10.21544/2359-3075.v28n2.f

GLOBAL VALUE CHAINS AND THE DEFENSE INDUSTRIAL BASE: EVIDENCE FOR A PRODUCTIVITY AND COMPETITIVENESS AGENDA

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SUMMARY

The approval of the National Defense Strategy in 2008 marked an important milestone in terms of the most relevant strategic aspects of National Defense. With it, the reorganization of the Defense Industrial Base was solidified as a fundamental structuring axis, establishing the promotion of its competitiveness in the global market as a top priority. Drawing from the international trade literature, this article aims to explore how greater integration with global value chains emerges as a significant factor in considering the promotion of the external competitiveness of the Brazilian Defense Industrial Base through productivity gains. To test this hypothesis, a Vector Error Correction model (VEC) was constructed, incorporating Granger causality tests and Impulse-Response functions, using a database comprising time series data of total commercial and military transactions. The evidence found suggests that increases in the level of total imports significantly impact Brazilian military export capacity. These effects are significantly greater the more comprehensive the trade liberalization promoted in the scope of imports of goods and services, which are essential for realizing gains in specialization, resource allocation, and competitiveness.

Keywords: Defense Industry; International Trade; National Defense Strategy.

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INTRODUCTION

With the approval of the National Defense Strategy (NDS), in 2008, the debate regarding the acquisition of the military means necessary to guarantee national security reached new heights of importance in Brazil, in alignment with the "construction of a new structure for National Defense" (OLIVEIRA, 2009, p. 71). In this sense, since the first version of this document, through the respective revisions and updates in 2012, 2016 and 2020, the modernization of the Armed Forces has always been present as an inseparable element of a national development strategy, finding significant expression in the emphasis given to the reorganization and promotion of the Brazilian Defense Industrial Base[2] (Brazil, 2008, 2012, 2016, 2020).

Recognizing the strategic importance of this sector for providing the capacity and autonomy necessary to protect national interests and paving the way for significant investments and public policies in the subsequent years, "boosting the launch of large military projects" (MAGALHÃES, 2016, p. 34), the approval of the NDS was structured around two priority objectives: 1) the acquisition of defense products in Brazil, in order to ensure the Armed Forces the supply of military means of high tactical mobility and ready employment; and 2) the increase of their productive competitiveness in the international market (BRASIL, 2008, 2020).

Consequently, it has become imperative for Brazil to outline the ways to enable the achievement of these important objectives, paying attention to the political and economic particularities of this sector.[3] Since these objectives are fundamentally focused on the expansion of the technological and operational capacity of national military production and the promotion of its competitiveness, it is understood that such paths should encompass a robust effort to implement a comprehensive and complex agenda aimed at productivity gains[4].

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[2]The concept of Defense Industrial Base includes the entire "set of bodies and entities, public and private, civil and military, governed by the Brazilian legal system, that carry out or conduct research, projects, development, industrialization, production, repair, conservation, revision, conversion, modernization, maintenance, integration, deactivation or termination of defense goods and services" (BRASIL, 2022b).

[3]Among these particularities, we can highlight: the need for large production scales; high investments in research and development; maturation of long-term projects; short life cycle of materials; frequent specialization in dual activities; and a restricted, highly competitive and regulated market, as well as susceptible to influence by government procurement programs, guided by both technical and economic issues and geopolitical interests (CUNHA; AMARANTE, 2011).

[4]Understood here as an indicator of technical efficiency capable of expressing the ability of

This agenda, in its potential beneficial effects for the expansion of national export capacity, is particularly relevant to Brazil, in general, and to its defense industrial sector, in particular, with a view to both mitigating fixed production costs through gains in scale (KURÇ; NEUMAN, 2017; SILVA, 2020) and a better productive insertion in the face of high standards of competition and concentration verified in the scope of international trade in defense products (GOUVEA, 2015; HARTLEY, 2011; SILVA, 2020). It should be noted, however, that despite its notable implications for the promotion of long-term economic growth, including at the intra-sectoral levels (BONELLI; VELOSO; PINHEIRO, 2017; DE NEGRI, 2015; KIM; LOAYZA; MEZA-CUADRA, 2016; KRUGMAN; OBSTFELD; MELITZ, 2015), the concept of productivity is not even mentioned in the NDS, thus reflecting a worrying absence of dialogue with an element of paramount importance for economic development literature.

Given the wide scope of this productivity agenda, encompassing a series of more general and interrelated elements that influence each other – among which we can mention scientific and technological innovation, efficiency in resource allocation and physical and intangible infrastructure (e.g., public institutions and macroeconomic environment) (KIM; LOAYZA; MEZA – CUADRA, 2016) –, this study will be guided in order to specifically analyze the importance of integration with global value chains[5] as a relevant vector for the development of the Brazilian Defense Industrial Base, in view of its most direct impact on promoting its competitiveness in the global market.

It is noteworthy that the view solidly established in the state-of-the-art economic literature of international trade suggests that societies that are more open to imports tend to integrate better into highly specialized global value chains. This greater integration, in turn, emerges as a relevant access route to inputs that generate savings and quality (HALL; MARKOWSKI; WYLIE, 2010; KALOUT et al., 2018; KRUGMAN;

companies, sectors and countries to increase their production capacity based on the same amount of work and a better allocation of available resources (WORLD BANK, 2018; BONELLI; VELOSO; PINHEIRO, 2017; DE NEGRI, 2015).

[5]According to Zhang and Schimanski, value chains integrate "a set of interrelated activities in the production cycle – from research and development, design and manufacturing, to the final distribution phase and other after-sales services – that involves the creation of value of the said good" (2014, p. 74). In this sense, the concept of global value chains refers to an increase in the "fragmentation of the different stages of the production cycle of goods and services, in different countries. That is, the line from the creation of a product to delivery to the consumer is carried out by a global network of companies" (2014, p. 75).

OBSTFELD; MELITZ, 2015), with subsequent inductive effects on resource allocation and the expansion of export volume and competitiveness (ANDRIÁN; GARAY, 2017; EATON; KORTUM, 2002).

In this sense, in order to better understand the adherence and pertinence of this vision to subsidize the development of strategies and public policies that favor gains in productivity and external competitiveness by the Brazilian Defense Industrial Base, this article aims to explore, through a mathematical-statistical instrument called Error Correction Vector model (ECV) – also known as Johansen's multivariate Cointegration model (JOHANSEN, 1995) –, Granger causality tests and Impulse-Response functions, the potential effects associated with a greater integration with global value chains on the export capacity of Brazilian military production – or put in other words, whether the premise about the benefits associated with greater trade liberalization on export capacity in fact finds validity in the more distinctive context of the defense industrial sector.

In addition to advancing a research theme and a quantitative methodological approach that is still too restricted in the national literature on defense economics, it is intended that the evidence identified in this study contribute to effectively promote a greater dialogue between this field of research and the literature on economic development and international trade, for the benefit of strengthening and promoting the Brazilian Defense Industrial Base, in line with the objectives then assumed in the NDS.

1- DEFENSE INDUSTRIAL BASE: GLOBALIZATION, TRADE AND DEVELOPMENT

The promotion of the competitiveness of the Defense Industrial Base, "aiming at increases to the export of military goods, services and technologies and its possible adaptations for employment in the civilian segment" (BRASIL, 2020, p. 41), has always emerged as an important structuring objective in the discussions around the formulation of the NDS, as well as in its subsequent updates. Its main orientation, in this sense, is to expand its "production scale and, in this way, promote greater regularity to the demands of products, whether exclusively defense or dual application" (BRASIL, 2020, p. 41).

This concern began to acquire greater contours of importance and urgency especially since the end of the Cold War, in 1989, given its irreversible impacts on the global military and weapons dynamics, in general, and on the vast programs of manufacturing and military

development, in particular (NEUMAN, 2006). The results were the profound structural changes observed in technological processes, in the regularity of acquisitions and in the military investment patterns, with the worsening of government restrictions and the greater difficulty in mobilizing the scientific, technical and financial resources necessary for this purpose, in addition to the extensive business restructuring processes[6] that would directly culminate in the elevation of competition standards and economic concentration in this sector (DAGNINO, 2008; LESKE, 2018; SILVA FILHO; MORAES, 2012).

> "Although the concentration was an inevitable consequence of the cancellation of military projects and the need for a larger scale of production for the survival of companies in the sector, it also served the interests of leading American and British defense companies. These firms received large amounts in subsidies to finance the acquisition of rivals and their expansion in the foreign market, in addition to remaining immune to the effects of antitrust laws in force for other economic branches in these countries. At the end of this adjustment process, the United States defense industry would be restricted to five major contractors (Boeing, Lockheed Martin, Northrop Grumman, Raytheon and General Dynamics), while in the British industry, BAE Systems would consolidate itself as the only major player in the sector" (SILVA FILHO; MORAES, 2012, p. 95).

Faced with this new global context, even advanced industrialized nations that stood out as important producers of armaments, such as the United Kingdom, France, and Israel, began to reorient their commercial strategies, seeking "niche positions in the global defense market, promoting their main comparative strengths [...] as a way to retain some of their productive capacities and increase their exports"[7] (NEUMAN, 2006, p. 443)

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[6] Among these corporate restructuring processes, the following stand out: mergers, incorporations, productive diversifications, bankruptcies and even the abandonment of economic activities traditionally linked to defense.

[7] In this regard, it should be noted that retaining productive capacities, especially in the development of sensitive technologies, emerges as an important factor not restricted only to the commercial dimension, but mainly strategic.

– even if this inevitably implied the renunciation of more comprehensive productive capacities to focus on specific, highly specialized skills with greater potential for competitiveness and profitability, in addition to an explicit dependence on technologies and inputs from the United States and, therefore, subordination to its strict export control and restriction policies.

The greater dependence on foreign markets, in turn, became an integral element of the growing awareness of the ongoing globalization process and its corresponding impact on the defense market.

> "As armies continue to shrink and domestic military markets decline, arms producers worldwide are increasingly turning to foreign markets to achieve economies of scale for their products. With the possible exception of the United States, in the coming years domestic defense industries may consider their own military as less important customers than foreign markets. This may have already happened in France and Israel. In both countries, export earnings are much higher than domestic sales. In France, the military expressed concerns that export demand, rather than the needs of the armed forces, is driving weapons production. In Israel, the military has become a secondary customer for almost all Israeli defense industries, and exports now account for almost 80% of its revenues – the inverse of the U.S. market" (NEUMAN, 2006, p. 430-431).

Another consequence of this advancement in the globalization process, coupled with the high costs associated with the independent weapons production, was the consolidation of collaborative international security communities, based on cooperation agreements and strategic alliances aimed at minimizing the risks associated with large military procurement programs (PRICEWATERHOUSECOOPERS, 2005). A subsequent phase of this collaborative effort occurred within the heart of multinational defense corporations themselves, from the establishment of transnational networks of intra-firm relationships, through which agreements and partnerships for co-production, development, and subcontracting were formed to support increasingly integrated and permanent production systems (KURÇ; NEUMAN, 2017).

Therefore, the coveted goal of productive self-sufficiency, with its inevitably high costs, therefore, began to encounter increasingly limitations. This was even true in the specific case of the United States, a country with the largest military budget in the world – representing 46% of global expenditures in this heading throughout the 1990s (SIPRI, 2022).

> "[...] self-sufficient autarchy – that is, non-dependence on external sources – may appear to be a desirable policy; however, given the current environment – including domestic budgetary constraints and the rapid pace of foreign technological innovation –, protectionist policies are not only inaccessible but would quickly lead to a reduction in the military superiority of the United States. In fact, today, every weapon system in the United States contains foreign components – because they are better, not because they are cheaper" (GANSLER; LUCYSHYN; RIGILANO, 2013, p. vii).

In this regard, Gansler, Lucyshyn, and Rigilano draw attention to the radical transformation in the composition of the American Defense Industrial Base itself, thus becoming "increasingly reliant on international sources for its development, production and provision" (2013, p. ix), in favor of gains in: i) economy of scale, efficiency and productive capacity by reducing fixed costs associated with the acquisition of inputs, technologies, and services offering better cost-benefit; and ii) interoperability, given the trend for military operations to be conducted within international coalitions, allowing allied countries to design their respective military systems to operate in coordination, resulting in complementary strategic advantages, closer diplomatic ties, and enhanced cooperation among them.

In the face of the inevitable advancement of globalization, which is also impacting the defense industries, the United States would have no choice but to definitively embrace this ongoing process.

> "There is no alternative. Failure to embrace the globalization of Science and Technology (S&T) in general, or the globalization of the defense industry in particular, will insulate the United States from

> the latest developments, most of which will soon occur in other countries. For the U.S. Department of Defense to shape and take advantage of tomorrow's technologies, it must embrace industry globalization by relying on the best available technologies, allowing foreign access to certain American technologies, and building partnerships within the global S&T community... Denying its reality, or insisting that the United States could easily adopt a protectionist policy, is counterproductive, especially in light of emerging security, budgetary, and other rising challenges (GANSLER; LUCYSHYN; RIGILANO, 2013, p. x).

It is worth noting that the arguments presented by Gansler, Lucyshyn and Rigilano (2013) have great alignment with a body of evidence identified in the international trade literature, particularly in its connection to economic development. This relation is notably addressed in the referential analyzes of Krugman (1995), Krugman, Obstfeld and Melitz (2015) and Eaton and Kortum (2002), for which the act of commercializing directly and effectively contributes to the enhancement of a country's technological capabilities, providing access to higher-quality, more diverse, and better value for money goods, services, and technologies.

In this same perspective, numerous empirical studies have been conducted to analyze and measure the impact of trade openness on productivity gains in Brazilian industrial sectors. For instance, Rossi and Ferreira (1999) and Silva, Bezerra, and Lima (2012) emphasize the stimulating effects of increased external competition – which accompanies, therefore, the greater availability of imported goods – on levels of productive efficiency, quality and price reductions.

According to Rossi and Ferreira (1999), the changes observed in the Brazilian tariff structure during the trade liberalization cycle in the first half of the 1990s resulted in a significant increase in total factor productivity in the analyzed industrial sectors –from a negative annual average rate of -2.49% between 1985 and 1990 to a growth rate of 2.15% per year between 1991 and 1997. Silva, Bezerra and Lima found a bicausality relationship between the variables related to the volume of imports and the labor productivity of the

manufacturing industry, thus corroborating "the evidence, present both in the theoretical literature and in empirical works, that this way it is possible to promote the growth of industrial productivity, which generates undeniable benefits for competitiveness and economic growth" (2012, p. 82).

These findings are strongly supported by studies conducted by Lisboa, Menezes and Schor (2010) and Ferreira and Rossi (2003), which also identified in international trade, and more specifically in the input market, a vector of the most absolute relevance to think about promoting productivity growth in the country – thanks, fundamentally, to greater access to inputs that result in cost savings and improved quality, which are essential for achieving gains in specialization, resource allocation, and competitiveness.

It is also noteworthy, even when considering a broader context beyond Brazil, the results found by Andrián and Garay (2017): based on an analysis structured on aggregated data for a total of 113 countries – including Brazil – in the period from 1960 to 2014, the authors provided compelling evidence that trade opening policies have a positive impact on enhancing nation's export capacity.

Finally, Villela (2013), in a comprehensive historical perspective on the long-term process of world economic development, rescues the analyzes of Cameron and Neal (1997), Findlay and O'Rourke (2007) and Lucas (2009) to emphasize that the expansion of world trade has served as one of the primary drivers of productivity gains since the nineteenth century, "either directly, by allowing better allocation of resources within and between economies, or as a vehicle for the dissemination of technological knowledge throughout the world" (Villela, 2013, p. 75).

However, despite the significant body of evidence surrounding the economic and trade implications associated with increased openness and integration with global value chains, there remains a notable gap in the literature regarding how these effects manifest themselves on military production. Furthermore, a considerable portion of the analysis related to the development strategies of the Brazilian Defense Industrial Base pays little attention to the phenomenon of productivity itself. In this context, this article aims to contribute to bridging these gaps, establishing potential approaches to address the "continuity of the defense segment in the current context of fiscal restrictions" (SILVA FILHO, 2017, p. 108), particularly given the limited financial capacity of the Brazilian government to support companies operating in this sector.

2- DATA AND METHODOLOGY

To test the hypothesis that international trade, through increased integration with global value chains, effectively emerges as a relevant factor in promoting productivity and enhancing the external competitiveness of the Brazilian Defense Industrial Base, a database was structured consisting of four time series: two referring to the transfers of imports and exports of military products, while the other two relate to the annual percentage of total imports and exports of goods and services as a proportion of national GDP.

The series of military product transfers were collected from the databases of the Stockholm International Peace Research Institute (SIPRI), an independent think tank founded in 1966 with headquarters in Stockholm, Sweden, aimed at providing "data, analysis, and recommendations, based on open sources, to public policymakers, researchers, the media, and the interested public" (SIPRI, 2022a). These series encompass the supply of major weapons and conventional military components, including "sales, aid, donations, and those made through manufacturing license agreements" (SIPRI, 2022b), highlighting the following product categories: aircraft; air defense systems; armored vehicles; artillery; engines; missiles; naval weapons; satellites; sensors; ships; and others.

Importantly, these series are not based on the financial value of arms transfers per se, but on an index derived from the known unit production costs of a basic set of weapons.[8] In this manner, they are organized using their own system of common units of Trend Indicative Values (TIV), which can be employed to "calculate trends in international transfers over time, indicative global percentages for suppliers and recipients, and the volume of transfers to or from specific countries" (SIPRI, 2022b).

The series concerning the annual percentage of total imports and exports of goods and services as a proportion of Brazilian GDP, in turn, belong

[8] According to SIPRI (2022b), "weapons whose cost of production is not known are compared with equivalent weapons in terms of: size and performance characteristics; specifics of electronics, loading or unloading arrangements, engine, tracks or wheels, armaments and materials; and year of production". In the case of already used weapons, these receive a value equivalent to 40% of a new one, while weapons that have been significantly refurbished or modified by the supplier receive a value equivalent to 66% of a new one. When it is not possible to identify the supplier or recipient with an "acceptable degree of certainty", transfers are recorded as coming from "unknown" suppliers or recipients, while weapons produced through cooperation agreements in which the country providing the final delivery is not clearly verified are indicated as "multiple". Loans or leases for weapons, in turn, are included only in the case of contracts longer than three months.

to the World Bank's development indicators platform (WORLD BANK, 2022).

The database created for this study covers the years between 1989 to 2020. The decision to proceed the analysis during this period was driven by the conclusion of the Iran-Iraq War in 1988. Given that this conflict, which lasted from September 1980 to August 1988, significantly contributed to stimulating and sustaining the high levels of Brazilian military product exports observed during that time (MAGALHÃES, 2016), an analysis that included the years of its occurrence could introduce distortions into the military transaction series due to the exceptional geopolitical nature of this particular event. Furthermore, an analysis post-1989 also provides a better understanding of the context surrounding the Brazilian defense industry after the end of the Cold War, considering its profound impacts on global military and arms dynamics.

Given the presence of non-stationarity issues in the series related to the total transfers of goods and services as a proportion of Brazilian GDP, identified through a unit root KPSS Test (Table 1), and the presence of at least one cointegration vector among the variables in the database, confirmed by the Johansen Cointengration Test (Table 2), a mathematical-statistical instrument called Vector Error Correction Model (VEC) – also known as the Multivariate Cointegration Model, such as proposed by Johansen (1995) – will be employed. The determination of the order p of the model lag, in turn, was performed empirically using an analysis of information criteria (PFAFF, 2008), which resulted in the selection of order p = 4.

TABLE 1 - Unit root KPSS test applied to time series

Variables	Statistic *(critical value at 10% = 0.347)*
Military imports	0.194
Military exports	0.189
Total imports	0.777
Total exports	0.453

Source: Prepared by the author based on data from SIPRI (2022) and World Bank (2022).

TABLE 2 - Johansen Cointengration Test

Cointegration vector	Test statistics	Critical value
r <= 1	18.37	19.77
r = 0	36.13	25.56

Source: Prepared by the author based on data from SIPRI (2022) and World Bank (2022).

From this model, Granger causality tests (TODA; YAMAMOTO, 1995) will be applied to explore the existence of possible temporal precedence effects among the analyzed variables. Additionally, Impulse-Response functions will be used to graphically delineate the proportion of their movements (ENDERS, 2010).

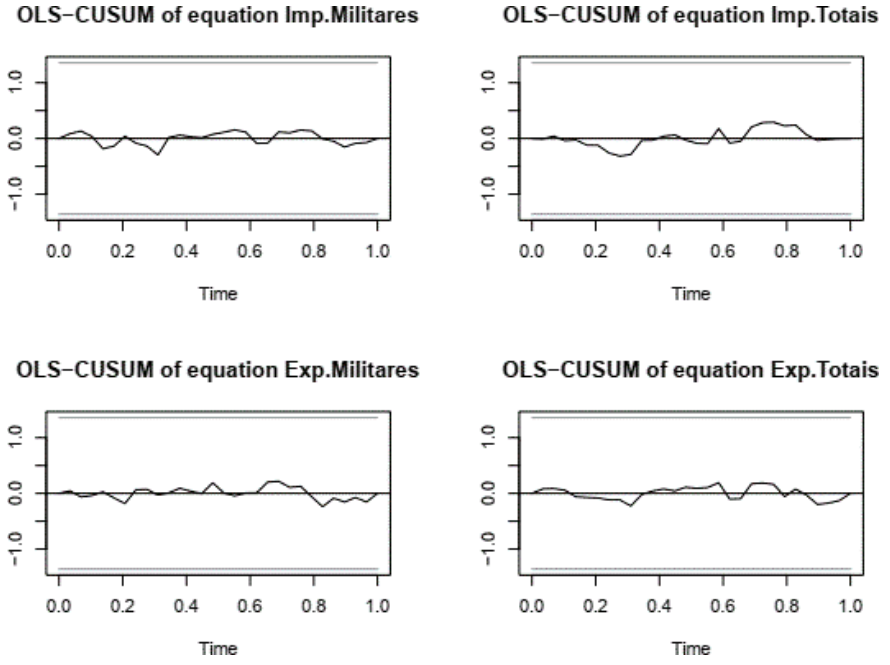
All data analysis procedures were conducted using the statistical software RStudio, following the guidelines and treatments suggested by Pfaff (2008). Serial autocorrelation tests (Portmanteau test), multivariate normality (JB-Test), heteroscedasticity (ARCH test) and structural stability (OLS-CUSUM) were conducted, and no issues were identified that compromise the model's effectiveness.

TABLE 3 - Results of serial autocorrelation tests, multivariate normality and heteroscedasticity

Tests	Chi-squared	p-value
Portmanteau test	197.64	0.374
JB-Test	14.915	0.060
ARCH test	240	1

Source: Prepared by the author based on data from SIPRI (2022) and World Bank (2022).

FIGURE 1 - Graphs of the structural stability test (OLS-CUSUM)

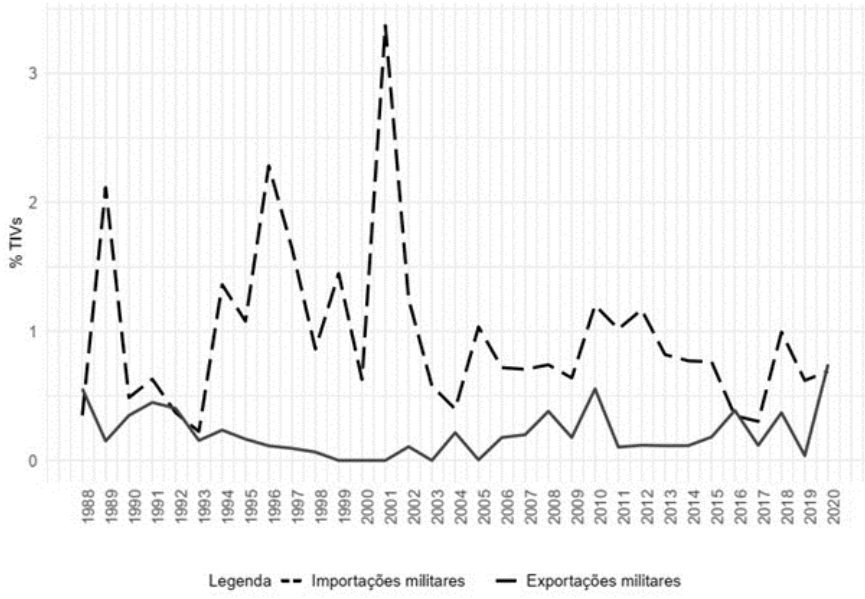


Source: Prepared by the author based on data from SIPRI (2022) and World Bank (2022).

3- RESULTS

An exploratory analysis of data on Brazilian arms imports and exports, as depicted graphically in Figure 2 below, reveals that Brazil consistently relies on military imports to meet its military capacity needs. In contrast, its export volume remains relatively low: while the average of imports observed during the period 1989-2020 accounted for approximately 1% of global transfers, reaching an exceptional peak of 3.3% in 2001, the average of exports only accounted for 0.2%, peaking at 0.5% in 2010.

FIGURE 2 - Brazilian arms imports and exports



Source: Prepared by the author based on data from SIPRI (2022) and World Bank (2022).

When comparing the average percentage of national military transfers against the global flow of these transfers by Brazil and five other countries holding some of the most robust Defense Industrial Bases on the planet, listed by their prominent position in terms of export, it is evident the long way to be traveled for the Brazilian Defense Industrial Base to reach a higher level of prominence in terms of capacity and international competitiveness.

TABLE 4 - Arms imports and exports of selected countries

Countries	Imports	Exports
United States	2.5%	33.7%
Russia	0.3%	23.6%
France	0.3%	7.1%
United Kingdom	2.2%	4.8%
Italy	1.2%	2.2%
Brazil	1,0%	0,2%

Source: Prepared by the author based on data from SIPRI (2022) and World Bank (2022).

Given the absence of structural problems that would compromise the effectiveness of the VEC model, as evidenced by the tests presented in Section 3 of this article, we proceeded with the Granger causality tests. The results, summarized in Table 5, allow us to reject the null hypothesis of non-causality for the relationship between the variables of Brazilian total imports and military exports at a level of 5%, as well as for the relationship between military imports and exports at a significance level of 10%. Therefore, we can confirm the presence of statistically significant effects of unidirectional temporal precedence between these variables, so that the behavior of the former directly influences the evolution of the latter.

TABLE 5 - Granger noncausality test results

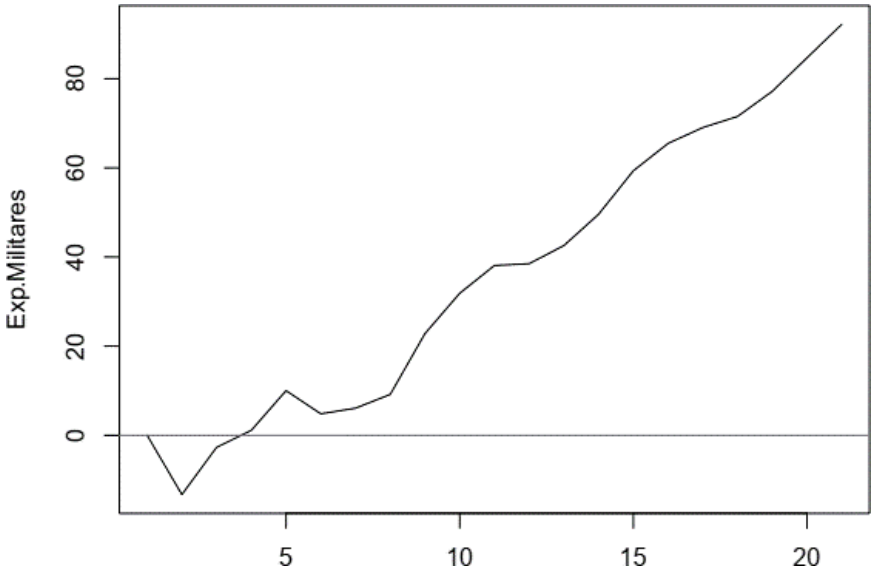
Null hypotheses	p-valor
Total Imports non-Granger-cause Military Exports	0.012**
Military Exports non-Granger-cause Total Imports	0.920
Military Imports non-Granger-cause Military Exports	0.068*
Military Exports non-Granger-cause Military Imports	0.840

Source: prepared by the author based on data from SIPRI (2022) and World Bank (2022).

** Significance level of 5%; * significance level of 10%.

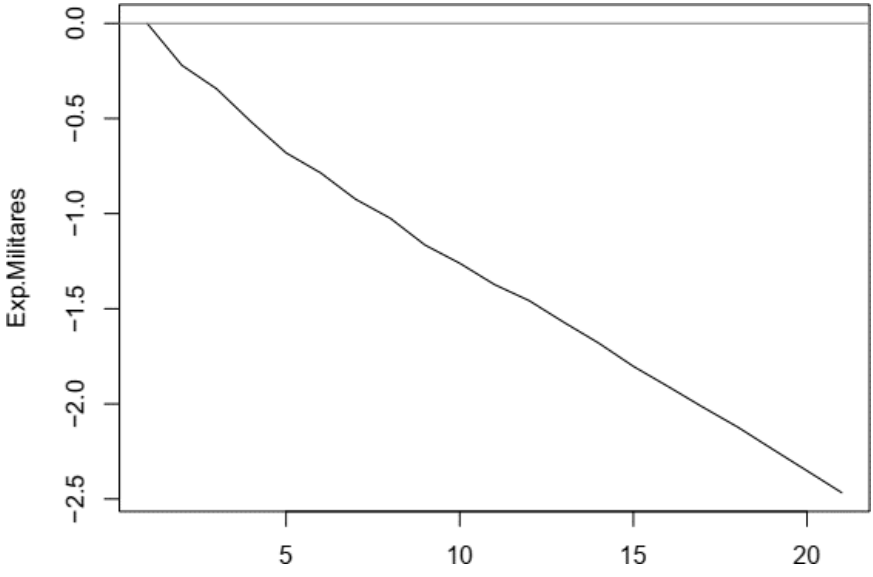
Considering the identified relationships of temporal precedence and aiming to illustrate the impact of a shock or impulse in the variables of total and military imports on the behavior of military exports, the following Impulse-Response functions are graphically expressed in Figures 3 and 4:

FIGURE 3 - Impulse-Response function (cumulative):
'Total Imports' on 'Military Exports'



Source: Prepared by the author based on data from SIPRI (2022) and World Bank (2022).

FIGURE 4 - Impulse-Response function (cumulative):
'Military Imports' on 'Military Exports'



Source: Prepared by the author based on data from SIPRI (2022) and World Bank (2022).

It is evident, therefore, that immediately after a sustained shock in the percentage of total imports, the variable related to military exports briefly becomes negative, converting, however, into a strongly positive and ascending pattern over time, reaching an increase of 40 TIVs in military exports in a period of ten years, while surpassing 80 TIVs in two decades (Figure 3). Conversely, a sustained shock in the variable of military imports, in TIVs, produces a permanently negative effect on the variable of military exports, although of relatively smaller magnitude, reaching -2.5 TIVs in a period of 20 years (Figure 4).

ANALYSIS AND DISCUSSIONS

The results presented above support the hypothesis that international trade, through increased integration with global value chains, plays a significant role in enhancing the productivity and external competitiveness of the Brazilian Defense Industrial Base. Moreover, these benefits are significantly greater the more comprehensive the trade liberalization promoted in the scope of imports of goods and services – both due to the pressures of external competition that come with the increased availability of imported goods and the reduction in costs associated with high-quality machinery, equipment, and inputs (FERREIRA; ROSSI, 2003; LISBOA; MENEZES FILHO; SCHOR, 2010), essential for fostering gains in specialization, resource allocation, and competitiveness.

This evidence is also supported by the most successful Brazilian company in the international market for defense and high-tech dual-use manufactured products: Embraer[9], a company that imports approximately 70% of what it exports (BACHA, 2014; BRASIL, 2022a), thus emerging as a prominent example of integration with global value chains.

Considering that "increasingly, societies that are more open to imports are better integrated into highly specialized global value chains" (KALOUT et al., 2018, p. 13), Brazil, one of the most closed countries in the world,[10] with international trade accounting for approximately 25% of its

[9] Largest exporter of high-tech manufactured products in the southern hemisphere, third largest manufacturer of commercial jets in the world and a leader in the aerospace and defense industry in Latin America (EMBRAER, 2022).

[10] "Brazil is a point outside the curve when it comes to the level of tariff protection granted to industrial products. In 2020, only nine countries in the world had average import tariffs for non-agricultural products higher than Brazil: Algeria, Argentina, Bhutan, Cameroon,

GDP (WORLD BANK, 2022), would no longer benefit from the expected productivity gains mentioned earlier, reducing the efficiency of its economy and its overall well-being levels (BACHA, 2014; KALOUT et al., 2018).

It's worth noting that the positive results evidenced in this study regarding the external competitiveness of Brazilian military exports may not manifest immediately, as indicated by the initial negative effect shown in Figure 3. This phenomenon is in line with the findings of Alesina et al. (2020) and Duval and Furceri (2018), who explain that the economic benefits of liberalizing reforms may have a lag time of approximately four years before they are fully realized. Furthermore, trade liberalization can have adverse effects on less competitive and efficient sectors, demanding complementary transition policies to mitigate potential impacts on the employment and income of vulnerable groups (CINDES, 2022; KALOUT et al., 2018).

On the other hand, the acquisition of off-the-shelf military products – that is, products already available on the market, also called "shelf purchases" – as reflected in time series of military imports from the SIPRI database (2022), has a long-term negative impact on the export capacity of Brazilian military products (Figure 4). This effect could be attributed to the potential displacement of domestic products by foreign ones in government procurement processes, which subsequently affects the supply and investment capabilities of Brazilian companies. This highlights the ongoing significance of government procurement programs in promoting the defense industrial sector, in line with the findings of Cunha and Amarante (2011).

Important to note that meeting the requirements related to national security and defense is a critical strategic concern for any nation. Therefore, countries aim to ensure their armed forces are adequately equipped, within established reliability frameworks and timelines, and at the best possible cost-benefit ratio (HALL; MARKOWSKI; WYLIE, 2010). In this sense, it's natural for countries to prioritize strengthening their Defense Industrial Bases since procuring such products from abroad can involve risks that shouldn't be neglected (CUNHA; AMARANTE, 2011; HALL; MARKOWSKI; WYLIE, 2010; HARTLEY, 2011).

Some of these risks are related to factors like: the uncertainty associated with monopolistic suppliers who can adjust prices arbitrarily; the volatility of exchange rates and their impact on trade; and dependence on the complex political and strategic interests of the supplier, with a possible – albeit remote – probability of abrupt

Comoros, Gabon, Iran, Venezuela and Zimbabwe" (CINDES, 2022, p. 20).

interruption in the supply of strategic inputs (HARTLEY, 2011).

However, it's worth considering that local suppliers may not necessarily be more competent and reliable than foreign suppliers – especially when compared to large multinational companies capable of achieving economies of scale, flexibility, and resilience (HALL; MARKOWSKI; WYLIE, 2010). At the same time, if the acquisition of domestic products and inputs leads to higher prices and/or lower quality compared to foreign alternatives, it will inevitably impose a cost on the national defense capacity, as well as on the productivity and competitiveness of the defense industries.

Therefore, Hall, Markowiski, and Wylie (2010) point out that there is no reason to assume that external supply of military inputs and products is necessarily less reliable than local production – especially because in contexts of conflict escalation, local industries are as exposed to damage as the military capabilities themselves. The argument of the strategic element associated with meeting national security and defense needs, therefore, should not be the sole determining factor in a public policy decision-making process. Moreover, holding the domain of sensitive technologies does not necessarily imply nationalizing all stages of the production or neglect the benefits of greater integration around global value chains, as evidenced in this study.

In addition, to mitigate risks associated with a single supplier, it's important to consider and strategically monitor supply alternatives. This may involve diversifying suppliers or participating in military alliances that reduce potential supply uncertainties (HALL; MARKOWSKI; WYLIE, 2010; HARTLEY, 2011). Strategic partnerships for the development of new generations of products and technologies also gain importance, highlighting a path for understanding how global value chains can be integrated into the defense industry, especially in an "economic context marked by increasing production fragmentation and the growing importance of services" (SILVA FILHO, 2017, p. 106).

In conclusion, advancing the development of the Brazilian Defense Industrial Base will necessitate significant economic and regulatory improvements, [11] as well as a fundamental reorientation of its international insertion strategy. This new strategy should prioritize

[11] Ambitious public policies, such as the Defense Articulation and Equipment Plan (PAED, in Portuguese) and the Special Tax Regime for the Defense Industry (RETID, in Portuguese), prove valuable in this effort to organize demand and strengthen this sectoral production chain of goods and services (GOUVEA, 2018; SILVA, 2020).

economic openness, increased integration with global value chains, and the establishment of robust strategic partnerships for technology development and joint access to foreign markets. Important to say that this approach should not be anchored in polarized views of complete independence or total import dependence but should seek an optimal level determined by evidence and circumstances – a determination that can only be achieved through political discussion with society.

CONCLUSION

As discussed throughout this article, providing access to cost-effective and high-quality inputs through greater integration with global value chains leads to significant productivity and external competitiveness gains, both for the Brazilian industrial sector as a whole and the defense industry in particular. Furthermore, the structural changes brought about by the end of the Cold War facilitated the emergence and consolidation of dual-use technologies, blurring the lines between civilian and military production – a trend motivated largely by the growing search for foreign markets, economies of scale gains, and the need to retain specific productive capacities.

Paying close attention to the competitive and commercial performance of the companies within the Brazilian Defense Industrial Base means, ultimately, making them viable in terms of investment expansion and acquisition of differentiated levels of technology and innovation, in full benefit of their military production and, consequently, of the national defense capacity itself. Preserving inefficient companies, on the other hand, can result in outdated products, lower quality, and unfavorable cost-effectiveness, imposing significant costs on the nation's defense.

Finally, although the strategic nature of the supply of defense products makes it necessary – and even inevitable – to adopt measures that ensure the development of sensitive technologies and capabilities, the evidence pointed out in this article, in line with the state-of-the art of the economic literature on international trade, deserves to be carefully observed so that the country does not fall into market reserve traps and overly broad and generalized import substitution strategies. These measures require technical studies that thoroughly evaluate all associated costs, benefits, and opportunities, so that they not to become mere instruments at the service of interest groups.

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*** Received on March 22, 2022, and approved for publication on September 15, 2022.**