.019	-0.004	-3.718***	-3.854***	-0.102*	-0.093*
	(0.050)	(0.047)	(0.960)	(0.981)	(0.054)	(0.054)
Rank*Post	0.192**	0.178**	-3.747	-3.670	-0.438	-0.458
	(0.080)	(0.072)	(4.241)	(4.388)	(0.502)	(0.525)
Constant	5.947***	6.048***	18.044**	-8.603	0.942	0.858
	(0.267)	(0.266)	(7.708)	(9.901)	(0.897)	-1.170
Observations	2,650	2,486	2,439	2,275	2,431	2,267
Industry Dummies	No	Yes	No	Yes	No	Yes

Data are for 277 Spanish defence firms during 2000-2018 from SABI. All results are derived from panel data estimation. Control variables are introduced lagged to mitigate potential simultaneity concerns. Estimation takes into account the possible existence of non-observable heterogeneity including industry dummies to reduce the sampling variability of estimates. Robust standard errors, in parenthesis, are clustered at the firm level to allow for time-series persistence of the shocks. $^{*}p < 0.10,^{**}p < 0.05,^{***}p < 0.01$.

Table 4. Differences-in-differences estimation: Effects of the 2011 and 2014 reforms.

	(1)	(2)	(3)	(4)	(5)	(6)
	Labour Productivity	Labour Productivity	ROA	ROA	Profitability	Profitability
Age	0.048	0.028	1.092	1.125	0.140	0.131
	(0.054)	(0.051)	(1.129)	(1.074)	(0.102)	(0.094)
Size	-0.029	-0.045	-0.309	-0.570**	0.011	-0.014
	(0.034)	(0.035)	(0.351)	(0.277)	(0.033)	(0.021)
Labour Cost	-0.320***	-0.293***	-3.425	-3.429	-0.318	-0.333
	(0.049)	(0.047)	(2.707)	(2.831)	(0.309)	(0.325)
Intangible Assets	-0.013	0.038	-3.107	-4.079	-0.341	-0.370
	(0.084)	(0.082)	(3.647)	(3.938)	(0.359)	(0.388)
Export		0.040		1.927		0.179
		(0.113)		(2.439)		(0.238)
Foreign		0.389**		0.629		0.182
		(0.158)		(2.188)		(0.180)
Crisis	-0.010	0.007	-6.315*	-6.244*	-0.454	-0.427
	(0.028)	(0.028)	(3.553)	(-3.316)	(0.394)	(0.368)
Rank	0.187*	0.105	0.453	0.319	-0.140	-0.180
	(0.110)	(0.102)	(1.873)	(2.186)	(0.142)	(0.181)
Post11	0.043	0.052	-3.680***	-3.871***	-0.025	-0.027
	(0.045)	(0.043)	(1.036)	(1.066)	(0.046)	(0.048)
Rank*Post11	0.027	0.039	1.059	1.373	-0.009	0.039
	(0.060)	(0.060)	(1.460)	(1.552)	(0.066)	(0.047)
Post14	-0.112*	-0.115**	-0.259	-0.132	-0.162	-0.156
	(0.061)	(0.056)	(1.761)	(1.744)	(0.136)	(0.130)
Rank*Post14	0.301***	0.287***	-8.384	-10.241	-0.747	-1.015
	(0.112)	(0.100)	(7.135)	(9.423)	(0.785)	(1.058)
Constant	5.954***	6.039***	17.945**	-8.663	0.928	0.882
	(0.267)	(0.266)	(7.607)	(10.006)	(0.884)	(1.179)
Observations	2,650	2,486	2,439	2,275	2,431	2,267
Industry Dummies	No	Yes	No	Yes	No	Yes

Data are for 277 Spanish defence firms during 2000-2018 from SABI. All results are derived from panel data estimation. Control variables are introduced lagged to mitigate potential simultaneity concerns. Estimation takes into account the possible existence of non-observable heterogeneity including industry dummies to reduce the sampling variability of estimates. Robust standard errors, in parenthesis, are clustered at the firm level to allow for time-series persistence of the shocks. $^{*}p < 0.10,^{**}p < 0.05,^{***}p < 0.01$.

Table 5. Effects of the 2011 and 2014 reforms: Large firms vs. Small firms

	Panel A: Large Firms			Panel B: Small and Medium Firms		
	(1)	(2)	(3)	(4)	(5)	(6)
	Labour Productivity	ROA	Profitability	Labour Productivity	ROA	Profitability
Rank	0.480***	-0.938	0.011	-0.072	-0.294	-0.288
	(0.184)	(1.981)	(0.030)	(0.115)	(2.857)	(0.249)
Post11	0.031	-2.748	-0.043*	0.028	-4.018***	-0.019
	(0.051)	(1.866)	(0.024)	(0.048)	(1.280)	(0.069)
Rank*Post11	0.126**	0.655	0.023	-0.019	1.437	0.054
	(0.063)	(2.391)	(0.026)	(0.070)	(1.870)	(0.068)
Post14	-0.103	-0.639	-0.006	-0.112*	-0.310	-0.203
	(0.074)	(-2.175)	(0.016)	(0.066)	(2.123)	(0.171)
Rank*Post14	0.029	0.237	-0.022	0.354***	-14.400	-1.513
	(0.184)	(2.864)	(0.041)	(0.097)	(13.800)	(1.567)
Observations	553	529	526	1,933	1,746	1,741

Data are for 277 Spanish defence firms during 2000-2018 from SABI. All results are derived from panel data estimation. Large firms: more than 250 employees; small and medium firms: 250 employees or less. All regressions include the same control variables as in Table 4. Estimation takes into account the possible existence of non-observable heterogeneity including industry dummies to reduce the sampling variability of estimates. Robust standard errors, in parenthesis, are clustered at the firm level to allow for time-series persistence of the shocks. $^{*}p < 0.10,^{**}p < 0.05,^{***}p < 0.01$.

Figure 1. Differences-in-Differences estimation: Placebo exercise.