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Research and Development of Dual-Use Technologies in Latin America and the Caribbean as a Regional Evolution and Integration Tool

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Abstract

Amid the 21st-century imperative of innovation, particularly evident within the defense sector, this paper delves into the challenges and prospects for Latin American and Caribbean (LAC) countries in enhancing their capabilities in dual-use technologies and collaborative alliances. The study emphasizes the heightened intensity of this phenomenon in defense, where military and dual-use technologies intersect with geopolitical dynamics in a global context marked by resurgent power rivalries. LAC nations, varying in developmental stages and constrained by economic shifts, face an urgent need to prioritize research and development (R&D) for dual-use technologies, warranting a serious consideration of innovation. The research delineates three country categories within LAC: those capable of autonomous dual-use technology production, those progressing towards that goal, and a third group contributing to the supply chain. Finally, this paper offers a timely exploration of LAC's strategic opportunities, from innovation to collaboration, with the potential to shape the region's defense landscape and broader global positioning.

Keywords

Dual-Use Technologies, Integration, Latin America and the Caribbean, Research and Development

1. Introduction

Development and use of technologies prone for dual-use, characterized as those technologies that can be employed both for civilian applications, or for typical

military missions (with or without minor adaptations), is a historical phenomenon, detected all along the human species evolution. Such a duality takes place bi-directional, sometimes civilian devices are adapted from originally bellicose purposes equipment, other times in a reverse direction. Commonly cited examples of the first are: the animal traction vehicles, and maritime navigation artifacts. More contemporarily, the worldwide web, born from a Defense Advanced Research Projects Agency's communications network, under the name ARPANET (Advanced Research Projects Agency Network).

The first decades of the 21st century witnessed a rebirth of polarization between states in conjunction with social conflicts, increase of inequalities between peoples, and a re-emergence of state geostrategic opposition, all of which challenges the balance of forces carved out after WWII in a phenomenon branded by most experts as the "return of great power competition", that affects all regions of the planet, including LAC. One group of nations led by the United States identifies China and Russia as the main concerns, and another group, driven by China and Russia, perceives the United States, Western Europe, and Japan as nemeses.

This particular moment in history is a golden chance for LAC to catch-up with modernized economies, and also for Western countries, the United States especially, to decrease dependence on more distant and potentially unfavorable supplier countries through a process of nearshoring whereby manufacturers or service providers move all or part of their business to another geographical location, usually one relatively close to the company's area.

The most cited example of nearshoring nowadays involves the common border between the United States and Mexico. However, the Inter-American Development Bank indicates that nearshoring moves by Western industrialized nations (especially the United States) to LAC could add up to US$ 78 billion annually to the entire region's economy.

This article indicates ways in which LAC's capabilities for providing dual-use technologies can be leveraged in a nearshoring regime for the benefit of the entire Western Hemisphere.

2. Dual-Use Technology Development Systems and Trends

Dual-use technologies are those fed from a common core technology, defined by end use (rather than by the source of the resources for development), can find either civilian or military users, and often serve both (Gummett & Reppy, 1988). Another interesting and elegant simple definition of dual-use technologies is:

Dual-use technologies are those that have application by both the military and the civilian sectors of the market. In this way, the dual aspect of technology can be seen as something to be promoted and pursued in research and development of innovations, as it serves two important aspects: i) allow the maintenance of a good defense technological base, amidst the limited budgets available, and ii) improve the economic competitiveness of the country as a whole, through a more efficient allocation of Research and Development (R&D) funds (da Motta, 2011).

It is important to note, however, that some of the most important dual-use technologies are not often the "artifacts" traditionally considered technology but are often what could be described as "technical" or "tacit" knowledge, including not only the science base but also the workforces' experience, skill, and artisanry (i.e., human capital, "know-how and why") (Jensen et al., 2022). Additionally, manufacturing processes and management skills, such as systems integration (Watkins, 1990), required to produce those artifacts also fall under dual-use technologies.

As a comparison, two relatively antagonistic models of dual-use technology development were chosen: The US and the People's Republic of China (PRC).

One particular feature of US dual-use technologies development policy is the lack of any single centralised document or governmental agency, unlike in other countries; (Nichols, 2008) rather, US development is spread out over various public and private organisations. Each area is subject varying degrees of controls and sectorial policies, some heavily regulated as in the case of nuclear energy, space, or advanced computing (Steinbock, 2014).

For its part, PRC innovated the Military-Civil Fusion (MCF), which sharply differs from US model in the fact that all the Chinese programs are highly centralised and planned, with the specific aim to surpass other countries, especially the US, geopolitical technological advantages. From Chinese writings, it is clear that MCF is not a simple addition to China's other national strategic priorities but rather a strategy whose components are to be woven into China's system of national strategies to form an organic, powerful, and comprehensive national strategic system to advance the PRC's overarching security and development goals.

Despite the philosophical and economic differences of these two dual-technology development models, it may be noted both rely in two operational concepts, namely: a defense industrial base (DIB) and a permanently close integration between government, academia, and corporate actors.

3. Defense Industrial Base and the Triple Helix of Defense Innovation

On a superficial level, the idea of a DIB is straightforward. It constitutes the companies supplying defense and defense-related equipment to national security and military organisations. Defining defense industry itself is not simple because of the wide range of products involved. A useful way to classify DIB products is to consider their relationship to military action or warfare: lethal large or small arms systems; non-lethal but strategic products (e.g., vehicles and fuel); and other products consumed by the military (e.g., food and clothing) (Dunne, 1995).

It is important to acknowledge that this hierarchy does not necessarily reflect importance to the military or security production. Most weapons systems could not operate without strategic products, fuel, and transportation, and soldiers could not survive without food. The companies that make up the DIB are differentiated, both in the degree of their dependence on military production and their importance to the DIB. Some large, diversified firms may consider their DIB ac-

tivities to be marginal, but they may be vital producers of specific weapon systems, while some smaller firms may be totally dependent on military orders but not important suppliers (Dunne, 1995).

Governments are the major buyers and, often, the only buyers of defense equipment (monopsony); therefore, to survive, defense industries need to adjust to uncertainties resulting from technical change and external shocks. Companies require (R&D) resources to be innovative in military and civilian markets (Hartley, 2015). In fact, defense-related R&D spending represents the most important source of public subsidies for innovation (Moretti et al., 2019). Private contractors and corporations soften the impacts of declines in defense budgets by having a flexible workforce shared with similar companies and by partnering with other public spending or non-governmental institutions, like universities, which may bring their own human and technical skills to assist with costly and time-consuming development of profitable applications, whose funds will return benefits in the form of enhanced scientific knowledge and a more highly skilled workforce.

This well-studied collaboration cycle has been branded by different names, but the most current version is the triple helix model of innovation. The triple helix can be defined as a model of innovation in which university/academia, industry, and government, as primary institutional spheres, interact to promote development through innovation and entrepreneurship (Etzkowitz & Zhou, 2017).

Concepts of entrepreneurial university and the triple helix are closely interrelated. In this context, universities are required to be entrepreneurial. Other terms such as the third mission, academic capitalism, and mode II of knowledge production are associated with the idea of the entrepreneurial university. The notion disrupts traditional teaching and research paths of academia and leads it to seek reciprocal relationships with stakeholders, for example in industry and government (Cai & Amaral, 2021).

This creates a new dynamic bringing technological demands to the university and disseminating research results through cooperative relationships with companies. However, this process of alteration of the productive dynamics is not a simple achievement (Vega-Jurado et al., 2007). Innumerable researchers, mostly university professors, many in public universities, tend to reject attempts to approach industry; they see these as "commercialisation" of teaching and research. Such repulsion can be even more intense when governmental and corporate initiatives are part of defense related projects (Mancebo, 2004).

The collaboration between governmental defense entities and private industries tends to be stronger. Recent research highlights an interesting phenomenon known as the "crowding in" effect. When there are heightened levels of government-funded R&D directed towards the defense industry or specific defense companies, it significantly influences private sector R&D within the same industry. The magnitude of this effect has been quantified to be around a 5% to 6% increase in private sector R&D activities. It means that as the government invests more in R&D for defense-related purposes, private businesses operating within the same

industry respond by ramping up their R&D efforts (Moretti et al., 2019). Moretti, Steinwender, and Van Reenen revealed the consequential outcome of this phenomenon. Their study on OECD countries confirmed that the boost in private sector R&D activity induced by the rise in public defense R&D investments leads to a subsequent increase in productivity.

In essence, a local economy has the potential for consistent growth through innovation when the triple helix model is effectively implanted in its territory. This circumstance also creates several spillover effects that advantage other industries, and economic sectors. The cluster is a higher stage of the triple helix implementation. Innovation, resulting from integrating university/academia, industry, and government, is enhanced when combined with other specific territorial elements.

According to Porter, forming a regional industrial cluster provides competitive advantages rooted in shared infrastructure, a skilled labour pool, collaborative research and innovation projects, inter-company competition, and institutional incentives. These factors work together to foster an environment conducive to economic growth and innovation. The proximity of diverse resources and stakeholders encourages cooperation, knowledge exchange, and rapid technological advancement, enhancing the cluster's competitiveness on a global scale (Porter, 1990). This approach benefits individual companies and stimulates overall regional economic development by attracting investment, generating jobs, and cultivating a culture of innovation.

4. Innovation and Dual-Use Technology Development in Latin America and the Caribbean

In Latin America and the Caribbean, as elsewhere, innovation policies serve as a potential antidote to regional and global economic uncertainties; nevertheless, even if the overall scores increased during the last years, countries in the region still struggle with fulfilling their innovation potential. No country in the region outperforms in innovation relative to its level of development (as India and Vietnam did, for example), and the largest countries in the region have not seen improvements in their rankings. Numbers are also limited in terms of patent applications filed and scientific articles published (León, 2017).

However, even if the general innovation landscape is daunting, world-class development poles exist, within which there still is strong technological development based on the influence of the local support structure for innovative activity, wherein the sharing of a regional environment and physical proximity contributes to the interaction between industry and innovation. This is not limited to institutions and organisations directly linked to research and technological development but also to the effort of building the region's urban infrastructure, such as accessibility and telecommunications, associated with the existence of a broad structure of services oriented to meet the demands of innovative ventures, such as financial support, insurance, training, and qualification (Dos Santos & Caliari, 2012).

Four countries in the region have established industrial clusters: Argentina,

Brazil, Chile, and Mexico. In the defense field, the most successful case is the São José dos Campos aerospace cluster, with EMBRAER as its leading company (Salarichs, 2015). Beginning with an initial impulse from the government to advance the field of Brazilian aeronautics back in 1969, this industrial conglomerate evolved significantly over time. Currently, it encompasses an array of over a hundred companies. These entities collaborate with researchers and academics to push the boundaries of innovation. Their efforts extend across the entirety of the value chain, encompassing not only ground-breaking advancements but also a comprehensive spectrum of services. This collective endeavor serves as a testament to the collaborative synergy between various stakeholders, all of whom contribute to the growth and vitality of this intricate industrial network.

As such, there are human and material resources that can be harnessed to develop a dual-use defense technology development framework through improving what already exists (in fact or potentially) in some countries, in addition to those of United States and Canada. These nations could be interested in collaborating on the regional development of a hemispheric defense technology network in an integrated defense effort against threats from other regions of the world (Leal & Figueiredo, 2021).

This research discovered there is no specific measurement method for assessing a group of countries' abilities to develop defense innovation, nor dual-use technology within that. Creation of a completely new quantitative model for such analysis would surpass this investigation's scope and length, and for this reason, one methodological decision is, partially, the extraction of indicators from other already validated models, such as the system used by the World Intellectual Property Organisation for its Global Innovation Index (GII) (Dutta et al., 2022).

GII inventors depart from the understanding that contemporary innovation capability is increasingly understood as the ability to exploit new technological combinations, including the notions of incremental innovation and "innovation without research." Even non-innovative expenditure, such as for people and cultural adjustments, is an important component of harvesting benefits (Dutta et al., 2022). Therefore, borrowing some GII's metrics allows for its broader definition of innovation, which helps in the domain of dual-use technologies considering that even if they are not unprecedented, given their inherently restricted nature and the autonomous ability to produce them is itself a sort of innovation.

GII conceptual framework is based on a *correlation* of two sub-indices: the Innovation-Input Sub-Index and the Innovation Output Sub-Index, whereas the global score is the average function of both the sub-indices (Dutta et al., 2022). An in-depth analysis of all sub-indices GII accounts for would far exceed the research's scope; however, it is noteworthy that the GII does not consider factors such as the limited publicity of defense related technologies (often deliberately not patented to avoid disclosure of sensitive features), the capacity for a sustainable scale production, or the geopolitical propensity of a given country to pursue defense related technology, even if for commercially available dual-use.

Another major flaw is that, for various reasons, GII does not list all Western Hemisphere countries. Therefore, the researcher needed different analytic tools. Analysis of research production in business by country shows paper production is concentrated in three countries: Brazil, Chile, and México.

Research production by *country in business* does not follow the same trend as in *all sciences*, where Argentina has a stronger position, which seems to be an indication that not only size is a key variable for producing business research, but additional structural factors, such as the strength and competition level in the university and business school market, can also be important. For example, good business research statistics of Costa Rica and Nicaragua in the Central American region may be linked with the strength of INCAE Business School in those countries. This level of academic competitiveness between innovative scholars may be the cause for augmented research production in countries like Chile or, increasingly, in Peru, México and Colombia (Olavarrieta & Villena, 2014).

Gross domestic product (GDP) per capita figures in Latin America may be correlated with the number of research publications, in particular with economics and business publications (r = 0.54) and business publications alone (r = 0.49), compared to social sciences or all sciences (r = and 0.39 respectively). Such is consistent with findings on a certain relationship between research production and GDP, and indicates the likelihood that in the near future, business research production may increase for those countries that are consistently growing (i.e., Brazil, Chile, México, Peru, Colombia, and Panama) (Olavarrieta & Villena, 2014).

Departing from an assumption that a nation state should be the provider of external and internal security as a public good, in terms of defense innovation in the LAC, impulses for domestic or regional defense technology initiatives, in progress for some decades, have been concerning for the region's governments. To that end, special attention should be directed to projects in space systems, cyber defense/cybersecurity, maritime safety/security, environmental protection, sustainable energy, and others where civil-military synergies can be achieved with dual-use technology projects (Pellerano, 2022).

One major problem for Latin American governments to overcome is the issue of excess spending in personal instead of modern military hardware, which drains an average of 60% of all resources, leaving less than one percent budget space for (R&D) funding (Vega & Comini, 2017). This factual framework makes it essential to identify not only institutional models of articulation among the productive, governmental, and academic sectors but also an objective framework of project financing that may enable the participation of private capital, if defense innovation it to be achieved (Salarichs, 2015).

On the other hand, it is necessary to recognise the great asymmetry between nations in the region, which makes a direct comparison between them erroneous; therefore, for methodological purposes, we aggregated the region's countries into three groups and then examined them according to the characteristics of these groups. This study relies on an average of data already taken from scientific pub-

lications on the topic of military science and technology that seem to point with some homogeneity to certain groups of countries that are more advanced in military and security technological developments.

Note that the Caribbean countries Costa Rica, Dominica, Grenada, Panama, and Saint Vincent and the Grenadines have officially renounced maintenance of traditional military organisations, even though security forces execute functions normally committed the military (Barbey, 2015). This is why this research considers possibilities to develop dual-use technologies proper for internal security goals area and also because for some countries in the region, it is not easy to distinguish, using official reports, the allocation of financial resources, training of technical personnel, etc. for defense from that for public security.

Another element this research considers is that some countries in the region are part of the Commonwealth of Nations (formerly British Commonwealth) and consequently have varying degrees of defense structures and services provided by the United Kingdom (Mckenzie, 2006). The same is to be observed of former colonies of the Netherlands (Economist Intelligence Unit, 2008).

Innovation studies tend to look separately at countries with development programs of greater complexity and at a more prominent stage and those at a less advanced stage. For purposes of cataloging, this study indicates a third residual category to contemplate countries with a very low level of technological innovation (in general and military), or else, which are very opaque to external analysis, usually due to censorship of their production data.

Olavarrieta and Villenara have identified some LAC countries as relevant producers of scientific and technological innovation, others as evolving producers of scientific and technological innovation, and a third group with either very low scores or none at all (due to unavailability of data during their research) (Olavarrieta & Villena, 2014).

Pelerano identified some relevant defense technology innovators based on a given set of complex projects in development from 2016 to 2030 (Pellerano, 2022). Franko and Herz singled out countries based on statistic variables of autonomy, spending, and integration versus the trade-offs in each country's strategy while facing the pressure of rising costs of technologically sophisticated systems (Franko & Herz, 2018). Pasquarelli indicated promising countries in the regional by appraising current economic, scientific, and academic abilities in the realm of AI, considered to be a key strategic factor for development and leadership (Economist Impact, 2022).

Cross-referencing these findings, already validated by peer reviewed aggregated analysis, as shown in **Table 1**, we empirically established the following groups of countries (alphabetically) in terms of capacity to generate innovative dual-use technology:

1) Argentina, Brazil, Chile, Colombia, and Mexico;

2) Costa Rica, Ecuador, Panama, and Peru;

3) Remaining Latin American and the Caribbean, plus Bolivia, Cuba, Nicaragua, and Venezuela, due to the general absence of updated data for credible re-

search of these.

Table 1. LAC countries' classification by dual-use technological development capacities: Selected Indicators (2022).

2022	DIB			Industrial Base			Triple Helix		Human capital and			R&D	
Countries per group	Military Expenditures /US$ mn cp^	Military R&D, % Military Expenditures*	Military Power Index (PwrIndx)~ (1)	High-tech manufacturing, % <>	Gross capital formation, % GDP <>	Electricity output, GWh/mn pop <>	University-industry R&D collaboration <>	State of cluster development and depth <>	Gross expenditure on R&D, % GDP <>	Graduates in science and engineering, % <>	Patents by origin/bn PPP$ GDP <>	Scientific & technical articles/bn PPP$ GDP	Researchers in R&D, FTE/mn pop <>
I Group													
Argentina	2577.6	0.036	0.4243	25.9	18.9	3184.7	38	40.4	0.5	15.4	1	10.8	1230.8
Brazil	20210.8	0.9	0.2151	37.5	17.3	2922.5	40.4	49.8	1.2	18.5	1.7	18.9	887.7
Chile	5566.5	0.42	0.7712	23.9	22.3	4210.4	41.4	45.4	0.3	20.6	0.8	23.5	510.3
Colombia	9937.7	0.013 [2019]	0.7011	19.9	19.4	1454.2	46.7	50.3	0.3	23.5	0.5	10.1	88
Mexico	8535.5	1.7**	0.4687	50.3	20.7	2705.7	39.1	54.8	0.3	25.8	0.5	7.8	348.8
II Group													
Costa Rica	n/a	n/a	n/a	13.8	19	2169	45.3	52.5	0.4	16.2	0.1	9.7	345.1
Ecuador	2488.6	1.53	1.2181	11	26.4	1767	34.5	37.6	0.4	16.2	0.2	12.4	399.5
Panama	n/a	n/a	n/a	7.5	32.5	2741.2	35.7	46.5	0.1	15.4	0.2	5.5	39.1
Peru	2845.4	0.015***	0.8466	12.6	21.2	1605.4	32.7	42.8	0.2	29.6	0.3	5.8	n/a
III Group													
Dominican Republic	760.8	0****	2.5742	n/a	27.2	1849.2	37.2	49	n/a	11.6	0.1	1.2	n/a
Uruguay	1375.6	0	1.9269	15	16	3775.2	42.7	45.6	0.5	17.2	0.3	18	767.2
Nicaragua	84.2	n/a	2.5685	12.8	20	697.7	22.4	30.8	0.1	n/a	0	2.5	n/a
El Salvador	422.4	0.0005	2.8583	n/a	16.3	942.6	29.8	34.8	0.2	21.8	0.1	1.6	73
Guatemala	430.6	0 [2011]	2.0419	n/a	15.3	745	39.7	47.6	0	9.8	0	2	14.4
Honduras	477.5	0*****	1.8851	n/a	25.6	1080	32.1	42.4	0	15.7	0	2.7	34.7
Paraguay	365.7	0	1.7863	n/a	20.8	6617.1	26.8	40.5	0.1	n/a	0.2	2.4	155.6
Trindad and Tobago	201.1	0	n/a	n/a	n/a	6564.3	33.6	42.3	0.1	n/a	0	8.2	491.8

Source: Elaborated from multiple sources: *https://www.sipri.org/databases/milex, **https://milex.un-arm.org/|, ***https://www.diputados.gob.mx/sedia/sia/se/SAE-ASS-12-21.pdf, |****https://www.congreso.gob.pe/Docs/comisiones2021/Presupuesto/files/cronograma_de_sectores/sectores/defensa/resumen_ejecutivo_sector_defensa_2022.pdf|, ****https://www.hacienda.gob.do/|, *****Secretaria de Defensa (2022) Ejecución del Presupuesto por Objetivos a Nivel de Actividades Obra. República de Honduras| ~ https://www.globalfirepower.com/countries-listing-latin-america.php#google_vignette| <> https://www.globalinnovationindex.org/Home; Note: (1) An ideal PwrIndx score of 0, means that the lower the PwrIndx value, the greater a nation's conventional combat effectiveness is (https://www.globalfirepower.com/countries-listing.php). n/a: data not available or not applicable; []: indicates data prior to 2022.

5. Advanced Dual-Use Technology Capabilities Countries

The first group of nations this research examines is countries with already functioning domestic DIB and with a set of economic, institutional, and academic features able to, theoretically, support implementation of a triple-helix style effort focused on developing relevant and innovative dual-use technologies in the subset of Western Hemisphere geography, as adopted by this research.

5.1. Argentina

As the second largest country in South America, Argentina is world's eighth larg-

est country and has the 32nd largest population, and it benefits from natural riches, a highly educated population, a well-developed export-oriented agriculture, and a diversified industrial base (Central Intelligence Agency, 2023a). Previously, Argentina had a long tradition of connecting its military acquisitions with technological independence, but such practice has been largely discarded for the last 20 years; thus, the Argentine DIB is virtually dismantled today (Iriondo & Vega, 2019).

Despite the discouraging picture, the country retains well-developed and active academic and scientific circles (Ministry of Science, Technology and Innovation (MSTI), 2021) and excellent research infrastructures (Ministry of Science, Technology and Innovation (MSTI), 2022). Its aeronautical industry is nascent (Larre, 2022), but Argentina is able to join multinational joint programs (Dubois, 2023). It also has domestic technical and industrial capacities in nuclear energy, inherently dual-use, presently concentrated with the state-owned company INVAP. Moreover, it has well-succeeded international projects (Malacalza, 2016) and has been an integrator for more complex, technological nonnuclear projects, such as space and satellites (Seijo, 2017), air defense radars, unmanned aerial vehicles (UAV), etc. (Invap, 2023). To that end, Argentina created a national defense fund with budget specifically for developing defense innovation and dual-use systems (Saponaro, 2020).

5.2. Brazil

Brazil is world's fifth largest country and ninth-largest economy with the seventh largest population, and it is a major non-NATO ally (MNNA) (Central Intelligence Agency, 2023b). Complimentary to this, Brazil and the United States have a bilateral treaty on RDT&E, which allows for partnerships in the development of defense (USDOS, 2022). Another agreement provides safeguards for US-licensed space launches from Brazil's *Alcantara* Space Centre (Mouray, 2020).

Brazil was one of the winning Allies in World War II. The war's aftermath saw the creation of the Coordination for the Improvement of Higher Education Personnel and the National Council for Scientific and Technological Development. Both played roles financing scientific and technological research, including for industrial production and defense (Brustolin, 2022). As of 2021, Brazil has 71 technological parks (MCTI, 2022), of which at least three can be identified as defense innovation clusters: 1) aerospace technology cluster in the state of Sao Paulo; 2) nuclear and naval technology clusters, split between the states of São Paulo and Rio de Janeiro; 3) an army technology cluster centred in the state of Minas Gerais.

In 2012, legislation established special rules for procurement, contracting, and development of defense products and systems, and favorable taxation. Additionally, it defines defense products, strategic defense products, defense systems, and strategic defense enterprises (Siqueira Brick & Fernandes Alvarez Vilas Porto, 2020). Moreover, general provisions from the innovation law applies to projects conducted either in civilian or military research centres, which allows for the *tech-*

nological procurement, a model that brings the purchasing power of the state to develop new technologies characterised by technological risk (Oliveira et al., 2021). There are studies for creation of a financial institution dedicated exclusively for defense products and services (Caiafa, 2020).

5.3. Chile

Chile is world's 39th largest country and has the 66th largest population (Central Intelligence Agency, 2023c). Notwithstanding its relatively small territory and population, it is world's 43rd largest economy, which is attributable to a consistently maintained set of economic reforms since the 1980s, which favored securing the country's commitment to democratic and representative government. Befitting its status as a stable, democratic nation, Chile increasingly assumes regional and international leadership roles (Central Intelligence Agency, 2023d).

The 2020 *National Defense Policy of Chile* highlights the importance of advanced technologies and the development of strategic defense companies (Aránguiz, 2021). Within the guidelines for development of strategic capabilities, it mandates effectiveness of technology and defense industries, and it considers not only platforms and weapon systems but also decision-making systems comprising, among others, technologies and algorithms associated with robotics, AI, data analysis, unmanned vehicles, nanotechnology, materials technology, and social sciences (Aránguiz, 2021).

Chile's uncommon legislative apparatus, the Copper Reserved Law, channels 10% of the income in foreign currency from copper and its by-product exports for acquisition of military equipment and supplies to ensure continuous and stable funds for development of defense technologies (Marcel & Engl, 2009). This amounts to the third highest defense budget in South America and 7.6% of total defense spending in the region. Chilean DIB is structured on a strong group of suppliers consisting of state-owned companies that are the main contractors for the armed forces and in private companies (Guajardo, 2021). Furthermore, the country also has an increasingly developed space industry (Dallamuta et al., 2023).

5.4. Colombia

Colombia is world's 27th largest country with the 29th largest population (Central Intelligence Agency, 2023e). Before COVID-19 outbreak, it had consistent economic growth and shrinking poverty; however, insufficient investment in infrastructure has hampered trade integration. A history of conflict with paramilitary and antigovernment insurgency funded by the drug trade has resulted in one of the highest proportional investments in military and security forces (3.1% of its GDP) in the region (Central Intelligence Agency, 2023e). Colombia has been a US MNNA since 2022, which results in closer training, advising, and equipping Colombian forces (Ktaish, 2022).

Regardless of its security challenges, Colombia developed the National Science, Technology and Innovation System, and in 2010, it implemented the National Program for Science, Technology and Innovation in Defense and Security (Her-

nandez & Dominguez, 2022). As of 2021, Colombia has 68 R&D centres, and seven are connected to the armed forces (Contreras-Gutiérrez et al., 2021). Additionally, Colombia recently created the Navy's Research, Innovation and Development Centre for Maritime Activities (Saumeth, 2022). Furthermore, the country has an ongoing space program (Becerra, 2014) and a space situational awareness agreement with the United States Space Command (USSPACECOM) (Castillano, 2022).

One major limitation for Colombia's DIB is a constitutional mandate that stipulates only the state entity INDUMIL can industrialise and sell firearms, ammunition, explosives, and blasting accessories, even though the restriction does not seem to apply to other defense sectors (Pérez Mejía, 2013). Finally, Colombia also has state-owned corporations for maritime and naval platforms, for aerospace applications, and for high technology systems.

5.5. Mexico

Mexico is world's 15th largest country with the 10th largest population, including the planet's third largest metropolis, Mexico City (Central Intelligence Agency, 2023e). As the 13th largest global economy, the country suffered heavy losses during 2008 global financial crisis; however, in 2019, as a party in the 2020 US-Mexico-Canada Agreement, it was the US's largest goods trading-partner (US$ 614.5 billion). Notwithstanding its economic might, Mexico has very low military spending at only approximately 0.8% of the GDP (Central Intelligence Agency, 2023e).

The country was a World War II ally and since then has continued supporting US defense initiatives (Suarez, 2016). At the same time, Mexico has a tradition of self-limitation posed by the Estrada Doctrine (Castro, 2018), which has sometimes proven detrimental to national defense (Moyano, 2022). Despite that, Mexican security cooperation with the United States has regained momentum with renewed discussions on integrating the North American Defense Aerospace Command infrastructure (Camacho, 2022) and an increasing closeness with the US Northern Command (Bucheit Jr, 2021). These operations benefit from Mexico's general military industry direction equipment, which connects with civilian research institutes (Revista Armas, 2021).

Mexico has a full civilian nuclear energy industry, with academic excellence, and it has expanded its framework of the global energy transition (World Nuclear Association, 2022), a mature scientific and commercial space program (Johnson, 2020), and a competitive aeronautical cluster centred on the state of Querétaro. Finally, Mexico's marine industry is well-developed in connection with the country's position as one of the world's largest oil producers (Suarez, 2016).

6. Countries with Evolving Dual-Use Technology Capabilities

6.1. Costa Rica

Costa Rica presents meaningful capabilities for dual-use technology development even though the country does not formally have armed forces. Today, the Costa

Rican civilian Public Force (*Fuerza Pública*) comprises units for ground, counter-narcotics, and border patrol, and coast guard duties—duties typical of a paramilitary organisation (Solano, 2017). The force has a reserve component, and it is legally tasked with preventing violations of the country territorial integrity (Barquero, 2012). Successful economic and educational policies have led to remarkable evolution and a burgeoning innovative system (OECD, 2017), highly enhanced by Intel chipmaker installing a microprocessor plant in 1997 (Larrain, Lopez-Calva et al., 2000). Not surprisingly, the country has developed advanced local command, control, communications, and intelligence systems with on-board AI features for domestic and international security goals (Fonseca, 2019).

6.2. Ecuador

Ecuador is a major oil exporter, ranking as the world's 19th largest producer (Bnamericas, 2023), and its income affords the country intermediate investments in technological innovation, mainly in the oil industry itself and telecommunications, though the country spends 2.4% of GDP in defense. Ecuadorian army owns a group of industries (Ponce, 2021), which were incorporated in 2000 as HOLDINGDINE S.A. to operate power plants and telecommunications services; this later merged with the Social Security Institute of the Armed Forces (Calero, 2008). ASTINAVE EP shipyard has developed successful naval applications, such as retrofitting missile corvettes and patrol boats (Sanchez, 2023), while Ecuadorian air force has developed a domestic UAV (Ochoa, 2022).

6.3. Panama

Panama has formally abolished armed forces as consequence of US intervention in 1989, but it has subsequently created paramilitary border security and air-naval forces, which, with the National Police, form the *Panamanian Public Force* (MSP, 2019). The country has become an important financial and business centre, which has led to enhanced IT capabilities (Berdiales, 2019) and almost two decades of the highest economic growth in LAC (Beaton & Hadzi-Vaskov, 2017). Benefited by geography, trade openness, world-class logistic operations, and financial system depth, Panama's economic convergence has been double the region's average (Aliperti et al., 2021). Panama hosts the best LAC submarine fiber-optic connections linking to eight undersea cables and has an ongoing effort by the Government Innovation Authority to develop military grade cyber-defenses (International Trade Administration, 2023) against hybrid-threats (Campos, 2021).

6.4. Peru

Averaging a growth rate of 5.9%, Peru is one of the fastest-growing economies in LAC; overcoming a post-pandemic slump, Peru's GDP grew by 3.5% in 2022 (World Bank, 2023a). The country has the sixth largest military forces and the largest submarine fleet in LAC (Global Firepower, 2023). Peru boasts a respectable arsenal (Klein, 2004), mostly due to historic border and maritime disputes with

Ecuador and Chile (Jain, 2015), respectively, some of which led to actual confrontations (Viatori, 2015), and counterterrorist actions against the Shining Path guerrillas (Malone, 2010). Although raw data indicates Peru has a quantity of modern equipment, the myriad of models and suppliers indicates lack of a developed DIB (Americas Quarterly, 2023). Nonetheless, the country approved a *National Multisector Policy for National Security and Defense* to enhance capacities until 2030 (Ministry of Defense, 2022) and specially to replace Russian made vectors, impacted by international sanctions, and a state-owned naval shipyard able to build guided-missile frigates and patrol boats. Peru also has an evolved space program led by the Ministry of Defense's (2022) National Commission for Aerospace Research and Aerospace Development, which established the National Centre for Imaging Operations (de la Cruz, 2020). This led to an agreement with the USSPACECOM for data sharing to increase space domain awareness (US Space Command, 2020).

7. Nations with Very Small or Undetermined Capacities

As previously stated in the methodology section, some countries in the LAC region did not demonstrate a sufficient combination of economic conditions, industrial bases, and a critical mass of personnel in science or technology professionals, which could, even if only hypothetically, allow a forecast of potential dual-use technologies development. However, this is not to say other countries in the region do not have defense or technological capabilities.

Findings of dedicated research groups within the Inter-American Defense College point to the existence of limited defense and security technologies initiatives. For example, the Dominican Republic (Valencia et al., 2022), which develops imported combat airplanes integration in its air force and a technology institute (Ferreira, 2022). Additionally, Uruguay has a notable cybersecurity infrastructure (Opazo, 2021) and collaborates in scientific, high-performance infrastructure (Nesmachnow & Iturriaga, 2019); however, Uruguay seems to have purposely removed both from its defense or security institutions.

Small countries still part of Britain's Commonwealth of Nations indicate a preference to rely on United Kingdom defense commitments, including the permanent deployment of Royal Navy and Royal Fleet Auxiliary vessels on the Caribbean (Navy Lookout, 2020); this deployment is dedicated mostly for counternarcotic missions and disaster relief. Generally, the Royal Air Force maintains its strategic position on the Isle of Ascension (Raf, 2023), whereas the Royal Army still keeps garrisons in Belize (Miller, 2020) and, increasingly, in Turks and Caicos (Turks and Caicos Islands, 2020). If it were not for this reliance, some of these states would present basic economic, educational, and institutional conditions to start developing defense technology projects (Heritage Foundation, 2023), especially considering the relative ease with which they could participate in other Commonwealth of Nations scientific forays (Commonwealth, 2020).

Albeit less intensely, the same pattern affects former Dutch colonies, some of which are still part of the kingdom. Amsterdam usually provides security assis-

tance through direct deployment of military contingents from the Dutch Caribbean Coast Guard and from the military police corps, the Royal Netherlands gendarmerie (Antilliaans Dagblad, 2022). In general, former Dutch colonies do not fear traditional military threats, although they do channel security assets to counter-drug assignments; however, verbal threats from neighboring Venezuela prompted Netherlands to send reinforcements to the region, such as deploying new aerial transport and surveillance, including Reaper UAVs (Granja Sánchez & Manzano, 2022). In 2022, Netherlands defense agreements with Suriname were renewed, and the Netherlands committed to provide military education and training support and to refitting Surinamese National Army and its Coast Guard (Defensie nl, 2022). As a result, both British and Dutch components integrate with the *Joint Interagency Task Force South*, based in Key West, Florida. The taskforce is in charge of patrolling Caribbean and South American waterways (Wilson, 2022).

The final group of Nations with minor capacities is distinct, as there is little scientifically peer reviewed or independent research data and an abundance of distortion-prone discourses under a logic inspired by hybrid warfare principles developed by extra-hemispheric actors (Farah & Babineau, 2019). The most visible case is Venezuela, once the fastest-growing economy of the 20th century and owner of world's largest known oil reserves; it experienced the greatest economic collapse in LAC's history (Jraissati & Jakee, 2022). After peaking in 1993, Venezuelan scientific productivity dropped to its lowest level in mid-2010s, even if official numbers about researchers or investments claim increases in recent years (Requena, 2010). Regardless of Venezuela's scientific meltdown, it is reasonable to believe some competent researchers and infrastructures are still viable (Arocha, 2021) and that claims of domestically made UAVs with Iranian technology (Nadimi, 2022), for example, could be true. If the conditions that existed previously return, it is realistic to forecast that the Venezuelan DIB could be restored to an advanced level, perhaps integrating extra-hemispheric dual-technologies enterprises (MSU-BIT, 2022).

A second notable case is Nicaragua, a country with a small economy (Aguirre González et al., 2018) and a near invisible scientific output (Monge-Nájera & Yuh-Shan, 2017), which would normally indicate the probability of dual-use technologies development is very low. Notwithstanding, out of geopolitical causality, countries like the Russian Federation have installed high-tech structures in its territory, including GLONASS satellite monitoring stations (Haines, 2016), a counterdrug training centre sponsored by the Russian anti-drug office, facilities for troop deployments (Ellis, 2022), and more recently, investments in non-energy nuclear applications (Baires, 2023). It is reasonable to believe that Nicaraguans will be at least partially retrained with the associated knowledge, which could lead to future dual-use technologies skills.

The third case worth mentioning is Bolivia, a resource-rich country that was able to channel commodities income to moderately reduce poverty and social inequalities, at least until the world pandemic crisis (World Bank, 2023b), but with

generally low scientific-technological production (Muriel, 2020). Despite its lower middle income that would normally be unattractive to investors from the innovation sector, most probably motivated by geopolitical considerations and its vast lithium reserves (Bos & Forget, 2021), Bolivia has attracted higher than usual technological transfers. It has an agreement with the Russian Federation for construction of a nuclear research centre, which aims, among other goals, for the design and construction of research nuclear reactors, particle accelerators and their applications, nuclear minerals prospection, and provision of nuclear fuel cycle services for research nuclear reactors, including the supply of nuclear fuel for research nuclear reactors (FAO, 2016). Additionally, China is making high-level investments in rare earths mining, including processing and industrialization transfer of technology for the recently created state-owned *Yacimientos de Litio Bolivianos* (Bouchard, 2023). Also, Chinese origin technologies and training have been transferred for Bolivia's space program (Ellis, 2016). In such a context, it is a realistic expectation that in a relatively short time, the country might evolve technological dual-use capabilities of an intermediate grade.

8. Nearshoring and the Historic Opportunity for Dual-Use Technologies in the Americas

As discussed previously, the first decades of the 21st century witnessed a rebirth of polarisation between states in conjunction with social conflicts, increase of inequalities between peoples, and a re-emergence of state geostrategic opposition, all of which challenges the balance of forces carved out after WWII in a phenomenon branded by most experts as the "return of great power competition." (Mankoff, 2020). In-depth analysis of such trend exceeds this work's scope, but suffice to say that it affects all regions of the planet, including LAC. One group of nations led by the United States identifies China and Russia as the main concerns, and another group, driven by China and Russia, perceives the United States, Western Europe, and Japan as nemeses (da Silva & Grassi, 2022).

As a result of this international configuration, similar to that of the Cold War, LAC could once again become the battlefield between extra-regional powers, whereby the risk of global conflicts could expand with negative impact, greater financial markets volatility, higher investment uncertainty, disruption of supply chains, and downward pressure on commodity prices. However, alternatively, countries in the region could find ways to increase trade competitiveness and boost regional integration, as an insurance policy, by reaching local and regional sociopolitical consensus to allow for greater democratic stability and economic growth (Álvarez, 2020).

Departing from the previous assumptions about the connection between the development of dual-use technologies and economic growth associated with a consequent rapprochement and overcoming of mistrust between civilian and military institutions, a historical opportunity seems to be currently arising in the context of nearshoring. The concept of nearshoring appears as the opposite of more

widespread offshoring idea (i.e., transferring business to a neighboring or closer country where production costs and wages are lower to increase profit) (Piatanesi & Arauzo-Carod, 2019).

Even if both ideas tend to express similar thoughts, it is useful to differ near-shoring from back shoring. The latter denotes "the decision to relocate in the firm's home country production or supply previously off-shored," (Fratocchi et al., 2014) whereas nearshoring happens "when a manufacturer or service provider moves all or part of their business to another geographical location, usually one relatively close to the company's area." (Haar, 2022). Not coincidently, the most cited example of nearshoring involves the common border between the United States and Mexico.

A 2022 study by the Inter-American Development Bank indicates that near-shoring moves by Western industrialized nations (especially the United States) to LAC could add up to US$ 78 billion annually to the region's economy (IADB, 2022). Though Brazil and Mexico would benefit more, others would also gain, and even sustainability would increase, considering that current internal LAC green-house-gas emissions are significantly below average global trade linked emissions (IADB, 2022).

Apart from purely economic considerations, in a context of worsening great-power competition, nearshoring also entails geostrategic advantages. Economic competition is inherent to great-power rivalry, which brings back industrial policy concerns. As an example, the American government identified the following as vital to national security: semiconductors, large-capacity batteries, pharmaceuti-cals, and critical minerals—all drawing stockpile expansion policies. However, most countries realise that, apart from a few highly sensitive or vital products, most companies are not able to fully backshore because of much higher costs. More realistically, multinational corporations would likely favor shorter, more duplicative regional supply chains giving way to corporate regionalization on the near future (O'Neil, 2022a).

This particular moment is a golden chance for LAC to catch-up with modern-ized economies, and also for Western countries, the United States especially, to decrease dependence on more distant and potentially unfavorable supplier coun-tries (Harrup & Montes, 2023). Nevertheless, nearshoring by Western corpora-tions into the Americas would necessitate countries in the region to make a stra-tegic decision to put themselves in a position to exploit productive capabilities already available in sectors such as automotive, food, tourism, etc. To realize these aspirations, it is imperative for LAC countries to create more knowledge transfer opportunities from more developed economies. This would lead to improvements of local innovative enterprises that may attract once offshored companies (Bravo, 2022). From a developed world perspective, leveraging nearshoring as an alterna-tive channel for private investment in the Western Hemisphere is a way to appease their companies' need of developing a base of suppliers geographically closer, given concerns about logistics costs and risks of delays posed by farther away ones,

particularly in more sensitive sectors like digital technologies, strategic minerals, green energy devices, etc. (Ellis, 2023).

In addition, as corporations seek new commercial options, LAC offers attractive advantages. More than half of the electricity in LAC comes from clean sources, and region's countries have at their disposal abundant sun, wind, and geothermal reserves, coupled with plentiful minerals essential for green technologies, which would aid multinationals' need to reduce their global carbon footprints. Also, even if less than before, LAC still has a demographic advantage (O'Neil, 2022b).

What is true for economic and technological development in general is even truer for development of dual-use technologies. To the extent that a policy of *integrated deterrence* was proposed at the hemispheric level in 2022 at the Conference of Defense Ministers of the Americas (Garamone, 2022), held in Brasilia, Brazil, a paradigm of progressive deepening of defense cooperation by the countries in the region depends on the improvement and communion of updated systems and logistic chains in technologically advanced defense materials. Countries cannot realistically and, from a military viewpoint, securely, be dependent on the supply from just one developed actor above all others.

In this sense, without disregarding the differences between the two regions, the European model seems more adequate to achieve the effects intended by America's integrated dissuasion proposal, whereby the European Union (EU) Defense Technological and Industrial Base Sector, within the *Permanent Security Cooperation* framework, aims to diminish strategic dependence on countries outside the region and provide self-sufficient means on air, land, maritime, space, and cyber domains to allow the EU improved deterrence of present and future adversaries (Eur-Lex, 2022). As in LAC, in the EU, there are proportionally more and less developed countries, but these view each other like peers sharing common values, and they try to generally compensate for their mutual strengths and vulnerabilities (Tekiner, 2020).

It is important to highlight that, as the global COVID19 pandemic showed, improving dual- use capacities in LAC does not mean only the physical creation of new weapons and systems but also increasing the region's workforce awareness and resilience against "under the radar" threats posed by antagonistic extra hemispherical dual-use technologies in all possible realms. Such an objective can be achieved in a homogeneous way in all countries of the region, even in those with still limited industrial innovation, by the means of shared professional education efforts (Hirsch, 2021).

In this respect, a model of part-time or temporary military service with defense technology institutions, similar to what is done in the United States, could be an institutional way to offer standardized and adequate training without jeopardizing the main civilian professional or academic careers. After 1973, the US armed forces changed from a compulsory conscription model to a voluntary one with the aim, among other things, to reduce budgetary pressures; however, in doing so, a prominent role had to be envisioned for reserve components, which would

permanently perform key combat support services, thus bolstering active units' strength—a concept that eventually resulted in the *Total Force* concept (Jensen, 2016).

Within this framework, in addition to the traditional path of joining military academies after high-school, college students could enroll in part-time reserve officers training centres or join after graduating through officer candidates' schools. For some more specific positions, senior professionals have a chance to join as direct commission officers (Today's Military, 2014). Many of these opportunities are available specifically for military science and technology centres, such as the US Air Force's scientific applications specialist or US Navy's science officers (Peer, 2022). To some extent, even foreign nationals are encouraged to apply for these positions via the Military Accessions Vital to the National Interest program (Chishti et al., 2019).

A similar, more recent effort can be found in Brazil's Technical-Scientific Service, whereby each of the armed forces branches may incorporate and directly commission Brazilian civilians with recognised technical-professional competence or scientific experts in specific fields of knowledge with the rank and paygrade of lieutenant-commanders or majors for eight years (SSPM, 2023). The disadvantage of this initiative is that it is not a regime of part-time dedication (as in the US practice), which might make it less attractive for mid-career professionals worried about possible difficulties of returning to the market at the end of their service period.

A sum of investments in the reindustrialisation of the region, conducted from a nearshoring process, with the rearrangement of existing institutional capacities, especially when it comes to the skilled labour force, in the critical sectors for innovation would allow a notable increase in the design of dual-use technologies in the region.

9. Dual-Use Technology as an Integration Tool in LAC

Several countries have been developing their military capabilities through innovation and cooperation. Brazil, Argentina, Chile, and Colombia are the most important providers of South-South and triangular cooperation in LAC. This region has the potential to enhance its military capabilities by strategically focusing on a collaborative approach that involves partnerships between two countries or regions facilitated by a third party, often possessing advanced technological or operational expertise, as shown in **Figure 1**.

In this context, the United States and Canada assume crucial roles as potential facilitators and contributors to this cooperative framework. By leveraging these North American countries' experience, resources, and technological advancements, LAC nations can effectively bolster their defense capabilities through innovation and knowledge exchange. Triangular cooperation offers the opportunity to tap into the wealth of expertise that the United States and Canada possess, not only in terms of military technology but also in areas such as strategy, training, and operational efficiency. This collaborative model can lead to the transfer of

cutting-edge military technologies, the establishment of joint research initiatives, and the enhancement of training programs, ultimately elevating the overall security landscape in the region. As these partnerships unfold, they contribute to strengthening the military capacities of individual nations and building a more interconnected and secure hemisphere through shared expertise and mutual collaboration.

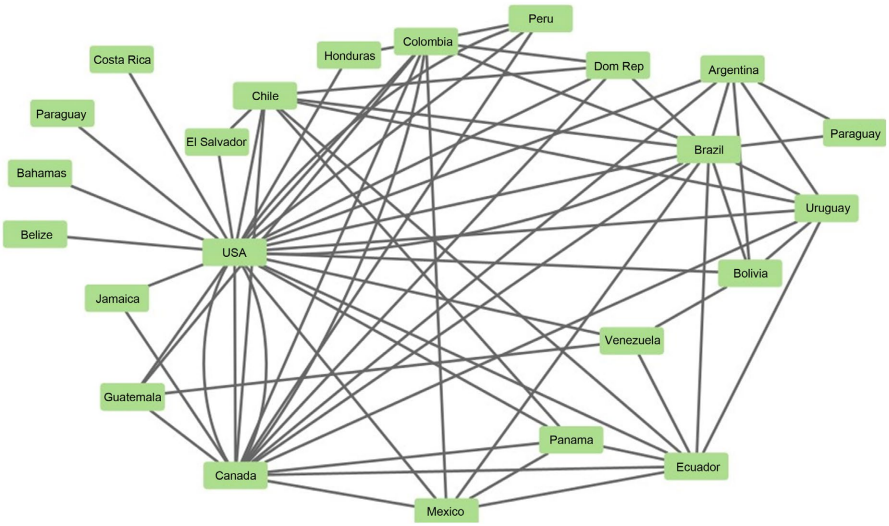
LAC nations predominantly rely on their domestic defense enterprises to procure missile systems, firearms, ammunition, and other military equipment for their armed forces. Notable examples of these companies include *Fábrica de Armas de SEDENA* in Mexico, INDUMIL in Colombia, *Fábricas y Maestranzas del Ejército* (FAMAE) in Chile, *Fábrica de Armas y Municiones del Ejército* (FAME) in Peru, and *Fábrica de Municiones* (IMG) in Guatemala. However, the region also plays a significant role as an importer of armored vehicles, vessels, submarines, helicopters, and aircraft.

We can discern the promising opportunities in this sector by analyzing the major weapons exchanges among hemisphere countries, including the United States and Canada. The figure depicts regional arms agreements and deliveries from 2000 to 2022. It reveals that the United States is the principal supplier, exporting to 21 countries, closely followed by Canada, reaching 15 nations. Brazil is the privileged one, with sales to 10 nations. Chile and Argentina follow, exporting to 5 and 3 countries respectively. According to Mordor Intelligence, key players in the Latin American defense market include Embraer SA, *Avibras Indústria Aeroespacial*, and The Boeing Company (Mordor Intelligence, 2023). Once again, Brazil is well positioned here, reflecting its solid Defense Industrial Base.

In line with our categorization, it becomes crucial to facilitate the engagement of countries positioned within the first group in collaborative innovation endeavors alongside nations positioned in the other two groups. The extensive and multifaceted value chain inherent to dual-use technologies allows diverse countries with varying economic growth and human capital levels to participate effectively. This inclusiveness is particularly significant as it permits nations at different stages of development to contribute their unique strengths and expertise to joint ventures. Furthermore, this collaborative approach does not compromise the national security interests of the participating states. A dynamic ecosystem is cultivated by involving countries from distinct groups in these joint innovation projects where knowledge exchange and resource pooling can lead to technologically advanced solutions that address common challenges.

10. Conclusion

Producing innovation in the 21st century is a challenge for all countries, with capitalism clearly linked to the continuous production of new technologies in all fields of knowledge. This phenomenon is even more intense in the defense field, wherein purely military or dual-use technologies involve geopolitical aspects in a context of remerging planetary dispute between powerful nations.



Source: Elaborated using SIPRI Arms Transfers Database.

Figure 1. Transfers of major weapons in the Americas (2020-2022).

Against this backdrop, for LAC countries in various stages of development and with defense budgets squeezed by successive crises, the discussion about innovation fostered by the R&D of dual-use technologies must be taken more seriously than ever. The research highlights the presence of three different groups of countries in LAC, some developed to the point of being able to design and produce dual-use technologies autonomously, as long as the necessary economic and institutional conditions are provided, and others that, if they are not yet at the same level as the previous ones, could realistically reach such a level. That is as long as LAC nations concentrate effort in key sectors, especially in the formation of critical mass of technical personnel, and the activation, or reactivation, of basic industrial infrastructures, such as in communications, computer systems, chemistry, metallurgy, etc.

There is also a third group of countries at a very incipient level of scientific-technological capacity but that could participate in an effort to develop dual-use technologies, which in themselves do not involve so much innovation but are part of the supply chain of any armed forces. For them, it is not so absurd to imagine a significant increase in the local economy through a concentrated effort in sectors such as special materials (fabrics, ballistic protection, glassware, etc.) and primary processing of raw materials (mining, fuels, food products, etc.). In any case, for these, a concentrated effort in the general improvement of educational levels, both academic and technical-professional, is fundamental.

At present, two basic conceptions of dual technology development models seem to prevail: the first one led by the North American system, in which private initiative prevails as the generator of innovation, supported by academia, and subtly guided by the state, which uses its purchasing power and regulation of standards to induce business decisions toward a certain path. Nearly opposite, but reaching similar results, is the Chinese model of military-civilian fusion, whereby a highly

centralized economic system requires that all projects from the outset be conceived with dual purposes regardless of whether they come from academia, "private industry," or government technology centers, including the military.

A realistic balance of the current state of defense industrial bases in LAC leads to the conclusion that some intermediate form between the two main models would be appropriate. It is certain that none of the LAC countries have currently a private sector sufficiently developed to lead innovation in defense; the sector is merely advised by the respective governments. Conversely, as democratic countries with highly mobilized civil societies, it is neither possible nor desirable to completely submit technological development to government preferences. This intermediate route has been found by some countries through parliamentary legislative measures to organize and support the defense industrial base, combined with transparent development goals in critical defense sectors, preceded by debates with civil society and its elected representatives, to point out the direction and the budgetary resources to be spent.

The research also indicates that all countries, even the least developed ones, have complementary capabilities, which would favor the development of regional arrangements for production of dual technologies. In turn, this could mirror the longstanding partnership between Argentina and Brazil in the nuclear sector. In such hypothesis, linguistic facilities and similar constitutional models are useful to engage companies, public or private, universities and governments of the region in joint ventures.

Furthermore, LAC countries have the potential to fortify their military strengths by strategically focusing on partnerships between countries facilitated by a third party, with the United States and Canada playing crucial roles. This collaborative framework allows LAC nations to harness North American countries' expertise and technological advancements, leading to the transfer of advanced military technologies, joint research, and improved training programs. Concurrently, engaging countries from diverse development stages in dual-use technology projects foster a dynamic ecosystem that taps into various strengths without compromising national security, culminating in advanced solutions to shared challenges.

In conclusion, it seems that the current moment of resumption of great powers competition serves as a historic opportunity for LAC in terms of attracting long-lasting investments capable of promoting the long-awaited development of the region. Directly associated with this, there is the possibility of a qualitative leap in the production of dual-use technologies involving the North and South of the American continent. Subsequently, this could lead to an integrated empowerment of continental allies that could bring onward, as a consequence, to the implementation of an integrated deterrence strategy against extra-hemispheric actors.

Conflicts of Interest

The authors declare no conflicts of interest regarding the publication of this paper.

References

Aguirre González, M., Candia Campano, C., & Antón López, L. (2018). A Gravity Model of Trade for Nicaraguan Agricultural Exports. *Cuadernos de Economía, 37,* 391-428. https://doi.org/10.15446/cuad.econ.v37n74.55016

Aliperti, P., Chow, J., Rousset, M., & Santos, A. (2021). *Panama's Story of Convergence.* International Monetary Fund. https://www.imf.org/en/News/Articles/2021/11/17/na111821-panamas-story-of-con-vergence

Álvarez, M. V. (2020). "Stranger Things": The Future of Latin American Regionalism. *Con-juntura Austral, 11,* 63-73. https://doi.org/10.22456/2178-8839.105703

Americas Quarterly (2023). *Latin America's Armed Forces: Peru.* https://www.americasquarterly.org/fullwidthpage/perus-armed-forces/

Antilliaans Dagblad (2022). *Eindredactie, Defensie-inzet Cariben ver-sterken [Strengthen Defense Deployment in Caribbean].* https://antilliaansdagblad.com/nieuws-menu/26373-defensie-inzet-cariben-versterken

Aránguiz, Ó. E. (2021). *Chile Apuesta por la efectividad, La Tecnología de Punta y sus Em-presas de Defensa [Chile Bets on Effectiveness, State-of-the-Art Technology and Defense Companies].* Infodefensa. https://www.infodefensa.com/texto-diario/mostrar/2964182/chile-apuesta-efectividad-tecnologia-punta-empresas-defensa

Arocha, J. G. (2021). Examining Russian and Chinese Military Operations in Venezuela. *Defense Dossier, 32,* 12-15. https://www.afpc.org/publications/e-journals/the-americas-influx

Baires, L. (2023). *Nicaragua and Russia Sign Nuclear Energy Use Agreement.* Diálogo Américas. https://dialogo-americas.com/articles/nicaragua-and-russia-sign-nuclear-ener-gy-use-agreement/

Barbey, C. (2015). *Non-Militarisation: Countries without Armies. Identification Criteria and First Findings.* Åland Islands Peace Institute.

Barquero, J. C. M. (2012). Does International Humanitarian Law Play Any Role in Demil-itarized Countries? A Policy Analysis of Costa Rica and Panama. *Relaciones Internac-ionales, 84,* 109-130.

Beaton, K., & Hadzi-Vaskov, M. (2017). *Panama's Growth Prospects: Determinants and Sectoral Perspectives.* IMF Working Paper WP/17/150.

Becerra, J. (2014). Colombia's Space Policy: An Analysis of Six Years of Progress and Chal-lenges. *Acta Astronautica, 100,* 94-100. https://doi.org/10.1016/j.actaastro.2014.03.018

Berdiales, E. (2019). La innovación y su vinculación al desarrollo económico de Panamá: Un análisis teórico-conceptual [Innovation and Its Link to Panama's Economic Devel-opment: A Theoretical-Conceptual Analysis]. *Revista FAECO Sapiens, 2,* 49-63. https://revistas.up.ac.pa/index.php/faeco_sapiens/issue/view/64

BNamericas (2023). *Ecuador Could Increase Oil Production but Political Fac-tors Are Seen as a Hurdle.* https://www.bnamericas.com/en/news/ecuador-could-increase-oil-produc-tion-but-political-factors-are-seen-as-a-hurdle

Bos, V., & Forget, M. (2021). Global Production Networks and the Lithium Industry: A Bolivian Perspective. *Geoforum, 125,* 168-180.

https://doi.org/10.1016/j.geoforum.2021.06.001

Bouchard, J. (2023). *In Bolivia, China Signs Deal For World's Largest Lithium Reserves.* The Diplomat. https://thediplomat.com/2023/02/in-bolivia-china-signs-deal-for-worlds-larg-est-lith-ium-reserves/

Bravo, Y. M. G. (2022). Nearshoring of US Manufacturing Corporates' Supply Chains: Exploring Administrative and Economic Issues for their Potential Expansion across the Americas. *Latin American Journal of Trade Policy, 5,* 7-57.

Brustolin, V. (2022). The Military Influence on Industrial Policies in Brazil during the 20th and Early 21st Centuries. *Brasiliana: Journal for Brazilian Studies, vol. 10.* https://doi.org/10.25160/bjbs.v10i2.128359

Bucheit Jr., W. E. (2021). As North American Defense Evolves, What Role Does Mexico Play? *FAOA Journal of International Affairs.* https://faoajournal.substack.com/p/as-north-american-defense-evolves

Cai, Y., & Amaral, M. (2021). The Triple Helix Model and the Future of Innovation: A Reflection on the Triple Helix Research Agenda. *Triple Helix, 8,* 217-229. https://doi.org/10.1163/21971927-12340004

Caiafa, R. (2020). *O Banco de Desenvolvimento do Brasil apoiará a base de defesa industrial [The Development Bank of Brazil Will Support the Industrial Defense Base].* Infodefensa. https://www.infodefensa.com/texto-diario/mostrar/3126743/banco-desenvolvimento-do-brasil-apoiara-base-defesa-industrial

Calero, M. A. V. (2008). *Estudio de factibilidad para la Implementación de una Empresa Operadora de Servicios de Telecomunicaciones Del Holding Dine S. A. [Feasibility Study for the Implementation of a Telecommunications Service Operator for HOLDING DINE SA].* Repositorio de la Universidad de Fuerzas Armada. https://repositorio.espe.edu.ec/items/23d16025-aa4d-43a4-9919-53e72e8bba32

Camacho, Z. (2022). *Avanza 'Cooperación militar' de México con El Comando Norte de EU [Mexico's 'Military Cooperation' with U.S. Northern Command Moves forward].* Contralínea. https://contralinea.com.mx/investigacion/avanza-cooperacion-militar-de-mexico-con-el-comando-norte-de-eu/

Campos, E. E. T. (2021). The Panama Canal and Its False Security and Defence. *Ukrainian Policymaker, 8,* 117-120. https://doi.org/10.29202/up/8/12

Castillano, S. (2022). *USSPACECOM's Scotty Van Sant Presented Colombian Ad Astra Medal by President of the Republic of Columbia.* United States Space Command. https://www.spacecom.mil/Newsroom/News/Article-Display/Article/3114569/usspace-coms-scotty-van-sant-presented-colombian-ad-astra-medal-by-president-of/

Castro, L. P. (2018). La Doctrina Estrada, una nota para su relectura [The Estrada Doctrine, a Note for Its Rereading]. *Revista de Relaciones Internacionales de la UNAM, vol. 89.* https://revistas.unam.mx/index.php/rri/article/view/66413

Central Intelligence Agency (2023a). *Argentina South America.* The World Factbook. https://www.cia.gov/the-world-factbook/countries/argentina

Central Intelligence Agency (2023b). *Brazil South America.* The World Factbook. https://www.cia.gov/the-world-factbook/countries/brazil/

Central Intelligence Agency (2023c). *Chile South America.* The World Factbook. https://www.cia.gov/the-world-factbook/countries/chile/

Central Intelligence Agency (2023d). *Colombia South America.* The World Factbook.

https://www.cia.gov/the-world-factbook/countries/colombia/

Central Intelligence Agency (2023e). *Mexico North America.* The World Factbook, https://www.cia.gov/the-world-factbook/countries/mexico/>

Chishti, M., Rose, A., & Yale-Loehr, S. (2019). *Noncitizens in the US Military-Navigating National Security Concerns and Recruitment Needs.* Policy Brief, Migration Policy Institute.

Commonwealth (2020). *Commonwealth and UN Technology Bank Join Forces to Support Least Developed Countries.* https://thecommonwealth.org/news/commonwealth-and-un-technology-bank-join-forces-support-least-developed-countries

Contreras-Gutiérrez, D. C., Martínez-Lobo, A. d. P., & Fierro-Russi, A. F. (2021). Capacidades de los centros de investigación colombianos del sector aeronáutico militar y su enfoque estratégico. *Revista Científica General José María Córdova, 19,* 679-701. https://doi.org/10.21830/19006586.767

da Motta, R. M. (2011). *Gestão da inovação e transformação do Exército. Coleção Meira Mattos-Revista das Ciências Militares, (24).*

da Silva, A. K. M., & Grassi, J. M. (2022). Impactos da disputa geopolítica entre as grandes potências no Sul Global: Desestabilização e (des)integração sul-americana. *Conjuntura Austral, 13,* 33-46. https://doi.org/10.22456/2178-8839.113748

Dallamuta, J., Perondi, L. F., & Rocha de Oliveira, M. E. (2023). Space Missions in South America: Profile and Evolutionary Perspective of Their Development. *Acta Astronautica, 206,* 9-17. https://doi.org/10.1016/j.actaastro.2023.02.008

de la Cruz, S. K. O. (2020). *Despegar sin salir del territorio: Factores que explican los diferentes grados de capacidad y autonomía estatal en el caso de la Agencia Espacial del Perú [Taking off without Leaving the Territory: Factors That Explain the Different Degrees of State Capacity and Autonomy in the Case of the Peruvian Space Agency].* Ph.D. Thesis, Pontificia Universidad Católica del Perú.

Defensie.nl (2022). *Militaire samenwerking met Suriname is win-win situatie [Military Cooperation with Suriname Is Win-Win Situation].* Nieuwsbericht. https://www.defensie.nl/actueel/nieuws/2022/04/13/militaire-samenwerking-met-suriname-is-win-win-situatie

Dos Santos, U. P., & Caliari, T. (2012). Distribuição espacial das estruturas de apoio às atividades tecnológicas no Brasil: Uma análise multivariada para as cinquenta maiores microrregiões do País [Spatial Distribution of Support Structures for Technological Activities in Brazil: A Multivariate Analysis for the Country's Fifty Largest Microregions]. *Economia, 13,* 759-783.

Dubois, G. (2023). *Aero India 2023: HAL Aims to Sell Tejas Fighters to Argentina and Egypt.* https://www.aviacionline.com/aero-india-2023-hal-aims-to-sell-tejas-fighters-to-argentina-and-egypt

Dunne, J. P. (1995). Chapter 14 the Defense Industrial Base. *Handbook of Defense Economics, 1,* 399-430. https://doi.org/10.1016/s1574-0013(05)80016-x

Dutta, S. et al. (2022). *The Global Innovation Index 2022: What Is the Future of Innovation-Driven Growth.* World Intellectual Property Organization.

Economist Impact (2022). *Seizing the Opportunity: The Future of AI in Latin America.* https://impact.economist.com/perspectives/sites/default/files/seizing-the-opportunity-the-future-of-ai-in-latin-america.pdf

Economist Intelligence Unit (2008). *Politics: International Relations and Defence.* Country

Profile.
https://link.gale.com/apps/doc/A182047367/AONE?u=capes&sid=bookmark-AONE&xid=e07d789d

Ellis, E. (2022). *Nicaragua: Dictatorship and Collaboration with Extra-Hemispheric U.S. Rivals.* Center for Strategic and International Studies.
https://www.csis.org/analysis/nicaragua-dictator-ship-and-collaboration-extra-hemi-spheric-us-rivals

Ellis, E. R. (2016). Chinese Engagement with Bolivia. Resources, Business Opportunities, and Strategic Location. *Air & Space Power Journal, 28,* 1-18.
https://www.csis.org/analysis/nicaragua-dictatorship-and-collaboration-extra-hemi-spheric-us-rivals

Ellis, E. R. (2023). *A Strategy to Respond to Extra-Hemispheric Actors in Latin America and the Caribbean.* IndraStra Whitepaper, IndraStra Global Publishing Solutions Inc.

Etzkowitz, H., & Zhou, C. Y. (2017). Hélice Tríplice: inovação e empreendedorismo universidade-indústria-governo. *Estudos avançados, 31,* 23-48.
https://doi.org/10.1590/s0103-40142017.3190003

EUR-LEX (2022). *Joint Communication to the European Parliament, the European Council, the Council, The European Economic and Social Committee and the Committee of the Regions on Defence Investment Gaps, Analysis and Way Forward.* Document 52022JC0024.
https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=CELEX:52022JC0024

FAO (2016). *Agreement between the Government of the Russian Federation and the Government of the Plurinational State of Bolivia on Cooperation in the Construction of the Center for Nuclear Research and Technology on the Territory of the Multinational State of Bolivia.* Food and Agriculture Organization of the United Nations.
https://www.fao.org/faolex/results/details/en/c/LEX-FAOC172782/

Farah, D., & Babineau, K. (2019). Extra-Regional Actors in Latin America. *Prism, 8,* 96-113.

Ferreira, R. (2022). *Desafíos, Amenazas y Respuestas: El Caribe [Challenges, Threats, and Answers: The Caribbean].* Class Handout, Inter-American Defense College, PEDS62.

Fonseca, H. V. (2019). El desarrollo tecnológico en materia policial: Una receta de éxito para la prevención del delito [Technological Development in Policing: A Recipe for Success in Crime Prevention]. *Revista Relaciones Internacionales, Estrategia Y Seguridad, 15,* 79-97.

Franko, P. M., & Herz, M. (2018). Defense Industrialization in Latin America. *Comparative Strategy, 37,* 331-345. https://doi.org/10.1080/01495933.2018.1497366

Fratocchi, L., Di Mauro, C., Barbieri, P., Nassimbeni, G., & Zanoni, A. (2014). When Manufacturing Moves Back: Concepts and Questions. *Journal of Purchasing and Supply Management, 20,* 54-59. https://doi.org/10.1016/j.pursup.2014.01.004

Garamone, J. (2022). *Austin Emphasizes Common Values, Beliefs with Hemispheric Partners.* U.S. Southern Command.
https://www.southcom.mil/MEDIA/NEWS-ARTI-CLES/Article/3106008/austin-emphasizes-common-values-beliefs-with-hemispheric-partners/

Global Firepower (2023). *South American Military Powers Ranked.*
https://www.globalfirepower.com/countries-listing-south-america.php

Granja Sánchez, M. A., & Manzano Terán, L. S. (2022). El Presupuesto e industria para la defensa ecuatoriana, una mirada del antes y después de la constitución de Montecristi. *Revista de la Academia del Guerra del Ejército Ecuatoriano, 15,* 75-133.

https://doi.org/10.24133/age.n15.2022.06

Guajardo, R. (2021). Industria de Defensa Chilena-30 años de evolución y Futuros desafíos [Chilean Defense Industry-30 Years of Evolution and Future Challenges]. *Iberoamericana Quinqueecclensiensis, 19,* 75-97.

Gummett, P., & Reppy, J. (1988). *The Relations between Defence and Civil Technologies, NATO Science Series D.* Springer.

Haar, J. (2022). *The Role of Nearshoring in Shoring Up Supply Chains.* The Wilson Quarterly. https://www.wilsonquarterly.com/quarterly/as-strong-as-our-weakest-link/the-role-of-nearshoring-in-shoring-up-supply-chains

Haines, J. R. (2016). *Everything Old Is New Again: Russia Returns to Nicaragua.* Foreign Policy Research Institute. https://www.fpri.org/article/2016/07/everything-old-new-russia-returns-nicaragua/

Harrup, A., & Montes, J. (2023). *Mexico's Industrial Hubs Grow as Part of Trade Shift toward Nearshoring.* Wall Street Journal. https://www.wsj.com/articles/mexicos-industrial-hubs-grow-as-part-of-trade-shift-toward-nearshoring-11675257070

Hartley, K. (2015). Defence Economics and the Industrial Base. *World, vol. 185.*

Heritage Foundation (2023). *2023 Index of Economic Freedom.* https://www.heritage.org/index/

Hernandez, J. B. (2022). *Oscar Fernando Castellanos Dominguez, Gestión tecnológica y de la in-novación para el cambio en instituciones militares [Technology and Innovation Management for Change in Military Institutions].* Instituto Tecnologico Metro-politano.

Hirsch, P. B. (2021). Building a New Resilience. *Journal of Business Strategy, 42,* 143-146. https://doi.org/10.1108/jbs-01-2021-0002

IADB (2022). *Nearshoring Can Add Annual $78 bln in Exports from Latin America and Caribbean.* Inter-American Development Bank. https://www.iadb.org/en/news/nearshoring-can-add-annual-78-bln-exports-latin-america-and-caribbean

International Trade Administration (2023). *Panama-Country Commercial Guide.* https://www.trade.gov/country-commercial-guides/panama-cybersecurity

INVAP (2023). *Defense, Security and Environment.* https://www.invap.com.ar/en/defense-security-and-environment/

Iriondo, M., & Vega, C. (2019). *La reconstrucción tecnológica de la defensa [The Technological Reconstruction of Defense].* TSS. https://www.unsam.edu.ar/tss/la-reconstruccion-tecnologica-de-la-defensa/

Jain, A. G. (2015). Maritime Dispute. *American Journal of International Law, 109,* 379-386. https://doi.org/10.5305/amerjintelaw.109.2.0379

Jensen, B. M. (2016). *Forging the Sword: Doctrinal Shange in the US Army.* Stanford University Press.

Jensen, B. M., Whyte, C., & Cuomo, S. (2022). *Information in War.* Georgetown University Press. https://doi.org/10.2307/j.ctv2k88t2w

Johnson, A. W. (2020). Space Cultures and Space Imaginaries in Mexico: Anthropological Dialogues with the Mexican Space Agency. *Acta Astronautica, 177,* 398-404. https://doi.org/10.1016/j.actaastro.2020.08.002

Jraissati, J., & Jakee, K. (2022). Venezuela's Collapse: Exogenous Shock or Institutional Design? *Economic Affairs, 42,* 344-360. https://doi.org/10.1111/ecaf.12537

Klein, T. (1970). Military Expenditure and Economic Growth: Peru 1970-1996. *Defence and Peace Economics, 15,* 275-288. https://doi.org/10.1080/102426903200035101

Ktaish, H. A. (2022). Colombia, Qatar Named Non-NATO Allies. *Arms Control Today, 52,* 44.

Larrain, F. B., Lopez-Calva, L. F., & Rodriguez-Clare, A. (2000). *Intel: A Case Study of Foreign Direct Investment in Central America.* CID Working Paper No. 58. https://www.hks.harvard.edu/centers/cid/publications/faculty-working-papers/intel

Larre, A. (2022). *La argentina Fadea presentará sus aviones Pampa III bloque II y al IA-100 en Santiago [Argentina's Fadea to present its Pampa III Block II and IA-100 Aircraft in Santiago].* Infodefense. https://www.infodefensa.com/texto-diario/mostrar/3499187/argentina-fadea-presentara-pampa-iii-bloque-ii-ia-100-fidae

Leal, C. I. S., & Figueiredo, P. N. (2021). Inovação tecnológica no Brasil: desafios e insumos para políticas públicas. *Revista de Administração Pública, 55,* 512-537. https://doi.org/10.1590/0034-761220200583

León, L. R. (2017). Latin America's Innovation Potential Remains Largely Untapped. *International Trade Forum, 2017,* 10-11. https://doi.org/10.18356/15645304-2017-3-4

Malacalza, B. (2016). International Co-Operation in Science and Technology: Concepts, Politics, and Dynamics in the Case of Argentine-Brazilian Nuclear Co-operation. *Contexto Internacional, 38,* 663-684. https://doi.org/10.1590/s0102-8529.2016380200007

Malone, E. (2010). *The Shining Path of Peru: Defeated or Alive?* Ph.D. Thesis, Georgetown University.

Mancebo, D. (2004). Reforma universitária: reflexões sobre a privatização e a mercantilização do conhecimento. *Educação & Sociedade, 25,* 845-866. https://doi.org/10.1590/s0101-73302004000300010

Mankoff, J. (2020). The United States in a World of Great Power Competition. *Journal of International Analytics, 11,* 78-94. https://doi.org/10.46272/2587-8476-2020-11-3-78-94

Marcel, M. (2009). *Reinhard Engl, ¿Es posible derogar la Ley Reservada del Cobre? ¿Alternativas para el financiamiento de las adquisiciones militares en Chile [Is It Possible to Repeal the Reserved Copper Law? Alternatives for the Financing of Military Acquisitions in Chile].* Corporación de Estudios para Latinoamérica, Cieplan, Working Paper. https://issuu.com/cieplan/docs/paper

Mckenzie, F. (2006). In the National Interest: Dominions' Support for Britain and the Commonwealth after the Second World War. *The Journal of Imperial and Commonwealth History, 34,* 553-576. https://doi.org/10.1080/03086530600991472

MCTI (2021). *Parques Tecnológicos do Brasil [Technology Parks in Brazil].* Ministério da Ciência, Tecnologia e Inovações. http://www.finep.gov.br/images/chamadas-publicas/2022/17_01_2022_ParquesTecnologicos_Brasil_-_NTG-MCTI-UFV.pdf

Miller, P. (2020). *Declassified UK: Revealed: The UK Military's Overseas Base Network Involves 145 Sites in 42 Countries.* Daily Maverick. https://www.dailymaverick.co.za/article/2020-11-24-revealed-the-uk-militarys-overseas-base-network-involves-145-sites-in-42-countries/

Ministerio de Seguridad Publica (MSP) (2019). *Memoria.* Ministerio de Seguridad Publica. https://www.minseg.gob.pa/descargas/Memoria2019.pdf

Ministry of Defense [Peru] (2022). *Política Nacional multisectorial de seguridad y defensa nacional al 2030 [Multisectoral National Policy on National Security and Defense to 2030].*

https://www.gob.pe/institucion/mindef/informes-publicaciones/3212559-politica-nacional-multisectorial-de-seguridad-y-defensa-nacional-al-2030

Ministry of Science, Technology and Innovation (2021). *Indicadores de Ciencia y Tecnologia: Argentina 2019 [Science and Technology Indicators: Argentina 2019].* Ministry of Science, Technology, and Innovation.

Ministry of Science, Technology and Innovation (2022). *Diagnosis and Roadmap for an Open Science Policy in Argentina.* Ministry of Science, Technology, and Innovation.

Monge-Nájera, J., & Shan Ho, Y. (2017). Bibliometrics of Nicaraguan Publications in the Science Citation Index Expanded. *Revista de Biología Tropical, 65,* 643-655. https://doi.org/10.15517/rbt.v65i2.23985

Mordor Intelligence (2023). *Latin America Defense Market Share.* https://www.mordorintelligence.com/industry-reports/latin-america-defense-market/market-share

Moretti, S., Steinwender, C., & Van Reenen, J. (2019). The Intellectual Spoils of War? Defense R&D, Productivity and International Spillovers. *The Review of Economics and Statistics, 107,* 14-27.

Mouray, T. (2020). *Brazil and US Sign Agreement on Use of Alcântara Launch Center.* Diálogo Américas. https://dialogo-americas.com/articles/brazil-and-us-sign-agreement-on-use-of-alcantara-launch-center/#.Y-qGInbMKUk

Moyano, I. G. (2022). *Mexico's Armed Forces under AMLO.* Wilson Center Canada. https://policycommons.net/artifacts/2367773/mexicos-armed-forces-under-amlo/3388785/CID:20.500.12592/m9sq8w

MSU-BIT (2022). *МГУ-ППИ В Шэньчжэне и МГТУ им. Н.Э. Баумана подписали меморандум о сотрудничестве-Университет МГУ-ППИ в Шэньчжэне [MSU-PPI in Shenzhen and Signed a Memorandum of Cooperation MSU-PPI University in Shenzhen].* Shenzen MSU-BIT University. https://szmsubit.ru/mgu-ppi-i-mgtu-podpisali-memorandum/

Muriel, H. B. (2020). *¿Cómo está Bolivia en materia de desarrollo tecnológico? [How Is Bolivia Doing in Terms of Technological Development].* Desarrollo Sobre La Mesa. https://inesad.edu.bo/dslm/2020/09/como-esta-bolivia-en-materia-de-desarrollo-tecnologico/

Nadimi, F. (2022). *Iran May Be Outsourcing Kamikaze Drone Production to Venezuela.* Policy Analysis, Policy Watch 3670, Washington Institute for Near East Policy. https://www.washingtoninstitute.org/policy-analysis/iran-may-be-outsourcing-kamikaze-drone-production-venezuela

Navy Lookout (2020). *In Focus: The Royal Navy Presence in the Caribbean.* https://www.navylookout.com/in-focus-the-royal-navy-presence-in-the-caribbean/

Nesmachnow, S., & Iturriaga, S. (2019). Cluster-UY: Collaborative Scientific High Performance Computing in Uruguay. In M. Torres, & J. Klapp (Eds.), *Supercomputing* (pp. 188-202). Springer International Publishing. https://doi.org/10.1007/978-3-030-38043-4_16

Nichols, R. W. (2008). Innovation, Change, and Order: Reflections on Science and Technology in India, China, and the United States. *Technology in Society, 30,* 437-450. https://doi.org/10.1016/j.techsoc.2008.04.011

O'Neil S. K. (2022a). The Myth of the Global: Why Regional Ties Win the Day. *Foreign Affairs, 104,* 53.

O'Neil, S. K. (2022b). *Why Latin America Lost at Globalization—And How It Can Win*

Now.

Ochoa, H. D. (2022). La investigación y desarrollo tecnológico como una inversión para la defensa nacional en américa latina. *Revista de la Academia del Guerra del Ejército Ecuatoriano, 15,* 137-148. https://doi.org/10.24133/age.n15.2022.11

OECD (2017). *Organisation for Economic Co-operation and Development, OECD Reviews of Innovation Policy: Costa Rica 2017.* OECD Publishing.

Olavarrieta, S., & Villena, M. G. (2014). Innovation and Business Research in Latin America: An Overview. *Journal of Business Research, 67,* 489-497. https://doi.org/10.1016/j.jbusres.2013.11.005

Oliveira, W. L. D., Oliveira, J. R. M. D. D. S. D., Campos Júnior, J. M. D., & Matos, P. (2021). Encomendas tecnológicas em processos de obtenção de sistemas complexos de defesa. *Coleção Meira Mattos, 15,* 127-145. https://doi.org/10.52781/cmm.a045

Opazo, J. E. C. (2021). *NIST Cybersecurity Framework in South America: Argentina, Brazil, Chile, Colombia, and Uruguay.* Master's Thesis, Universidad de Chile. https://repositorio.uchile.cl/handle/2250/184569

Peer, D. (2022). *Military Science Careers.* Chron. https://work.chron.com/military-science-careers-19295.html

Pellerano, F. Q. (2022). La tecnologia militar como motor de desarollo: Una fórmula postergada [Defense Technology as a Development Drive: A Postponed Formula]. In Escola Superior de Guerra, *Ciberseguri-dad, Inteligencia Artificial y Nuevas Tecnologías en el área de Defensa [Cybersecurity, Artificial Intelligence and New Technologies in the Defense Area]* (pp. 61-92). Es-cola Superior de Guerra.

Pérez Mejía, J. F. (2013). *La Industria Militar colombiana, una empresa industrial y comercial del Estado [The Colombian Military Industry, a State-Owned Industrial and Commercial Enterprise].* Master's Thesis, Universidad de los Andes.

Piatanesi, B., & Arauzo-Carod, J. (2019). Backshoring and Nearshoring: An Overview. *Growth and Change, 50,* 806-823. https://doi.org/10.1111/grow.12316

Ponce, L. G. (2021). *El Costo de la Defensa Nacional en Ecuador [The Cost of National Defense in Ecuador].* Gasto Público. https://www.gastopublico.org/informes-del-observatorio/el-costo-de-la-defensa-nacional-en-ecuador

Porter, M. (1990). *The Competitive Advantage of Nations.* Free Press.

Requena, J. (2010). Science Meltdown in Venezuela. *Interciencia, 35,* 437-444.

Revista Armas (2021). *Transformación y Modernización de la industria militar [Transformation and Modernization of the Military Industry].* https://www.editorialgea.com.mx/transformacion-y-modernizacion-de-la-industria-militar/

Royal Air Force (RAF) (2023). *Ascension Island Base, Royal Air Force.* https://www.raf.mod.uk/our-organisation/stations/ascension-island-base/

Salarichs, M. R. (2015). Los Clusters Industriales de Defensa como Impulsores de la Innovación Tecnológica en América Latina. *Hemisferio Revista del Colegio Interamericano de Defensa, 1,* 100-114.

Sanchez, W. A. (2023). *De Nederlands Caribische eilanden verdedigen: Een beoordeling van buiten [Defending the Dutch Caribbean Islands: An Outside Assessment].* Curacao.nu. https://curacao.nu/de-nederlands-caribische-eilanden-verdedigen-een-beoordeling-van-buiten/

Saponaro, J. A. S. (2020). *Fuerzas Armadas en Tiempos de Ajuste Fiscal: Presente y futuro [The Armed Forces in Times of Fiscal Adjustment: Present and Future].* Master's Thesis, Escuela de Formación Política Resurgir.

Saumeth, E. (2022). *Cidiam, el centro de investigaciones e innovación de la Armada de Colombia [Cidiam, the Colombian Navy's Research and Innovation Center].* Infodefensa. https://www.infodefensa.com/texto-diario/mostrar/3488987/cidiam-centro-investigaciones-innovacion-armada-colombiana

Seijo, G. (2017). How to Make an Artificial Satellite Out of a Nuclear Reactor. An Exploration of Research-Technology Emergence and Management at Invap. *Prometheus, 35,* 291-304. https://doi.org/10.1080/08109028.2018.1510675

Siqueira Brick, E., & Fernandes Alvarez Vilas Porto, H. (2020). O papel do Estado e a interação entre empresas, Institutos de Ciência e Tecnologia (ICT) e Instituições de Ensino Superior (IES) para inovação e capacitação industrial e tecnológica para defesa no Brasil. *Revista da Escola de Guerra Naval, 26,* 254-303. https://doi.org/10.21544/1809-3191.v26n1.p254-303

Solano, J. S. (2017). *De La militarización a la paramilitarización en Costa Rica [From Militarization to Paramilitarization in Costa Rica].* EquipoCritica.org. https://critica.jimdofree.com/reflexion-editorial/editoriales-anterioresde-la-militarizacion-a-la-paramilitarizacion-en-costa-rica/

SSPM (2023). *Informações Atualizadas: Oficial Superior Temporário [Updated Information: Temporary Senior Officer].* Serviço de Seleção do Pessoal da Marinha [Service of Navy Personnel Selection]. https://www.marinha.mil.br/sspm/?q=noticias/informa%C3%A7%C3%B5es-atualizadas-oficial-superior-tempor%C3%A1rio

Steinbock, D. (2014). The Erosion of America's Defense Innovation. *American Foreign Policy Interests, 36,* 366-374. https://doi.org/10.1080/10803920.2014.993251

Suarez, R. A. V. (2016). *Reflexiones sobre Defensa y Seguridad Nacional del Estado Mexicano en el Contexto de la Globalización [Reflections on Defense and National Security of the Mexican State in the Context of Globalization].* Instituto de Investigaciones Estratégicas de la Armada de Mexico. https://cesnav.uninav.edu.mx/cesnav/ININVESTAM/docs/docs_analisis/da_13-16.pdf

Tekiner, U. (2020). *The 'European (Union) Identity': An Overview.* E-International Relations. https://www.e-ir.info/2020/04/15/the-european-union-identity-an-overview/

Today's Military (2014). *Becoming an Officer.* https://www.todaysmilitary.com/joining-eligibility/becoming-military-officer

Turks and Caicos Islands (2020). *Arrival of a Security Assistance Team in TCI from the UK.* https://turksandcaicostourism.com/arrival-of-a-security-assistance-team-in-tci-from-the-uk/

U.S. Department of State (USDOS) (2022). *U.S. Relations with Brazil.* U.S. Department of State. https://www.state.gov/u-s-relations-with-brazil/

US Space Command (2020). *US, Peru Expand Space Data Sharing Partnership.* https://www.spacecom.mil/Newsroom/News/Article-Display/Article/2193473/us-peru-expand-space-data-sharing-partnership/

Valencia, M. et al. (2022). *Triángulo Sur Centroamericano [South Central American Triangle].* Inter-American Defense College, PEDS62.

Vega, J. M., & Comini, N. (2017). Registro Suramericano de Gastos de Defensa: El legado

de UNASUR [South American Defense Expenditure Register: UNASUR's Legacy]. *Boletín IEEE, 129,* 874-895.

Vega-Jurado, J., Fernández-de-Lucio, I., & Huanca-Lopez, R. (2007). La relación universidad-empresa en América Latina: ¿apropiación incorrecta de modelos foráneos? [The University-Industry Relationship in Latin America: Misappropriation of Foreign Models?]. *Journal of Technology Management & Innovation, 2,* 97-109.

Viatori, M. (2015). Rift, Rupture and the Temporal Politics of Race in Ecuador: Whiteness and the Narration of Neoliberal Futures during and after the Cenepa War. *History and Anthropology, 26,* 187-205. https://doi.org/10.1080/02757206.2014.949700

Watkins, T. A. (1990). Beyond guns and butter: managing dual-use technologies. *Technovation, 10,* 389-406.

Wilson, J. R. (2022). *Joint Interagency Task Force South Changes Command.* U.S. Southern Command. https://www.southcom.mil/MEDIA/NEWS-ARTICLES/Article/3097365/joint-interagency-task-force-south-changes-command/

World Bank (2023a). *The World Bank in Bolivia.* https://www.worldbank.org/en/country/bolivia

World Bank (2023b). *The World Bank in Peru.* https://www.worldbank.org/en/country/peru/overview

World Nuclear Association Library (2022). *Nuclear Power in Mexico.* https://world-nuclear.org/information-library/country-profiles/countries-g-n/mexico.aspx