

VALUE AND SUPPLY CHAINS IN INTERNATIONAL TRADE. PUERTO RICO AMIDST DISASTERS, CAPTURES AND LEAKAGES

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ABSTRACT

This research introduces the Chain-Business-Trade mapping method, integrating import-export and Bill of Lading data for supply chain analysis. Two quantitative studies, employing Proof of Concept and Pilot Project approaches, focused on identifying alternative sources for critical imports during disasters and assessing Puerto Rico's alignment with America's Supply Chains priorities. Qualitative methods contextualized findings, addressing international trade constraints and value leakages caused by the US Jones Act. During import disruptions, the Greater Caribbean emerged as a vital alternative network for Puerto Rico, with Mexico, the Dominican Republic, Panama, and the US Virgin Islands playing crucial roles. Puerto Rico's prominence in lithium supply chains (exporting 90% of pacemakers) and pharmaceuticals, aligned with America's Supply Chains priorities, highlights the impact of international trade constraints on supply chains. The study emphasizes the need for comprehensive mapping and adaptive strategies, noting challenges due to the absence of dedicated institutions for informed decision-making.

KEYWORDS

supply chains; value chains; Puerto Rico; Cabotage Laws; America's Supply Chains.

1. INTRODUCTION

This article has a threefold objective. First, it presents the chain mapping method developed by the author. Second, it summarizes preliminary findings from two studies. These studies applied the method and received funding from the Business Resilience and Innovation Program. This program is part of the Puerto Rico Science, Technology, and Research Trust. Third, it examines these findings in a specific context. The context is international trade affected by value leakages. It also considers the impact of the US Cabotage Laws. These laws are Section 27 of the 1920 Merchant Marine Act (46 USC. 883), also known as the Jones Act. The Jones Act imposes certain requirements on maritime transportation. These requirements apply to shipping between US state ports and territories.

This study addresses challenges in Puerto Rico's international trade, particularly regarding "resilient" value and supply chains. The paper assesses imports, emphasizing limitations due to the colonial status, and scrutinizes capture and value leakages in the export process. The theoretical foundations center on value and supply chain mapping, and value capture. A value chain involves a sequence from raw material acquisition to final product delivery, while the supply chain encompasses activities, shipping logistics, multimodal transport, distribution, and international sales. Value capture describes how specific stakeholders gain or lose the value of a created and distributed good or service.

Since 2017, events like hurricanes, the COVID-19 pandemic, and the Russia-Ukraine conflict have caused disruptions, leading to product shortages and price hikes. Examples include water supplies and relief goods after Hurricane Maria, mask and vaccine availability during the pandemic, and high gasoline prices with food shortages after Hurricane Fiona in 2022.

The absence of dedicated institutions collecting and analyzing relevant information, as well as conducting a comprehensive and accurate mapping of the supply chain and trade system, hampers informed decision-making in the public, private, and third sectors. To address this gap, the author founded in 2015, at the University of Puerto Rico, Río Piedras Campus, the project "Value and Supply Chains in International Trade", focused on two main areas: disasters (atmospheric and pandemic); and international geopolitics. The project has obtained recognition and awards locally and internationally. It developed the original "Chain-Business-Trade method," constructing integrated databases from knowledge of import and export data organized by Harmonized Tariff System product codes and Bill of Lading documents from international carriers.

In 2020, the research applied the method, generating a Proof of Concept to identify alternatives for disruptions in critical import supply chains during atmospheric disasters and pandemics. These critical imports, such as water, relief items, COVID-19 diagnostic reagents, and solar products, aimed to apply the method in identifying alternative import sources, including company names. This process aimed to create an integrated database for effective responses to disruptions. In 2021, the investigation utilized the method to generate a Pilot Project, determining if Puerto Rico produces and exports products falling within the categories of Executive Order 14017, known as America's Supply Chains (ASC). Signed by President Joseph R. Biden on February 24, 2021, the ASC aims to establish "resilient" supply chains, reducing disruptions from dependence on strategic products and geopolitical conflicts. The ASC outlines four priority areas: health products and medicines, critical minerals, semiconductors, and large-capacity lithium batteries [1]. The objective was to use the method to identify if Puerto Rico exports products included in the ASC.

As a colony, Puerto Rico encounters constraints in international trade. Until the 1990s, two distinctive trade-related features set Puerto Rico apart in the Caribbean region and Latin America. First, it enjoyed a duty-free trade regime with the United States. Second, it faced the impositions of the Jones Act, which imposes protectionist restrictions on maritime trade between the US and its territories (known as Cabotage laws).

However, this landscape underwent significant changes after 2000. Free trade expanded to other countries in Latin America and the Caribbean through open regionalism agreements. Alternative regional schemes, such as new strategic regionalism or post-hegemonic regionalism, experienced considerable growth. Consequently, a dual scenario developed in the region: open regionalist schemes seeking proximity to the United States and alternative schemes aiming for autonomy from the United States. In this context, Puerto Rico faced a dilemma. It struggled to adapt to the changing scenario of open regionalism or integrate into alternative schemes. While other countries gained the benefits that once distinguished Puerto Rico, such as free trade with the United States, the island lost a crucial competitive advantage by persisting in limitations imposed by cabotage laws [2].

2. LITERATURE REVIEW AND RESEARCH GAPS

The literature review is based on three key areas: mapping value and supply chains; resilient chains; and value capture and leakages.

2.1. Mapping Value and Supply Chains: A Literature Review

This study integrates with literature exploring the intersections of chains, trade, and businesses, bridging theoretical concepts with quantitative measures. Value chain analysis, pivotal since the 1980s, is essential in trade, industrial policymaking, and sustainable trade and development. The commodity chain concept, introduced by Terence Hopkins and Emmanuel Wallerstein in 1977, is foundational, while "supply chain management" emerged in the 1980s, with important contributors [3].

The relevant literature for this article falls into two categories: those using mixed or qualitative methods and those using quantitative approaches. The chain governance approach [4], integrates commercial and business functions, emphasizing chain governance. It conceptualizes "advancement" through the "upgrading" concept along the chain, using both qualitative and quantitative methods. Other authors focus on macroeconomics, industry, trade, and exclusive business data, supplemented by on-site interviews.

Quantitative methods, particularly those using input-output matrices, stand out. The "Trade in Value Added" (TiVa) database streamlines analysis by providing matrices for specific countries. The supply-chain-trade methodology, influenced by Richard Baldwin's work, exemplifies this approach, scrutinizing the cross-border flow of goods. Scholars, leveraging these matrices, have devised indices to measure a country's participation in value chains.

Despite their advantages, these methods have limitations. Challenges associated with the input-output matrix analysis method include issues with availability, size uniformity, and technical difficulties in extending the analysis. Survey-based methods also present technical problems, such as cost and difficulty in administration. To overcome limitations, a method is presented to link mapping and chain analyses to databases, offering a more comprehensive approach.

2.2. Resilient Chains

Resilient Supply Chain Management in Disaster Situations has burgeoned post-9/11 and the 2004 Indian Ocean tsunami [5]. This discipline orchestrates material goods' movement, encompassing medicines, food, water, and rescue equipment, involving key actors like governments, NGOs, international organizations, and public/private transport service providers [6].

Despite theoretical resilience analysis in supply chain management, empirical studies leveraging quantitative trade data are notably scarce [7], [8]. The gap is compounded by the confidentiality of customs treating company data, impeding mapping and posing challenges for researchers. There's a clear need for enhanced quantitative trade data collection in supply chain resilience.

In disaster contexts, MIT's Disaster Supply Chain Institute outlines two vital resilience-building steps [9]. The first involves mapping critical supply chains and infrastructure, understanding the system, while the second deploys bills of materials to comprehend supplier disruption implications. The latter is often accessible to large companies, not SMEs or NGOs [10].

Some studies explored diesel fuel and bottled water supply chains' hurricane season performance, revealing hindrances due to the private sector's lack of automation and data standardization [11]. Standardizing data for intersectoral analysis is recommended, particularly for emergency managers facing difficulties.

Only three studies were found employing Bill of Lading data for supply chain disruption analysis: [7] focused on supply chain strategies, while [10] identified alternatives to disruptions in pandemics and atmospheric disasters. A 2023 study [6] investigated the COVID-19 vaccine supply chain trade in six Latin American and Caribbean countries.

Some authors argue that risks conceal power relations and induce apolitical stances. Scholars suggest reconceptualizing resilient behaviors as "resilient resistance" [12]. The term "resilient chains" within the ASC context raises geopolitical concerns amid the US-China trade war and global transitions. A focus on disruptions as threats to resilience might oversimplify complex socio-political processes, potentially reinforcing the status quo.

Post-Hurricane Maria, scholars explored Puerto Rico's colonial status, US austerity measures, and corporate influence on recovery efforts. Disaster capitalism, as coined by Naomi Klein, emphasizes the "coloniality of disaster," exacerbating racial and colonial inequities. These scholars advocate for reevaluating resilience and recovery concepts [13], proposing resilience as a foundation for postcolonial recovery, challenging the status quo.

2.3. Value Capture and Capital Flight

Value capture and capital flight are intertwined concepts representing the transfer or leakage of value and wealth between entities or spaces. Value capture prioritizes retaining the value generated by suppliers or creators in a product, service, or infrastructure project, averting its appropriation by intermediaries or other agents. Capital flight involves the movement of investment capital or financial wealth across borders, aiming for higher returns or favorable conditions.

This phenomenon can diminish a country's value capture as wealth intended for productive enterprises or public goods relocates abroad. In economic development, understanding actors' ability to capture and retain value within global production networks amid power dynamics is crucial.

In a colonial context, value capture and capital flight depict how colonial powers extract resources and wealth from colonies while exporting capital. Dependency theory, from 1960 onwards, highlights how this process perpetuates underdevelopment in Africa, Latin America, the Caribbean, and Asia.

Dependency theory has made significant contributions concerning the challenges of capture and value leakages in dependent economies. In the realm of dependency theory, starting from 1960, pivotal works by scholars like Norman Girvan, Theotonio Dos Santos, Ruy Mauro Marini, André Gunder Frank, among others, have been prominent (refer to [14] for a literature review). These studies extensively examine the appropriation of wealth by colonial powers from impoverished countries and how the exportation of capital and profits to Europe has contributed to the underdevelopment of Africa, Latin America, the Caribbean, and Asia, perpetuating poverty in those regions.

These contributions establish that unequal power relations allow core countries to extract and capture the value generated in peripheral economies. The peripheral economies are often

unevenly integrated into the global economy, with the highest value-added economic activities concentrated in the core countries, and specialization in lower-value activities relegated to the peripheral countries. Additionally, value leakage mechanisms encompass unequal technology transfer, exploitation of natural resources, disparate capital flows, unfavorable terms of trade, and core countries imposing trade barriers.

These value leaks adversely affect the economic development of dependent countries. Since then, the concept of value capture has been developed and applied in various fields. Anne Krueger used the term in the 1970s to describe the process by which economic benefits derived from public investments in infrastructure and services are appropriated by private individuals or companies. Some academics [15] argue that the way value capture is distributed can have significant implications for trade efficiency and equity, and policymakers should consider these effects when designing trade policies.

Among these, some emphasize the significance of concentrating on capturing and distributing value along global chains [16]. Prominent authors developing the production network concept include [17] and [18]. In production networks, "value" denotes the surplus generated through the production and exchange of goods and services, along with the diverse forms of economic rents obtainable through market and non-market transactions.

These incomes include technological, human resources, organizational, and brand. In addition, there may be exogenous rents derived from factors such as access to natural resources, government policies, infrastructure, and the financial system. The framework of production networks highlights the complex relationships both within and between firms involved in economic activity, and how they are structured both organizationally and geographically.

The constructs of value capture and capital flight make it possible to address the retention of benefits from economic growth and investment, as well as the factors that contribute to capital outflow. Large companies avoid paying taxes fairly, resulting in value leakages for countries [19] [20]. Multinational enterprises capture value through their size, resources, knowledge transfer and technology [21]. In addition, they participate in tax planning, transfer pricing, and strategic profit allocation [22]. These concepts offer a conceptual framework for designing value capture strategies.

The concept of value capture has evolved, applied by Anne Krueger in the 1970s to describe private appropriation of public infrastructure investments. Scholars argue its distribution affects trade efficiency and equity, with Kaplinsky emphasizing the importance of concentrating on capturing and distributing value along global chains. In production networks, value represents surplus and economic rents from market and non-market transactions.

The constructs of value capture and capital flight provide a framework for addressing benefits retention, factors contributing to capital outflow, and the design of value capture strategies. Large companies' tax avoidance, multinational enterprises' value capture strategies, and the complex relationships within production networks underscore the need for comprehensive approaches in economic planning.

3. METHOD AND PRELIMINARY FINDINGS OF PUERTO RICO

The method relies on analyzing trade and Bill of Lading data, concentrating on value or supply chain components. Its application facilitates the creation of an integrated database using Harmonized System (HS) and Broad Economic Categories (BEC) codes to organize information.

For an in-depth explanation, refer to [6], with a concise summary presented here due to space constraints.

The HS is an international trade classification established by the World Customs Organization (WCO) and is used by most countries to report on their trade and negotiate trade agreements. The HS has a 6-digit level disaggregation, which can be broken down at country level into more digits. The Bill of Lading furnishes pertinent details like HS codes, sender and recipient names and addresses, transport information, and goods description. On the other hand, BEC codes aim to analyze international trade statistics based on broad economic categories for goods and services. These categories can be used to identify aspects related to primary and intermediate goods, and final consumption, among others [23].

The method provides a quantitative approach that poses certain advantages over previously developed methods, as it relies on analyzing trade and Bill of Lading data, available both monthly and annually (refer to Figure 1). Unlike earlier approaches concentrating on business functions, this method centers on the components within the value or supply chain. By using HS and BEC codes, the activities present in the international chains can be analyzed.

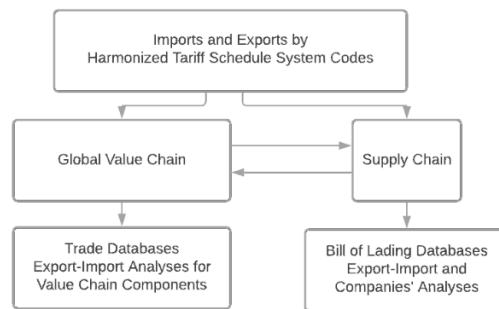


Figure 1. Method that integrates the global value chain and the Bill of Lading data
Source: Author.

The procedure involves several sequential steps. Initially, we select the products for analysis in the supply chain, relying on validated lists from national or international entities (e.g., lists of critical goods under atmospheric disasters, COVID-19 vaccine products, products included in the ASC Executive Order 14017). The second step entails analyzing the pertinent data for the selected products within the studied value and supply chain, considering their schedule codes in the Harmonized Tariff System of the United States. This analysis utilizes various databases for Puerto Rico, namely, USA Trade Online and the United States Census Bureau.

The third step involves creating an integrated database that connects international trade data with Bill of Lading data, following the relevant years' harmonized tariff schedule codes for the investigation. This process gathers information on Puerto Rico's exports and imports. Additionally, a data subset is derived from the Import Key database, focusing on companies and utilizing the codes from the United States Harmonized Tariff Schedule System. Within this subset, data is organized based on the company's buyers and suppliers, establishing pertinent relationships. For this specific dataset, additional steps are implemented within the method's framework.

The fourth step entails categorizing the previously selected data from step 3 according to the corresponding components of the value and supply chain.

Following this, in the fifth step, the analysis of trade and Bill of Lading data for the chosen products is conducted to examine the hypotheses or questions formulated in the research design. The sixth step involves categorizing the data selected in step 5 according to the Broad Economic Categories, as defined by the specifications established by the United Nations.

Moving on to the seventh step, a thorough analysis of the data for the selected products is performed, considering aspects like alternative sources of import supply and potential export markets. This analysis is conducted both regionally and globally, taking into account their participation in global value and supply chains.

In the eighth step, a specific subset of data from the Import Key database is assessed to determine the products' involvement in various supply chain components.

The final step is to generate conclusions from the integrated analysis performed. These findings offer a detailed map for handling potential supply chain disruptions and approximating data related to the local production of critical goods for identifying exports.

3.1. Research 1 Findings. Caribbean Supply Chain Import Alternatives to Disasters: Method with Applications to Puerto Rico

The research aimed to identify sources of critical goods' supply in Puerto Rico following the impact of Hurricane Maria in 2017, utilizing the Chain-Business-Trade method in a Proof of Concept. Findings focus on water and relief goods, providing insights for small and medium-sized enterprises, humanitarian organizations, and government entities to enhance resilience in Puerto Rico.

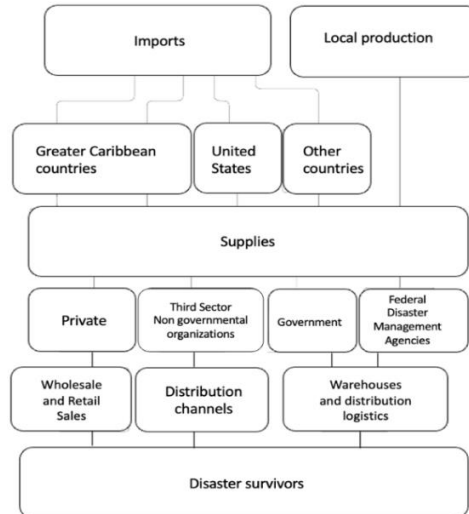


Figure 2. The supply chain of water and relief goods
Source: Author's elaboration based on Boutilier et.al., 2019: 15.

The relief items category covers four components, and the product of bottled water covers three categories. Analysis involved tariff codes HS 980210, 980220, 980230, 980240 for relief goods and HS 220110, 220190 for water. Notably, the Bill of Lading data was employed to capture water data as a relief good, given its absence as a separate tariff code in HS 980210. The analysis revealed mineral water mainly from Europe, while "common" water, essential during disasters, is

dominated by imports from the United States and Canada. Humanitarian relief water primarily originates in the Greater Caribbean region.

Table 1. Relief goods imported into Puerto Rico (August-December 2017)
Includes only water and food, August-December 2017
In kilograms by country of origin as place of receipt

Country	Kilograms	As a % of total kilograms
Mexico	307.883.840	91,10%
Panama	14.257.817	4,22%
United States	8.437.012	2,50%
Dominican Republic	3.728.678	1,10%
US Virgin Islands Islas	3.547.886	1,05%
Jamaica	44.480	0,01%
Suriname	27.200	0,01%
Costa Rica	21.260	0,01%
Total	337.948.173	

Source: Author’s elaboration, based on data from the United States Census Bureau and the United States Trade Online Database.

The Greater Caribbean emerged as a crucial hub for both receiving and shipping relief goods. Over 50% of the cases recorded in the database indicated the origin of relief goods from Caribbean Basin countries. The region played a vital role in supplying water and food to Puerto Rico during the disaster. In Figure 3, the water import supply chains for humanitarian aid in 2017 highlight the Greater Caribbean's significance. Mexico, in particular, held a pivotal position in delivering relief water to Puerto Rico, emphasizing the importance of alternative supplier networks in the region.

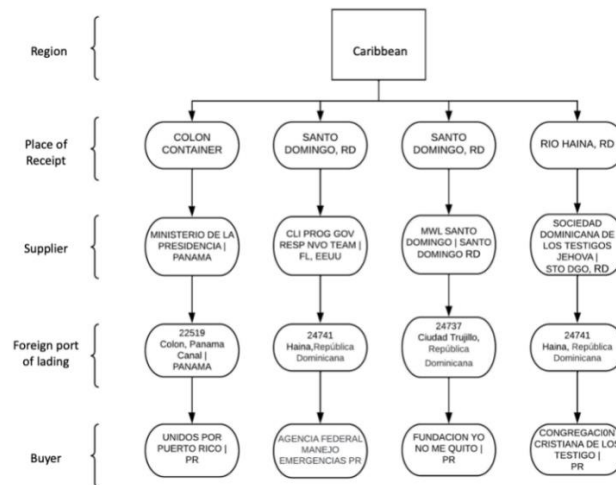


Figure 3. Puerto Rico. Water import supply chains for humanitarian aid, 2017
(Top five shipments in kilograms)

Source: Prepared by Carlos A. Álvarez based on data from Import Key.

These initial findings underscore the role of alternative supplier networks in the Greater Caribbean, emphasizing resilience enhancement during crises. The study advocates for further development and strengthening of these networks to prevent situations similar to those experienced in 2017 during atmospheric and pandemic disasters. These findings are subsequently connected to highlight the impact of Cabotage Laws on the development of alternative networks in the Greater Caribbean.

3.2. Research 2 Findings. What is the Role of Puerto Rican exports in America's Supply Chains?

The research centered on Puerto Rico's role in America's supply chains, with a Chain-Business-Trade Pilot Project focusing on Executive Order 14017's four priority areas. Partial findings reveal Puerto Rico's vital contribution to lithium (pacemakers) and active pharmaceutical ingredients, specifically cardiovascular drugs. Puerto Rico emerges as a pivotal production center, manufacturing five of the world's best-selling drugs and contributing to 90% of global pacemakers.

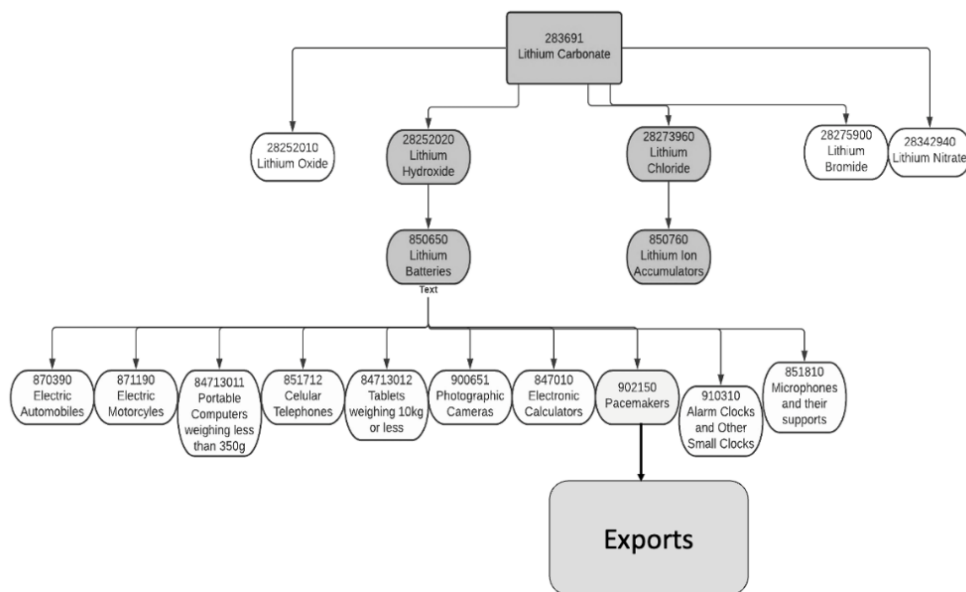


Figure 4. The lithium supply chain

Source: Author and Carlos A. Álvarez's elaboration based on Cadena, 2018; and Cadena-Cancino and Author, 2021.

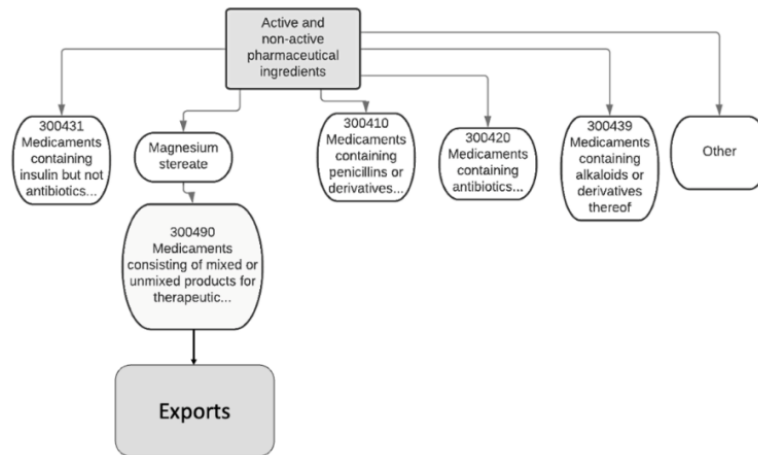


Figure 5: Cardiovascular Drug Supply Chain

Source: Prepared by author and Carlos A. Álvarez based on the code of the Harmonized Tariff Schedule System of the United States, HS Codes for the pharmaceutical industry, and Tewari and Guinn, 2017.

Puerto Rico's significance in drug and medical device manufacturing, often overlooked due to data exclusions, led to the establishment of an integrated database. Figures 6 and 7 demonstrate Puerto Rico among the top global exporters in pacemakers and drugs.

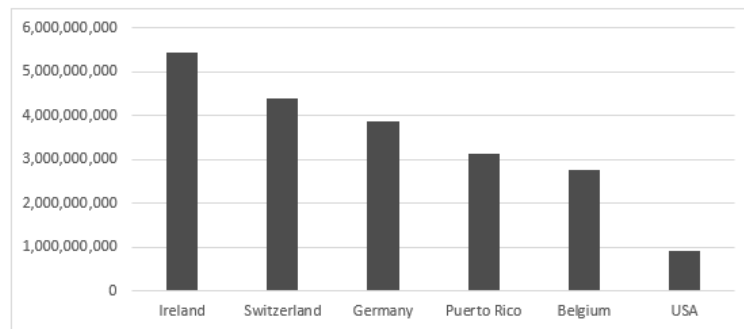


Figure 6. Global Pacemaker Exports

Source: Prepared by author and Carlos A. Álvarez based on the United Nations Commodity Trade Database, USA Trade Online, and the US Census Bureau.

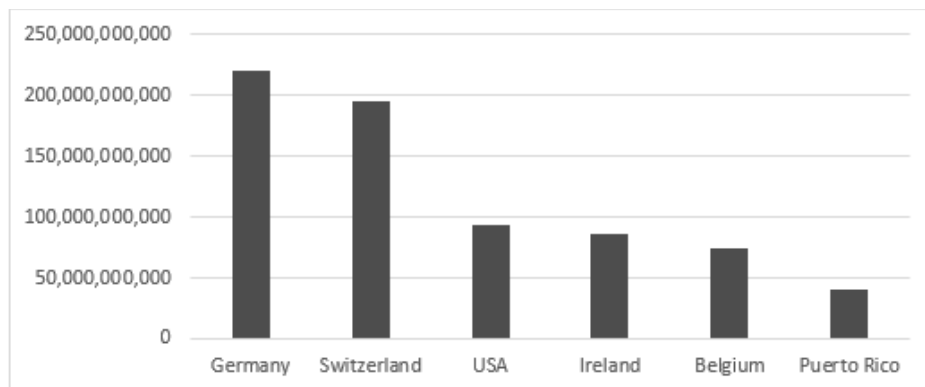


Figure 7. Global Cardiovascular Pharmaceutical Exports

Source: Prepared by author and Carlos A. Álvarez based on the United Nations Commodity Trade Database, USA Trade Online, and the US Census Bureau.

To scrutinize the pharmaceutical supply chain, active pharmaceutical ingredients were examined, focusing on US reliance on foreign sources. Puerto Rico, identified among the top global exporters, underscores its pivotal role in these chains.

Figures 8 and 9 illustrate the characterization of supply chains in terms of corporate imports and exports for lithium and pharmaceuticals. The integrated database provides insights into Puerto Rico's engagement in regional and global value chains.

BEC Categories	Commodity name	Total value exported (USD)	Top countries exported to	Total value exported (USD)
Consumer Goods not elsewhere specified; durable	Appliances worn/carried/implanted and parts, NESOI	\$8,142,470,000	USA	\$11,030,498,000
	Oth Artificial Pts Of The Body & Pts & Accessories	\$1,848,886,826	Netherlands	\$1,372,511,539
	Pacemakers For Stimulating Heart Muscles	\$3,116,022,854	Ireland	\$349,795,044
Capital Goods	Inst & appliances for medical, surgical, etc; NESOI	\$7,456,432,307	Switzerland	\$174,802,621
			Canada	\$67,684,637
			USA	\$5,810,426,000
			Belgium	\$513,584,086
			Dominican Republic	\$337,274,132
Consumer Goods not elsewhere specified, non-durable	Primary Batteries, Lithium	\$6,102,328	Mexico	\$170,824,664
			Canada	\$125,467,897
			USA	\$4,769,000
			Switzerland	\$182,206
			Germany	\$165,150
			France	\$111,975
			United Kingdom	\$104,190

Figure 8. Lithium Chain by Major Economic Categories

Source: Prepared by author and Carlos A. Álvarez based on data from USA Trade Online and US Census Bureau.

BEC Categories	Commodity name	Total value exported (USD)	Top countries exported to	Total value exported (USD)
Consumer Goods not elsewhere specified, non-durable	Medicaments Nesoi, Measured Doses, Retail Pk Nesoi	\$40,971,278,404	USA	\$9,394,736,000
			Belgium	\$5,502,267,849
			Spain	\$5,329,922,426
			Japan	\$3,857,872,503
			Italy	\$3,231,805,204
Industrial Supplies not elsewhere specified, processed	Palmitic Acid, Stearic Acid, Their Salts And Esters	\$7,457	Japan	\$7,457

Figure 9. Pharmaceutical Chain by Major Economic Categories

Source: Prepared by author and Carlos A. Álvarez based on data from USA Trade Online and US Census Bureau.

The pharmaceutical and medical device industry in Puerto Rico hosts major international companies, with the sector's consolidation dominated by a limited number of multinational corporations. Puerto Rico's role as a powerhouse in this domain is crucial, manufacturing critical products and hosting 12 of the top 20 global biopharmaceutical companies. Figures 10 and 11 delve into the characterization of the pacemaker supply chain, showcasing imports and exports. The industry's consolidation and Puerto Rico's role in manufacturing critical products emphasize the island's significance in the global market.

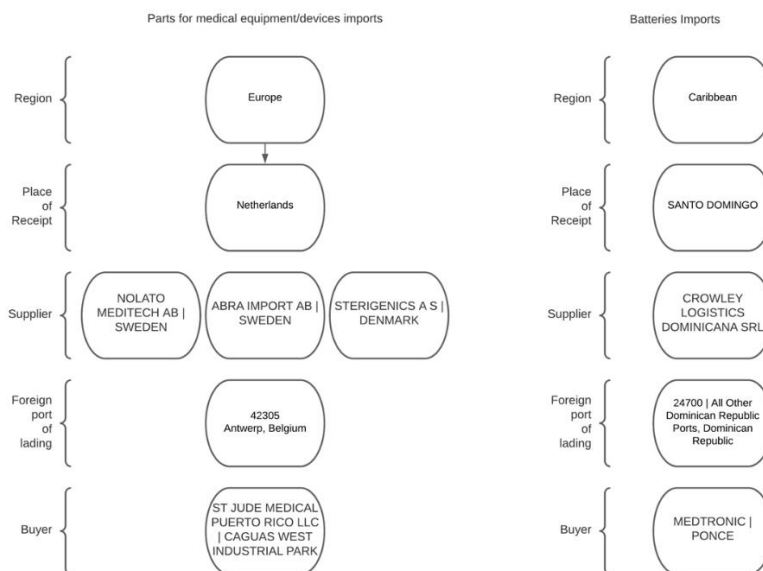


Figure 10. Characterization of the Pacemaker Supply Chain (Imports)

Source: Prepared by author and Carlos A. Álvarez based on data from Import Key.



Figure 11. Characterization of the Pacemaker Supply Chain (Exports)

Source: Carlos A. Álvarez elaboration based on data from Import Key.

The findings underscore Puerto Rico's pivotal role in pharmaceutical and medical device manufacturing, emphasizing the need for a comprehensive database to delve into supply chain intricacies. The subsequent sections analyze challenges related to cabotage restrictions and value leakages, hindering the full potential of international trade in this context.

3.3. Cabotage-Barrier in Import Trade and Value Leakages

The unincorporated territories of the United States comprise Puerto Rico, Guam, the Virgin Islands, the Northern Mariana Islands, and American Samoa. The United States Cabotage Laws, commonly referred to as the Jones Act, enforce specific regulations for maritime transportation between ports within the states and territories of the United States, with exceptions for the Virgin Islands, Samoa, and the Northern Mariana Islands.

Vessels must meet the following criteria: (1) have been built in the United States, (2) be documented under US law, (3) be owned by US citizens, and (4) have a 75% US crew. As Puerto Rico imports almost all goods from the US, then these restrictions significantly impact the island's international trade.

Although these laws do not prohibit the unloading of foreign vessels from countries other than the US, the Jones Act effectively protects the US shipping industry by creating economic barriers for those foreign vessels carrying cargo directly to Puerto Rico [24]. Foreign ships cannot unload goods at multiple US ports. Consequently, the carrier has two unfavorable options. It can travel directly to Puerto Rico for unloading, but foreign carriers seldom opt for this due to the market's small size and the financial impracticality of loading a ship exclusively with goods for Puerto Rico.

Instead, a foreign vessel unloads at a US port, such as Jacksonville, Florida and then the goods are loaded onto a US vessel going to Puerto Rico. In this way, American carriers benefit [24].

The costs of vessels operating under the US are sometimes higher compared to those under foreign flags in similar trade. Overcapacity is also a significant problem in liner shipping [25] and return shipping. A study conducted by the Federal Reserve Bank of New York in 2012 showed that the Jones Act has a negative impact on Puerto Rico's commercial competitiveness, since shipping costs tend to be higher compared to those destined for nearby regions that are not subject to the restrictions established by said law [25].

The Cabotage laws exclude three territories (the US Virgin Islands, American Samoa, and the Northern Mariana Islands). In the US Virgin Islands, a Caribbean territory situated a few miles from Puerto Rico, an exemption permits foreign-flagged vessels to transport goods between ports within the Virgin Islands and the US. This waiver boosts the economic competitiveness of the territory, granted to attract foreign investment, stimulate shipping industry growth, and support overall economic development in the US Virgin Islands [25].

Puerto Rico has 11 registered seaports, 9 administered by its Port Authority, and the other 2 managed by the municipalities of Ponce and Mayagüez. The port in San Juan, the capital city, plays a crucial role as a container terminal. However, the navigation channel's depth at the cargo port is limited to 12.2 meters (40 feet), restricting the access of cargo ships with greater draft commonly found in international markets [25], [26]. There is no public maritime system in Puerto Rico, and maritime operations are predominantly carried out by three US companies: Crowley Puerto Rico Services, Inc.; Tote Maritime; and Trailer Bridge, Inc.

Current cabotage laws impose costs that can adversely affect Puerto Rico's competitive position and lead to increased prices for goods, both imports and exports. These costs are considered value leakages, diverting economic benefits to US-flagged vessels, operating companies, and importers responsible for distribution in Puerto Rico. Moreover, they contribute to delayed arrival times for critical goods after a disaster or supply chain disruptions, potentially impacting the ports of Jacksonville, Florida (a significant source of Puerto Rico's imports), Pennsauken, New Jersey in the North Atlantic, and/or Houston, Texas in the Gulf area [27].

In addition, importers on the island depend on timely and regular shipping by US carriers, to reduce inventory storage costs. Storage in Puerto Rico is expensive due to high energy costs and inventory taxes required by the island's government. Therefore, it is vital that "just-in-time" delivery requirements are met [28].

Faced with this problem, the proposal for cabotage liberalization has been suggested as a potential solution to explore, aiming to reduce costs and benefit the economy. This liberalization could improve supply chain resilience by providing flexible and efficient transport and logistics alternatives.

Foreign-flagged vessels handle cargo transport between Puerto Rico and global destinations, influenced by factors like ship supply, demand, operating costs, and Jones Act implications. Despite longer distances, average freight rates from major Jones Act carriers surpass those from foreign carriers in this market [29].

Introducing lower-cost suppliers can disrupt market dynamics, posing challenges for higher-cost producers. If foreign operators capitalize on cost advantages to offer more affordable rates and gain a larger market share, Jones Act operators may lose services, exit the market, or consolidate their presence [30].

The impact of the US Cabotage Act on Puerto Rico's economy has been studied over several decades. Various estimates have pointed to the costs generated by these laws, which have ranged

from approximately \$45 million in 1965 to \$1.1 billion in 2012 [31], [33], [34], [28], [35], [36]. Some studies favor the continuity of cabotage laws and suggest that they do not negatively impact Puerto Rico [37].

These laws can significantly affect the logistics and distribution of critical goods imported into Puerto Rico during post-disaster situations or when disruptions occur in the ports of Jacksonville, Florida, Pennsauken, New Jersey in the North Atlantic and/or Houston, Texas in the Gulf area. For products from ports in the Greater Caribbean to reach Puerto Rico, they sometimes need to be transported or transshipped to US-flagged vessels from ports in the US. This process limits Puerto Rico's ability to quickly obtain critical goods and respond efficiently to atmospheric events and other situations that may disrupt supply chains. Temporary exemptions or gradual elimination of cabotage regulations could enhance Puerto Rico's import capacity during atmospheric or pandemic disasters. This would involve permitting the entry of more products from other ports in the Greater Caribbean, using non-US registered, owned, flagged, and crewed ships. Consequently, the island would lose the ability to diversify risks associated with import supply during disruptions.

Cabotage Laws significantly impact the logistics of critical goods imported into Puerto Rico during post-disaster situations or disruptions in specific ports. To reach Puerto Rico from ports in the Greater Caribbean, products often need to be transported or transshipped to US-flagged vessels from US ports. This process limits Puerto Rico's ability to swiftly obtain critical goods and respond efficiently to disruptions. Temporary exemptions or gradual elimination of cabotage regulations could enhance Puerto Rico's import capacity during disasters, allowing the entry of more products from other Greater Caribbean ports, using non-US registered, owned, flagged, and crewed ships. However, this would entail losing the ability to diversify risks associated with import supply during disruptions.

Historically, Puerto Rico has been granted short-term exemptions from cabotage laws in various disaster situations, such as the 2017 waiver granted by President Trump in response to Hurricane Maria. The Government of Puerto Rico recognizes the Jones Act as a vulnerability, limiting its procurement abilities for various goods and services. Recent efforts include Puerto Rico's formal petition to the US Congress in 2023 for exemptions from cabotage laws concerning fuel transportation following natural disasters.

The proposal to eliminate or impose a moratorium on Cabotage Laws has been discussed multiple times to promote internationalization and exports while reducing marketing and overseas transportation expenses. However, recent exemptions, like the 2020 allowance for international airlines to use Puerto Rico's airports as cargo transshipment platforms, indicate some flexibility. Nevertheless, the lack of a cabotage laws exemption for Puerto Rico influences global marketing of cardiovascular products, affecting costs, prices, logistics, and distribution.

The political, economic, and legal factors influencing the absence of a cabotage laws exemption for Puerto Rico will be discussed further in the following section, along with the benefits associated with bilateral trade and multinational company operations at the macroeconomic level.

3.4. Amidst Disasters, Value Leakages and Capital Flight

The earlier findings indicate that Puerto Rico exports essential products, including pacemakers and cardiovascular drugs. However, it is crucial to recognize that challenges arise in terms of economic development due to value capture and leakages. Analyzing the Puerto Rico case requires considering macroeconomic value capture results, backward participation indices in value chains, and various forms of multinational company value leakages.

Multinational companies, particularly in the chemical and pharmaceutical sectors, witnessed a notable surge in exports after the repeal of Section 936 in the Internal Revenue Code in 1996. This provision, in force since 1976 and eliminated by the United States in 1996 with a phase-out period until 2006, allowed US multinational companies to repatriate profits from Puerto Rico to that country without paying taxes in the US. Figure 12 shows that exports continued to increase markedly until the completion of the phase-out process in 2006. Subsequently, from 2008, they remained stable with a slight decrease in 2011, and except for the period between 2015 and 2017, they have not exceeded the level reached in 2011.

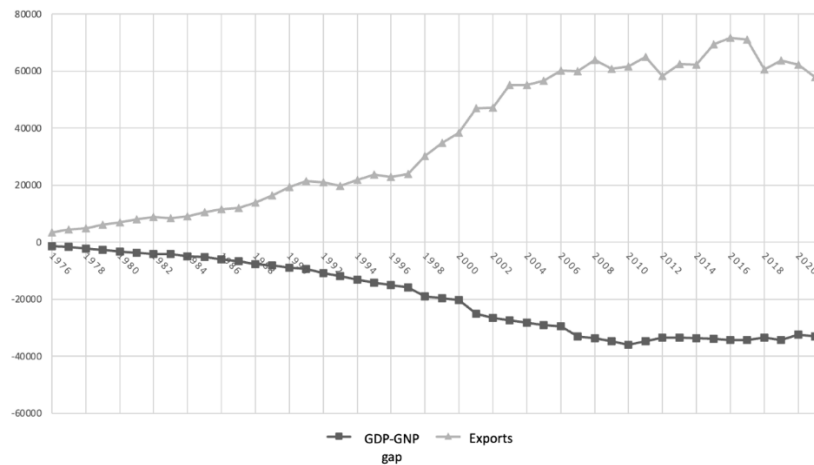


Figure 12. Puerto Rico. Exports and the GDP-GNP Gap
In millions of dollars at current prices

Source: Author’s elaboration based on Statistical Appendices, Economic Report to the Governor, Puerto Rico Planning Board, several years.

Figure 12 visually represents an aspect related to value capture and flight from Puerto Rico at the macroeconomic level. It illustrates the gap, characterized as the variance between Gross Domestic Product (GDP) and Gross National Product (GNP).

This computation offers an approximation of the profits, interest, and dividends acquired by non-residents in Puerto Rico, including foreign corporations and creditors [38]. This indicator unveils that a substantial portion of the income generated on the island has been claimed by foreign investors, remaining unavailable for local consumption or investment. In other words, it is a value that has not been captured, which constitutes a value leakage, or capital flight. According to official government data, the leakage of value is estimated to reach 33 billion US dollars annually. Thus, value leakages restrict the potential for economic development linked to export growth.

Puerto Rico's significance is tied to the tax advantages it offers multinational corporations, even post the elimination of Section 936. Corporate tax rates locally are notably lower at 4%, compared to various US jurisdictions, such as North Carolina (6.9%), Pennsylvania (9.99%), Massachusetts (9%), or New Jersey (9%) (source: investpr.org). This, coupled with a skilled workforce and substantially lower annual salaries (40%) than in the United States, makes Puerto Rico an appealing destination.

Recognized as a tax haven, Puerto Rico is leveraged by large multinational companies, particularly from the United States, to minimize taxes and alleviate their global tax burdens. A tax haven, characterized by low taxes, facilitates profit shifting through legal means like transferring intellectual property, setting high prices for subsidiary-sold products, paying inter-company interest, and outsourcing manufacturing to jurisdictions with higher taxes [39]. In March 2021, the International Centre for Tax Development (ICTD) identified only 10 jurisdictions, including Puerto Rico, significantly contributing to the global shifting of profits [40], [39].

The macroeconomic estimation of value leakage, along with results on backward participation indices in Puerto Rico's global value chains, deepens our comprehension of the value capture scenario in the territory. To date, [41] conducted the singular study calculating the rate of backward participation in Puerto Rico's global value chains. His findings, relying on input-output matrices and their respective government publication dates, produced these indices: 41.4% (1977), 42.5% (1982), 35.4% (1987), 31.3% (1992), and 16.7% (2002). These indices highlight that a substantial portion of imported intermediate inputs for Puerto Rico's export production doesn't circulate within the local economy, limiting the establishment of links with productive activities. Additionally, they indicate a reduction in these rates from 1977 to 2002.

4. CONCLUSION

This study introduced the "Chain-Business-Trade" method for analyzing value and supply chains in Puerto Rico, focusing on disaster contexts and "resilient" chains in America's Supply Chains. Utilizing the International Trade Value and Supply Chains' Project, two investigations employing Proof of Concept and Pilot Project methods identified key challenges in Puerto Rico's international trade. The method facilitates the identification of alternative import sources, emphasizing shipment ports, countries, and entities, creating an integrated database for efficient supply chain responses.

The first investigation underscores the Greater Caribbean network's role as a crucial supply chain alternative during disasters, benefiting businesses and humanitarian aid organizations. Emergency response speed heavily relies on Greater Caribbean ports, especially those in Mexico, the Dominican Republic, Panama, and the US Virgin Islands. Simultaneous hurricane impacts on Puerto Rico and Jacksonville, Florida, a significant supply source, exacerbate these challenges. The second investigation highlights Puerto Rico's global export of strategic products, including pacemakers and cardiovascular drugs.

However, Puerto Rico faces constraints from cabotage laws and value capture processes, potentially causing delays and increased costs in critical goods arrival post-disaster. Analyzing Puerto Rico's case requires consideration of value capture, macroeconomic gaps, backward participation indices, and diverse value leakages by multinational companies, acting as barriers to international trade benefits for economic development.

Despite available import-export options and the establishment of a unified database, persistent limitations necessitate urgent advocacy for alternatives. Creating an enabling environment to address both constraints ensures maximizing opportunities from strengthened value and supply chains, ensuring the realization of economic and resilience benefits in international trade.

5. FUTURE SCOPE OF WORK

The future scope of work in this field, derived from the conclusions of the study, should prioritize the following three areas.

5.1. Leveraging Regional Networks

The Greater Caribbean network's potential as an alternative supply chain, especially during disaster scenarios, has been underscored. Future work should focus on strengthening these relationships and exploring more resilient trade routes. This includes leveraging ports in Mexico, the Dominican Republic, Panama, and the US Virgin Islands for emergency response and routine trade operations. Investigating the feasibility of using the US Virgin Islands' exemption from cabotage laws to reroute imports to Puerto Rico should be explored. This could reveal ways to bypass restrictions, reduce shipping costs, and improve supply chain efficiency for Puerto Rico.

5.2. Policy Advocacy and Development

Advocating for policy changes that address the constraints imposed by cabotage laws and value capture processes is essential. Future efforts should aim to create an enabling environment that maximizes opportunities from strengthened value and supply chains. Developing methods to mitigate value leakages and prevent capital flight is vital. Research should aim to create solutions that ensure value captured from international trade remains within the local economy, contributing to sustainable economic development. A comprehensive study of macroeconomic gaps, backward participation indices, and diverse value leakages by multinational companies is needed. Such an analysis will help identify barriers that prevent Puerto Rico from fully benefiting from international trade for economic development. With Puerto Rico's significant role in exporting strategic products such as pacemakers and cardiovascular drugs, future research should map out the global supply chain for these products. Identifying ways to streamline exports can help maintain Puerto Rico's position as a key player in these crucial sectors. A detailed investigation into the economic impact of cabotage laws on Puerto Rico's international trade should be conducted. This analysis should break down the additional costs imposed by these laws on the import and export of goods. Understanding the full financial burden can lead to the development of strategies that minimize these costs and improve Puerto Rico's competitive position in the global market.

5.3. Method Contributions and Extensions

Future research should also examine and potentially extend the "Chain-Business-Trade" method introduced in this study. It's crucial to assess the method's applicability to other contexts and its ability to integrate new types of data or analytical techniques. By refining and expanding the methodological toolset, researchers can provide deeper insights into value and supply chain dynamics. This could involve the development of the incorporation of emerging technologies like AI and machine learning to enhance predictive capabilities and supply chain responsiveness. Further, methodological advancements could lead to better disaster preparedness and more robust economic systems, particularly in regions vulnerable to trade disruptions. The establishment of an integrated database should be used to its full potential. Future work must focus on how this tool can be used for efficient supply chain responses, especially in identifying alternative import sources and facilitating swift disaster recovery.

Each of these areas offers a path forward to enhance the economic resilience and competitive advantage of Puerto Rico in the face of natural disasters and legislative challenges.

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