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Abstract

While plenty of existing literature focuses on Latin America's trade relations with key partners, i.e. the US and China, and on its insertion into global value chains, intra-regional trade networks remain understudied. In this paper, we contribute to the understanding of the latter by looking at trade patterns in the region, focusing on how balanced and unbalanced trade occurs among Latin American countries and selected trade partners. We first develop an Index of Modern Balanced Trade (IMBT) that identifies balanced trade relations based on the share of complex goods that is exported and imported among two countries using data from the Observatory of Economic Complexity (Hausmann & Hidalgo, 2014). Based on the IMBT, we then build two types of networks (Balanced and Unbalanced Trade Networks) in three different years that represent specific moments in Latin American economic history. We find that, as expected, most Latin American countries' relations with partners outside the region remain largely unbalanced. However, our results also show that the Balanced Trade Network within the region has steadily expanded.

Keywords: Latin America, Trade Integration, Network Analysis, Economic Complexity.

JEL: F14, F15, N16, N76.

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1. Introduction

Latin America has increased its share in total world exports over the past 25 years – whether measured in terms of gross exports or value-added (Cerra et al., 2017). However, its trade pattern remains characterized by its high and ever growing dependency on commodity exports (Adler & Sosa, 2011) and its integration into global value chains remains relatively low for most countries – especially if compared to Asia.

Since the end of the 2000s commodity boom until mid 2010's, Latin America's net commodity-exporters had been facing an increase in terms-of-trade shocks. The continent went through a period of slower growth whose effect has expanded to the rest of the region resulting in an overall sharp drop in export values. Such slowdown translated into an almost nil cumulative GDP growth over 2013 to 2016, in contrast to 10 percent in the rest of the world (Cerra et al., 2017).

Inter-regional trade also remains highly concentrated on a few partners: by far and large, the US and China are currently the major key partners for the bulk of Latin America. Generally speaking, the US sources oil and China metals from the region – especially from the southern cone countries. However, trade partners' concentration is heterogenous across the region: Mexico and Central America are less diversified in terms of commercial linkages than South American countries (ibid).

Akin to inter-regional, intra-regional trade is also limited to handful of participating countries and large economies. For instance, Mexico and Brazil are top-five trading partners for no more than 12 regional partners. While Mexico being is highly focused on NAFTA partners, Brazil has significant commercial links only with Paraguay, Uruguay, Argentina, and Bolivia (Morgan, 2017).

The number of trade agreements in the region has been growing since the 1990s (Devlin & Ffrench-Davis, 1998): Mercosur, NAFTA and, more recently, the Pacific Alliance are examples of this trend. Yet, some of the larger Latin American economies remain isolated from the network of trade agreements. For instance, Argentina and Brazil do not have a free trade agreement with Mexico (Morgan, 2017). However, other aspects, such as infrastructure or productive complementarity, might have a higher impact on trade than de jure integration (Baumann, 2010).

The increasing competition of Asian exports and the economic slowdown have bolstered renewed focus on the development of intra-regional trade links. It represents an opportunity to leverage trade for growth. Diversification of trade partners is a crucial element of trade performance and empirical results confirm that countries with more trade partners benefit from stronger economic growth (Cerra et al., 2017). The increased benefits lie not only on the expansion of markets for final goods but also on complementarity of intermediate goods. When a country is capable of sourcing intermediate goods efficiently and cheaply from its neighbors this has a positive effect on its production capacity enhancing the country's global competitiveness. Furthermore, regional trade can create a *regional multiplier effect* from which producers of intermediate goods and final goods derive gains.

This type of trade integration can be observed in high-income regions, such as the European Union, where there has been a sharp increment of intermediate goods, indicating a higher level of intra-industry trade. In contrast, low- and middle-income regions tend to trade on an inter-industry base (Brülhart, 2008). In the specific case of Latin America, intra-industry trade levels are, on average, half of Asia's (Blyde, 2014). This is probably due a fundamental difference among these regions: the former region focuses on natural resources and the latter on producer goods. Unsurprisingly, Asia's level of intra-industry trade of intermediate goods is almost the same as Europe's (Baumann, 2010).

An analysis based on the World Bank's trade complementarity index shows that complementarity levels vary across the region. The trade profiles of Brazil, Argentina, Chile, Colombia, Mexico, and Peru, show similar degrees of complementarity with other Latin American countries and with the rest of the world. However, most of them are slightly more compatible with OECD countries than with the rest of the region. Mexico seems to be the exception: its complementarity index values are substantially higher and show higher complementarity with the rest of Latin America than with OECD countries and other regions (Cerra et al., 2017).

Trade complementarity, thus, brings us to a discussion on the nexus between trade and growth: moving beyond the idea of exploiting a country's comparative advantage, it is now almost a consensus that quality of exports is a major determinant of income convergence (Hausmann et al., 2005). Furthermore, other studies indicate that countries need to reach a minimum level of quality in their export basket to really reap the benefits of open trade (Huchet-Bourdon et al., 2011).

The *product complexity* index can be used as a proxy of the quality of goods by looking at attributes involved in the production of goods, i.e. the level of knowledge and technological capacity[1]. Empirical studies suggest that higher product complexity has a positive impact on economic growth (Hausmann et al., 2013). This is in line with recent studies on the effect of free-trade agreements on Latin America: Compared to the world average, export gains in Latin America, while positive, are more limited – probably due to the low-complexity exports of the region (Hannan (2016), cited in Cerra et al. (2017)).

A brief review of recent Latin American development strategies and the global context in which they took place, provide a departure point to analyze how the region managed, or failed, to upgrade their capacity to produce goods with higher complexity.

After the WWII, the Prebisch-Singer hypothesis (Prebisch, 1950) galvanized a lot of support. This hypothesis prompted countries to move away from exports with lower income elasticity, i.e. commodities, and into higher income elastic exports, i.e. manufactures, in order to avoid deteriorating terms-of-trade, reduce dependency from developed countries (a "center-periphery" relation), and sustain economic growth. This resulted in the widespread adoption of industrialization policies across Latin America – the period known as the Import Substitution Industrialization (ISI).

With the support of foreign creditors, the ISI period ran from the 1950s to the beginning of the 1980s when the Debt Crisis hit the region (Griffith-Jones & Sunkel, 1987). In the ISI period, Latin American

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[1] The measure relies on two dimensions: diversity and ubiquity. The amount of embedded knowledge that a country has is expressed in its productive diversity, or the number of distinct products that it makes. Second, products that demand large volumes of knowledge are feasible only in the few places where all the requisite knowledge is available (Hausmann et al., 2013).

countries attempted to move towards modern goods, i.e. goods of higher complexity, and away from the specialization pattern of traditional goods, i.e. natural resources and other low added-value manufactures. As a result, the exchange of goods of higher complexity started taking place among the region. This, however, did not happen uniformly as industrial expansion developed with varying levels of success across Latin America.

In the late 1970's major changes began to occur for multinational companies (MNCs). Economic liberalization in countries such as Mexico and Chile (Vos, Taylor, & Barros, 2002), and the increase of financialization allowed for a more flexible structure of production. As a result, MNCs started offshoring some of parts of its operations to regions where it was possible to reduce costs and focusing on core business activities. This global decentralization of production resulted in the emergence of the global value chains (GVCs).

Since the Debt Crisis of the 1980s, the majority of Latin American countries adopted a set of liberal policies known as the Washington Consensus (Williamson, 1993). Among several macroeconomic measures, this policy package included removing public measures aimed at protecting industries from external competition in order to move the economy closer to its natural competitive advantage. Moreover, it is in this period when some Latin American countries initiated a process of integration into the GVCs, albeit heterogeneously[2]. Subsequently, regional trade patterns changed once again as the productive structure was transformed in an abrupt manner.

Furthermore, these changes took place at time when key Asian players began to expand economically through industrialization and a strong outward-looking trade approach (Gereffi & Wyman, 2014). Their demand for natural resources grew rapidly and with this, their trade activities and influence outside the Asian continent. After 1990s the free trade agreements grew exponentially around the world and Latin America was no exception. The NAFTA and Mercosur agreements materialized leading to further changes in Latin America's trade interactions.

From 2003 onwards, Latin American economies received positive external shocks from an increase in international demand for natural resources (Ocampo, 2017). The commodities price boom led to a stable growth pattern for Latin America for about a decade. The boom also consolidated China as a key partner for net commodity exporters in Latin American countries (Jenkins, Peters, & Moreira, 2008). Moreover, the transition to complex and technologically-advanced exports was interrupted by the commodity price boom (Ding & Hadzi-Vaskov (2017) cited in Cerra et al. (2017)).

The end of the commodity boom resulted in a substantial reduction of global trade. Since then, Latin America has been facing contraction of trade, FDI and creation of GVCs in the region (Morgan, 2017). The new sentiments of trade protectionism, especially coming from developed countries like the US,

[2] Mexico perhaps is the prime example of integration into GVCs. The largest increases in intra-industry trade between 1985 and 2010 took place in China, Indonesia, Malaysia, Mexico, Philippines, and Thailand – countries which are highly integrated into GVCs. Other Central American countries, i.e. Honduras, also took part in this integration focusing mostly on industries such as textiles (Blyde, 2014).

have resulted in political uncertainty which also represent a challenge for Mexico and other Central American economies.

To conclude, in the past decades growth trajectories in the region have been driven by diverging production capacities and specialization patterns. This in turn is the result of different adaptation mechanisms, policies at the national level, natural endowments, social capabilities, and external factors.

Our motivation is to further understand how those changes in the production patterns of the region shape trade relations. For this research, we will use network analysis tools to outline of the evolution of trade interactions among Latin American countries and selected trade partners. The purpose of this work is to generate a network that takes into account the complexity of traded goods in order to have a better understanding of how trade intra-regional integration has evolved in the past half a century. Our analysis focuses on the evenness of the share of complex goods exchanged between two countries, i.e. how *(un)balanced* trade is. By mapping out these trade relations, we provide an alternative approximation of how trade complementarities evolve in recent years.

The structure of our paper is as follows: In section two we describe the methodology and data. We then present the results and the corresponding analysis of results. Finally, we conclude the paper with some considerations and future perspectives.

2. Methodology

In this paper, we developed a new measure of trade balance – composed by two forms of bilateral trade networks based on the nature of exports – Balanced Trade Networks (BTNs) and Unbalanced Trade Networks (UTNs) – to understand the different trade patterns in Latin America.

We used the years 1975, 1995 and 2013 to do a comparative static analysis across three economic contexts: The Import Substitution Industrialization period (1975), the adoption of liberalization reforms in all major economies and integration to GVCs (1995) and the end of the 2000s commodity boom (2013). Using the outcomes of our network analysis, we then select three countries and explore in more detail the reasons behind their network centrality either in the BTNs or UTNs.

Countries

We selected a total of 18 countries: nine from South America (Argentina, Bolivia, Brazil, Chile, Colombia, Ecuador, Paraguay, Peru, Uruguay, and Venezuela); three from Central America (El Salvador, Guatemala, and Panama); three from North America (Canada, Mexico, and USA) and two Asian countries (China and India). The Asian countries were selected based on their strong recent GDP growth, which turned them into relevant global players. This resulted in a sample of 14 Latin American countries which are at the center of the analysis of this paper.

Data

In order to understand the trade patterns among selected countries, we developed an index that captures the balance of bilateral trade relations. For this, we used data from the Economic Complexity Index of the Atlas of Economic Complexity (AEC) and the Observatory of Economic Complexity (OEC). These data allowed us to observe the trade pattern among countries making a clear distinction between modern and traditional products. Products are ranked according to their Product Complexity Index (ECI). This ranking allowed us to identify the categories which are comprised primarily by products with higher levels of complexity, and thus, considered modern. The product categories we considered as modern, i.e. higher complexity, are machines (includes instruments and electronics), chemical products, plastics and rubbers, transportation and miscellaneous (e.g. medical furniture, wheeled toys, rubber stamps, etc.).

Index

We then developed the index based on the dichotomy between modern (i.e. of higher complexity) and traditional products. We took bilateral trade between countries, A and B. We consider country A's exports to country B (X_{AB}) and the exports coming from the modern sector X_{AB}^{m}; likewise, we consider country A's imports from country B (M_{AB}) and the exports that come from the modern sector M_{AB}^{m}. This results in the index of modern balanced trade (IMBT) which we calculated as

$$IMBT = \frac{X_{AB}^{m}\ M_{AB}^{m}}{X_{AB}\ M_{AB}}$$

The IMBT values range then from 0 to 1 and define the commercial balance between two countries. For example, if these countries have a highly specialized pattern where country A exports to country B only products related to natural resources and imports manufactured goods, then the ratio $(\frac{X_{AB}^{m}}{X_{AB}})$ will be close to zero and $(\frac{X_{AB}^{m}}{X_{AB}})$ close to one - the product of these rations will then be close to zero, which indicates an imbalance of the trade in sectors of higher complexity.

The Networks

Using the selected countries as nodes of the network, we calculated the size of each node using the total amount of exports of a selected country to the other selected countries. The data comes from the AEC and OEC. These export data were then normalized in order to find values that allow for the analysis of the results without distorting the network graphics.

We then created two networks for each year, the Balanced Trade Network (BTN) and the Unbalanced Trade Network (UTN). The ideas are based on the respective concepts developed by Thirlwall (1979) and Moreno-Brid (1998) To facilitate visualization, the countries were assigned different colors according to the region they belong to. In Figure 1, we have South America in green, Central America in gray, North America in blue, and China and India in red we have. In Figure 2 (see Appendix) Latin American countries in pink and the other countries in red.

Balanced Trade Network (BTN)

For the BTN, we weighted the links (edges) using the IMBT index. As there are a lot of links that indicate a very specialized pattern in traditional goods (IMBT < 0.1), we ignored the values of such links giving them the value of null in the BTNs. The weighted links are thicker when the index values were closer to 1.

Unbalanced Trade Network (UTN)

For the UTN, the weights are computed as 1 - IMBT and we only took values higher than 0.9 as links. We chose to use an unweighted network because for the resulting range of values, the weights could not explain much.

Network Attributes

In order to analyze the properties at network level, we computed average path length, transitivity, and density properties for BTNs and UTNs. For BTNs we computed average weighted degree. We then calculated different centrality measures – degree, weighted degree, centrality[3] - at the node level.

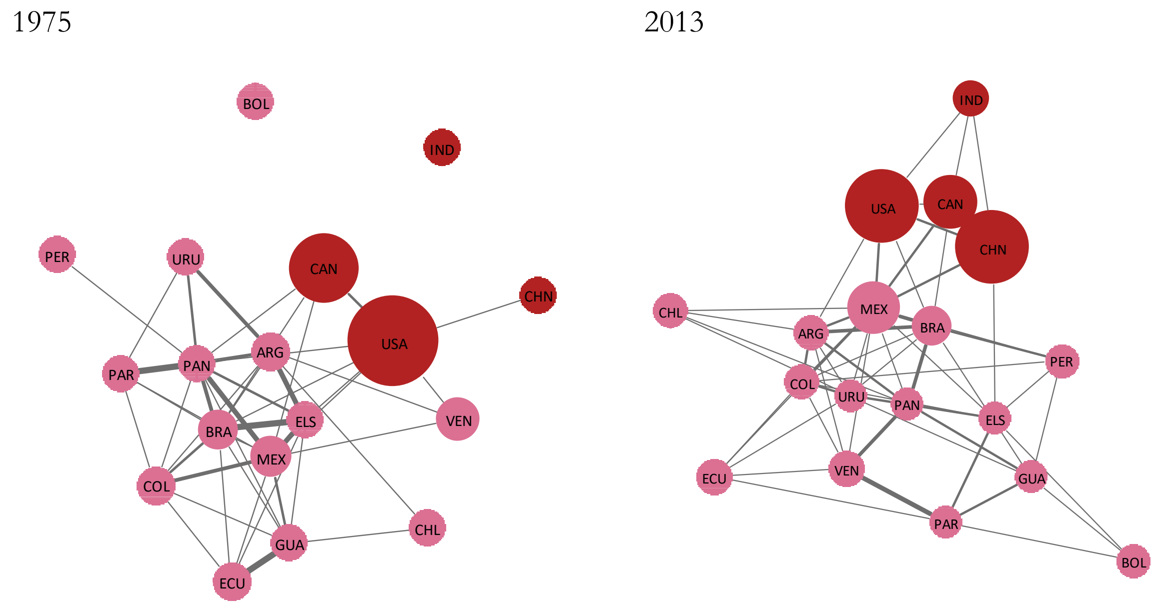
[3] We calculated eigenvalue centrality for UTNs as links are unweighted and page rank centrality for BTNs as links are weighted. In the latter calculation, degree is weighted according to the total weighted degree value using a geometric average.

3. Results

In this section we present the results using concepts of network theory and social network analysis, for a better understanding on the concepts of centrality, path length and transitivity, see Wasserman & Faust, 1994.

Using the methodology described in the previous sector, we have the following results. We opted to just highlight some of the results in order to illustrate. The overall results can be found in the Annex:

Figure 1. Balanced Trade Networks for 1975 and 2013



Source: Atlas of Economic Complexity and Observatory of Economic Complexity.
Colors: Latin America: pink; other countries: red.

Table 1. Network Properties – All Networks (BTN and UTN for 1975, 1995 and 2013)

	Number of Nodes	Number of Links	Average Path Length	Average Weighted Degree	Transitivity (Clustering)	Density
1975 - BTN	18	46	1.74	2.83	0.56	0.30
1995 - BTN	18	50	1.86	2.83	0.46	0.32
2013 - BTN	18	58	1.74	3.36	0.50	0.37
1975 - UTN	18	107	1.30	-	0.76	0.70
1995 - UTN	18	103	1.33	-	0.68	0.67
2013 - UTN	18	95	1.38	-	0.61	0.62

Source: Atlas of Economic Complexity and Observatory of Economic Complexity.

4. Discussion of Results

In 1975, the Import Substitution Industrialization period, the properties of the BTN mirrored the inward-looking trade policies as well as the uneven industrial expansion across the region. In 1975 the density for the BTN was the lowest of all periods. The majority of Latin American countries – 8 out of 13 – had higher degree values in the UTN than in the BTN. This indicates, on one side, the unevenness of trade with larger economies (US and Canada – the largest nodes) and, on the other, the low levels of modern products trade among many of the Latin American cases.

The BTN also reflected the different levels of industrialization in the region. Almost half of the links in the BTN were concentrated in Panama, Mexico, Brazil, and Argentina; these also had the highest values for page rank centrality and weighted degree. While these countries had low or modest IMBT values for trade with the US – by far the largest trade partner– they had on average high IMBT values among each other and neighboring countries. For example, Panama had an average IMBT value of 0.32 with Latin American countries and an IMBT of 0.11 with the US. A closer look at the total volume of exports within the network confirms that, with the exception of Mexico, the largest percentage of modern exports of these countries stayed in the region (Panama 69%, Brazil 62%, and Argentina 91%).

In the same period China, India, Peru, and Bolivia had degree and centrality values of zero or close to zero in the BTN. This low level of integration in the BTN is due to various reasons. India, and in particular, China did export products of higher complexity to Latin America; for instance, over 50% of Chinese imports in Argentina, Ecuador, Chile, Peru, Paraguay, and Venezuela belonged to the modern sector. Yet China only had a bilateral modern trade relation with the US (with an IMBT value of 0.17). Bolivia and Peru were virtually excluded from any modern trade and thus from the BTN; Peru managed to have a link with Panama with an IMBT value of 0.23.

In 1995 major changes took place in the BTN reflecting the liberalization policy effects. The first change was a reduction of IMBT values for Latin American countries. This can be observed in the average page rank centrality of these countries which went from 0.063 in 1975 to 0.057 in 1995. Likewise, in most Latin American cases, UTN degree values remained the same and/or increased. Moreover, the most central countries in the previous period – Panama, Mexico Brazil, and Argentina – reduced their degree and page rank centrality values in 1995, with Argentina and Panama being the most affected.

Vertical production systems and liberalized trade regimes had further changes in the network. While Mexico did show lower centrality and degree values (a result of lower weight links with other Latin American countries) it strengthened links with North America and created links with India and China clearly an effect of NAFTA and of the consolidated integration to the GVCs. From this period on, Mexico became the most central node in the BTN. Furthermore, Bolivia, and to a lesser degree Guatemala, Venezuela, Colombia, and Paraguay, became slightly more central (as per degree and page rank centrality values), probably indicating a higher integration to GVCs in modern industries.

Latin America experienced a reduction in the proportion of complex products – which drove down the overall degree and centrality values – and in the relative share of the Total trade volume within the network. With the exception of Mexico, the overall region's position in the BTN weakened. However, BTN values at network level show a higher density and the same average weighted degree as in the previous period.

This can be explained firstly by the increased centrality of India and China in the BTN - their weighted degree and page rank centrality were substantially higher in 1995 than in 1975. Secondly, the US and Canada also increased their weighted degree and centrality values in the BTN. Canada and, especially China, had an improved position in the network in terms of centrality and of the relative share of total trade volume.

It is important to note that the increased centrality of China, India, Canada, and the US in the BTN was mainly the result of higher trade integration, i.e. more and more heavily weighted links, with each other. Mexico became at this point the main node with which they connected to the region. Very few links with moderate IMBT values were created besides those with Mexico; these included US-Argentina (IMBT) value of 0.19), US-Brazil (IMBT of 0.27) and China-Venezuela (0.21).

The polarization of values – lower for Latin American while higher for North American and Asian countries – could explain why despite higher density there is a reduced clustering value and the longer average path at network level in the 1995 BTN. This polarization is in line with the specialization patterns brought about by the structural reforms in the region: While Mexico engages in assembly type operations within the GVCs, South American countries focus on natural resource based exports.

In the last period, 2013, the BTN shows important characteristics of trade dynamics in the Latin American region. Properties at network level point to higher integration in the region: average path length was reduced to the same value of 1975, transitivity increased and density reached its highest level. These changes came as the result of new links formed among Latin American countries. Most increments in terms of degree (unweighted and weighted degree) came from South America - specifically from Argentina, Peru, Brazil, Uruguay, and Venezuela. Contrariwise, Guatemala, Bolivia, Ecuador, and Paraguay reduced their centrality and degree values. Mexico remained the most central country followed by Brazil, Argentina, and Panama – the same group as in the first period.

The non-Latin American countries followed two trends. On the one hand, the US and Canada reduced their relative importance in the total trade volume of the network as well as their centrality – despite the slight increase in weighted degree values. On the other, China and India increased considerably their importance in terms of total trade. China, in particular, became, along with the US, the most important trade partner in the network.

Despite a much stronger trade relation with Latin America, Asian countries have developed predominantly uneven relations with the region – perhaps slightly more than those of the US and

Canada. India, for instance, did not have any balanced trade links with Latin America (hence its low centrality in the BTN).

Besides links with the US, Canada and India, China only had links with Mexico and El Salvador mostly likely due to GVCs relations. The NAFTA block integrated further; Mexico's IMBT values are 0.41 and 0.46 with the US and Canada respectively. The integration of US to the rest of Latin America remained the same as in the previous period; it was limited to Brazil and Argentina with an IMBT value of 0.20. Likewise, Canada had only a link with Brazil.

Regarding the structure, two clusters can be distinguished: the one taking place in Central/South America – characterized by its high degree of specialization in natural resources - and the one formed by the Asian and NAFTA countries – characterized by stronger manufacturing capacity. The former is comprised by countries which had a relative high industrial expansion in the first period, i.e. Brazil and Argentina, but also by countries that incremented their export capacity of complex products, such as Chile, Peru, and Uruguay. Naturally, it is in this cluster where the least central countries develop the few links they have (mostly with countries with similar weighted and centrality values, e.g. Ecuador-Venezuela or Paraguay- Bolivia). The latter cluster is formed by large economies which tend to have mostly unbalanced trade relations with Latin America (with the exception of Mexico). This Asian-NAFTA cluster is connected to the other one mainly via Mexico and Brazil – important GVC platforms for automotive and electronic industries, among others.

BTNs show that trade among Latin America in general are different to those with trade partners outside region, especially with China – which strongly resembles the "core-periphery" relation that the Singer-Prebisch hypothesis outlined almost 70 years ago. Our network analysis indicate that Latin American countries are more likely to have balanced relations with neighboring countries with a similar industrial capacity. For instance, Brazil has unbalanced relations with Bolivia or Ecuador – countries with historically low industrial capacity – yet those two countries are able to trade a similar of complex goods among each other. All in all, while most large Latin American countries are specialized in natural resources such as copper, oil and soy, there is an increment in the exchange of complex products within the region.

The interpretation of such increment is beyond the scope of this network analysis. Possible explanations, though, could be that after the initial adjustment in the region, industrial capacities were upgraded due to the presence of foreign multinational companies (MNCs) and large local industries forced to modernize in an open economy, spillover effects of MNCs and other highly productive sectors, e.g. mining, or a mix of all these. Likewise, there is also the possibility that the dominant effect behind the increment is simply the expansion of vertical production operations within a GVC framework.

A brief look into modern trade flows in the case of Mexico and Brazil – two key nodes in the most recent BTN – show some level of complementarity at the intra-industrial level. In 2013, Mexico and Brazil IMBT values had the highest coefficient (0.66). The top industries are *transportation, machines, and* *chemicals* in both type of trade flows as can be seen in Table 1. The automotive industry – largely dominated by MNCs in both countries - is the most important one with final goods, i.e. cars as well as intermediary goods, i.e. vehicle parts. Brazil also has some imports of intermediary goods in the aerospace industry from Mexico – a key high-tech industry for both countries. Within the machinery sector, a significant difference is that Mexico's exports to Brazil are mainly consumer goods, i.e. computers and telephones, and, Brazil's exports to Mexico are mainly intermediary goods, i.e. parts of engines or different engines.

Table 3. Trade flows between Brazil and Mexico

Mexico's exports to Brazil

	2016	2013	1995		1975
Total	3.53B	5.81B	886M	SITC	117M
Transportation	33%	43%	22%	**Electronics**	15%
Cars	17%	34%	19%		
Vehicle parts	13%	7%	2%		
Aircraft parts	2%	1%	0%		
Machines	26%	18%	25%	**Machinery**	11%
Computers and Telephones	7%	4%	9%		
Chemicals	17%	18%	20%	**Chemicals***	41%

Brazil's exports to Mexico

	2016	2013	1995		1975
	3.81B	4.44B	560M	SITC	97.6M
Transportation	24%	32%	29%	**Electronics**	24%
Vehicle parts	4%	5%	4%		
Cars	8%	7%	0%		
Delivery trucks	7%	3%	0%		
Machines	25%	28%	6%	**Machinery**	24%
Engines parts, spark ignition engines	5%	8%	4%		
Transmissions	1%	2%	2%		
Construction vehicles	2%	4%	0%		
Chemicals	9%	10%	12%	**Chemicals**	13%

*Aggregation of STIC2: Chemicals and Health Related Products + Other chemicals + Inorganic Salts and Acids
Source: OEC

The Latin American countries with which Brazil has the second and third highest linkages as indicated by IMBT values in 2013, were Argentina and Panama. In the case of Argentina, it was largely driven by the automotive sector, i.e. final goods (cars, trucks) and vehicle parts. Brazil's exports to Argentina were 19.3 billion and imports from Argentina were 16 billion. Panama's exports to Brazil (12.8 million) were mostly perfumes and machine parts whereas Brazil's exports to Panama (4.4 billion) were special equipment, such as ships and construction vehicles, as well as medicaments. Trade flows with both countries decreased substantially since 2013 to 2016.

In 2013, Mexico's second and third largest Latin American partners, as indicated by IMBT values, were Argentina and Colombia. Mexico's modern imports from Argentina (1.16 billion) were mostly in transportation, i.e. trucks, aircrafts, and vehicle parts. Argentina's modern imports from Mexico (2.16 billion) were final goods in the automotive sector, i.e. cars, as well as chemicals, i.e. beauty products and industrial acids, and consumer electronics. Colombia's imports from Mexico (5.39 billion) were also cars along with tractors, and trucks, followed by consumer electronics and other equipment. Chemicals for industrial purpose and for final consumption (e.g. medicaments, beauty products) were also important. Colombia's imports from Mexico (875 million) were of the same nature: cars and chemicals for industrial purpose and for final consumption (.e.g. medicaments, beauty products). While imports from Colombia to Mexico have slightly increased, flows from Mexico to Colombia have decreased substantially.

From our analysis, it is easy to recognize that the countries with highest centrality values in the BTNs are the largest economies of Latin America, i.e. Mexico, Brazil, and Argentina. Panama seems the exception in this regard. Modern trade flows among the largest economies seem to be strongly tied to GVC operations – especially in the automotive sector where there is an important flow of intermediary goods. Yet, final goods, such as cars and electronics, also represent an important share of modern trade flows. The position of these countries in the most recent BTN can be attributed to a combination of geographical advantages, human capital, market size and, probably also, to the extent to which they implemented industrial policies during the ISI period.

5. Conclusions

The objective of our paper was to understand, using network analysis tools, regional trade interactions in Latin America. We focused on balanced trade of complex products among countries in the region and their main trade partners. We analyzed how the BTN changed over three important periods: at the peak of ISI, shortly after the onset of liberalization and at the end of the commodities boom.

We found that the structure of the BTN reflects very well internal dynamics and how these are affected by policy and large partners outside the region. The BTN of 1975 shows the differences in the success of the industrial policy expansion with Brazil, Argentina, Panama, and Mexico at the center and with Peru and Bolivia excluded. The BTN in 1995 mirrors on the one hand the industrial losses suffered in most of the region and on the other the integration to GVCs especially in Mexico. The BTN in 2013 points to the generation of two clusters connected by Mexico and Brazil; one where balanced trade takes place among Latin American countries and the other among US, China, Canada, and India.

Trade flows among Brazil and Mexico, and their main Latin American partners (as per IMBT values), are concentrated in the transportation, machinery, and chemicals sectors. The former sector is heavily dominated by the automotive industry – highlighting the importance of GVC operations for modern trade flows among Latin America.

BTNs show that trade among Latin America in general are different to those with trade partners outside region, especially with China – which strongly resembles the "core-periphery" relation that the Singer-Prebisch hypothesis outlined almost 70 years ago. Our network analysis indicate that Latin American countries are more likely to have balanced relations with neighboring countries with a similar industrial capacity. Stronger regional trade integration could bring significant benefits to industries of higher complexity in Latin America: geographical and cultural proximity, wage structure, technological capacities and industrial activities are similar, and thus complex products are more likely to be competitive in terms of quality and costs.

In terms of future research possibilities, it would be interesting to expand the scope of analysis to the entire Latin American region and other important partners, such as Germany and Japan. Further analyses could also include the analysis of the Latin American networks vis-à-vis a more 'balanced' region, such as the European Union.

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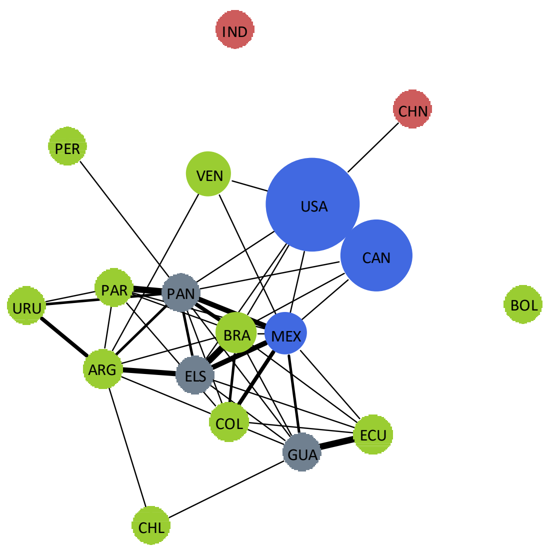
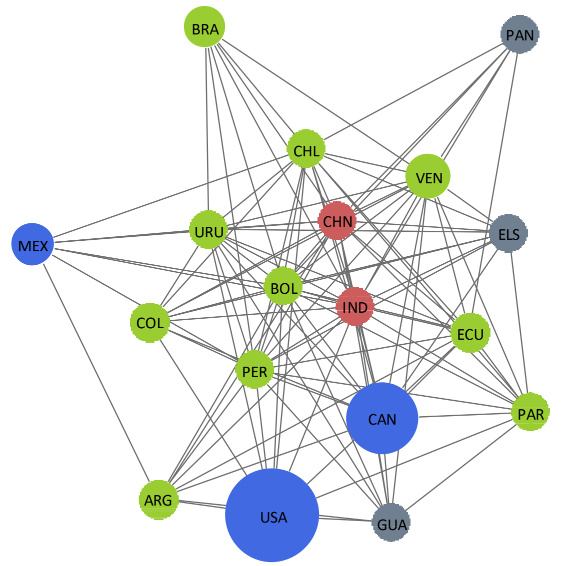
7. Annex

Figure 2. Plotted Networks - Balanced and Unbalanced Trade Networks (1975, 1995 and 2013)

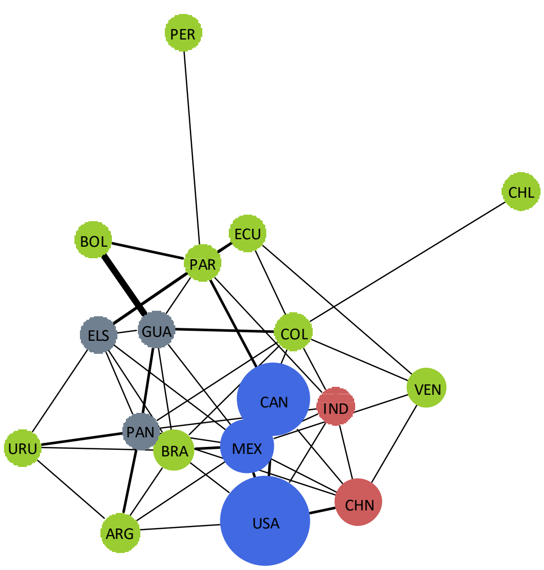
Balanced Trade Networks (BTN)	**Unbalanced Trade Networks (UTN)**

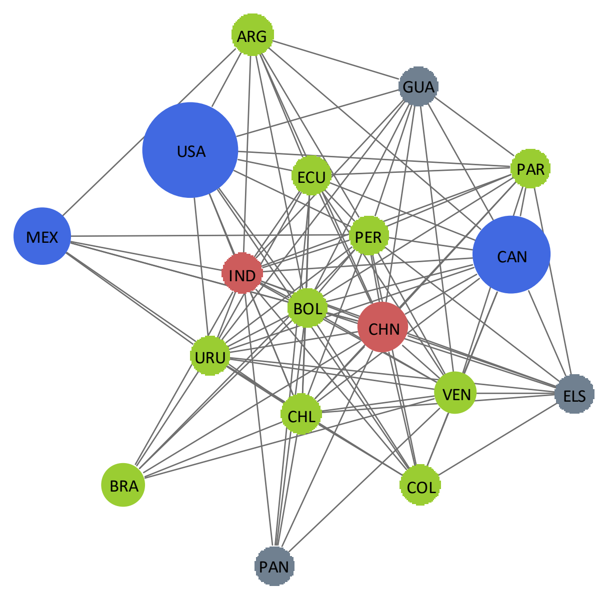
1975



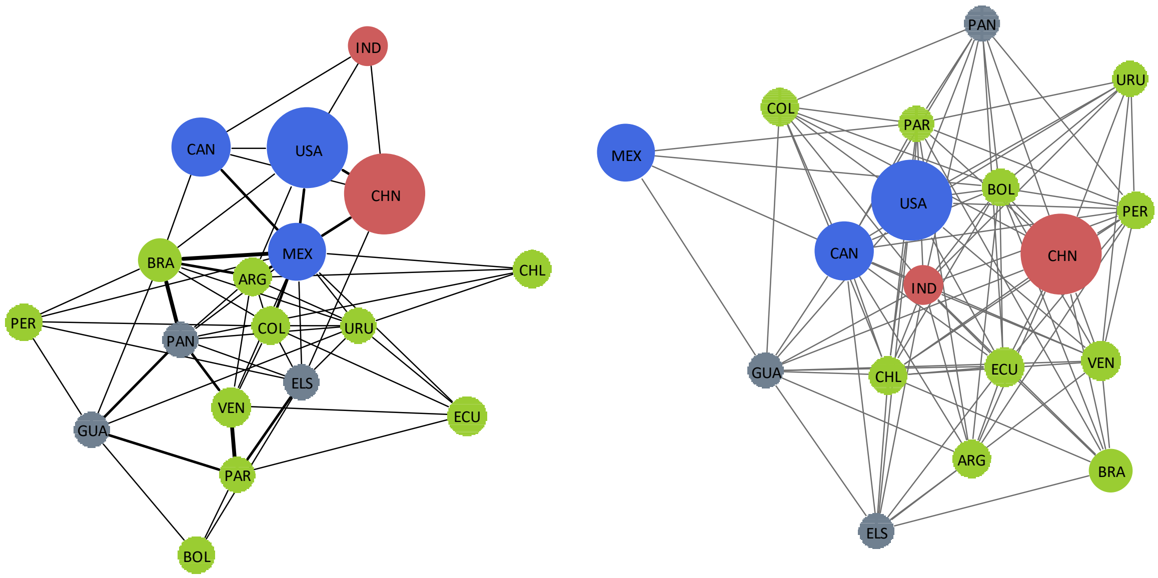


1995





2013



Source: Atlas of Economic Complexity and Observatory of Economic Complexity.
Colors: Blue: North America, Central America: Gray, South America: Green, Asia: Red.

Table 2. Node Properties – Degree, Weighted Degree and Node Size (BTN and UTN – 1975, 1995 and 2013)

	Degree BTN			Degree UTN			Weighted Degree BTN			Size of Node BTN		
	1975	1995	2013	1975	1995	2013	1975	1995	2013	1975	1995	2013
ARG	8	5	8	9	12	9	4.58	2.52	4.56	-0.33	-0.31	-0.44
BOL	0	2	3	17	15	14	0.00	1.56	1.17	-0.42	-0.52	-0.59
BRA	10	8	9	7	9	8	5.44	4.06	5.41	-0.16	-0.17	-0.06
CHL	2	1	4	15	16	13	0.82	0.37	1.46	-0.39	-0.43	-0.43
COL	7	8	8	10	9	9	3.49	3.69	4.07	-0.35	-0.42	-0.45
ECU	5	4	5	12	13	12	2.70	2.08	1.80	-0.35	-0.48	-0.41
PAR	6	7	5	11	10	12	3.40	3.82	3.06	-0.43	-0.51	-0.62
PER	1	1	5	16	16	12	0.48	0.39	2.15	-0.38	-0.49	-0.52
URU	3	4	9	14	13	8	1.82	2.07	4.42	-0.43	-0.50	-0.61
VEN	3	4	6	14	13	11	1.28	1.61	3.45	0.11	-0.28	-0.38
CAN	4	4	5	13	13	12	1.83	2.39	2.51	1.93	2.01	0.98
MEX	10	11	13	7	6	4	6.07	5.79	7.39	-0.09	0.66	0.85
USA	7	6	6	10	11	11	3.09	3.27	3.29	3.35	3.11	2.43
CHN	1	6	5	16	11	12	0.41	2.66	2.77	-0.42	0.28	2.43
IND	0	6	3	17	11	14	0.00	2.42	1.30	-0.38	-0.41	-0.34
ELS	7	7	8	10	10	9	4.76	3.12	4.00	-0.42	-0.52	-0.62
GUA	7	7	6	10	10	11	3.84	4.27	2.87	-0.41	-0.50	-0.60
PAN	11	9	8	6	8	9	6.95	4.81	4.72	-0.41	-0.51	-0.62

Table 3. Node Properties – Centrality and Betweeness measures (BTN and UTN – 1975, 1995 and 2013)

	Page Rank Centrality BTN			Eigenvalue Centrality UTN			Betweenness BTN			Betweenness UTN		
	1975	1995	2013	1975	1995	2013	1975	1995	2013	1975	1995	2013
ARG	0.086	0.046	0.074	0.68	0.77	0.67	10.00	2.25	7.00	0.92	2.48	1.40
BOL	0.009	0.046	0.021	1.00	0.89	0.55	0.00	0.00	7.00	7.32	5.73	7.80
BRA	0.091	0.072	0.092	0.63	0.68	0.71	12.00	16.75	19.00	0.00	1.08	0.96
CHL	0.019	0.013	0.022	0.89	0.94	0.67	0.00	0.00	15.00	4.90	6.32	3.34
COL	0.056	0.069	0.062	0.71	0.68	0.70	16.00	23.00	3.00	0.45	1.13	1.12
ECU	0.050	0.045	0.025	0.77	0.81	0.66	10.00	0.00	15.00	2.07	3.91	3.16
PAR	0.062	0.083	0.061	0.74	0.71	0.50	13.00	31.00	3.00	0.90	3.44	6.29
PER	0.015	0.013	0.032	0.94	0.94	0.70	0.00	0.00	6.00	5.05	6.68	2.40

URU	0.040	0.041	0.065	0.85	0.81	0.71	0.00	0.00	18.00	3.36	3.83	0.75
VEN	0.026	0.030	0.061	0.85	0.81	0.65	2.00	5.00	0.00	3.31	3.22	2.62
CAN	0.036	0.053	0.042	0.81	0.81	0.56	6.00	0.00	12.00	1.76	3.17	4.27
MEX	0.116	0.106	0.120	0.63	0.61	0.50	11.00	6.00	13.00	0.24	0.33	0.38
USA	0.061	0.064	0.058	0.71	0.74	0.56	24.00	7.25	7.00	1.18	2.41	3.54
CHN	0.016	0.046	0.051	0.94	0.74	0.56	0.00	18.25	6.00	6.25	2.34	4.21
IND	0.009	0.039	0.024	1.00	0.74	0.51	0.00	37.25	0.00	7.32	1.15	8.60
ELS	0.098	0.053	0.064	0.71	0.71	0.69	6.00	26.75	14.00	0.20	1.17	1.45
GUA	0.071	0.091	0.046	0.71	0.71	0.56	9.00	0.00	27.00	0.78	0.95	4.78
PAN	0.139	0.089	0.081	0.61	0.65	0.72	18.00	15.25	3.00	0.00	0.66	0.98

Source: Atlas of Economic Complexity and Observatory of Economic Complexity.

Table 4. Symmetric Matrix - IMBT values: Years 1975, 1995 and 2013

	ARG	BOL	BRA	CHL	COL	ECU	PAR	PER	URU	VEN	CAN	MEX	USA	CHN	IND	ELS	GUA	PAN
1975																		
ARG	0.00	0.04	0.16	0.17	0.10	0.05	0.32	0.01	0.54	0.13	0.04	0.05	0.08	0.01	0.00	0.83	0.02	0.37
BOL	0.04	0.00	0.04	0.02	0.00	0.00	0.00	0.00	0.00	0.09	0.02	0.03	0.07	0.00	0.00	0.00	0.00	0.00
BRA	0.16	0.04	0.00	0.02	0.34	0.11	0.26	0.03	0.05	0.08	0.10	0.27	0.13	0.00	0.03	0.93	0.15	0.51
CHL	0.17	0.02	0.02	0.00	0.02	0.00	0.01	0.02	0.01	0.01	0.05	0.06	0.09	0.00	0.00	0.01	0.17	0.05
COL	0.10	0.00	0.34	0.02	0.00	0.10	0.17	0.04	0.02	0.07	0.01	0.53	0.09	0.00	0.03	0.00	0.18	0.32
ECU	0.05	0.00	0.11	0.00	0.10	0.00	0.00	0.02	0.00	0.05	0.00	0.27	0.04	0.00	0.00	0.10	0.88	0.00
PAR	0.32	0.00	0.26	0.01	0.17	0.00	0.00	0.02	0.11	0.00	0.03	0.11	0.05	0.00	0.00	0.00	0.00	0.96
PER	0.01	0.00	0.03	0.02	0.04	0.02	0.02	0.00	0.00	0.02	0.01	0.01	0.07	0.00	0.00	0.05	0.03	0.23
URU	0.54	0.00	0.05	0.01	0.02	0.00	0.11	0.00	0.00	0.00	0.00	0.04	0.02	0.00	0.00	0.00	0.00	0.46
VEN	0.13	0.09	0.08	0.01	0.07	0.05	0.00	0.02	0.00	0.00	0.00	0.21	0.21	0.00	0.00	0.00	0.00	0.01
CAN	0.04	0.02	0.10	0.05	0.01	0.00	0.03	0.01	0.00	0.00	0.00	0.13	0.39	0.00	0.02	0.04	0.00	0.22
MEX	0.05	0.03	0.27	0.06	0.53	0.27	0.11	0.01	0.04	0.21	0.13	0.00	0.25	0.00	0.01	0.75	0.43	0.74
USA	0.08	0.07	0.13	0.09	0.09	0.04	0.05	0.07	0.02	0.21	0.39	0.25	0.00	0.17	0.01	0.10	0.02	0.11
CHN	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.17	0.00	0.00	0.00	0.00	0.00
IND	0.00	0.00	0.03	0.00	0.03	0.00	0.00	0.00	0.00	0.00	0.02	0.01	0.01	0.00	0.00	0.00	0.00	0.00
ELS	0.83	0.00	0.93	0.01	0.00	0.10	0.00	0.05	0.00	0.00	0.04	0.75	0.10	0.00	0.00	0.00	0.18	0.35
GUA	0.02	0.00	0.15	0.17	0.18	0.88	0.00	0.03	0.00	0.00	0.00	0.43	0.02	0.00	0.00	0.18	0.00	0.12
PAN	0.37	0.00	0.51	0.05	0.32	0.00	0.96	0.23	0.46	0.01	0.22	0.74	0.11	0.00	0.00	0.35	0.12	0.00
1995																		
ARG	0.00	0.02	0.21	0.05	0.04	0.00	0.01	0.04	0.19	0.05	0.06	0.21	0.19	0.03	0.03	0.06	0.04	0.47
BOL	0.02	0.00	0.09	0.01	0.00	0.04	0.36	0.01	0.04	0.00	0.00	0.01	0.05	0.00	0.00	0.00	0.86	0.00
BRA	0.21	0.09	0.00	0.08	0.24	0.03	0.01	0.03	0.14	0.06	0.07	0.39	0.27	0.07	0.06	0.11	0.33	0.37
CHL	0.05	0.01	0.08	0.00	0.14	0.00	0.01	0.03	0.05	0.04	0.03	0.08	0.07	0.02	0.02	0.00	0.01	0.04
COL	0.04	0.00	0.24	0.14	0.00	0.17	0.02	0.05	0.05	0.16	0.01	0.25	0.02	0.05	0.17	0.01	0.38	0.19
ECU	0.00	0.04	0.03	0.00	0.17	0.00	0.47	0.06	0.02	0.10	0.00	0.00	0.00	0.00	0.02	0.34	0.06	0.01
PAR	0.01	0.36	0.01	0.01	0.02	0.47	0.00	0.15	0.01	0.00	0.44	0.07	0.06	0.00	0.17	0.24	0.26	0.00
PER	0.04	0.01	0.03	0.03	0.05	0.06	0.15	0.00	0.00	0.01	0.00	0.03	0.02	0.00	0.01	0.06	0.01	0.03
URU	0.19	0.04	0.14	0.05	0.05	0.02	0.01	0.00	0.00	0.04	0.02	0.05	0.03	0.00	0.01	0.33	0.05	0.41
VEN	0.05	0.00	0.06	0.04	0.16	0.10	0.00	0.01	0.04	0.00	0.02	0.18	0.03	0.21	0.03	0.00	0.00	0.02
CAN	0.06	0.00	0.07	0.03	0.01	0.00	0.44	0.00	0.02	0.02	0.00	0.40	0.43	0.16	0.04	0.04	0.02	0.08
MEX	0.21	0.01	0.39	0.08	0.25	0.00	0.07	0.03	0.05	0.18	0.40	0.00	0.44	0.24	0.30	0.14	0.18	0.32
USA	0.19	0.05	0.27	0.07	0.02	0.00	0.06	0.02	0.03	0.03	0.43	0.44	0.00	0.35	0.10	0.05	0.04	0.04
CHN	0.03	0.00	0.07	0.02	0.05	0.00	0.00	0.00	0.00	0.21	0.16	0.24	0.35	0.00	0.11	0.00	0.00	0.11
IND	0.03	0.00	0.06	0.02	0.17	0.02	0.17	0.01	0.01	0.03	0.04	0.30	0.10	0.11	0.00	0.00	0.00	0.13
ELS	0.06	0.00	0.11	0.00	0.01	0.34	0.24	0.06	0.33	0.00	0.04	0.14	0.05	0.00	0.00	0.00	0.13	0.10
GUA	0.04	0.86	0.33	0.01	0.38	0.06	0.26	0.01	0.05	0.00	0.02	0.18	0.04	0.00	0.00	0.13	0.00	0.47
PAN	0.47	0.00	0.37	0.04	0.19	0.01	0.00	0.03	0.41	0.02	0.08	0.32	0.04	0.11	0.13	0.10	0.47	0.00
2013																		
ARG	0.00	0.00	0.53	0.11	0.37	0.00	0.04	0.06	0.31	0.23	0.04	0.48	0.20	0.02	0.02	0.09	0.15	0.38
BOL	0.00	0.00	0.01	0.04	0.01	0.01	0.12	0.00	0.01	0.00	0.01	0.05	0.02	0.01	0.02	0.20	0.14	0.00
BRA	0.53	0.01	0.00	0.07	0.28	0.07	0.07	0.35	0.23	0.04	0.28	0.66	0.20	0.02	0.04	0.09	0.37	0.61

CHL	0.11	0.04	0.07	0.00	0.03	0.00	0.00	0.08	0.10	0.10	0.02	0.22	0.05	0.01	0.02	0.03	0.05	0.11
COL	0.37	0.01	0.28	0.03	0.00	0.17	0.03	0.15	0.39	0.16	0.03	0.41	0.01	0.01	0.01	0.14	0.15	0.05
ECU	0.00	0.01	0.07	0.00	0.17	0.00	0.10	0.02	0.11	0.15	0.00	0.12	0.00	0.01	0.00	0.01	0.02	0.00
PAR	0.04	0.12	0.07	0.00	0.03	0.10	0.00	0.02	0.06	0.70	0.02	0.02	0.01	0.01	0.02	0.48	0.46	0.04
PER	0.06	0.00	0.35	0.08	0.15	0.02	0.02	0.00	0.02	0.04	0.00	0.12	0.00	0.01	0.01	0.15	0.36	0.00
URU	0.31	0.01	0.23	0.10	0.39	0.11	0.06	0.02	0.00	0.00	0.06	0.30	0.08	0.01	0.06	0.36	0.70	0.26
VEN	0.23	0.00	0.04	0.10	0.16	0.15	0.70	0.04	0.00	0.00	0.02	0.15	0.01	0.00	0.00	0.00	0.04	0.59
CAN	0.04	0.01	0.28	0.02	0.03	0.00	0.02	0.00	0.06	0.02	0.00	0.46	0.26	0.14	0.12	0.02	0.02	0.00
MEX	0.48	0.05	0.66	0.22	0.41	0.12	0.02	0.12	0.30	0.15	0.46	0.00	0.41	0.47	0.08	0.19	0.15	0.22
USA	0.20	0.02	0.20	0.05	0.01	0.00	0.01	0.00	0.08	0.01	0.26	0.41	0.00	0.47	0.27	0.03	0.02	0.04
CHN	0.02	0.01	0.02	0.01	0.01	0.01	0.01	0.01	0.01	0.00	0.14	0.47	0.47	0.00	0.18	0.28	0.02	0.05
IND	0.02	0.02	0.04	0.02	0.01	0.00	0.02	0.01	0.06	0.00	0.12	0.08	0.27	0.18	0.00	0.03	0.07	0.00
ELS	0.09	0.20	0.09	0.03	0.14	0.01	0.48	0.15	0.36	0.00	0.02	0.19	0.03	0.28	0.03	0.00	0.07	0.21
GUA	0.15	0.14	0.37	0.05	0.15	0.02	0.46	0.36	0.70	0.04	0.02	0.15	0.02	0.02	0.07	0.07	0.00	0.41
PAN	0.38	0.00	0.61	0.11	0.05	0.00	0.04	0.00	0.26	0.59	0.00	0.22	0.04	0.05	0.00	0.21	0.41	0.00

Source: Atlas of Economic Complexity and Observatory of Economic Complexity.

Values in red (IMBT > 0.1) indicate where a link is formed in the Balanced Trade Network.