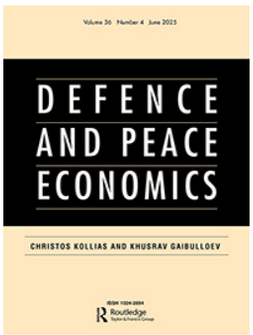

Routledge
Taylor & Francis Group

Defence and Peace Economics

ISSN: 1024-2694 (Print) 1476-8267 (Online) Journal homepage: www.tandfonline.com/journals/gdpe20

Offset Multipliers and Defence Industrial Policy Efficiency

Ugurhan G. Berkok

To cite this article: Ugurhan G. Berkok (2025) Offset Multipliers and Defence Industrial Policy Efficiency, Defence and Peace Economics, 36:4, 469-492, DOI: 10.1080/10242694.2024.2378278

To link to this article: https://doi.org/10.1080/10242694.2024.2378278

DEFENCE AND PEACE ECONOMICS
2025, VOL. 36, NO. 4, 469–492
https://doi.org/10.1080/10242694.2024.2378278

Routledge
Taylor & Francis Group

Offset Multipliers and Defence Industrial Policy Efficiency

Ugurhan G. Berkok[a,b]

[a]Department of Politics & Economics, Royal Military College of Canada, Kingston, Ontario, Canada; [b]Department of Economics, Queen´s University, Canada

ABSTRACT

Mandatory offsets are policy instruments to leverage defence procurement projects to conduct industrial policy. The prime contractor commits to generate new business in mutually acceptable sectors equivalent to a large percentage of the project value. Offset multipliers "relax" this constraint by discounting the prime contractor's offset obligations if investments flow to sectors prioritized by the purchasing country's industrial policy objectives. This endogenizes the relationship between the original project and the offset contracts. This paper provides a new theoretical analysis of the following three questions that have gone unaddressed in the literature. First, the efficiency of such policies depends on the absorption capacity of a targeted industry. If this capacity is low, import substitution is expensive and the prime contractor may rather choose to invest elsewhere in the economy to satisfy the overall mandatory offset constraint thereby thwarting the original objective. Second, whereas a uniform relaxation of offsets through multipliers can reduce distortions introduced by mandated offsets, multipliers may enhance distortions as an unintended consequence. Third, the prime contractor's response to offset credit incentives may be weak due to transaction costs arising from having to find new domestic partners to satisfy the offset requirements and manage the contracts.

ARTICLE HISTORY
Received 23 September 2023
Accepted 6 July 2024

KEYWORDS
Defence procurement; offset multipliers; industrial policy; mandatory offsets; absorption capacity; transaction cost

JEL CLASSIFICATION
D78; H44; H57; L52

Introduction

Mandatory offsets in defence procurement are policy instruments used by a large number of countries (Balakrishnan 2020; IFBEC 2016; Matthews and Anicetti 2021) to leverage their procurement contracts in order to develop domestic industries either for operational and strategic reasons or for economic development objectives. These latter are simply infant industries. Yet, other reasons appear in the literature, such as the provision of hidden subsidies to domestic military and other industries, and efforts to make unpopular weapons purchases palatable through derived economic benefits (Dumas 2004). Whereas the academic literature on offsets may be adequate (Lazar 2020), analytical papers are nearly inexistent, the most recent ones being (Markowski and Hall 2014, 2004). This paper builds on these two Markowski & Hall papers. The 2004 paper explains the defence offsets with precision: 'With a high local content target, the overseas prime contractor would have to include uncompetitive local subcontractors in its supply chain.' The present model builds in four novel features in order to contribute to the existing gaps in the literature, as well as building an explicit model endogenizing the link between the acquisition and the offset contracts. First, we explicitly introduce absorption capacity and transaction costs to operationalize the rising cost of local content. Second, we derive the effective offset multipliers that aim to relax the local content

CONTACT Ugurhan G. Berkok Ugurhan.Berkok@rmc.ca Department of Politics & Economics, Royal Military College of Canada, 13 General Crerar Crescent, Kingston, Ontario K7K 7B4, Canada

constraints in sectors targeted for industrial and technological development or deemed operationally important. Third, we endogenize the offset ratio by introducing a social welfare function trading off the incremental cost of local content for potential economic development or operational needs. Finally, the prime contractor can choose how much of the production will be shifted to the host country. This component of the contract value does of course generate direct offsets. The concept of direct offsets is graphically explained in Figure 2 and in the section entitled Offsets and domestic industrial absorption capacity.

Two important developments, the European Commission's 2009 directive to eliminate indirect offsets, called by Weiss and Blauberger (2016) as judicialized lawmaking, and NATO's recent insistence, upon invasion of Ukraine by Russia, for the 2% floor on member defence expenditures necessitate a re-examination of offsets especially in terms of member production capacities and sharing munitions and equipment. The 2009 directive pit nationalist urges to protect their champions from competition that would eliminate duplication and waste through scale and competition (Balakrishnan 2020). The protectionist urge may be particularly true for countries with strong defence industries.

Body of Research on Offsets

The offset policies amount to import substitution by using targeted financial quotas imposed on the prime contractor that must invest a large percentage φ of the value of the procurement contract in the purchasing country. The prime contractor normally signs two contracts (Markowski and Hall 2014). First, as supplier, it promises to deliver the contractually stipulated military equipment on cost and on time. Second, as obligor, it promises to generate new domestic business through new projects that create value added in the buying country (de Beaufort, DeVilder, and Sylvain 2014). This industrial policy yields regulatory instruments such as offset credits, with such variations as bankable and tradable credits (Balakrishnan 2020; Melitz 2005).

In developed market economies where the opportunity cost of the policy could be high as those defence industries seeking and enjoying protection do not necessarily exhibit potential comparative advantage. Such costs can always be outweighed by the high value of strategic and operational needs. Since benefit–cost studies are either inexistent or ignored, resources transferred from efficient sectors into inefficient but prioritized sectors with their high opportunity costs are rarely incorporated into offset implementation decisions (Markowski and Wylie 2012). Whereas operational security needs may necessitate offset arrangements, arguments for using offsets for economic and other strategic objectives (Dehoff, Dowdy, and Kwon 2014; Fevolden and Tvetbråten 2016; Petersen 2011; Petty 1999) abound without proper economic justification but possibly due to advocacy by local industries trying to convince decision-makers of their operational relevance.

The process of direct offsets, i.e. concerning the inputs into the equipment purchased, can be described as follows. The winning prime contractor has to invest in the country and generate a certain percentage of the value of the contract, say 100%, in the domestic economy. This percentage varies over countries implementing offset policies, if not for the baseline offset percentage itself, through offset credits that reduce the effective percentage below that baseline. Under mandatory offsets, the prime contractor is typically a partnership including domestic partners. These latter are of two types. First are internationally competitive domestic firms that might have been in the prime contractor's supply chain anyway. Moreover, if the prime contractor discovers efficient domestic firms, these latter can become part of its supply chain. Second are domestic partner firms either out of necessity or due to offset multipliers that reduce their costs to the prime contractor. The former partners' costs have to be passed on to the purchasing government. Those investments that would not have taken place under standard business decisions are now subject to offset rules. This means that sums equal to the full value of imported inputs will have to be invested in domestic sectors whose outputs are costlier than international competitors are. This triggers a misallocation of resources. The higher the offset percentage, the costlier will be the procurement to the purchasing

country. For, the prime contractor will build into its bid all expected cost increases attributable to offset policies (Jung et al. 2019) via inefficiently produced direct inputs as well as net costs of indirect offset investments that do not generate a profit. Understanding the mechanisms at work generating costs requires a consideration of the domestic industry's absorption capacity (Coadour, Droff, and Bellais 2018; Lazar 2019; Matthews and Ansari 2015) by measuring the rising costs of inputs acquired domestically as direct offsets rather than from international suppliers as imports. In this context, absorption presupposes technology acquisition, adoption and adaptation, or, in other words, it is wider in scope than adaptation that requires the necessary infrastructure as well as tweaks in the use of imported technology. However, absorption surpasses the adaptation in that the firm assimilates the technology and gradually masters it as well as the original manufacturer, both in quality and cost, to become competitive in global supply chains.

Since absorption capacity is not uniform across domestic sectors, the total extra cost induced by a domestic acquisition of inputs can be approximated as an increasing and convex function of the percentage of mandated offsets. For, if mandated direct offset percentage rises, further sectors with falling absorptive capacity and hence higher cost will increase the overall cost of acquisition. We draw a parallel with Ricardo's theory of value where the value reflects the rising costs of production as resource use runs into scarcity (Hollander 1991). In other words, like in the Ricardian intensive margin phenomenon, sectors with less absorptive capacity are less efficient, hence costlier in production and, as the margin or, in the case under consideration, the effective offset percentage, net of multipliers, is increased, the marginal cost of domestically acquired inputs rises. Lazar (2019) provides country examples.

Offset multipliers relax the constraint to the prime contractor as a dollar of investment into a targeted sector saves more than a dollar to the prime contractor in terms of offset obligations and may lower the cost of offsets to the purchaser because, effectively, multipliers reduce the intensive margin. However, this latter effect critically depends on the choice of multipliers: If the sector benefiting from a high multiplier exhibits low absorption, then the prime contractor's investment will increase the sector's unit costs.

Policy-makers would expect the prime contractor to concentrate its offset-obligation investment in high-multiplier sectors. A high multiplier relaxes the mandatory offset constraint. Intuitively, the use of a high multiplier should indeed induce the prime contractor in such sectors. We find that this depends on the absorption capacity of the domestic industry targeted. If this capacity is low, import substitution is expensive, and the prime contractor may rather choose to invest elsewhere in the economy to satisfy the overall mandatory offset constraint. About 20 countries[1] (Broecker and Beraldi 2017), including Canada, India, South Africa and Turkey, use offset multipliers in order to channel such industrial development towards their priority sectors in a variety of ways. 'The types of contracts that are subject to offset obligations, the minimum percentage of offset requirements, and offset credit multipliers all vary by country' (Dehoff, Dowdy, and Kwon 2014; IFBEC 2016). First, countries impose mandatory offsets at differing overall contract value thresholds. Typically, no threshold is imposed on projects with small contract value. Second, the minimum percentage imposed varies from 20% to 80% of the contract value, but it is not uncommon to see 100% alleviated by offset multipliers. Third, offset multipliers range from a fraction to eight (Balakrishnan 2020) and even 20 as recently negotiated by the BAE Systems and Malaysia (Balakrishnan and Matthews 2009). This paragraph has broadly described the mandatory offset policies. Some countries, for example Germany, implement non-mandatory offset policies that amount to negotiating individual contracts.

Offset policy exhibits visible benefits to governments but blurs costs. In fact, the very imposition of in-kind offset obligations by the buyer rather than negotiating a lower price is inefficient (Hall and Markowski 1994; Markowski and Hall 2014). First, a strict benefit-cost analysis might clarify its comparison to other policy instruments that can be used to achieve the same objectives such as subsidizing technology acquisition directly or negotiate a lower price for the acquisition. For example, might bargaining for price discounts on the basic platform and then using these proceeds

to purchase new technology on the open market be preferable to mandatory offsets? Alternatively, perhaps the government could provide explicit subsidies to a targeted industry rather than shielding the industry with offsets as quotas (Markowski and Hall 2014). Second, when an offset is linked to the original transaction, called bundling in Markowski and Hall (2014), the governments normally construct detailed contracts specifying specific sectors where the seller can form partnerships with domestic firms to fulfill the offset obligation, schedule for fulfillment of various stages of the offset obligation, and design penalty clauses for non-compliance. Since these have to be enforced, administration and transaction costs arise. Since offset obligations are normally large, they are normally audited. Then and only then, argues Brauer et al. (2011, p. 13), can the 'public-at-large decide whether the losses or profits are worth the original objective' (Taylor 2003, 2012). Such caution also suggests that governments should expend 'a serious effort to develop criteria to distinguish between beneficial offsets and detrimental offsets' (Udis and Maskus 1991). For instance, the success of offsets policies is not whether the domestic firms are able to supply the prime contractor during the contractual process but whether nurtured industries integrate into world supply chains (Matthews and Ansari 2015; Palavenis 2021). This is a necessary condition for success simply because with the exception of a few, no defence contractor can survive and flourish by selling to its own government only in the absence of subsidies because the scale at which they operate to supply their own government would be too small to achieve global competitiveness. While it is true that global market penetration is difficult, the success of offset policies can only be evaluated by this objective measure, the ability to export primed by the initial offset contract. To the best of my knowledge, no such empirical post-contractual export study exists in the literature. Some preliminary ideas are offered in the potential extensions section.

A Theory of Offset Multipliers

The simple model developed in this paper provides, at least partially, success criteria in terms of policy parameters crystallized in a social welfare function as in Figure 1 and the existing industrial structure of the country. This point was also mentioned in (Taylor 2003): 'Since institutions and

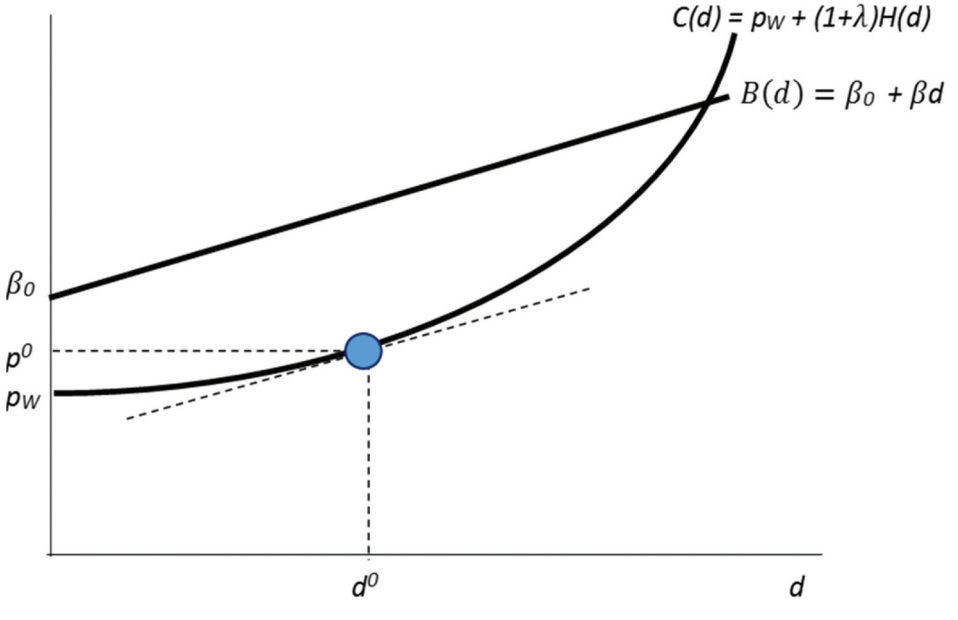

Figure 1. Benefits and costs of platform procurement under mandated offsets.

economic infrastructures differ across countries, governments considering offsets for international procurement need to be cognizant of the efficiency tradeoffs between markets, offsets, and other policies. A prescriptive model is developed that explains these tradeoffs under various economic settings. Mandatory procurement policies that require offsets for all government procurement above a particular threshold are found to be detrimental to the country's welfare.' Although this point is correct in general, there cannot be thresholds, unless they are meant to be approximations. Intuitively, if the increasing costs at intensive margins suddenly become significantly steeper, they can be considered approximate thresholds. However, the fundamental observation remains that of global competitiveness below which inefficiencies are incurred as costs to any offset policy.

When the buyer country implements offset multipliers, the offset obligations are reduced for sectors targeted by high multipliers, and the prime contractor is thus incentivized to invest in those sectors. If, however, high multiplier sectors happen to have low absorption capacities, the sectors in question inefficiently expand. We use a two-input model with direct offsets in order to analyze whether the use of offset multipliers reduces the original distortion induced by the overall offset obligation policy. The profit-maximizing prime contractor trades off domestic industrial expansions and import contents in the two sectors in responding to two incentives, the original offset obligation percentage and the sectoral offset multipliers. While the potential of the sectors in terms of global competitiveness is not the prime contractor's concern, charging the buyer the full cost of domestic manufacturing is. If the buyer trades off offset obligations through higher multipliers to induce the prime contractor to invest in prioritized but less-promising sectors, the original distortions may not be reduced or, in other words, offsets may not be offset.

Plan of the Paper

The paper is organized as follows. Section 'The Model' sets up the basic model and introduces the key concept of industrial absorption based on industrial clusters and backward linkages. Section 'Results Obtained from the buyer's and the seller's Problems' builds on the basic symmetric agency model of offsets to be used in the analysis. Section 'Results Obtained from the Prime Contractor's Problem with Multipliers' adds the offset multipliers to the basic model. Section 'Offset Credits and Multipliers: Policy Lessons' presents a policy discussion. Section 'Summary of Results and a Discussion of the Model' summarizes and Section 'Extensions and Research Directions' concludes by pointing to several extension directions.

The Model

We build a basic model driven by the interaction of the offset obligation percentage imposed by the host government and the rising cost of the prime contractor because of that obligation. This cost would be lower with a higher absorption capacity of the domestic industrial capabilities and higher with the transaction costs arising from local producers' integration to the prime contractor's supply chain in the best-case scenario where those sub-contractors become competitive and rise to become part of global supply chains rather than one-off mandated-offset contractors. This latter cost item may generate a costly brokerage industry matching the potential local producers with the prime contractor in addition to the transaction costs incurred by the prime contractor deviating from its regular sub-contractors towards the domestic ones. The existence of such brokerage firms may reduce the search as well as transaction costs while costing the prime contractor their services (Saw 2022).

A mandated-offset policy rules out off-the-shelf acquisitions for reasons related to industrial development and climbing the global value chain or for operational and strategic objectives. Whereas an off-the-shelf acquisition is the purchase of the platform as originally manufactured and marketed by a supplier, direct offsets may replace the original components in favour of

domestically manufactured ones or, even in the absence of offsets, the buyer may impose changes to the design or request less or more capabilities on the original platform.

We consider the acquisition of a particular equipment (or platform) whose internationally minimized production cost, i.e. its off-the-shelf price, is given as

$$P_W = C_W = D_0 + M_0 \tag{2.1}$$

where D_0 is the share of the cost incurred in the purchasing or host country in question and M_0 the remaining cost originating from parts and services imported. Alternatively, major parts may have been assembled in the exporting country. Of course, the host country may not be producing any part of the equipment, in which case the initial value of D_0 would be zero and the equipment would be purchased off-the-shelf. The domestic cost or local content ratio, should the host country choose to purchase the equipment off the shelf, is then given as

$$D_0/(D_0 + M_0). \tag{2.2}$$

If a part D of M_0 is shifted to the host country as by mandated offsets or otherwise, this share would increase to

$$(D_0 + D)(D_0 + D + M) \tag{2.3}$$

for two reasons. First, it would cost more to produce the same items beyond D_0 in the host country compared to their original cost M_0. Had D been produced at a lower cost in the host country, the prime contractor might have already used the low-cost sub-contractors in its supply chain. Of course, the prime contractor includes the various transaction costs associated with the switch to such sub-contractors. Second, search costs for identifying local contractors and the transaction costs associated with new local contractors rather than the prime contractor's existing supply chain would add to existing costs. These extra costs are denoted by $H(d)$, where d is the part of M shifted to the host country. Since the mandatory-offset incentive induces the prime contractor to make a choice of import substitution, the relevant cost function can be written as

$$C(d, \varphi) = D_0 + D + M = D_0 + [d + H(d)] + (M_0 - d)(1 + \varphi). \tag{2.4}$$

The second term, D, corresponds to the domestic production cost of what could have costed the prime contractor just d abroad. The extra domestic cost is given by the convex and increasing function $H(d)$ where $H(0) = 0$, $H'(d) > 0$ and $H''(d) > 0$. We note that D amounts to direct offsets and the fact that it must cost more than d means the host country pays more than the off-the-shelf price. The third term, M, corresponds to the cost of imports augmented by mandatory offset obligations ratio. Whereas this component is an indirect offset, they may well be projected in defence.[2] The parameter φ, chosen and contractually imposed by the host government, represents the offset obligation by imposing that the prime contractor has to invest or generate business to the amount $(M_0 - d)\varphi$ domestically, over and above the production d already shifted to the domestic economy. Thus, $(M_0 - d)\varphi$ amounts to an indirect offset obligation that the prime contractor has to discharge once it chooses the domestic and imported production mix. We note that with no offset obligations, i.e. $\varphi = 0$, the prime contractor would have chosen $d = 0$ and hence $[d + H(d)] + (M_0 - d)(1 + \varphi)$ would reduce to M_0. That is, $C(0,0) = D_0 + M_0$ from equation (2.4).

Presuming that the host country is not globally competitive in every sector, the domestic extra cost of producing a share d of M is given by the function $H(d)$ as illustrated below in Figure 1. We recall that M_0 is the level of imports that would have been optimally produced abroad, whereas M ($<M_0$) is the level of imported components after the prime contractor increases domestic production in response to mandated offsets.

We posit, for simplicity, a functional form, which translates the intuition, developed above that, the host country exhibits a spectrum of efficiencies in sectors providing inputs to the procured equipment, that is domestic production cost follows a convex and increasing function as explained in detail below.

That is precisely the Ricardian intensive margin argument invoked above: The higher the offset obligations ratio, the higher the marginal cost of producing components due to lesser absorption capacity and transaction costs. The parameter $\alpha > 0$ thus codifies the differing absorption capacities of domestic industrial sectors, i.e. the higher the offset ratio, the higher the costs of marginal sectors that are to be co-opted as sub-contractors. In our simple function, a higher absorption capacity implies a lower extra domestic production cost relative to global competition (Coadour, Droff, and Bellais 2018). We define the coefficient α (>0) to incorporate the transaction costs as well but α varies inversely with transaction costs. A higher offset ratio requires yet more subcontractors that may not have been in global supply chains and hence more new contracts to manage for the prime contractor. By using a single parameter in the *H(d)* function we economize in terms of notation.

$$C(d) = p_W + (1 + \lambda)H(d) \tag{2.5}$$

where $H(d) = \frac{1}{2\alpha}d^2$.

The parameter $\lambda > 0$ in equation (2.5) is the marginal distortionary cost of public funds required to pay the extra costs $H(d)$ over and above the competitive price p_W. Figure 1 illustrates the extra costs induced by offset obligations as well as the defence benefit β_0 and the economic benefit βd from offsets.

These extra costs represented by *H(d)* may originate from various sources. First, the unavailability of skills and technologies in the sector or from retooling of the industries hitherto unfamiliar with inputs required by the equipment being procured or any other aspect of the production. Second, the opportunity costs for the prime contractor arising from a disruption of its global supply chains. Moreover, the transaction costs from searching new suppliers and a replacement of these latter by domestic suppliers. There exist costly matching markets where intermediaries or specialized brokerage firms match prime contractors to local companies (Palavenis 2021), generating transaction costs. The next section further develops this concept of absorption and presents the example of Canada within the Joint Strike Fighter program.

Offsets and Domestic Industrial Absorption Capacity

The local industrial expansion in response to mandated offsets, which we denoted above as *d*, depends on the domestic industry's absorption capacity, transaction costs arising from adding new subcontractors to the prime contractor's supply chains and the offset credit multipliers. A higher absorption capacity lowers the expansion cost to the economy as more efficient firms already exist in clusters with their backward linkages and hence the procurement cost increases only moderately if at all. This scenario is also conducive to transferring sophisticated technologies, adapting and further exploiting them (Matthews and Anicetti 2021).

Sweetening this transfer of technology is the offset multipliers offered to the prime contractor, whereby the offset obligation is reduced by the multiple of what the prime contractor's business activity generates. Of course, caution is in order as the success of the offset policy depends on the post-contractual performance of these firms, on which data is scarce. The multipliers thus relax the mandated offset constraint for those targeted sectors by reducing the offset discharge cost to the prime contractor. This lowers the offset-investment cost to the prime contractor by lowering the offset percentage φ. However, as we will discuss below in the conclusions and extension sections, high-valued multipliers channeling offset investments towards low-absorption sectors may generate costly expansions.

Absorption capacity can be explained using the traditional economic development concepts of backward (upstream) and forward (downstream) linkages supplemented by a more efficiency-related and recent concept of clusters where complementary and competing firms already coexist. The concept of linkage relates to the successive stages in the production of any good. For example, the manufacturing of landing gear would need a metallurgical backward linkage and an aircraft factory as a forward linkage in an economic region. (See, below, in Figure 2, the illustration in the Canadian aerospace industry context. A similar picture must exist for other members of the JSF

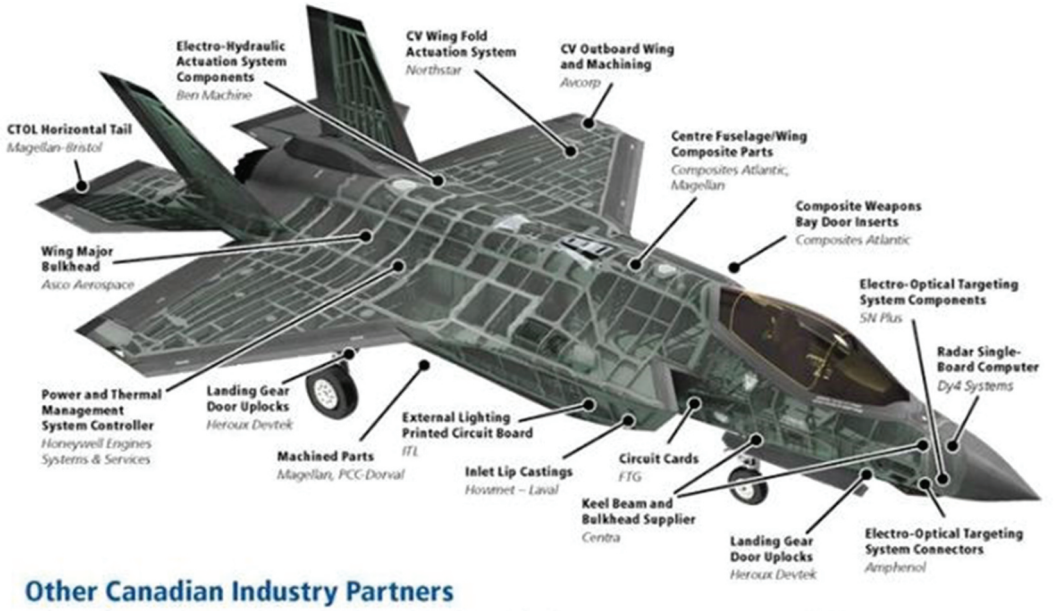

Figure 2. Joint strike fighter component contracts won by Canadian aerospace companies.[3]

project club.) The whole production can be integrated under a single roof yet, if not, a costly market coordination intervenes to coordinate subcontractors with arising transaction costs, a textbook case of a Coasian process. The existence of a whole chain of linkages would facilitate a foreign prime contractor's expansion of local production to satisfy the offset requirements, whereas a mere existence of a single metallurgical firm would provide for a weaker environment for the expansion. The former case would then exhibit a higher industrial absorption capacity as the adaptation and further exploitation of the adopted technology becomes possible with backward and forward clusters in place.

This, then, brings us to industrial clusters. If, there exist several metallurgical companies in proximity, keen competition for the prime contractor's subcontracts can not only lower costs but also ensure quality and timeliness and facilitate innovations through various channels. This horizontal cluster may provide the innovation (or IP generation) platform through which firms learn by doing, by commercializing products, by having to compete, by interacting due to proximity, and by imitating. This business activity is a necessary condition for the further exploitation of the transferred technology. Whereas horizontal clusters over a given product may change with firms leaving the industry and new firms entering, vertical clusters refer to the evolving industrial organization of the stages of production or the changing boundaries of firms in the cluster.

We use the Canadian participation in the Joint Strike Fighter project as an example. The 42 Canadian aerospace companies, as illustrated in Figure 2, won contracts at the Joint Strike Fighter (JSF) club run by Lockheed Martin. The sheer number of winning companies signals the presence of a significantly larger number in the industry, providing evidence to the high absorption capacity. Since only the companies from these highly industrialized participating

countries can bid in this JSF club, we can safely assume that the winning companies are at the frontiers of technology. The relevance of this example is as follows. First, the market place determines the winners rather than companies protected behind the mandated-offset policy. Had this Canadian involvement been through offsets, the Canadian companies involved would have been realizing direct offsets because they are manufacturing parts of the F-35 fighter, the platform purchased through the main procurement contract. Second, the fact that there are several winners from Canada demonstrates the high absorption capacity in that sector alone. Countries, including Canada, that implement mandated offsets may in fact be forcing prime contractors to shift production to inefficient and hence high-cost domestic sub-contractors as opposed to this special project (Berkok 2010; Nossal 2016).

In general, the prime contractor's direct-offset-obligation investments are facilitated by the existence of vertical clusters or, more specifically, backward linkages as the forward linkage

would correspond to the equipment being procured. If such an environment exists, the absorption capacity tends to be high and the resulting industrial expansion envisaged is less costly as clustered firms gain in productivity through 'sharing tailored facilities, infrastructure, and suppliers; matching workers productively through deep labor markets; and learning through dense, knowledge-rich environments that facilitate knowledge exchange and innovation between interdependent firms' (Donahue et al. 2018). In the JSF example, there are no mandated offsets but, by the design of the JSF project, purchasing countries buy the equipment without extra costs induced by mandated offsets.

Further exploitation of the adopted technology, as part of the absorption capacity, necessitates generating further innovation or adaptation and knowledge. These would involve scientific, technological, and organizational training and substantial learning efforts based on experience in related production processes (learning by doing), commercialization and use (learning by using). Thus, for new technical solutions to emerge in research and development units or in less formal situations (learning by searching), the existence of clusters is vital. These would allow interaction with external sources, such as suppliers of raw materials, components and equipment, customers, users, consultants, partners, universities, research institutes, government laboratories and agencies (learning by interacting). Moreover, specific interactions for outsourcing inputs, components or products (learning by subcontracting) or even competitor imitation processes (learning by imitation) will emerge.

Since absorption capacities vary across sectors, the total cost of domestic acquisition will be an increasing function of the mandated-offset ratio specific to the sector. In other words, sectors with less absorption capacity are less efficient and hence costlier.

In the implementation of offsets, the host government may leverage the purchase to induce the development of some industrial sectors deemed strategic but not necessarily related to the equipment purchased. An egregious distortion of the strategic-sector concept brings to mind the Raytheon Technologies (now known as RTX Corporation) contract, in 2006, with Saudi Arabia regarding the development of a shrimp aquaculture technology transfer (https://raytheon.mediaroom.com/index.php?s=43&item=408). This is an example of indirect offset (Dirksen 2010). The availability of such indirect offsets relaxes the prime contractor's constraints by allowing them to invest profitably. However, a misalignment of host country's priorities and the prime contractor's incentives may not always align. For instance, the prime contractor may choose to discharge its offset obligations by investing in high-return and low-absorption sectors.

Off-The-Shelf versus Mandated-Offset Acquisitions

The direct offset process works as follows. First, under an off-the-shelf acquisition policy (Berg, Presterud, and Øhrn 2019) as a benchmark, a portion D_0 of the contract C_0 would normally have been generated through production in the domestic economy and the rest, i.e. M_0, imported.[4] Since the prime contractor typically forms a partnership with efficient domestic firms, these latter would be internationally competitive and the inputs they produce would cost no more than international

competitors' prices. The remaining portion of the contract, i.e. $M_0 = C_0 - D_0$, would be the cost of components manufactured abroad. Of course, the final assembly would be included in either D_0 or M_0 depending on where it is performed.

Second, under an offset policy, a portion of the remaining value M_0 consists of parts that would not have taken place domestically under standard business decisions. Yet, the prime contractor may now find it profitable to expand the domestic production of components by an amount D to avoid the mandated-offset obligations applicable to remaining imports M at an offset rate of φ. The cost of the acquisition under an offset policy becomes

$$C = D_0 + D + M(1+\varphi) > D_0 + D + M > D_0 + M_0 = C_0. \tag{2.6}$$

We note that the second inequality corresponds to the actual import-substitution resulting from mandated offsets. The prime contractor decides to shift a portion D of M_0 from global supply chains to the domestic economy as it trades off the offset obligation ratio that applies to imports for higher domestic production. In other words, when the prime contractor shifts production to local sub-contractors, it minimizes the sum of two costs, the higher domestic production costs against lower offset obligations as imports decrease (Jung et al. 2019). As we already noted above, the mandated new business activity generation may or may not be profitable. If unprofitable, the prime contractor may fold the anticipated losses into the bid price.

An illustration of the breakdown $\{D_0, D, M(1+\varphi)\}$ is provided above, in Figure 2, in relation to Canada's involvement with its 42 aerospace companies holding contracts in the Joint Strike Fighter project. Since these contracts have been won in competition with global supply chains, they are at the frontiers of aerospace technology as well as competitive globally. If Canada were to purchase F-35s, the components manufactured in Canada would correspond to D_0. Matthews and Anicetti (2021) describes the U.K. defence industrial base as exhibiting a significantly wider spectrum of absorption capacity, i.e. sectors ready to absorb sophisticated technologies in most sectors (The Economist 2024). Within the JSF club to which accession was secured by the country's membership to the project early on.

In a hypothetical scenario where Lockheed-Martin concedes to the host government's pressure to switch the manufacturing of further components to the host country, their cost will correspond to D, and this cost will be higher than if those components are imported from more efficient suppliers in Lockheed-Martin's supply chains. Moreover, transaction costs would be lower for firms already in Lockheed-Martin supply chains and probably governed by relational contracts. Needless to mention, Lockheed-Martin would have to incur one-off search costs as well under domestic expansion. Finally, if Lockheed-Martin were to concede to offsets, it would generate business activity in the host country equivalent to some fraction of $M\varphi$, depending on the relevant offset multipliers and the anticipated profits from domestic expansion for the components of F-35. The higher the offset multipliers, the less costly for Lockheed-Martin to satisfy the required business activity constraint $M\varphi$ because the effective offset obligation ratio would be smaller than φ. It must, however, be noted that higher multipliers may induce inefficient investments because multipliers lower the opportunity cost of investing in targeted areas regardless of whether expected returns justify such investments.

Offset Multipliers

Offset multipliers provide a conditional discount to the prime contractor for its offset obligation, the condition being that the prime contractor generates economic activity in sectors targeted under the defence industrial policy. As such offset multipliers relax the constraint on the prime contractor by industrial sector as a dollar of investment into a targeted sector saves more than a dollar to the prime contractor in terms of discharging its offset obligations. This *may* (or may not) lower the cost of offsets to the purchaser because, effectively, multipliers shrink the costly intensive margin of the domestic expansion we denoted as D. This latter effect critically depends on the choice of multipliers: If the

sector benefiting from a high multiplier exhibits low absorption, then the prime contractor's investment will increase the purchaser's costs, while high multipliers reduce the prime contractor's investment cost. A high multiplier is a hidden subsidy to the target sector by inserting a wedge between the buyer's and the seller's costs and reduces the *effective* offset ratio to the sector.

The industrial policy-maker uses multipliers to induce the prime contractor to direct its offset-obligation investment towards priority and hence high-multiplier sectors. Intuitively, the use of a high multiplier relaxes the mandatory offset constraint. However, such investments depend on the absorption capacity of the domestic industry targeted. If this capacity is low, import substitution becomes expensive and the prime contractor may rather choose to invest elsewhere. About 20 countries, including Canada, India, South Africa and Turkey (Hagelin 2004), utilize offset multipliers in order to channel such industrial development towards their priority sectors. Germany, Greece, Italy, Netherlands, Norway, Poland, Turkey, UK, South Africa, Australia, India, Indonesia, South Korea, Singapore, Taiwan, Brazil, Chile, Colombia, Saudi Arabia and UAE (Kimla 2013; U.S. Department of Commerce 2018; Ungaro 2014). These countries use differing ranges of offset credit multipliers depending on their strategic priorities. For example, if the prime contractor invests in a small or medium enterprise conducting R&D or licenses IP, the multiplier rises to 9, i.e. for every dollar so invested, the prime contractor's offset obligation is reduced by 9 dollars. As another example, the multiplier for investment in a Canadian college or university or the National Research Council (NRC) is 5. This range may extend to as far as 20 such as in Malaysia, meaning that an investment into a high-priority sector may lower the prime contractor's offset obligation by 10 times the economic activity it generates in that sector (Balakrishnan 2020; Matthews and Anicetti 2021).

Offset multipliers can be powerful industrial policy instruments provided that the prime contractor perceives them to be credible or renegotiation-proof, i.e. not expected to be written off subsequently or immune to lobbying efforts. In addition, from the perspective of the acquisitioning government, policy recommendations emerge.

First, a uniform offset requirement may not be the best option if absorption capacity is rather low in priority sectors. A full benefit-cost estimate may clarify priorities based on sectoral efficiencies, by weighing priorities against existing absorption capacities. For example, as raised in (Markowski and Hall 2014) and Matthews (2011), bargaining for a price discount on the base platform and then using the savings to purchase new technology on the open market might be preferable to mandated and multiplier-directed offsets. For example, Canada's new-generation under-construction frigates may be costing the country 30–40 percent more (Busby, Kho, and Penney 2022) than if they were to be purchased off-the-shelf. Unlike the country's aerospace sector, the shipbuilding sector is not at the frontiers of technology. As such, the 100% offset ratio proves costly.

Second, when an offset policy is tied to the original transaction, the contract should specify specific items. First, a suggestive list of domestic firms the seller can collaborate with to fulfill the offset obligation would reduce search costs. Second, a reasonable and credible schedule for fulfillment of various stages of the offset obligation ought to be negotiated in advance. Finally, the contract must clearly specify the penalty clauses for non-compliance. Offset policy implementation must not appear weak in terms of offset arrears and must find a way to incentivize success beyond the contractual period, i.e. the integration of global supply chains, which ought to be the main criterion of policy success. Of course, such well-defined contracts, even if they may be constructed, will be costly by requiring a whole government department in charge as well as legal teams should disagreements and litigation arise.

Third, the offset policy raises questions about massive public funds in procurement and large figures in offset obligations in arrears despite the possibilities of banked offset credits, i.e. credits accumulated from the prime contractor's prior investment in the country or from its previous procurement projects. Such arrears or non-discharged offset obligations, not so visible to taxpayers, have to be monitored, and their discharge must be enforced in order to reinforce the credibility of the offset policy. These functions require costly offset management departments. Moreover, audits

may be necessary to generate the transparency that would empower 'public-at-large to decide whether the losses or profits are worth the original objective' (Taylor 2003).

The interaction between offset multipliers and targeted industries' absorption capacities yields the cost of the offset policy. Ironically, the use of offset multipliers may reduce the offset obligation cost to the prime contractor but significantly increase the cost of expansion in targeted industries with low absorption capacities. As any prime contractor will build the extra cost into its bid price, the use of multipliers may increase procurement costs beyond a simple offset policy without multipliers. Since particular industries may be targeted for strategic rather than economic reasons under offset policies, strategic and economic objectives conflict if targeted industries exhibit low absorption capacity. This leaves policy-makers in a bind because strategic objectives can be highly costly to achieve as a result. This inevitable tradeoff can be bypassed if policy-makers trust alliance partners to supply critical inputs and hence abstain from using high offset multipliers for low-absorption domestic industries (Hartley 2006; Matthews 2014). The existence of such trust not only relaxes the 'buy domestic' constraint in certain longer-term acquisition needs but may also guide policy regarding overall offsets themselves by necessitating 'a serious effort to develop criteria to distinguish between beneficial offsets and detrimental offsets' (Udis and Maskus 1991). Moreover, stated alternatively: 'Since institutions and economic infrastructures differ across countries, governments considering offsets for international procurement need to be cognizant of the efficiency tradeoffs between markets, offsets, and other policies. A prescriptive model is developed that explains these tradeoffs under various economic settings. Mandatory procurement policies that require offsets for all government procurement above a particular threshold are found to be detrimental to the country's welfare' (Taylor 2003, 2012).

Results Obtained from the buyer's and the seller's Problems

This section analyzes the problem with an offset policy without offset credit multipliers. In fact, we just operationalize the model introduced above, setting the stage for multipliers. An offset policy in place corresponds to a Stackelberg game where the government as buyer sets the offset ratio taking into account how the prime contractor as seller will respond in terms of its domestic expansion of the production of equipment components.

Buying Government's Problem

We posit the government objective in implementing the offset policy as maximizing the net industrial benefits by leveraging defence procurement projects (Cabral et al. 2006) while assuming that the equipment acquired yields a certain strategic value β_0 regardless of whether it is manufactured domestically or imported. The value of industrial benefits consists of the economic development value of investments undertaken by the prime contractor, whereas the cost is equal to the difference between the prices paid under the policy net of the off-the-shelf price $(p - p_W)$. Such an objective function explicitly takes into account the tradeoff between the perceived benefits and the costs of the policy. We also account for the distortionary cost of public funds. This net value function V(.) can then be written as

$$V(d, \varphi) = \beta_0 + \beta d - (1 + \lambda)[p - p_W] \tag{3.1}$$

where $\beta_0 > 0$ is the pure strategic-military value of the equipment, whether manufactured domestically or imported. $\beta > 0$ is the unit strategic-economic value of the prime contractor's domestic investment $(p - p_W)$ is the extra cost emanating from inducing the prime contractor to invest in the host country rather than buying the equipment off the shelf, and $\lambda > 0$ is the constant marginal distortionary cost of public funds. β can also be interpreted as of strategic-military value if the domestic expansion consists of direct offsets or even indirect offsets if the expansion inputs into the manufacturing of other military assets.

The simplicity of our model leaves out the potential strategic value that can be generated if the prime contractor were to invest in, say, the in-service support (ISS) capabilities for the platform being acquired as part of the offset incentives. Such an extension to the original contract would thus endogenize the strategic β_0 together with its associated costs. The ISS is a contested area where buyers see an opportunity to indigenize the industry, whereas the original equipment manufacturers (OEMs) see further profits.

Prime Contractor's Problem

Since the prime contractor's cost will exceed p_W due to the mandatory-offset constraint, it has to cover all such costs given as (from Equation 2.4)

$$C(d,\varphi) = D_0 + [d + H(d)] + [(M_0 - d)(1+\varphi)]. \tag{3.2}$$

Thence the prime contractor's profit function is given as

$$\pi(d,\varphi) = p - C(d,\varphi) = p - \{D_0 + [d + H(d)] + [(M_0 - d)(1+\varphi)]\} \tag{3.3}$$

where p is normally the negotiated price. Whereas in reality competing equipment and platforms are not identical, we adopt the perspective that price summarizes it all and hence the lowest bidder wins. This price may already yield some positive economic profit if the tender is of the Vickrey type. Combining this with the prime contractor's potential profits π_0 elsewhere, the buyer must offer a price satisfying

$$\pi(d,\varphi) = p - C(d,\varphi) \geq \pi_0 \tag{3.4}$$

where $\pi_0 > 0$ is the best business opportunity or alternative profit option for the prime contractor. In fact, the winning prime contractor's tender submission is assumed to be p, satisfying this participation constraint. This observation allows us to solve the prime contractor's problem in response to the offset policy. The prime contractor's response to the offset policy is obtained from its profit-maximization process. Assuming the buyer has bargaining power, i.e. $\pi(d,\varphi) = p - C(d,\varphi) = \pi_0$, it will set the price where the prime contractor minimizes its cost in response to a given offset ratio φ. The prime contractor's cost-minimizing choice of d trades off domestic expansion cost $H(d)$ against the mandated-offset obligations. Thus, the solution to

$$max_d\ \pi(d,\varphi) = p - C(d,\varphi) \tag{3.5A}$$

or

$$min_d\ C(d,\varphi), \tag{3.5B}$$

using $H(d) = \frac{1}{2a}d^2$ from equation (2.5), yields the prime contractor's best-response function

$$d = R(\varphi) = a\varphi. \tag{3.6}$$

Result 3.1 The domestic direct offset industry expands positively with the absorption capacity and negatively with transaction costs, and positively with the mandatory offset ratio φ.

Intuitively, the prime contractor responds to a higher mandatory-offset rate by increasing its domestic production d positively with the domestic industry's absorption capacity and negatively with transaction costs. Since the absorption capacity reflects the distortion of prime contractor's optimal allocation of production, a higher absorption capacity means a less costly offset policy and a lower absorption capacity signals higher cost offsets. It is interesting to note that, given a mandatory offset ratio φ, a higher absorption ratio is conducive to a larger expansion of the

domestic direct offset industry with a strong suggestion that governments should stay away from encouraging offsets-induced investments into low-absorption sectors except, perhaps, into operationally critical ones. The article (Matthews and Anicetti 2021) is suggestive that with the high absorption capacity in a wide variety of defence sectors, maybe $H(d) = 0$, the UK would not have to impose mandatory offsets to attract domestic production expansion d.

Buyer's Problem Solved

The buyer's objective is to obtain as much domestic industrial expansion as possible with as little as possible distortionary cost resulting. In the model, this is the only possibility, whereas, in reality, technology transfers through joint ventures and co-production and, perhaps, counter-trade provides other channels by which offsets may work. We now use the host government's objective function from (3.1), the prime contractor's cost function from (3.3) and its best-response function from Result 3.1 and, upon a simplification, we reduce the constrained Stackelberg problem to an unconstrained one. We obtain (3.7) below.

$$\begin{aligned} max_{\varphi}\ V(d,\varphi) &= \beta_0 + \beta d - (1+\lambda)[H(d)] \\ &= \beta_0 + \beta R(\varphi) - (1+\lambda)\left[\frac{1}{2a}[R(\varphi)]^2\right]. \\ &= \beta_0 + \beta a\varphi - (1+\lambda)\left[\frac{1}{2a}(a\varphi)^2\right] \end{aligned} \tag{3.7}$$

The first-order conditions yield the optimal mandated-offset ratio ϕ and the domestic production expansion d as follows.

$$\varphi = \frac{\beta}{1+\lambda} \tag{3.8A}$$

$$d = \frac{a\beta}{1+\lambda}. \tag{3.8B}$$

These results are summarized in Result 3.2.A and Result 3.2.B.

Result 3.2.A The mandated-offset ratio is positively related to the marginal benefit from the expansion of the mandated offset industry and negatively to the marginal cost of public funds.

Result 3.2.B The expansion of the mandated-offset industry is positively related to the marginal benefit of the direct offsets, negatively to transaction costs and positively to the industry's absorption ratio whereas negatively to the marginal cost of public funds.

Bearing in mind that this is a single sector model, a number of conclusions emerge. First, a higher marginal cost of public funds reduces the targeted expansion of domestic defence industrial infrastructure because cost is, unsurprisingly, a factor in the purchasing government decision. In other words, investment in domestic industry expansion induced by a strictly positive offset ratio is moderated by costs arising from lower absorption ratios as well as higher transaction costs. Second, if the industrial infrastructure is strong or absorption capacity α higher, then the import-substitution or offset industry expansion target is higher as the cost premium is lower. Third, deriving from the strategic-military component of the offset expansion, if β is higher (Fevolden and Tvetbråten 2016), then the target is also higher. Finally, if the desirable expansion (high β) and the low absorption capacity (low a) diverge the target may only be achieved at significant cost to buyer. As we will discuss in Offset Credits and Multipliers: Policy Lessons and Summary of Results and a Discussion of the Model, this simple result suggests caution in using the offset credit multipliers, i.e. in selecting

the industries targeted for offsets. This caution would amount to moderating the selection of low-absorption capacity industries. The above quote from (Matthews and Anicetti 2021) regarding the high absorption capacities in the UK industry means that the UK may not need offset policy to begin with given its wide range of defence industries with high absorption capacities.

Results Obtained from the Prime Contractor's Problem with Multipliers

The offset credit multipliers are policy instruments used to channel mandatory-offset investments to targeted sectors by assigning them higher offset credit multipliers, such as the multiplier 20 in the case of Malaysia (Balakrishnan and Matthews 2009). In fact, this method of targeting through multipliers simply narrows down the range of sectors by using a price mechanism rather than by fiat or quotas. Unlike through these two latter policy instruments, the use of multipliers still allows the prime contractor to invest into non-targeted sectors to satisfy its mandatory-offset ratio constraint. These multipliers work by generating discriminatory sector-specific costs to the prime contractors in their choices of generating business activity to discharge their offset obligations.

Prime Contractor's Response Functions to Sectorally Differentiated Multipliers

We now consider sectorally differentiated multipliers. Countries implementing offset policies deploy them, and they constitute price-based solutions towards a more efficient though not 'efficient' industrial policies. Since the simplest model that would allow analysis is one with two sectors, *A* and *B*, we adopt such an expansion of our base model from equation (2.4) in The Model. The prime contractor's expanded cost function is now given as

$$C(d_A, d_B; k_A, k_B; \varphi) = D_0 + D(d_A, d_B) + M(d_A, d_B; k_A, k_B; \varphi) \tag{4.1}$$

where k_A, $k_B \geq 1$. The offset credit multiplier simply amplifies the offset credit received by the prime contractor towards its offset obligation. Since an offset multiplier reduces the offset burden or, in other words, makes it less costly for the prime contractor to satisfy offset obligations, the relationship between the offset multiplier k_i and the offset ratio φ can be written as $\varphi_i = \varphi/k_i$. Therefore, if a particular sector is given a multiplier of 2, its offset rate for that sector is cut in half. Recalling Malaysia's multiplier equal to 20 that means an effective obligation of only one dollar for every 20 dollars.

In the cost function above, the first term on the right-hand side is the cost of business the prime contractor would have generated domestically anyway through sub-contractors that already belonged to its global supply chain. The second term is composed of the costs of two component inputs A and B that the prime contractor would normally have imported from its global supply chain. However, under mandatory offsets, it is the cost of manufacturing them domestically as induced by the offset policy and hence at no offset obligations accruing. Yet, parts of inputs A and B are still imported as given by the third term. The prime contractor will have to incur the unit offset cost of φ_i on each imported unit of inputs $i = A, B$.

To simplify the framework and give an example, we consider $\varphi_i = \varphi = 100\% = 1$. Moreover, m_A and m_B represent the two sectors' import shares in *M*, i.e. $M = m_A + m_B$, in the absence of domestic expansions d_A and d_B. Thus (4.1) becomes

$$M(d_A, d_B; k_A, k_B; \varphi) = [(m_A - d_A)(1+1) + (m_B - d_B)(1+1)] = 2[(m_A - d_A) + (m_B - d_B)]$$

If the prime contractor is supposed to generate 100% of the project value domestically that value will be half of the above. Of course, given k_A, $k_B > 1$, effective offset multipliers reduce this burden and incentivize a change in the flow of investments towards specific sectors depending on k_A and k_B.

Recalling the prime contractor's objective function from (3.5) and (3.6), we now obtain its objective function with two sectors as follows

$$C(d_A, d_B; k_A, k_B; \varphi) = D_0 + D(d_A, d_B) + M(d_A, d_B; k_A, k_B; \varphi)$$
$$D_0 + \underbrace{[d_A + H_A(d_A)] + [d_B + H_B(d_B)]}_{\text{TC of domestic production}} \tag{4.2}$$
$$+ \underbrace{[(M - d_A - d_B)(1 + \varphi)}_{\text{TC of imports}} - \underbrace{(k_A d_A + k_B d_B)]}_{\text{Total offset credits}}.$$

Substituting in the posited extra cost function $H(d) = \frac{1}{2\alpha} d^2$, we obtain

$$C(d_A, d_B; k_A, k_B; \varphi) = D0 + \left[d_A + \frac{1}{2a_A} d_A^2\right] + \left[d_B + \frac{1}{2a_B} d_B^2\right]$$

$$+ [(M - d_A - d_B)(1 + \varphi) - (k_A d_{A+} k_B d_B)] \tag{4.3}$$

where the term $(M - d_A - d_B)$ could have been written as $(m_A - d_A) + (m_B - d_B)$ with the restriction $m_A + m_B = M$.

Recalling that the sectoral offset ratios are given as $\phi_i = \phi/k_i$, the prime contractor's best-response functions to the buyer's sectoral mandated-offsets are given as, first for sector A as

$$\frac{\partial C(.)}{\partial d_A} = H_A^{'}(d_A) - \varphi_A = \frac{d_A}{a_A} - \varphi - k_A = 0 \tag{4.4}$$

or, simply,

$$d_A = a_A(\varphi + k_A), \tag{4.5}$$

and, similarly for sector B

$$\frac{\partial C(.)}{\partial d_B} = H_B^{'}(d_B) - \varphi_B = \frac{d_B}{a_B} - \varphi - k_B = 0 \tag{4.6}$$

or, simply,

$$d_B = a_B(\varphi + k_B). \tag{4.7}$$

These best-response functions are the multi-sectoral counterparts to the uni-sectoral best-response function in (3.6). We thus obtain, from (4.5) and (4.7), the prime contractor's two industrial expansion best-responses to the three incentive parameters ϕ, k_A, and k_B, noting that the sectoral effective offset ratios, ϕ_A and ϕ_B, are derived from the trio of incentive parameters. We express the result (4.7) in Result 4.1 below.

Result 4.1 The prime contractor expands the domestic production positively with the mandated-offset ratio, the sector's absorption capacity, and the sectoral offset credit multiplier.

A major result flowing from these simple functions is that if the host country wants to incentivize domestic production in a specific priority sector with a low-absorption rate, the incentive provided through k must be significantly strong since φ affects both sectors symmetrically. However, as we will see below, that is the scenario where such expansion can be prohibitively costly. A taxonomy of the interaction between the offset credit multiplier k_i and the absorption capacity α_i is summarized in the following table.

Of particular policy relevance is the cell corresponding to low absorption capacity and high multiplier incentive in a sector designated as a priority sector. The steep incentive running from a high offset credit multiplier would induce more investment in the sector where expansion would be highly costly due to the low absorption capacity. If, in fact, the multiplier in question reflects security priorities then the policy-maker has to accept the high costs. However, such high costs are of real fiscal concern if the high multiplier derives from political influences such as re-election concerns and influence activities.

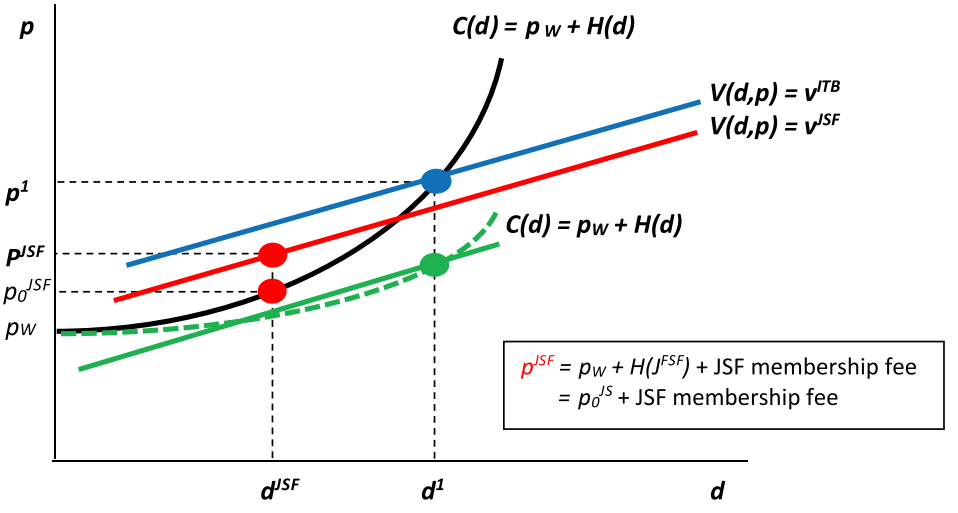

Figure 3. Equipment procurement decision with or without mandated offsets.

Reiterating the caution above flowing from Result 3.2.B, the low-absorption capacity and high offset credit multiplier combination are a highly costly proposition. Whereas this paper does not endogenize the selection of direct offset sectors, the operational capacity for security, as represented by parameter β_0, may impose a large marginal benefit that would make such high costs acceptable, while economic benefits may not justify them. We will revisit this issue below in the discussion of Figure 3.

The Buyer's Problem

In the light of the prime contractor's response functions where the mandated-offset ratio and multipliers enter additively, i.e. $d_A = \alpha_A(\varphi + k_A)$ and $d_B = \alpha_B(\varphi + k_B)$, the buyer's problem can be reduced to choosing the pair $\{d_A, d_A\}$. Thus, upon allocating the bargaining power to the buyer again, i.e. (4.9) holds as equality, and using (4.3), we formulate the buyer's problem as

$$max_{\{d_A,d_B,\varphi\}} V(d_A, d_B, \varphi) = \beta_0 + \beta_A d_A + \beta_A d_A - (1+\lambda)[H_A(d_A) + H_B(d_B)] \tag{4.8}$$

$$s.t.\, \pi(d_A, d_B, \varphi) = p - C(d_A, d_B, \varphi) = \pi_0 \tag{4.9}$$

$$argmin_{\{d_A,d_B,\varphi\}} C(d_A, d_B, \varphi) \tag{4.10}$$

which yields identical results to the single-sector model due to the separability of the extra cost function H(.) into its sectoral components. The optimization problem (4.8)–(4.10) is the generalization of the problem (3.7) to this multisector version, which allows us to analyze the choice of sectoral incentives under the generally mandated-offset policy. As we will discuss in the conclusions section, it paves the way to the discussion of tradable offset credits, a more efficient market environment that relaxes the time constraint on the discharge of offset obligations of individual obligors (more details in Balakrishnan 2020; Dirksen 2010 for The Netherlands).

The solution for the derivation of offset credit multipliers yields

$$\varphi + k_A = \frac{\beta_A}{1+\lambda} \tag{4.11}$$

$$\varphi + k_B = \frac{\beta_B}{1+\lambda} \tag{4.12}$$

where we note the indeterminacy of φ, i.e. the simplicity of the model only allows the determination of $\varphi + k_A$ and $\varphi + k_B$. This indeterminacy is not so detrimental simply because both φ and k incentivize the expansion of domestic direct offset sectors. The policy-maker can thence use φ as a scale factor and the individual multipliers as inter-sectoral distribution incentives. In other words, to a certain extent, the mandated-offset ratio and the offset credit multipliers are perfect substitutes up to the level of the weakly targeted sector but not beyond. For instance, if the optimal solution yields $k_A < k_B$, the former can be set to zero, leaving only two incentive parameters. (4.11) and (4.12) thus yield:

Result 4.2 The sectoral incentive is proportional to the marginal economic benefit from the sector but inversely proportional to the total marginal cost of public funds.

We reiterate the fact that the separability of the extra cost function H(.), in terms of different sectors, yields these simple results. The result (4.2) indicates that the relative sectoral expansions necessitate a differentiation of incentives that, in turn, require two independent incentive parameters, whereas the third one can be redundant. As pointed out in the above paragraph, $\varphi + k_i$ is the effective sectoral net multiplier, a combination of the common mandated offset ratio with the rebate on offset obligation to individual sectors. This makes intuitive sense: Whereas the overall offset ratio forces the prime contractor to undertake a domestic industrial expansion, the multiplier incentivizes the prime to invest in a particular sector.

Finally, in terms of sectoral expansions, we obtain

$$d_A = \frac{\alpha_A \beta_A}{1+\lambda} \tag{4.13}$$

$$d_B = \frac{\alpha_B \beta_B}{1+\lambda}. \tag{4.14}$$

These can be stated as:

Result 4.3 The expansion in the direct-offset sectors is positively related to the product of the marginal sectoral economic benefit and the sector's absorption capacity but inversely to the total marginal cost of public funds.

As in the single-sector model, the higher marginal cost of public funds reduces the targeted expansion of domestic defence industrial infrastructure in each sector. However, in the light of Table 4.1, this result calls for caution. Unless there is an overriding strategic security reason, expansion of low absorption sectors would be highly costly when strongly incentivized through offset multipliers. Perhaps in stronger terms, one should clearly caution against such expansions to be incentivized. As we point out in the next section, the parameters β_A and β_B may be determined more by politics than economics depending on the particular country's priorities in terms of its security.

If, however, the infrastructure is strong in a sector with higher absorption capacity α then the cost premium is lower. If the economic value β is higher, the target is higher. Thus, if the economically

Table 1. Multiplier k absorption capacity α interaction.

	Low k	High k
Low α	Low d	d?
High α	d?	High d

desirable expansion and the absorption capacity diverge in opposite directions, the target may not be achieved due to the costly nature of the expansion despite a high β. Thus, as in the table presented above, the two-sector model yields a further insight into that a high multiplierk_A (k_B) is ineffective and economically wasteful in changing the flow of investment towards sector A if $\alpha A(\alpha B)$ is low, i.e. the sector in question has low absorption capacity.

Offset Credits and Multipliers: Policy Lessons

A careful analysis of offset policies suggests prudence in the structuring of incentives and their implementation. First, the economic cost of offset policy increases if absorption capacity and offset multipliers diverge in opposite directions because a high multiplier incentivizes investment, whereas the sector has low absorption capacity and the further sectoral production will come at higher costs. This arises in the top right-hand cell in Table 1 in Section 'Results Obtained from the Prime Contractor's Problem with Multipliers'. Conversely, though, a sector weakly incentivized might inflict low expansion costs. The relaxation of the non-tradability of offset credit constraint, as discussed below in the extension section, will reduce the inefficiencies due to strict offset obligation discharge rules. Perhaps, a more judicious policy would incentivize building the required clusters or backward linkages at a lower cost to precede the development of the sector. Second, offset policies may fail, as sectors incentivized may never develop to become part of global supply chains beyond the offset contract period. This risk exists even if the initial absorption capacity may be high. After all, a high absorption capacity may just signal a high likelihood that such sectors will succeed in becoming part of global supply chains as in the case of Canadian companies that won contracts in the Joint Strike Fighter project (Matthews and Ansari 2015). Perhaps, instead, subsidies may be directed towards export support, levelling the field and enhancing competition within the sector (Aghion et al. 2015), rather than using multipliers. Third, offset policies expose both purchasing and selling countries to corruption, an area left unexplored in this article (The Economist 2013; Hoyos 2013; Lambrecht 2013; Nackman 2011; Platzgummer 2013).

In terms of immediate policy, we can illustrate a current, rather standard application to the political economy of offsets. The interaction between the absorption capacity that determines the overall cost and the policy-maker's preferences over offsets versus the cost will determine the acquisition and the related domestic industrial expansion. We note that these preferences are heavily influenced by the government's political dependence on the political, industrial and regional actors. We have already modeled this influence using the parameter β in the problems (3.7) and (4.8-4.10) above. The parameter β represent the marginal benefit of the domestic industrial expansion as measured by what the government is willing to tolerate in terms of cost increases. That is, just to clarify, this tradeoff is just economical. The strategic value of the equipment is not endogenized to interact with its cost of acquisition. It is just assumed that the equipment is acquired.

We now return to the Joint Strike Fighter (JSF) example and Canada's participation in order to illustrate the critical role of policy and the influence of politics. The pivotal parameter under scrutiny is β, the constant marginal value of domestic industrial expansion. It is represented as the slope of the level curves for the government objective function $V(d,\varphi) = \beta_0 + \beta d$ as shown in Figure 3.

With the offset cost curve drawn in black, JSF is preferred over an alternative with a higher domestic content at (d^1,p^1) because indifference curves increase in the south-easterly direction (lower cost, higher economic benefits). Indifference curves (straight lines for simplicity) are given as $V(d,p) = B(d) - p$. Note that for the procurement to take place the minimum condition is $\beta 0 > p_W$. Obviously, if the H(d) curve happened to be flatter (higher absorption capacities) such as in green, traditional offsets would have been preferred.

The parameter β, the marginal value of offsets in the government objective function, is pivotal in the sense that, for a higher value of β, the level curves would have been steeper and the selection in Figure 3 would have been reversed. Intuitively, β represents the relative value of domestic industrial expansion compared to the strategic value of the military equipment being acquired. Clearly, this is

an issue in political economy in that the government's choices will depend on re-electability, bowing to pressure groups (Martin 1996, Ch. 2; Reykers and Fonck 2019), and assessments of security threats. This latter factor generates a case for domestic expansion of industries supporting defence operational capabilities.

Summary of Results and a Discussion of the Model

This paper contributes to the literature on offset policies in several ways by using a precise and multi-sector original model, whereas the literature only included the Markowski and Hall (2014) model, which had a narrow scope to demonstrate the inefficiency of mandated offsets. Our model facilitated the derivation of novel results. First, it provides a model as a precursor to expansive analyses of offsets, as discussed below in the extension section, and paves the way towards empirical testing which has not been attempted. With the implementation of offsets by up to 100 countries (Matthews and Anicetti 2021; Schoeni 2015a, 2015b), with more than 20 countries using multipliers and the offset obligation arrears upwards from $100 billion range, the phenomenon has not received significant theoretical and empirical attention from academia although the press, several practitioners and international economic organizations have commented over time. Second, the absorption capacity, that is crucial in determining not only the efficiency of offsets in the short run but also the policy's success probability, is integrated into the model. The simple result that, when the absorption capacity and offset multipliers diverge, the cost of the offset policy increases significantly and guides the offset multiplier policy and, in that case, offset administrators must avoid setting multipliers independently of sectoral absorption capacities. If high-valued sectoral multiplier channel offset investments towards low-absorption sectors, they may induce costly expansions in those sectors. The availability and the use of data on these variables allows an operationalization of the model in assessing industrial policies. Third, our model shows that offset multipliers relax the local content constraints in targeted sectors deemed as strategically and operationally important by incentivizing investments. However, if such a sector exhibits low absorption capacity, the offset policy becomes costlier. Fourth, we endogenize the overall offset ratio by introducing a social welfare function trading off the incremental cost of local content for potential economic development through mandated offsets. This is a theoretical finding, whereas, in reality, countries choose baseline offset ratios by convention or inertia at 100% or lower levels without going through cost–benefit analyses. Finally, our model endogenizes the prime contractor's choice on the portion of the production to be shifted to the host country as this portion is no longer subject to offsets.

Section 'Results Obtained from the Prime Contractor's Problem with Multipliers' expanded the initial single-sector model to a two-sector model with the aim of modeling and analyzing the mandated offsets with differing offset multipliers. This is novel in the literature. However, such policy-relevant aspects of offsets as bankable and tradable offset credits have not been analyzed in this paper. The next section points out to research directions, including the author's recent work on bankable and tradable offset credits that are likely to improve the efficiency of the offset policies.

Extensions and Research Directions

As defence offset policy is a significantly under-researched area, with perhaps a single analytical paper (Markowski and Hall 2014), several extension directions exist, partly because of new policy tools developed in the past few decades, from powerful econometric techniques for empirical analysis to information economics models to understand the interactions of purchasing governments and the prime contractors.

First, offset policies may fail, as incentivized sectors may never develop to become part of global supply chains beyond the offset contract period. This risk exists even if the initial absorption capacity may be high. After all, a high absorption capacity may just signal high conditional success probabilities but no more (see Matthews and Ansari 2015 for a discussion).

Second, new policy developments include offset credit banking, where the prime contractor can transfer credits intertemporally or, though not widespread, exchange them with other prime contractors in offset credit markets. Moreover, prime contractors can speculate in these markets, especially if they have multiple procurement contracts with corresponding offset agreements with the buyer. The model can be extended to analyze a more general case where prime contractors can invest in indirect offsets in high-absorption but non-defence sectors should such sectors be considered economically strategic, which brings to mind the Saudi shrimp farm development by Raytheon (Dirksen 2010). However, this would reduce the cost of offsets relative to cases where direct offsets apply to low-absorption sectors. The phasing out of indirect offsets in Europe (Matthews and Anicetti 2020) might eventually precipitate the end of indirect offsets elsewhere as well.

Concerning multipliers, Canada uses a sophisticated offset mechanism with a wide array of multipliers, the largest reaching nine (ISED 2023) though nowhere near Malaysia's multiplier rising to 20 in their Hawk program with BAE Systems (Balakrishnan and Matthews 2009). Offset arrears are not a rarity despite high multipliers and, surprisingly, some recent evidence (Busby, Kho, and Penney 2022) showed that prime contractors may be choosing to accumulate arrears rather than rushing towards sectors assigned high multipliers (Lazar 2019; Yedvav, Kordova, and Fridkin 2022). This observation raises questions about the nudging role of offset credits towards designated sectors. Further empirical work has to target whether this nudging may generate definitive success, i.e. whether domestic companies receiving direct offset contracts successfully integrate into global supply chains in the post-contractual period.

This author's offset project includes ready and potential papers. Perhaps, a most-interesting direction would be to concentrate on hitherto-missing markets for offset credits, one intertemporal and the other contemporaneous. Recent efficiency-improving policy developments include offset credit banking, where the prime contractor can transfer credits intertemporally or exchange them with other prime contractors in tradable offset credit markets. Moreover, prime contractors can speculate in these markets, especially if they have multiple procurement contracts with corresponding offset agreements with different buyers. Since bankable offset credits are allowed in certain countries, a better understanding of this phenomenon as an internal market within the prime contractor's business portfolio may generate better policies. Allowing offset credit swaps between prime contractors would enhance efficiency by potentially increasing the domestic business generation for the same amount of aggregate offset obligations. This type of market exists as ad hoc contractual possibilities approved by governments. An institutionalization of these tradable offset credit markets would certainly be efficiency enhancing. A companion paper to the current one, incorporating both bankable and tradable offset credit markets already exists in its first draft.

A major extension of this research requires both a theoretical and then an empirical study on the success of offset policies. The present author already has a working theoretical model. Since offsets have been around for approximately 40 years, several countries may have accumulated data on post-contractual successes or failures of contractors. Their graduation from mandated-offset contracts towards full affiliation in global supply chains is the exclusive criterion to evaluate success. Successful offsprings are those companies with offset contracts that go on to become part of global supply chains. Empirical research in this area would contribute to our understanding of offset policies.

Another extension direction would consist of the endogenization of the strategic value β_0 of the equipment. As we noted in Section 'Offset Credits and Multipliers: Policy Lessons' above, this tradeoff is just economical. The strategic value of the equipment is not endogenized to interact with its cost of acquisition. It is just assumed that the equipment is acquired. Such an extension would require the integration of a threat variable and, consequently, the designation of critical domestic sectors necessary for the operational capabilities of the country's military. Whereas some countries attempt to draw a line between operational needs and economic development goals, others overemphasize the operational relevance of some domestic sectors, which blurs the line from threat to domestic industries.

Notes

1. Germany, Greece, Italy, Netherlands, Norway, Poland, Turkey, UK, South Africa, Australia, India, Indonesia, South Korea, Singapore, Taiwan, Brazil, Chile, Colombia, Saudi Arabia and UAE (Kimla 2013; El Hajami and Chinoperekweyi 2019).
2. Direct offsets themselves can perhaps be split into offsets towards the same project they derive from and offsets towards other defence sectors (Palavenis 2021; Yedvav, Kordova, and Fridkin 2022). Although a direct offset is normally defined as business activity related to the original project subject to the offsets agreement, the prime contractor can still produce items directly related to the equipment or platform in question without being part of the original project and hence count towards indirect offsets.
3. https://www.f35.com/global/participation/canada-industrial-participation.
4. In a similar, but smaller country, Norway, two-thirds of defence acquisitions are off-the-shelf OTS). Whereas 'the three most commonly mentioned advantages are reduced procurement costs, reduced technological risk and a faster acquisition process. . . . ' (Berg, Presterud, and Øhrn 2019]), there are two disadvantages. First, the product may not be precisely tailored to defence requirements, and as expectedly, OTS may be more suitable to consumables.

Disclosure Statement

No potential conflict of interest was reported by the author(s).

References

Aghion, P., J. Cai, M. Dewatripont, L. Du, A. Harrison, and P. Legros. 2015. "Industrial Policy and Competition." *American Economic Journal Macroeconomics* 7 (4): 1–32. https://doi.org/10.1257/mac.20120103.

Balakrishnan, K. 2020. "Future of the European Defence and Industrial Base (EDTIP) Post-Brexit: Nationalism versus Integration." *Defense & Security Analysis* 36 (4): 458–459. https://doi.org/10.1080/14751798.2020.1857919.

Balakrishnan, K., and R. Matthews. 2009. "The Role of Offsets in Malaysian Defence Industrialisation." *Defence and Peace Economics* 20 (4): 341–358. https://doi.org/10.1080/10242690802333117.

Berg, H., A. O. Presterud, and M. Øhrn. 2019. "Military off the Shelf Procurements: A Norwegian Case Study." *Defence and Peace Economics* 30 (1): 98–110. https://doi.org/10.1080/10242694.2017.1342182.

Berkok, U. G. 2010. "Canadian Defence Procurement." In *Defence Procurement and Industrial Policy*, edited by S. Markowski, P. Hall, and R. Wylie. London and New York: Routledge.

Brauer, J., and J. P. Dunne. 2011. "Arms Trade Offsets: What Do We Know?" In *The Handbook on the Political Economy of War*, edited by C. Coyne and R.L. Mathers. Cheltenham: Edward Elgar.

Broecker, E., and F. Beraldi. 2017. *Offsets in public-sector procurement: Tools for economic development or avenues for corruption? 2017 OECD Global Anti-Corruption &* Integrity Forum. https://www.shift.tools/resources/1504 .

Busby, C., A. Kho, and C. E. Penney. 2022. "The Life Cycle Cost of the Canadian Surface Combatants: A Fiscal Analysis". Parliamentary Budget Officer of Canada. https://www.pbo-dpb.ca/en/publications/RP-2223-016-C–life-cycle-cost-canadian-surface-combatants-fiscal-analysis–cout-cycle-vie-navires-combat-surface-canadien-analyse-financiere.

Cabral, L., G. Cozzi, V. Denicolo, G. Spagolo, and M. Zanza. 2006. "Procuring Innovations." In *Handbook of Procurement*, edited by N. Dimitri, G. Piga, and G. Spagolo, 483–529. New York: Cambridge University Press.

Coadour, D., J. Droff, and R. Bellais. 2018. "Technology Transfer and Risks of Knowledge Leakages Through Training Activities: An Assessment in Sovereign Industries." *International Management* 23:115–126. https://doi.org/10.7202/1068539ar.

de Beaufort, V., E. DeVilder, and C. Sylvain. 2014. "Competitiveness of European Companies and International Economic Countertrade Practices." *International Business Law Journal* 1:1–40.

Dehoff, K., J. Dowdy, and O. S. Kwon. 2014. "Defense Offsets: From 'Contractual burden' to Competitive Weapon". McKinsey & Company. https://www.mckinsey.com/industries/public-sector/our-insights/defense-offsets-from-contractual-burden-to-competitive-weapon.

Dirksen, E. 2010. "National Defence Organisation and Defence Procurement in the Netherlands." In *Defence Procurement and Industrial Policy*, edited by S. Markowski, P. Hall, and R. Wylie, 303–319. London and New York: Routledge.

Donahue, R., J. Parilla, and B. McDearman. 2018. *Rethinking Cluster Initiatives*. Metropolitan Policy Program at Brookings. https://www.brookings.edu/programs/brookings-metro/.

Dumas, L. L. 2004. "Do Offsets Mitigate or Magnify the Military Burden?" In *Arms Trade and Economic Development: Theory, Policy and Cases in Arms Trade Offsets*, edited by J. Brauer and P. Dunne, 21–33. Routledge.

The Economist. 2013. *Guns and Sugar. May 25th*.

The Economist. 2024, January 29. *Britain's Armed Forces Are Stretched Perilously Thin - Too Few People, Too Much Botched Procurement*.

El Hajami, N., and J. Chinoperekweyi. 2019. "A Global Analysis of the Role of Offsets in Aerospace Industry." *Saudi Journal of Business and Management Studies* 4 (1): 147–163.
Fevolden, A. M., and K. Tvetbråten. 2016. "Defence Industrial Policy – A Sound Security Strategy or an Economic Fallacy?" *Defence Studies* 16 (2): 176–192. https://doi.org/10.1080/14702436.2016.1169893.
Hagelin, B. 2004. "Nordic Offset Policies: Changes and Challenges." In *Arms Trade and Economic Development: Theory, Policy and Cases in Arms Trade Offsets*, edited by J. Brauer and P. Dunne, 137–148. New York: Routledge.
Hall, P., and S. Markowski. 1994. "On the Normality and Abnormality of Offsets Obligations." *Defence and Peace Economics* 5 (3): 173–188. https://doi.org/10.1080/10430719408404791.
Hartley, K. 2006. "Defence Industrial Policy in a Military Alliance." *Journal of Peace Research* 43 (4): 473–489. https://doi.org/10.1177/0022343306064976.
Hollander, S. 1991. "On the Endogeneity of the Margin and Related Issues in Ricardian Economics." *Journal of the History of Economic Thought* 13 (2): 159–174. https://doi.org/10.1017/S1053837200003540.
Hoyos, C. 2013, October 9. "Offset Side Deals Spark Calls for Transparency." *Financial Times*. http://www.ft.com/intl/cms/s/0/4c140b7a-251a-11e3-bcf7-00144feab7de.html#slide0.
IFBEC. 2016. Offsets in the Aerospace and Defence Industry. *International Forum on Business Ethical Conduct*. www.global-kinetics.com/wp-content/uploads/2016/02/IFBEC-Offsets-Report.pdf.
ISED. 2023. "Industrial and Technological Benefits Terms and Conditions", V5.6. https://ised-isde.canada.ca/site/industrial-technological-benefits/en/key-references/model-terms-and-conditions.
Jung, H., G. Kosmopoulou, C. Lamarche, and R. Sicotte. 2019. "Strategic Bidding and Contract Renegotiation." *International Economic Review* 60 (2): 801–820. https://doi.org/10.1111/iere.12368.
Kimla, D. 2013. "Military Offsets & In-Country Industrialisation - Market Insight". Frost & Sullivan. www.frost.com/prod/servlet/cio/275947347.
Lambrecht, R. J. 2013. "The Big Payback: How Corruption Taints Offset Agreements in International Defense Trade." *The Air Force Law Review* 70:73–118.
Lazar, Z. 2019. "Success and Failures of the Gripen Offsets in the Visegrad Group Countries." *Defense & Security Analysis* 35 (3): 283–307. https://doi.org/10.1080/14751798.2019.1640423.
Lazar, Z. 2020. "Book Review: Technology Offsets in International Defence Procurement." *Defense & Security Analysis* 36 (2): 245–247. https://doi.org/10.1080/14751798.2020.1750188.
Markowski, S., and P. Hall. 2004. "Mandatory Defense Offsets—Conceptual Foundations." In *Arms Trade and Economic Development: Theory, Policy and Cases in Arms Trade Offsets*, edited by J. Brauer and P. Dunne. Routledge.
Markowski, S., and P. Hall. 2014. "Mandated Defence Offsets: Can They Ever Deliver?" *Defense & Security Analysis* 30 (2): 148–162. https://doi.org/10.1080/14751798.2014.894294.
Markowski, S., and R. Wylie. 2012. "Using commercial discipline to improve Australian defence procurement: Misplaced enthusiasm?" *Contemporary Economic Policy* 30 (3): 448–462. https://doi.org/10.1111/j.1465-7287.2011.00267.x.
Martin, S. 1996. *The Economics of Offsets: Defence Procurement and Countertrade*. London and New York: Routledge.
Matthews, R. 2011. "Connecting the Defence Dots: Offset, Acquisition and Industrial Strategy." Paper presented at Conference on Industrial and Regional Benefits, School of Policy Studies, Kingston, Canada. Queen's University.
Matthews, R. 2014. The UK Offset Model. Royal United Services Institute, *Whitehall Report 1-14*. https://rusi.org/sites/default/files/201408_whr_matthews_web_0.pdf.
Matthews, R., and J. Anicetti. 2020. "Death Spiral of European Offset?" *Defense & Security Analysis* 36 (4): 453–454. https://doi.org/10.1080/14751798.2020.1857917.
Matthews, R., and R. J. Anicetti. 2021. "Offset in a Post-Brexit World." *The RUSI Journal* 166 (5): 50–62. https://doi.org/10.1080/03071847.2021.2017592.
Matthews, R., and I. Ansari. 2015. "Economic Orthodoxy V Market Pragmatism: A Case Study of Europe's 'Abandonment' of Defense Offset." *Public Finance and Management* 15 (4): 378–404. https://doi.org/10.1177/152397211501500405.
Melitz, M. J. 2005. "When and How Should Infant Industries Be Protected?" *Journal of International Economics* 66 (1): 177–196. https://doi.org/10.1016/j.jinteco.2004.07.001.
Nackman, M. J. 2011. "A Critical Examination of Offsets in International Defense Procurements: Policy Options for the United States." *Public Contract Law Journal* 40 (2): 511–529.
Nossal, K. R. 2016. *Charlie Foxtrot: Fixing Defence Procurement in Canada*. Toronto: Dundurn.
Palavenis, D. 2021. "Offset versus Off-The-Shelf in Arms Procurement: The Boxer Infantry Fighting Vehicle in Lithuania as a Case Study." *Journal of Baltic Studies* 52 (4): 565–584. https://doi.org/10.1080/01629778.2021.1969421.
Petersen, C. D. 2011. "Defense and Commercial Trade Offsets: Impacts on the U.S. Industrial Base Raise Economic and National Security Concerns." *Journal of Economic Issues* 45 (2): 485–491. https://doi.org/10.2753/JEI0021-3624450226.
Petty, F. S. 1999. "Defense Offsets: A Strategic Military Perspective." *DISAM Journal* 21 (4): 65–81.
Platzgummer, P. 2013. "Arms Trade Offsets and Cases of Corruption: The Usage of Anti-Corruption Tools in Special Forms of Arms Acquisitions." *International Public Management Review* 14 (2): 17–38.
Reykers, Y., and D. Fonck. 2019. "No Wings Attached? Civil–Military Relations and Agent Intrusion in the Procurement of Fighter Jets." *Cooperation and Conflict* 55 (1): 1–20. https://doi.org/10.1177/0010836719850203.
Saw, D. 2022. "Successfully Navigating the Canadian Offset Maze." *European Security and Defence*. https://euro-sd.com/2022/12/articles/28445/successfully-navigating-the-canadian-offset-maze/.

Schoeni, D. E. 2015a. "Second-Best Markets: On the Hidden Efficiency of Defense Offsets." *Public Contract Law Journal* 44 (3): 369–399.
Schoeni, D. E. 2015b, December. "Economic Efficiency: In Defence of Offsets and Countertrade." *Contract Management* 46–54.
Taylor, T. 2003. "The Proper Use of Offsets in International Procurement." *Journal of Public Procurement* 3 (3): 338–356.
Taylor, T. 2012. "Countertrade Offsets in International Procurement: Theory and Evidence." In *Designing Public Procurement Policy in Developing Countries*, edited by M. A. Yülek and T. K. Taylor, 15–34. New York: Springer.
Udis, B., and K. E. Maskus. 1991. "Offsets As Industrial Policy: Lessons from Aerospace." *Defence Economics* 2 (2): 151–164. https://doi.org/10.1080/10430719108404687.
Ungaro, A. 2014. "Trends in the Defence Offsets Market." *SSRN Electronic Journal*. https://ssrn.com/abstract=2386528.
U.S. Department of Commerce. "Bureau of Industry and Security." https://www.bis.doc.gov/index.php/other-areas/strategic-industries-and-economic-security-sies/offsets-in-defense-trade.
Weiss, M., and M. Blauberger. 2016. "Judicialized Law-Making and Opportunistic Enforcement: Explaining the EU's Challenge of National Defence Offsets." *Journal of Common Market Studies* 54 (2): 444–462. https://doi.org/10.1111/jcms.12290.
Yedvav, H., S. Kordova, and S. Fridkin. 2022. "Offset Obligation in Defense Projects: Schedule, Budget, and Performance Implications." *Sustainability* 14 (11184): 1–21. https://doi.org/10.3390/su141811184.