



PortReport

a PortEconomics Series

No 3- 2018



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Reflections on the future of container ports in view of the new containerization behaviour

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Almost from its inception, there has been a clear upward trend in the disruptive force of the container during its use. However, a relative decrease in container movement has been seen in recent years although the explanation of which goes beyond disturbances in the world economy. The authors notice that the inter-annual change in throughput with respect to changes in GDP is declining. To understand this phenomenon, the authors have examined variations in containerization, notably factors that cause containerization to increase and decrease.

With the intent to explain these upward and downward variations, some working hypotheses will be proposed and demonstrated, particularly the reprimarization of the economy, cargo miniaturization, possible decreases in transshipments, and the increasing use of 40-foot containers rather than 20-foot containers.

The following paragraphs outline the current status of trade and containerization, and advance hypotheses to better understand the phenomenon of containerization for the future.

As happens with any innovation, containers are reaching a stage in their life cycle* in which their pace of evolution might slow down in the coming years. This document considers the factors that could cause the containerization rate to increase (rise), and others that make it decrease (fall). It is not intended to close any discussion or forestall the emergence of new explanations in this regard.

1 THE CONTAINER AS A VECTOR OF PRODUCTION AND DISTRIBUTION

It is common knowledge that the container is a vector of production and distribution (Rodrigue and Notteboom, 2008) which has transformed transportation and caused it to evolve through time, paving the way for the creation of the modern logistics industry. This article aims to test hypotheses on the future of this vector, given that the pace of containerization seems to have slackened recently.

The use and evolution of the container in intermodal logistics is noteworthy. Until the present day, it has played an influential part in the interaction between the economy, production and distribution. Containerization has participated significantly not only in trade, but also in global industrial structure, contributing to the growth of bilateral trade between countries†.

Containers were first uploaded onto boats in 1956, after being created by the American Malcolm P. McClean, who was looking for a faster and more efficient way to transport goods. Although the container originated in the terrestrial mode of transport, its great potential was evident when it was used as a multimodal tool, especially between the maritime, railway and terrestrial modes‡. Its evolution followed, and currently, containers are the main agents of the internal and international logistics system§.

The advantages of containerization in international trade are many, among the most notables are the following (Rodrigue, Comtois and Slack, 2006):

* Theory propounded by Raymond Vernon (1966), in which products pass through three stages: introduction of the new product on the market, maturity and standardization.

† Rodrigue, J-P., (2013).

‡ Rodrigue, J-P., Comtois C, Slack B. p. 24 (2006).

§ Idem

- Standard transport products
- Flexibility of usage
- Computerized tracking management
- Lower transport costs
- Warehousing
- Security (containers can only be opened at the origin, destination, or in customs)

Containers also converted the handling of bulk loads, into mechanized systems of loads of various types and dimensions. They were also placed in boxes that followed measurement standards which facilitated international trade** and notably diminished labour requirements in the management of the cargo.

This discussion will begin with a brief historical review of the phenomenon of containerization followed by a hypothesis to develop understanding of its present use, in the face of the future.

2 FROM THE ORIGINS OF SHIPPING TO THE CURRENT TRADE

2.1 THE SHIPPING EVOLUTION: FROM BARRELS TO CONTAINERS

Containers are so present in our lives that they seem to have always been around. However, when we consider that its origins date back to 1956, it takes us back further to more than 2,000 years of history, where the first containers used for transport were wooden barrels, elaborated initially by the Celts and used by the Romans, explorers, pilgrims, pirates and samurais throughout more than 2,000 years of civilization††. During these years, the barrels were used as containers of bulk transport‡‡ and used to transport a diverse range of goods, from olives to wine, in addition to dry goods. Due to its geometric shape and the development and growth of trade, the need for standardization was a natural evolution towards other types of containers.

** Rodrigue, J-P., Comtois C, Slack B. p. 116 (2006).

†† Twede D., 2005.

‡‡ Work H. (2014), Wood, Whiskey and Wine: A History of Barrels.



Photo credit: Eliana Barleta / trade in barrels, Venice, Italy, 2018.

The pallet can be considered as one of the first units of intermodal use. Between the nineteenth and twentieth centuries (Rodrigue, J-P. & Notteboom, T., 2008) there was further development in its use for transshipment between the road vehicle and the railway. It could previously take up to three days to unload a full railroad wagon. Compared to today's standards, the evolution of containerization was enormous, an example of this evolution can be seen at Shanghai Port, which had a movement of more than 40 million TEU^{§§} in 2017^{***}.

^{§§} Twenty-foot equivalent unit, the dimensions of one TEU are equal to that of a standard 20'.

^{***} World Maritime News with data from the International Association of Ports and Harbours, 2018.



Shanghai port today. Photo credit: splash247.com.

Notteboom and Rodrigue (2008) argue that containerization has undergone three major paradigm changes, each representing a specific geographic and functional diffusion, which resembles the life cycle theory of the product^{†††}:

- the introduction of the container in the 60's and its diffusion within the maritime systems
- the dissemination of the containerization in the connections of terrestrial transport services
- intermodal and transmodal operations, with the functional diffusion of the containerization within the supply chains^{†††}

From the 1980's to 2000, the maritime trade grew almost 40% (Peters, 2001). Containerized cargo was responsible for a significant growth in trade. Compared to current times, from the mid 90's to 2017, the world maritime trade grew by 280%; Between 2000 to 2017, 179%; the pace of growth decreased dramatically over the past decade, growing "only" 36% between 2010 and 2017. This phenomenon occurred due, among other factors, to the post-crisis situation, and to changes in manufacturing and production worldwide, creating its own market, since the design of the containers was for manufactured or semi-manufactured goods. The vessels grew in technology and in size, and to accompany this growth, the design of the containers went through changes in search of solutions to optimize their uses to facilitate greater profitability, in line with growth of trade as also to offer economies of scale in a niche of great competitiveness (Peters, 2001).

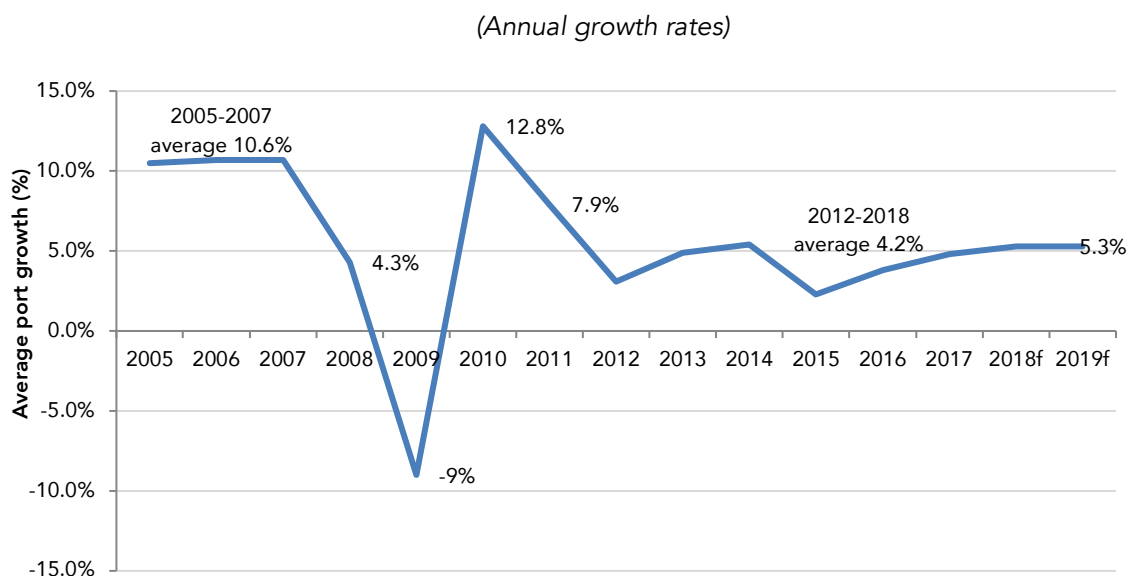
^{†††} Theory defended by Raymond Vernon in 1966, in which the products go through three cycles: introduction of the new product in the market, maturity and standardization.

^{†††} This efficiency is mainly based on reducing the number of times a container is handled.

2.2 SHIP GROWTH AND DECLINING CONTAINER MOVEMENT

After recording growth in container trade of less than 2.3% in 2015, port volumes worldwide grew by 3.8% in 2016 and 5.3% in 2018 (Clarksons, 2018). Nonetheless, the empirical evidence shows that the pace of growth of container movements relative to trade and economic activity has slackened. The general low-volume trend has persisted, since factors such as weak global growth and the saturation of container diffusion continue to weigh on the growth of port volumes. Figure 1 illustrates the lacklustre growth of global container trade in recent years.

Figure 1 Deceleration of the volume of trade via containers worldwide, 2005–2019



Source: Prepared by the authors, on the basis of Clarksons, various editions.

Note: The letter “f” in the years 2018 and 2019 indicates forecast.

Current trends in container trade have shaped a stressful situation, caused by the sector's high competition, pressure for improved infrastructure and investment in technology, declining profit margins. Current container trade trends have generated a stress situation, caused by the high level of competition in the sector, pressure to improve infrastructure and invest in technology, dwindling profit margins and very sluggish global growth in container volumes.

Another major contributory factor is the rapid growth in the size of container ships, especially since 2010. While this has enabled shipping companies to rationalize and improve their operations (once a certain rate of utilization has been attained), the phenomenon may have introduced supply chain inefficiencies. Ports are forced to persistently upgrade their infrastructure and operate with lower yields, and they face heavier pressures on quayside and container yard productivity.

2.3 THE CONTAINERIZATION PROCESS

Since their creation, containers have made a key contribution to the development of trade and have played a fundamental role, even in the most critical moments of the world economy. Despite a

succession of economic crises in the 1990s,^{§§§} containerization continued apace until the outbreak of the 2008/2009 crisis, at which point its behaviour changed.

The literature (for example, Peters, 2001; Rodrigue and Notteboom, 2009; and Wilmsmeier, 2014, among others) has traditionally explained the advance of “containerization” in terms of three essential factors:

Organic growth: related directly to economic and commercial activity, this growth factor is explained by the variation in cargo volumes, driven by two key factors. Firstly, the globalization of the economy has the effect of increasing world merchandise trade by more than the growth of world production and multiplying the number of journeys made by parts and final products in containers. As correctly predicted by Peters (2001), the trend towards cheaper labour would continue in the twenty-first century, moving industry to new locations, which has been happening until recently. Another factor that determines the organic growth of containerization is the progressive liberalization of trade, which has been strongly influenced by the successive rounds of the General Agreement on Tariffs and Trade (GATT) and later by the World Trade Organization (WTO).

Induced growth: driven by network economies, and by the prevalence of container transshipment traffic, which directly impacts both port throughputs and the number and size of the ships needed to handle the global container trade.

Complementing the idea put forward by Peters, other authors have related induced growth to three phenomena: trade imbalances, transshipments and empty containers. Trade imbalances have given rise to empty container flows, creating opportunities to fill empty backhaul movements. This is particularly the case for international container flows in North America. Moreover, the efficiency of port transshipments has improved, and inland transportation services, which were previously dominated by trucking, have begun to stabilize. Lastly, container cabotage significantly reduces the costs involved in repositioning empty containers; maritime operators will be able to forge relationships with inland transport operators, who move their equipment to where it is needed at no cost, while the operator can make free use of the box. It is also worth noting that trade growth has a direct impact in terms of reducing inventory costs, thus contributing to induced growth.

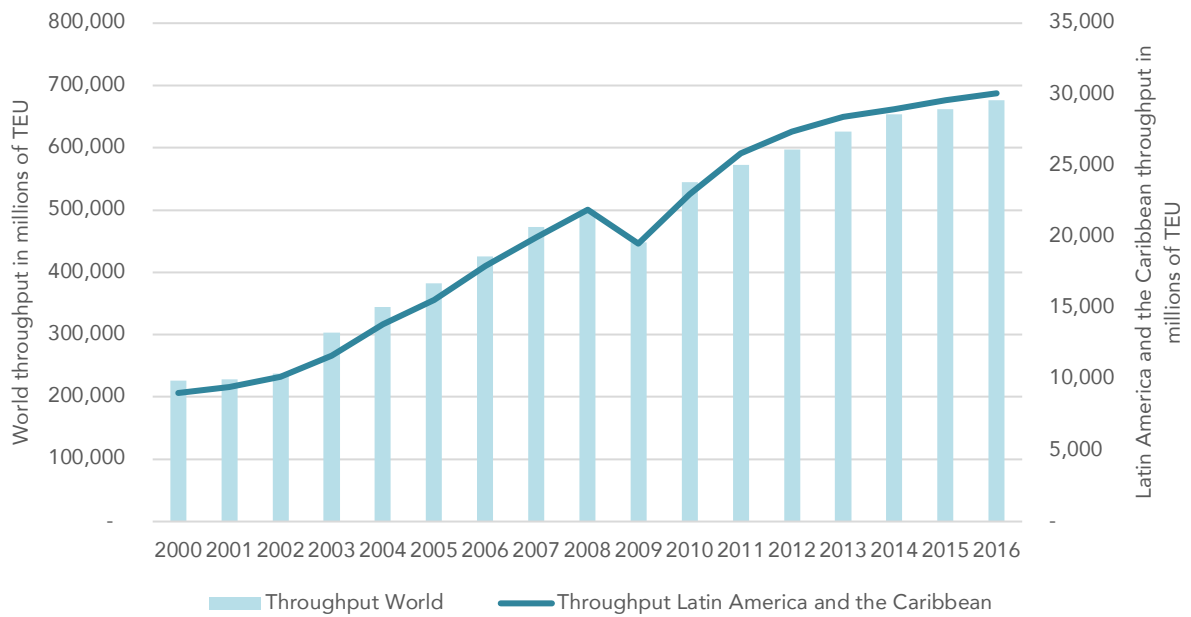
Growth driven by technological change: containers also shifted the handling of cargo in bulk towards a mechanized handling of cargoes of diverse types and dimensions that are placed into boxes of standard sizes, thereby facilitating international trade (Rodrigue, Comtois and Slack B, 2006) and greatly reducing labour requirements in cargo handling.

Figure 2 shows the throughput evolution, both globally and in Latin America and the Caribbean, from 2000 to 2016. Figure 3 shows the respective compound annual growth rate (CAGR) of gross domestic product (GDP) both in Latin America and the Caribbean and in the world. Then, figure 4 shows the throughput and GDP multipliers both for Latin America and the Caribbean and for the world in **2003–2008** and in **2010–2016**. The year 2009 has been excluded because it is considered atypical.

§§§ The Asian crisis and subsequent problems in other emerging markets.

Figure 2 Latin America and the Caribbean and the world: container throughput evolution, 2000-2016

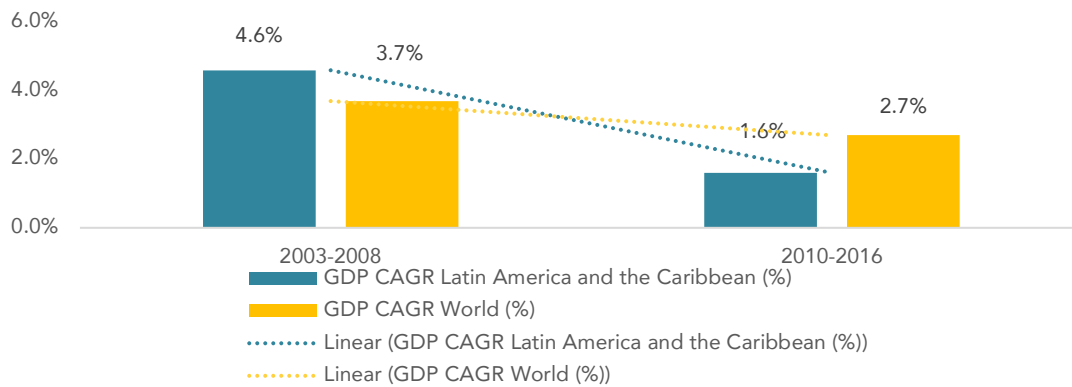
(Millions of twenty-foot equivalent units – TEU)



Source: Authors, with data from Latin America and the Caribbean based on the Maritime Profile, and for the world, Clarksons.

Note: For Latin America and the Caribbean, the following countries were considered: Argentina, Brazil, Chile, Ecuador, El Salvador, Guatemala, Honduras, Mexico, Nicaragua, Peru, Dominican Republic, Suriname, Costa Rica.

Figure 3 Latin America and the Caribbean and the world: GDP-CAGR*, 2003–2008 and 2010–2016**



Source: Prepared by the authors, on the basis of data from Economic Commission for Latin America and the Caribbean (ECLAC), CEPALSTAT, and World Bank.

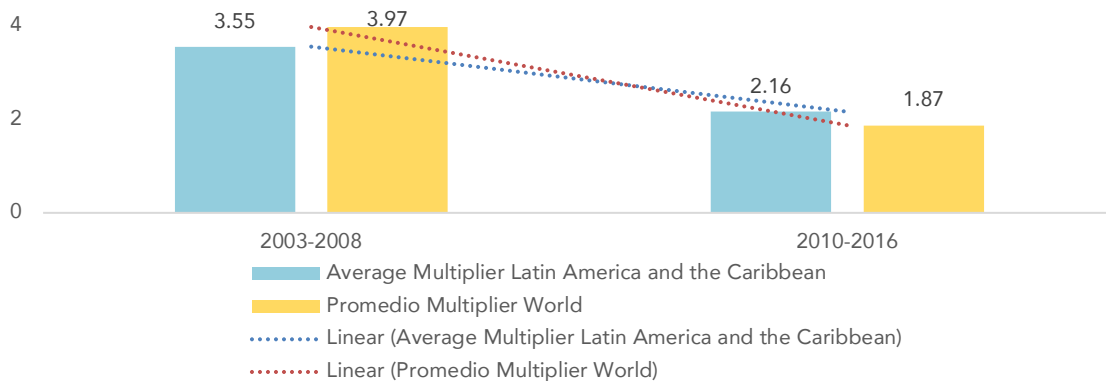
Notes:

* CAGR (Compound annual growth rate).

** The following countries were considered for Latin America and the Caribbean: Argentina, Brazil, Chile, Costa Rica, the Dominican Republic, Ecuador, El Salvador, Guatemala, Honduras, Mexico, Nicaragua, Peru and Suriname.

2009 was excluded because it was a very atypical year.

Figure 4 Latin America and the Caribbean and the world: multiplier, 2003–2008 and 2010–2016



Source: Prepared by the authors, on the basis of Economic Commission for Latin America and the Caribbean (ECLAC), and World Bank (data for GDP); Maritime and Logistics Profile of Latin America and the Caribbean, and, Clarksons, various editions (data for throughput).

Note: the following countries were considered for Latin America and the Caribbean, Argentina, Brazil, Chile, Costa Rica, the Dominican Republic, Ecuador, El Salvador, Guatemala, Honduras, Mexico, Nicaragua, Peru and Suriname.

2009 was excluded because it was a very atypical year.

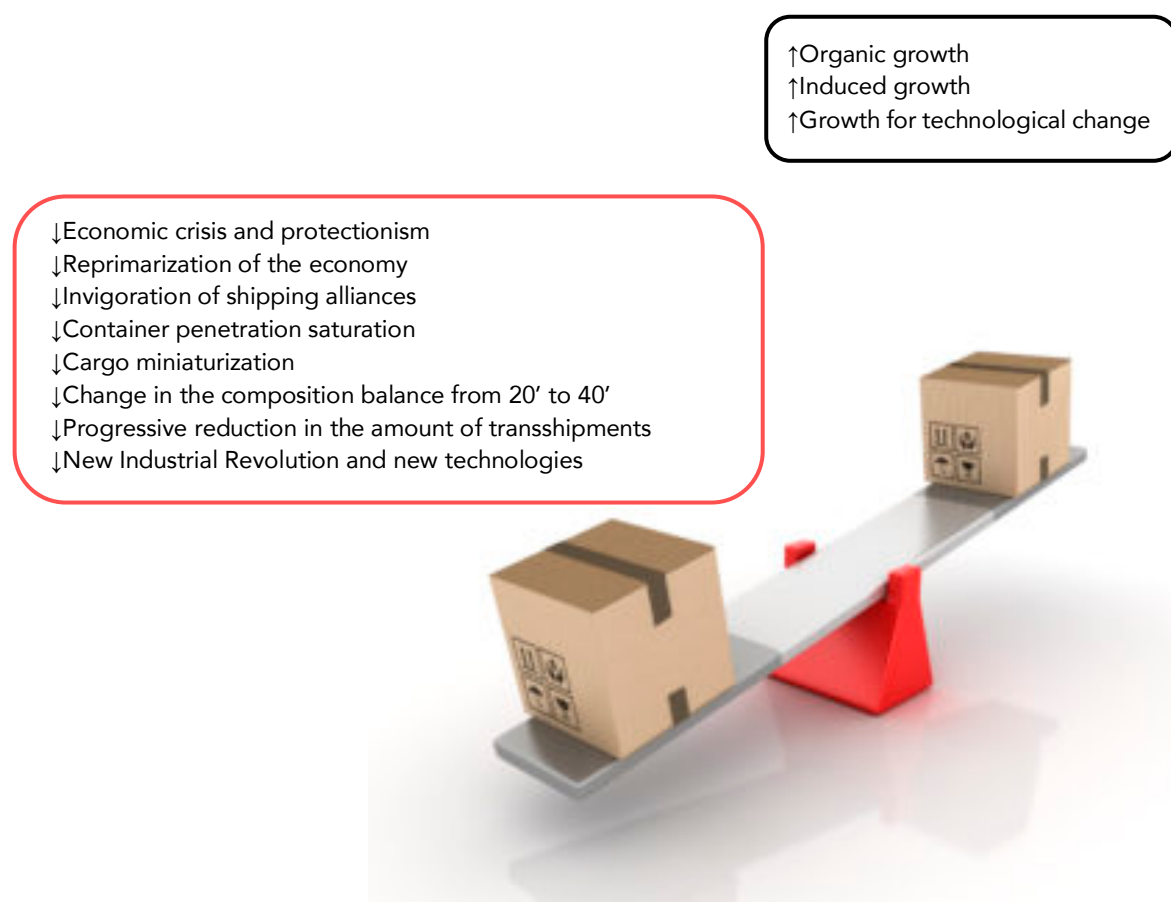
Nonetheless, the steep fall in the multiplier shown in figure 4 cannot be fully explained by changes in the three containerization factors mentioned above: it is no longer possible to consider the positive

factors alone, since containerization has been losing dynamism or is slowing down. This makes it necessary to consider both factors that increase containerization and others that reduce it or hold it back, which means testing new hypotheses.

3 THE CONTAINERIZATION "SEESAW" GAME

The world today is going through changes that are breaking with traditional paradigms. Disruptive forces are already present and will most likely cause even more far-reaching changes in the future.

Picture 1 The containerization "seesaw" game



Source: Ricardo J. Sánchez & Eliana Barleta, ECLAC.

Picture credit: porcorex / iStock.

In response to this situation, the authors have hypothesized on the reasons for the "seesaw movements" of containerization, by asking which factors foster it, and which hold it back or make it retreat. The reasons for downward trends are described in the following paragraphs.

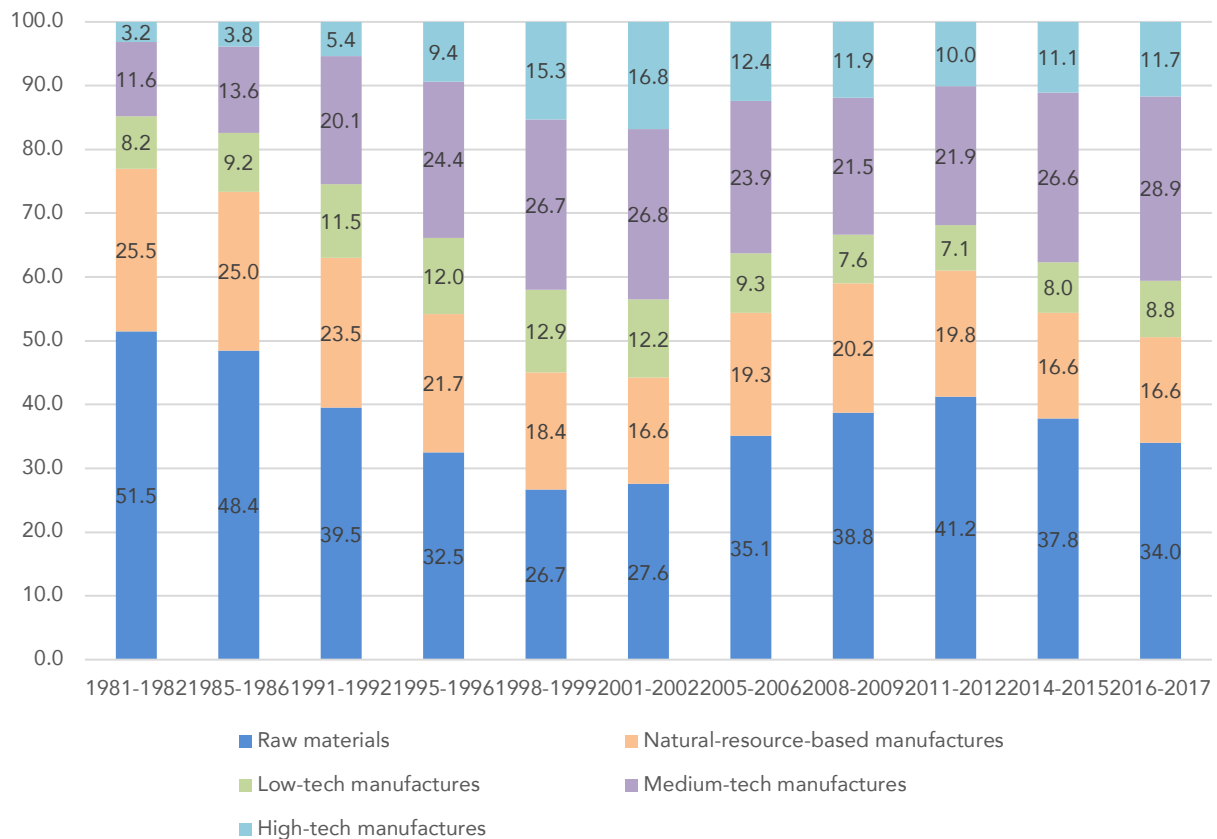
Economic crises and protectionism: economic crises cause countries to adopt protectionist measures, as a way to avoid balance of payments problems and to boost and encourage the domestic market in facing competition from other countries' goods. Such measures make it more difficult to export and import products, dampening interest among trading partners and consequently decreasing containerization.

Reprimarization of the economy (especially applicable to Latin America): this phenomenon occurred as a result of the commodity price boom in the early 2000 decade, driven largely by demand from China and other emerging economies, which concentrated exports in primary products; and also because of a reduction in the share of manufactured goods in total exports.

In 1981–1982, raw materials and natural resource-based manufactures jointly accounted for 77% of total exports throughout Latin America and the Caribbean; by 2001–2002, they represented 44% of total exports, showing an increase of low-, medium- and high-technology manufactures exports. Figure 5 shows the continuous decline in the share of raw materials and natural-resource-based manufactures in total exports, along with the increasing share of low-, medium- and high-technology manufactures, which occurred between 1981 and 2000–2001. Then, early in the 2000 decade, a reprimarization trend reappeared, in which raw materials and natural-resource-based manufactures regained an increasing share of the region’s total exports.

Figure 5 Latin America and the Caribbean: distribution of total exports by technological intensity, 1981–2017

(Percentages of total exports)



Source: Economic Commission for Latin America and the Caribbean (ECLAC), on the basis of UN Comtrade - International Trade Statistics Database and official information from the countries.

Note: estimates were made for Nicaragua (2016), Trinidad and Tobago (2016), and the Bolivarian Republic of Venezuela (2014, 2015, 2016 and 2017).

Strengthening of carrier alliances: the hypothesis here is that further consolidation of containerization is associated with synergetic services pertaining to the alliances themselves, which could result in fewer containers being used. Nonetheless, this remains a hypothesis because it has been impossible to measure.

Saturation of container diffusion: the possible saturation of container diffusion in other general or bulk cargoes, means that the positive factor of increased containerization relative to technological change and substitution could have entered a more mature phase, because the migration to the container of many cargoes that were previously transported in bulk or as general cargoes has already happened. On this point, although there are insufficient data to prove it, the authors have canvassed opinions in the port world and found a degree of consensus in favour of this hypothesis.

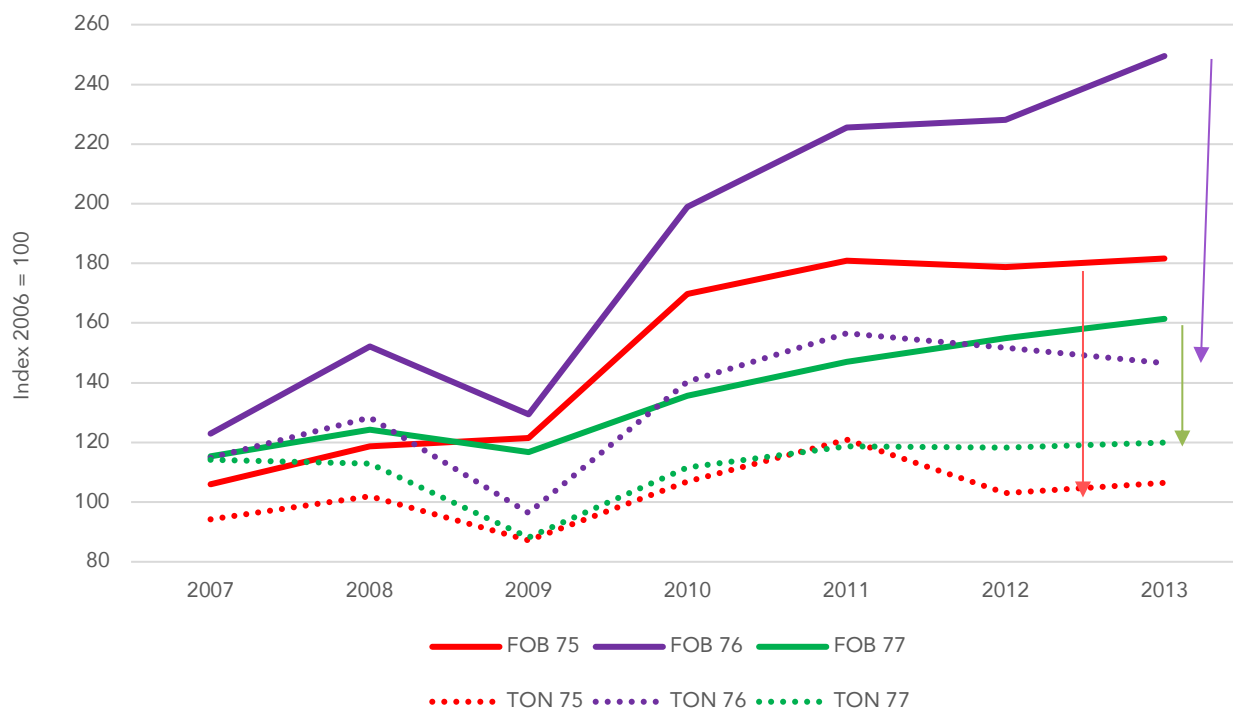
Cargo miniaturization: this involves a reduction in the size of products themselves, but also the fact that they are transported as disassembled units for assembly in locations closer to the consumers; and the size of packaging is reduced to save space and weight (examples include bicycles, toys and furniture). Moreover, mobile phones, electronic equipment, computers and other similar devices are all becoming smaller, more compact, or both, so less container space is needed. Other manufacturing sectors are also becoming more adept at reducing packaging to save space, or else they are sending components to the target markets for final assembly. By allowing a larger number of items to be placed in each container for a given cargo value, the number of containers transported by ships and operated by port terminals can be expected to decline.

In other words, for a given value of international trade, fewer containers were used in 2013 than in 2006. This analysis helps to explain the reduction in the containerization multiplier posited at the start of this section.

The appropriate methodology for testing the product miniaturization hypothesis involves analysing the stowage factor; nonetheless, it has not yet been possible to obtain the necessary information. Accordingly, the authors have used evidence that today's goods are lighter and possibly less bulky (such as computer monitors 10 years ago compared to those of today), but verification is left pending for the time being; and the hypothesis will be worked on with the data that are available.

Figure 6 illustrates this phenomenon through the behaviour of the index of FOB value (deflated) relative to weight. This is measured by tonnage (TON) of the goods (since volume data are not available), on the assumption that less weight implies less volume, so less use of container space. For this purposes, a number of product groups were selected according to the Standard International Trade Classification (SITC)—three of which the authors already hypothesized had decreased in weight relative to FOB value. Part of the product miniaturization phenomenon can be observed: the same figure shows this for SITC chapters 75, 76 and 77, representing a total of 20% of the FOB value and 18% by weight of the seven-digit classification, which covers machinery and transport equipment and is one of the most important within the group of products typically transported in containers.

Figure 6 South America trade: FOB value and tonnage of selected SITC product groups evolution
 (Sum of exports and imports)



Source: Prepared by the authors, on the basis of data from the Economic Commission for Latin America and the Caribbean (ECLAC).

Note: The selected countries are Argentina, Brazil, Chile, Colombia, Ecuador, Peru and Uruguay.

The SITC divisions chosen are:

- ✓ Division 75: Office machines and automatic data-processing machines
- ✓ Division 76: Telecommunications and sound-recording and reproducing apparatus and equipment
- ✓ Division 77: Electrical machinery, apparatus and appliance, and electrical parts thereof

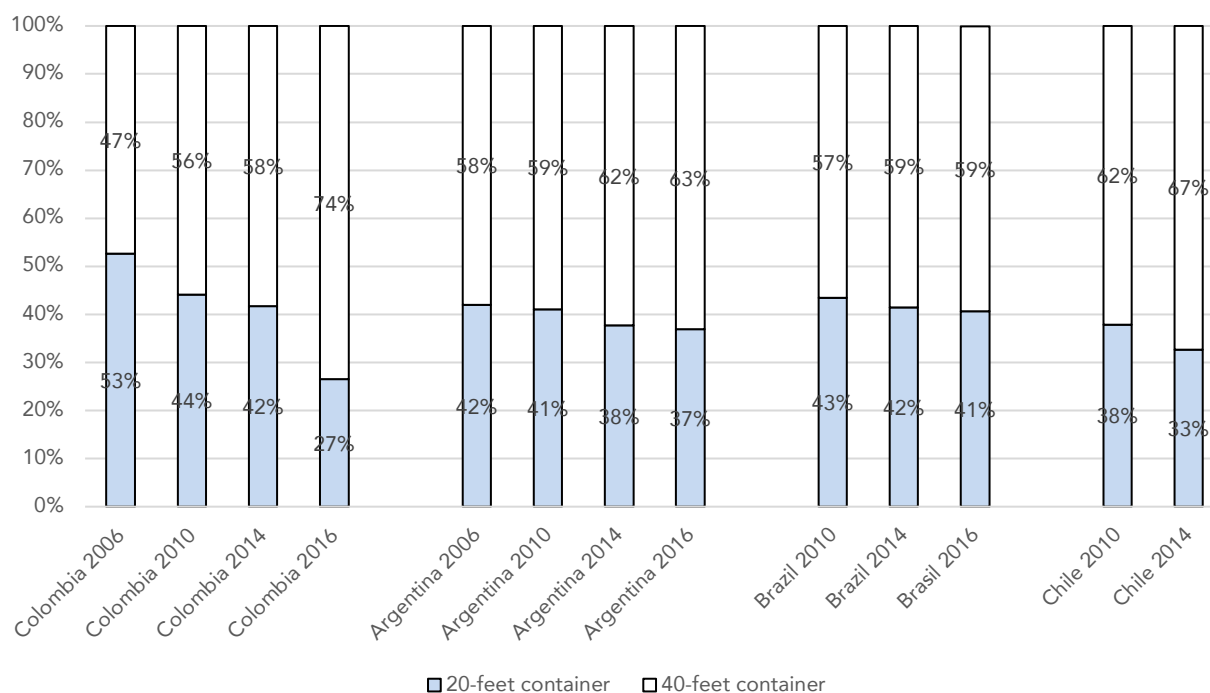
Figure 6 shows the visible reduction that has occurred in the weight of merchandise relative to its FOB value, with trend lines of weight and value diverging over the years. The goods in the selected SITC divisions are precisely those that have become smaller, such as computers or cellular devices, which are becoming slimmer and lighter than those used over a decade ago.

Relative shift from 20- to 40-foot containers: This change is happening in most container terminals. The selected countries display a clear trend from 20-foot to 40-foot containers, which by 2010 already accounted for more than 50% of container use.

Figure 7 displays evolution of use of 20-foot and 40-foot containers in Colombia, Argentina, Brazil and Chile. Due the lack of available information, for some countries it was impossible to report the data for 2006 (Brazil and Chile) and for 2016 (Chile).

Figure 7 Evolution of the use of 40-foot containers, selected countries and years between 2006 and 2016

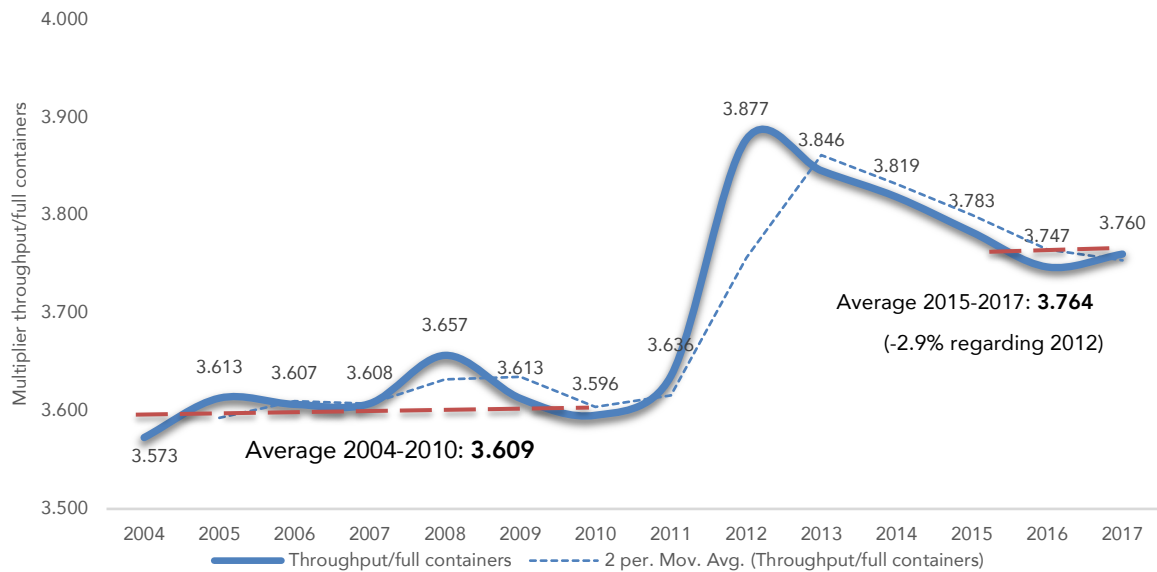
(Percentage of total container use)



Source: Prepared by the authors, on the basis of official data from the countries.

Progressive reduction in the number of transshipments: The relation between total port movements (throughput) and the number of full containers worldwide varied little between 2004 and 2010, averaging 3.6 port movements for each full container (trade). From then on, the number surged to 3.88 in 2012, after which another downswing phase began. The average between 2015 and 2017, at 3.76, is almost 3% down from the 2012 peak, as shown in Figure 8. In other words, if it had remained at the maximum level, total port movements would have been greater than actually observed since 2013. Although the variation in the ratio includes other variables, they largely correspond to transshipments: in 2012 transshipments accounted for 27.2% of total throughput, but the proportion had dropped to 25.7% by 2017.

Figure 8 Global evolution of the ratio of transferred containers/full containers, 2004-2018



Source: Prepared by the authors, on the basis of Clarksons, various editions.

New industrial revolution and new technologies: The new industrial revolution, or Revolution 4.0, is already in its early stages; and this has raised questions about the possible impacts that new technologies could have on trade and transport in the future.

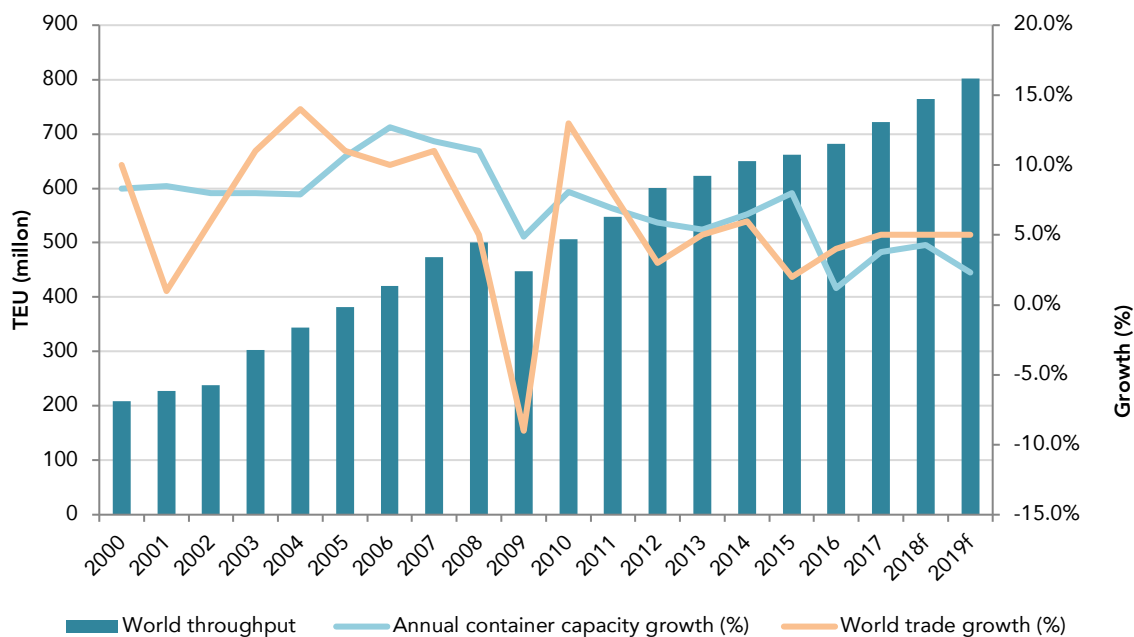
The definition of new technologies is very broad and uncertain. What is certain is that disruptive forces are already present, and they are likely to cause even more substantive changes in the future. The forecasts point to a transformation of the global energy, science and transport map, causing changes in the production of manufactured goods, its geographical location and mode of trade.

Having said that, any comment or assessment made in the technology sphere could be subject to changes in a short or medium term, since new technologies are being tested and introduced in the market; and, as is natural in all new development, some will not be successful and disappear, while others will evolve.

4 HYPOTHESIS FOR THE FUTURE OF COTAINERIZATION

Changes in trade and logistics have been unfolding rapidly in recent years. The outlook for container ports, therefore, is less expansionary than before, since global trends suggest an operating environment that combines greater rivalry, increasing concentration and slower growth of containerization. There are also certain risks that underpin expectations of slower growth, as may be seen in figure 9.

Figure 9 Trend of global throughput and annual growth of container capacity and world trade
(Millions of TEU and percentages)



Source: Prepared by the authors, on the basis of *Container Intelligence Monthly*, London, Clarkson Research Services, various editions.

Note: The letter "f" in 2018 and 2019 indicates forecast.

Analysis of the impact of technology in maritime trade requires a multidisciplinary effort that necessarily entails viewing the technology from many angles, influenced by the economic and social dimension and by natural resources. The future points to weaker organic growth and lower diffusion rates, owing to the slowdown in both economic growth and trade and the maturity now attained by the containerization process. These factors are being compounded by the phenomena mentioned in the first section, particularly the new technologies.

In the social domain, the demand for the development of new technologies is a growing phenomenon. Driving a social change, technology is growing rapidly and there are no signs of that growth slowing down. Smart technologies are one of the most important tools and one of the challenges that can already be discerned, causing changes in the structure of social behaviour and industrial processes around the world, changing the type of goods transported in containers, through product miniaturization: televisions are much slimmer, desktop computers are being replaced by laptops and tablets that fit into wallets; smartphones are replacing various devices, such as calculators, maps, flashlights, and even books.

Some of the new technologies were briefly introduced and discussed by Sánchez, Barleta and Mouftier (2017): changes in the global industrial structure and processes, the trend of the Internet of Things and big data analysis, the evolution of automation and robotics, the advance of cybersecurity and cybersafety, the role of autonomous vehicles, 3D printing, applied robotics and advanced e-commerce and its impacts on trade, among others.

In addition to these factors, maritime trade will also be impacted by smart container ships,^{****} which may involve vessels that do not have the large structure of the container ships known today. Nonetheless thought is needed before turning smart shipping into a buzzword. The shipping industry handles millions of TEU every year—an estimated 698 million containers worldwide in 2017 (Clarksons, 2017). Given the large numbers of the maritime industry, the size of the market plus the willingness to invest, are two factors that could slow down or advance certain technologies—smart shippings are small, without the transport capacity of large container ships.

3D printing could give rise to a new global production and trade paradigm, since this technology makes it possible to relocate production centres. The particular feature of this technology is that objects are created through successive layers of material, thus reducing unnecessary input expenses; and it allows objects to be produced directly at the destination, thus saving time and transport costs. This is a technology with disruptive capacity, but the quality and speed of its production is still subject to debate and development. Private investment in 3D printing is mainly targeted on the United States, which accounts for 39% of the world market, followed by Asia and the Pacific with 29% and Europe with 28% (ING, 2017). Latin America and the Caribbean is still taking hesitant steps towards significant investment in this area.

The automotive industry will be greatly impacted with 3D impressions, especially considering the production of Mexico, Japan, Germany and Canada, which have the United States as their main importing customer. The bilateral relations with the United States, together with other countries, focus particularly on these four countries, which may cause a decrease in the shipping of small and complex parts of motor vehicles. In addition to 3D impressions, another factor that can contribute to the rise and fall of containerization, the shipment of motor vehicles by containers, offering direct competition with RORO vessels. But time will show how the trade in the automotive industry evolves, what we see now are predictions, considering new technologies and recent trade behaviours.

The shipment of automobiles by container offers direct competition to roll-on-roll-off (ro-ro) vessels. Time will tell how the automotive trade will evolve; in the meantime, what we have are predictions that take account of the new technologies and recent trade developments.

Another factor that could affect the reduction (or slowdown) of containerization is the fact that consumption in China is becoming more service-centred (Saxon and Stone, 2017). Other major changes that are already discernible may also intensify in the future, relating to the supply chain and the role of technology in manufacturing (autonomous vehicles, 3D printing, applied robotics and advanced e-commerce), and in technologies and innovation applied to production and consumption models.

Lastly, geopolitical shifts and possible global conflicts should also be considered among phenomena that could impact maritime trade.

^{****} These are already in the testing phase on the sea crossing between Holland and Belgium. For further information, see: https://www.porttechnology.org/news/tesla_ships_to_hit_the_seas, viewed on 16 February 2018.

5 CONCLUDING COMMENTS

Containers have transformed the way trade is done, contributing to what is now known as logistics and to the benefits it brings to international trade. Notwithstanding the ups and downs of international trade, this article has formulated a number of hypotheses for the future of containerization.

The concern —or caution— in relation to containers is due to their importance in global trade, since the logistics industry moves millions of containers around the world every year, making it possible to transport all types of goods from one country to another.

Both positive and negative factors explain the slow growth or the rapid growth of the containerization. On the positive side, there is organic, induced and technological growth. An example of the possible current and future impulse of the containerization caused by technological change, is the attraction in the use of containers for the transport of agricultural commodities. The proportion of shipments of certain bulk cargoes transported by containers is increasing and can already be observed in some cases.

Since 2012, there has been a sharp slowdown in the rate of growth of container traffic. The hypotheses about factors that hold it back or slow it down are economic crises and protectionism, the reprimarization of the economy, the strengthening of carrier alliances, the saturation of container diffusion, the miniaturization of, the shift from 20-foot to 40-foot containers, and the new Industrial Revolution and new technologies —as had happened in the globalization era— volumes transported could be altered by the digital economy and the new technologies. It should also be noted that the trade dispute between the United States and China could have a significant impact on trade, and hence also on the container market;⁺⁺⁺⁺ but any other comment in this area would be largely speculative, particularly with regard to the impact on amounts traded.

Reaching effective conclusions on the trend of containerization requires more information on the elasticities of each of the factors discussed in this document. At the present time, these cannot be obtained, partly because some of the phenomena are recent and they need time to be analysed. The purpose of this document is to put forward hypotheses and not to forestall conclusions.

Demographic change, along with changes in labour productivity and structural changes are impacting the growth of long-term demand. Lacklustre growth of world trade is also caused by several other factors, such as increased protectionism, currency wars, nearshoring, miniaturization of goods, saturation of container diffusion, and the silent recovery of consumer spending (owing to demographic changes).

Technological development has proceeded very rapidly in the twenty-first century thus far. The major challenge is to know which technology to invest in and which technology will have an impact on maritime transport (Lloyd's Register, 2015). In fact, more than impact, the question is which technology will be beneficial, because large investments in technology also pose direct and indirect threats to the industry, owing to the interconnectedness, globalization and high concentrations of power among a small number of actors governing the global market. Those that can invest remain in the game; will those who cannot invest be excluded? In this connection, it is also necessary to consider the market structure for technologies and their applications to the logistics industry since concentration could have adverse effects.

⁺⁺⁺⁺ As noted by Hailey Desormeaux in an American Shipper publication: <https://www.americanshipper.com/main/fullasd/charting-equilibrium-supplyanddemand-struggle-72186.aspx>.

REFERENCES

- Clarksons (2018), *Container Intelligence Monthly, Volume 20, September 2018, N° 6* (ISSN: 1467-0488).
- Clarksons (2017), *Container Intelligence Monthly, Volume 19, June 2017, N° 6* (ISSN: 1467-0488).
- Clarksons (from 2000 to 2018), *Container Intelligence Monthly*, multiples editions.
- Desormeaux, H. (2018), "Charting equilibrium: supply-and-demand struggle", *American Shipper*, 9 August [online] <https://www.americanshipper.com/main/fullasd/charting-equilibrium-supplyanddemand-struggle-72186.aspx>.
- ECLAC (Economic Commission for Latin America and the Caribbean) (2016), *Latin America and the Caribbean in the World Economy, 2016* (LC/G.2697-P), Santiago.
- ING (2017), *3D printing: a threat to global trade*, Amsterdam.
- Lloyd's Register/QineIQ/University of Southampton (2015), *Global Marine Technology Trends 2030*, Southampton.
- Peters, H. (2001), "Developments in global seatriade and container shipping markets: their effects on the port industry and private sector involvement", *International Journal of Maritime Economics*, vol. 3, No. 1, Springer.
- Port Technology (2018), "'Tesla ships' to hit the seas", 15 January [online] https://www.porttechnology.org/news/tesla_ships_to_hit_the_seas.
- Rodrigue, J. P. and T. Notteboom (2008), "The geography of containerization: half a century of revolution, adaptation and diffusion", *GeoJournal*, vol. 74, No. 1, Springer.
- Rodrigue, J. P., C. Comtois and B. Slack (2006), *The Geography of Transport Systems*, Abingdon, Routledge.
- Sánchez, J. R., E. Palma Barleta and L. Mouftier (2017), "Reflexiones sobre el futuro de los puertos de contenedores", *Natural Resources and Infrastructure series*, No. 186 (LC/TS.2017/131), Santiago, Economic Commission for Latin America and the Caribbean (ECLAC).
- Saxon, S. and M. Stone (2017), *Container Shipping: The Next 50 Years*, McKinsey&Company.
- The Economist* (2013), "The humble hero", 18 May [online] <https://www.economist.com/finance-and-economics/2013/05/18/the-humble-hero>.
- Vernon, R. (1966), "International investment and international trade in the product cycle", *The Quarterly Journal of Economics*, vol. 80, No. 2, Oxford, Oxford University Press.
- Wilmsmeier, G. (2014), *International Maritime Transport Costs: Market Structures and Network Configurations*, Abingdon, Routledge.