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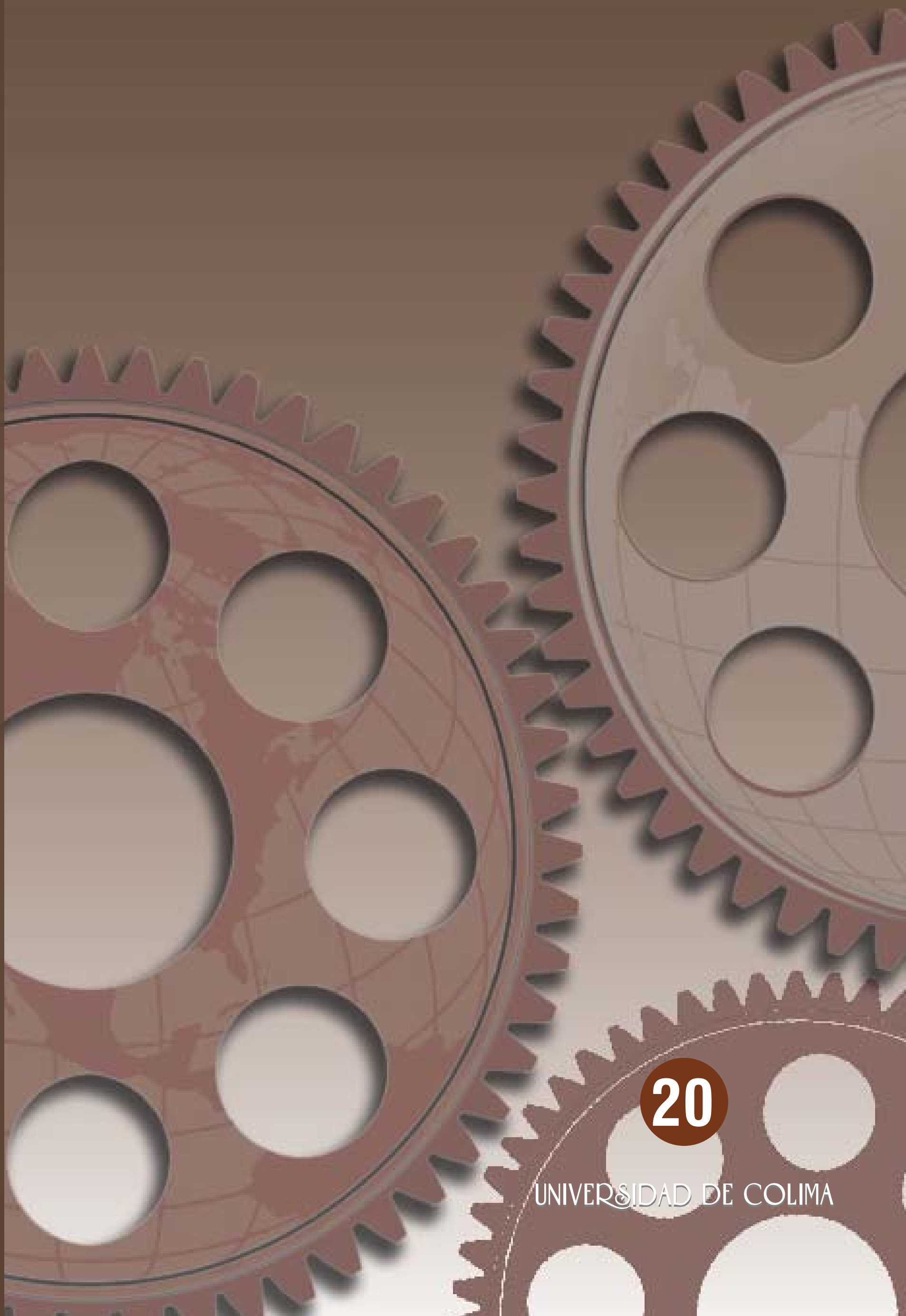

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Revealed comparative advantages and intra-industry trade changes between Mexico, China and the USA

Cambios en las ventajas comparativas reveladas y el comercio intra-industrial entre México, China y Estados Unidos

Jorge Eduardo Mendoza[1]

Abstract

The USA is the main trading partner of Mexico; however, Chinese exports to Mexico have increased their role in the international trade of the Mexican economy. The main exports from Mexico to the USA are based on intra-industry trade and are concentrated in the automobile industry and telecommunications. Mexican exports to China principally consist of inter-industrial trade and are related to comparative advantages and factor endowments and also, to a lesser extent, on intra-industry trade. The specialization of the Mexican exporting sector in the automobile and electronic industries has created comparative advantages revealed in the Mexican economy. A robust least squares model was estimated which suggest that revealed comparative advantages

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and the pull effect of trading partners have a positive impact on intra-industry trade.

Keywords: International trade, China and Mexico trade, intra-industry trade, Mexican exports, revealed comparative advantage.

Resumen

Estados Unidos (EU) es el socio comercial más importante de México; no obstante, las exportaciones de China hacia México han cobrado creciente importancia recientemente. Las principales exportaciones mexicanas hacia EU están basadas en el comercio intra-industrial y están concentradas en las industrias del automóvil y de telecomunicaciones. Las exportaciones mexicanas hacia China son principalmente de carácter inter-industrial, basadas en ventajas comparativas y en la dotación de factores; en menor medida, también existe comercio intra-industrial. La especialización de la industria del automóvil y la industria electrónica han generado ventajas comparativas reveladas en la economía mexicana. Se estimó un modelo robusto de mínimos cuadrados que sugiere que las ventajas comparativas reveladas y el efecto de arrastre de los socios comerciales han tenido un efecto positivo en el comercio intra-industrial.

Palabras clave: Comercio internacional, comercio México-China, comercio intra-industrial, exportaciones mexicanas, ventajas comparativas.

Introduction

Mexican international trade is characterized by an important share of intra-industry trade (IIT) with the USA, which was encouraged by the establishment of the North American Free Trade Agreement (NAFTA). Additionally, Mexican trade has been affected by the emergence of China as a substantial trade partner, which has become a major factor in the transformation of the trade structure of the Mexican economy since the beginning of the decade of the 2000s.

Mexican IIT has been studied by different authors; Esquivel (1992) pointed out that beginning in the early eighties Mexican IIT increased steadily, reaching more than half of all trade by the early nineties. He also indicated that several industries increased their integration with the US economic dynamics. In order to analyze the initial effect of the establishment of NAFTA on Mexican trade, Buitelaar and Padilla (1996) estimated the intra-industry trade of Mexico with its most important trade partners for the period 1990-1995. The results showed that more than 40% of Mexican foreign trade was IIT. Additionally, the authors pointed out that there was a reduction of IIT in Mexican non-manufacturing activities, while there was an increase of IIT in the manufacturing sectors that were capital-intensive.

Subsequently, Gonzalez and Dussel (1999) studied the period 1995-1999 and emphasized that the industries that exhibited IIT showed positive trade balances, while the inter-industrial trade exhibited a negative trade balance due to a lack of comparative advantages in those economic activities. They also mentioned that the total trade deficit could not be offset by the positive balances of exports with IIT. After the establishment of NAFTA, most of the industries with IIT continued to increase their trade integration with the US economy (Clark, Fullerton and Burdorf, 2001). Mexico continued to increase IIT, and by the second decade of the 2000s more than 50% of the values of its exports were considered IIT (López, Rodil and Valdez, 2014).

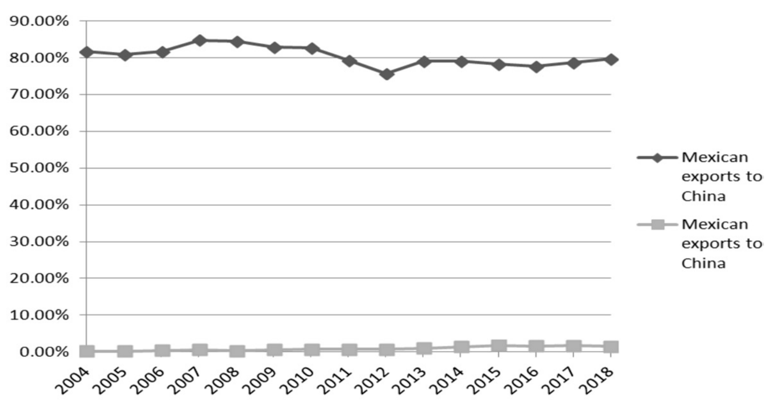
In addition to the increasing dependency of Mexican trade on US economic activity, recent papers have pointed out that China has become an important trade partner of the NAFTA members, exporting an important number of manufactures to the North American region and engaging in important intra-industry trade with the USA, while also importing a large amount of natural resources, raw materials and food from Mexico.

Given the large amount of Mexican trade with the USA and also the rapid expansion of trade between Mexico and China, the present paper seeks to describe the characteristics of the intra-industry trade of Mexico with two of its principal trading partners: the USA and China. In particular, the stady is focused on analyzing the IIT of Mexico with these two economies. The paper is also focused on estimating and examining the effect of vertical and horizontal IIT and the impact of revealed comparative advantages of Mexican exports on the expansion of IIT. The structure of the article is as follows: section one describes the characteristics of Mexican trade with the US and China; the second section presents and discusses the methodological aspects of IIT, vertical and horizontal trade and revealed comparative advantages; section three analyzes the evolution of IIT, and vertical and horizontal trade between Mexico, US and China, and finally discusses the impact of revealed comparative advantages on Mexican trade. The fourth section explains the empirical econometrical model and presents the estimations of the determinants of Mexican IIT with the US and China; finally, in section five the conclusions of the paper are presented.

A comparison of mexican trading patterns with China and the USA

The two most important countries in the international economy have been reshaping Mexican foreign trade. On the one hand, encouraged by NAFTA, the USA became the most important commercial partner of México and, in 2001, the Mexican exports to that country reached 81% of its total exports. However, the undeniable importance of the US market for the Mexican economy has been diminishing in recent years by the involvement of China in the North American region. As a result, a slight but continuous reduction of Mexican exports to the USA has been occurring in recent years. In 2014 the share of Mexican exports to the US decreased to 79.7% (figure 1).

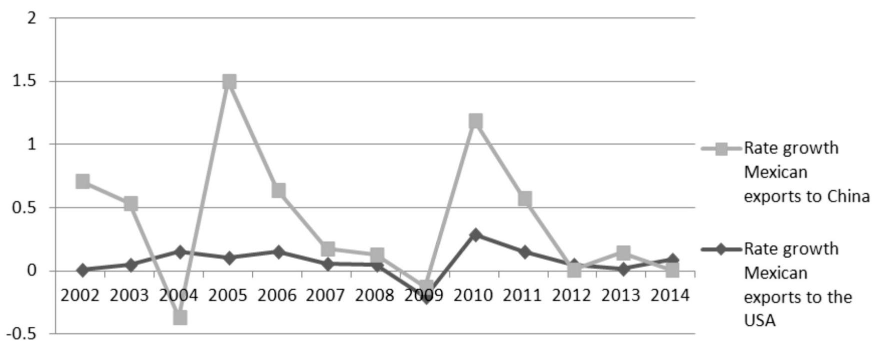
Figure 1. Mexican exports to the USA and China as a percentage of total exports



Source: Own elaboration with data from United Nations COMTRADE, in: http://comtrade.un.org/data/.

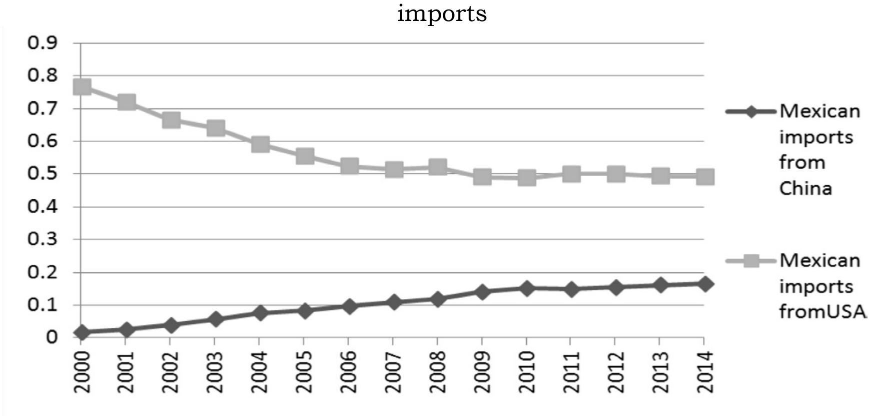
The Chinese economy has not yet reached an important role as a receptor of Mexican exports; however Mexican exports to China have experienced very rapid growth, increasing its share of total exports from 0.23 to 1.5% between 2001 and 2014. This expansion is related to the mining and manufacturing sectors (figure 2). Additionally, imports from China have increased even faster, and have made that economy the second exporter to Mexico (figure 3). As a result, important changes to the Mexican trade patterns have been developing.

Figure 2. Annual rate of growth of Mexican exports to the USA and China



Source: Own elaboration with data from United Nations COMTRADE, in: http://comtrade.un.org/data/.

Figure 3. Share of Mexican imports from the USA and China to total imports



Source: Own elaboration with data from United Nations COMTRADE, in: http://comtrade.un.org/data/.

The structure of Mexican trade with the USA and with China show different patterns, particularly with respect to the Mexican exports to those economies. On the one hand, the exports to the USA are mainly related to manufactures, particularly motor cars, auto-parts, telecommunication equipment, monitors, and televisions (table 1). On the other hand, the Mexican exports to China, besides automobiles, are more related to primary goods, of which the following stand out: copper ores, petroleum and non-ferrous base metals. Therefore, considering the exports of Mexico to the USA and China, it can be concluded that Mexican exports displayed a more traditional trade with China based on comparative advantages, although automobile exports are becoming more important. In contrast, the Mexican exports to the USA mostly consist of intra-industry trade.

With respect to Mexican imports, the trade with the USA confirms the predominance of intra-industry trade. Besides petroleum oils which are the highest value imports of Mexico, manufactures related to the automobile industry and electrical equipment are the next in importance (table 2). Therefore, considering both imports and exports, Mexican trade is characterized by a large volume of intra-industry trade.

In regards to China, besides oil, the highest value of Mexican imports from China are related to parts and inputs for telecommunication equipment and office machines as well as valves, tubes, electrical power machines and auto-parts. Hence, it can be concluded that the increasing imports from China are related to the manufacturing sector and that those imports are mainly inputs for that sector. Apparently, the Chinese economy has taken over many of the imports that were previously imported from the USA. Therefore, its presence has changed the trade structure of Mexico and the USA within NAFTA.

Table 1. Main Mexican exports and imports to the USA and China as a percentage of total Mexican trade, 2014

Commodity	Trade value (US$)	% exported to USA	% exported to China	Commodity	Trade value (US$)	% imported from the USA	% imported from China
Petroleum oils and oils obtained from bituminous minerals	36,247,985,204	70.40%	1.30%	Telecommunications equipment, parts, and accessories of apparatus	25,760,354,734	13.24%	55.00%
Motor cars and other motor vehicles principally designed for the transport of persons	32,391,314,141	69.70%	5.10%	Petroleum oils and oils obtained from bituminous minerals preparations	24,352,548,780	83.20%	0.00%
Parts and accessories of the motor vehicles	22,920,549,843	88.20%	2.40%	Parts and accessories of the motor vehicles	23,087,311,157	63.14%	6.58%
Motor vehicles for the transport of goods and special-purpose motor vehicles	21,565,812,148	89.00%	0.00%	Thermionic, cold cathode or photo-cathode valves and tubes, diodes, transistors	17,154,509,110	7.04%	19.76%
Automatic data-processing machines and units	20,737,855,971	88.20%	0.30%	Electrical apparatus for switching or protecting electrical circuits	13,650,819,881	44.10%	21.15%
Telecommunications equipment, parts, and accessories of apparatus	20,086,141,275	80.80%	1.30%	Special transactions and commodities	10,672,862,490	34.61%	19.75%
Monitors and projectors, not incorporating television	16,869,507,835	82.90%	0.00%	Internal combustion piston engines and parts	10,306,614,472	68.26%	2.90%

Equipment for distributing electricity	11,188,742,917	94.10%	0.20%	Automatic data-processing machines and units	8,973,930,777	11.39%	57.23%
Electrical machinery and apparatus	10,065,540,062	90.40%	0.30%	Electrical machinery and apparatus	8,962,810,834	38.49%	25.42%
Internal combustion piston engines and parts	9,442,818,345	85.60%	0.40%	Motor cars and other motor vehicles	8,574,942,445	38.31%	0.14%
Electrical apparatus for switching or protecting electrical circuits	9,005,891,409	93.50%	0.40%	Manufactures of base metal	7,067,345,797	57.20%	16.54%
Furniture and parts, bedding, mattresses, and mattress supports	7,505,706,028	92.70%	0.10%	Articles of plastics	6,800,514,280	1.10%	13.10%
Road motor vehicles	7,377,515,212	91.80%	0.00%	Equipment for distributing electricity	5,900,122,989	55.04%	17.37%
Instruments and appliances for medical, surgical, and dental or veterinary purposes	6,053,518,454	93.40%	0.10%	Pumps air or other gas compressors and fans; ventilating or recycling hoods	5,807,940,679	62.07%	11.36%
Petroleum oils and oils obtained from bituminous minerals	5,651,293,163	88.10%	0.50%	Parts and accessories suitable for use with machines	5,583,903,297	4.97%	82.46%
	Average	86.60%	0.80%	—	—	38.81%	23.25%

Source: Own elaboration with data from UN COMTRADE.

Table 2. Principal Mexican imports from the USA and China (current dollars), 2014

USA			China		
Code	Commodity	Trade value (US$)	Code	Commodity	Trade value (US$)
334	Petroleum oils and oils obtained from bituminous minerals (other than crude)	20,260,140,200	764	Telecommunications equipment, parts and accessories	14,167,347,402
784	Parts and accessories of the motor vehicles	14,577,767,105	752	Automatic data-processing machines and units	5,135,534,731
713	Internal combustion piston engines	7,035,466,853	759	Parts and accessories for office machines	4,604,655,395
772	Electrical apparatus for switching or protecting electrical circuits or for making connections to or in electrical circuits	6,019,391,254	776	Thermionic, cold cathode or photo-cathode valves and tubes, diodes, transistors and similar semiconductor devices	3,390,154,307
893	Articles of plastics	4,431,188,308	772	Electrical apparatus for switching or protecting electrical circuits	2,887,062,416
699	Manufactures of base metal	4,042,414,316	778	Electrical machinery and apparatus	2,278,474,221
931	Special transactions and commodities not classified according to kind	3,693,691,193	931	Special transactions and commodities not classified according to kind	2,108,149,026

743	Pumps air or other gas compressors and fans, ventilating or recycling hoods incorporating a fan, centrifuges and filtering or purifying apparatus	3,605,156,835	771	Electric power machinery (other than rotating electric plant)	1,630,858,328
778	Electrical machinery and apparatus	3,449,413,405	894	Baby carriages, toys, games and sporting goods	1,596,733,547
764	Telecommunications equipment and parts and accessories of apparatus	3,411,606,863	784	Parts and accessories of the motor vehicles	1,519,892,334
	Total	70,526,236,332		Total	39,318,861,707

Source: Own elaboration with information from the Standard International Trade Classification (SITC), Revision 4.

Intra-industry trade, revealed comparative advantages and trade structure: theoretical and methodological aspects

Theoretical approach

The estimations of IIT and revealed comparative advantages have become important instruments for understanding the changes within international trade patterns. In this study it is considered that the characteristics of Mexican trade with the USA and China can be better analyzed by considering the degree of IIT and the horizontal and vertical structure of the Mexican trade with those two economies. This comparison could be useful to explain the changes and challenges that Mexican trade has been experiencing in recent years, in addition to the obstacles and potential effects of the multilateral agreements, such as the Trans-Pacific Partnership negotiated in 2015.

The new developments within international trade theory provided by Romer (1991), among others, have generated endogenous growth models which emphasize that an important part of international trade is related to the specialization of the production of intermediate inputs. Additionally, Grossman and Helpman (1991) and Krugman (1981) developed the "new theory of international trade" based on models of monopolistic competition and increasing returns. These theoretical approaches propose that an important share of international trade is based on economies of scale and intra-industry trade.

Additionally, in order to understand intra-industry trade as a major component of international trade, it is necessary to take into consideration the product differentiation concept developed by Lancaster (1979), who modelled horizontal differentiation based on variety preferences. This theoretical approach was later applied, at the aggregate level, by Krugman (1979) who demonstrated a correlation between preference diversity and decreasing costs. Likewise, Stiglitz (1987) stated that the quality of commodities is determined by their characteristics, and therefore it is possible to use prices to separate IIT into vertical or horizontal components. By extending this approach to international trade and using differences in quality and unit costs of exports, it is possible to define vertical and horizontal trade and also to understand the different types of trade that engaged in by both developed and under developed economies.

Intra-industrial trade and revealed comparative advantages: methodological aspects

The measurement of intra-industry trade developed by Balassa (1986) initiated the development of a series of indices to measure intra-industry trade. In order to analyze Mexican trade with USA and China, this paper estimates intra-industry trade based on the so-called Grubel–Lloyd index (GL), which is formalized as follows:

$$ITT_j = \left\{\frac{\left[\left(X_j + M_j\right) - \left|X_j - M_j\right|\right]}{\left(X_j + M_j\right)}\right\}$$

Or:

$$ITT_j = 1 - \left\{\frac{\left|X_j - M_j\right|}{\left(\left(X_j + M_j\right)\right)}\right\}$$

Where X_j and M_j are a country's exports and imports of industry *j* for a specific period of time. The index rage is: 0 >IIT_j> 1. The greater the volume of the intra-industry trade index, the closer the value of IIT_j would be to one.

Vertical and horizontal intra-industry trade

As mentioned before, IIT can be divided into horizontal international trade (HIIT), which consists of the international trade of goods that are differentiated by their technical and specific characteristics and vertical intra-industry trade (VIIT) which involves the exchange of commodities that differ in quality and unit costs. HIIT relates to trade between similar partners, such as the case of developed economies with comparable per capita income; whereas VIIT is significant in trading partners which differ in income levels, which is related to the theory of comparative advantages.

In order to estimate the HIIT and VIIT, the unit value of specific commodity groups for both exports and imports must be obtained. The unit values are calculated by dividing the value of exports (imports) by the amount of exports (imports). Subsequently, by estimating the ratio of export value units to import value units, it is possible to determine the type of IIT. When the ratio lies within the range of 15%, it is considered that HIIT exits; values exceeding that range indicate the existence of VIIT (Greenaway, Hine and Milner, 1995). The 15% of the unit cost included in the estimations corresponds to the transportation and insurance expenditures added to the unit price of commodities. Formally, the division of IIT into HIIT and VIIT can be expressed as follows:

For horizontal IIT, $1-\alpha \leq \frac{UV_i^X}{M_i^M} \leq 1+\alpha$, and for VIIT, $\frac{UV_i^X}{M_i^M} \leq 1-\alpha$, or $\frac{UV_i^X}{M_i^M} > 1+\alpha$, where:

UV = unit value per kilo

i = differentiated product traded

α = unit value dispersion criterion, used to distinguish between vertical and horizontal trade. Normally, α = 0.15 (or 0.25)

M = Imports

X = exports

Relative comparative advantages and trade

The classical theory of trade according to Hecksher and Ohlin states that the comparative advantage of a country for a particular product is determined by factor endowments and factor scarcity. However, the trade model assumes a world without distortions, where comparative advantages are specified in terms of pre-trade relative prices. Nevertheless, in the real world the comparative advantage analysis can only be carried out by using data of ex-post trade flows, given the difficulty of estimating the relative prices required to set a value on the factors that determine the country's comparative advantages.

In order to deal with the empirical estimation of comparative advantages indices, Liesner (1958) developed a composite index based on the weighted indices of relative export growth and relative export levels for sixty products traded between Britain and three of its most important competitors: Italy, Netherlands and Belgium/Luxembourg. The index was considered to be the first approximation of an index of comparative advantage between trade partners for a single commodity. Balassa (1965) developed the index of revealed comparative advantages (RCA), also based on information about the structure of trade. The RCA index is useful for identifying comparative advantages of trading countries, although it does not determine the pre-trade relative costs of production that are the main source of comparative advantage; it only represents the comparative advantages of a group of exports of a country as compared to the same exports in the rest of the world. The index is defined as the ratio of a group of exports to the total exports of the country (excluding that group of exports) with respect to the ratio of that group of exports to the total exports of the world, excluding the country of the study. It can be formalized as follows:

$$RCA = \frac{X_{i,n}}{X_{t,n}} \Big/ \frac{X_{i,r}}{X_{t,r}}$$

Where $X_{i,n}$ represents the value of exports of a group of products *i* of country *n* and *t* represents the total other exports of country *n* (except exports *i*). $X_{i,r}$ is the exports of the same group in the world *r* (without considering the country analyzed). When the value of the RCA index is > 1, it is considered that the country has *revealed* comparative advantages for that product or group of products.

Principal mexican intra-industry trade sectors with the USA and China

Integration and intra-industry trade between Mexico and the USA

The rapid growth of the export manufacturing and maquiladora industries in Mexico during the decades of the eighties and nineties was based on the supply chains developed to reduce the costs of intermediate inputs in a competitive global market. Typically, a large share of the manufacturing exports of Mexico has been produced by the assembly plants (maquiladoras), which import intermediate inputs from abroad and then, after assembling those intermediate inputs and incorporating value-added, they export them back to the USA and the rest of the world (Hanson, 2010).

Therefore, a significant share of the trade between Mexico and the USA occurs within vertical and horizontal integration chains, where inputs from the USA are transformed in Mexico and re-exported to the USA (Kose *et al.*, 2004). The establishment of the North American Free Trade Agreement encouraged increased Mexican trade with the USA based on supply chains related to the automobile industry as well as electronics and machinery. As a result, those industries have become major players in the expansion of Mexican foreign trade since the decade of the nineties (López, Rodil and Valdez, 2014).

Therefore, considering that Mexican exports are highly oriented to the USA, the analysis of intra-industry trade is relevant, particularly with respect to manufacturing activities. Table 3 includes estimates for the Mexican trade commodities exported to the USA that exhibited the highest intra-industry trade index; it also contains the changes of the value of the index from 1999 to 2014.

The results identified 183 commodities at the 3-digit level that are present in intra-industry trade with the USA. They represented 45% of the total of Mexican trade (IIT > 0.10). Also, the dynamics of intra-industry trade showed that the industries that were initially encouraged by the North American Free Trade Agreement (NAFTA), such as engine motors (714), passenger motor vehicles (781) and road motor vehicles (783), have begun to stagnate, and even show a reduction in the intra-industry index (table 3). Therefore, even though these exporting activities are showing increased intra-industry trade, their IIT indexes have slightly declined since 2004.

The slowing down of IIT in Mexican trade is related to increasing competition resulting from changes in the international trade in parts, components and final assembly within international production networks, which has encouraged the expansion of intra-industry trade in the manufacturing consumer durables such as automobiles, computer, and televisions, increasing the competition of Southeast Asian economies. The growing presence of the countries of that region in the international trade of electronic and automobiles parts and assembly of manufactured goods is the result of an abundant labor supply and low wages in countries such as Malaysia, Thailand, Vietnam and the Philippines, which have lower wages than the northern East Asian economies and even Mexico. Additionally, very competitive ports and communications systems in most of the East Asian economies and the localization of economies in Singapore, Malaysia and Thailand that have generated agglomeration economies are factors which have encouraged outsourcing from other developed East Asian countries. Finally, the emergence of China as a major low-labor-cost assembly center has encouraged components and assembly activities in the region (Prema-Chandra, 2010).

Table 3. Mexican manufacturing exports to USA with the highest intra-industry trade 1994-2014

Code	Commodity	IIT 1994	IIT changes	
			2014	2014-1994
699	Base metal manufactures	0.59	1	0.41
211	Hides, skins	0.35	0.98	0.62
554	Soap, cleaners	0.76	0.98	0.22
897	Gold, silverware	0.98	0.97	-0.01
289	Precious metals	0.01	0.96	0.95
883	Cine film	0.39	0.95	0.56
278	Other crude minerals	0.94	0.95	0.01
664	Glassware	0.81	0.95	0.14
721	Agriculture machines	0.66	0.95	0.28
246	Wood in chips	0.07	0.94	0.87
692	Containers, storage	0.64	0.93	0.29
745	Other non-electric tools	0.33	0.93	0.61
713	Internal combustion engines	0.43	0.93	0.5
743	Pumps for fluids	0.8	0.93	0.13
292	Crude vegetable	0.75	0.93	0.18
747	Taps, valves	0.85	0.93	0.08
931	Special transactions	0	0.92	0.92
274	Sulphur	0.38	0.91	0.54
654	Other textile fabrics	0.57	0.91	0.34
679	Tubes, pipes	0.81	0.91	0.09
273	Stone, sand, gravel	0.62	0.9	0.28
522	Inorganic chemicals	0.83	0.9	0.07
714	Engines, motors non-electric	0.61	0.88	0.27
893	Articles of plastic	0.54	0.88	0.34
711	Boilers	0.96	0.88	-0.08
898	Musical instruments	0.83	0.88	0.05
784	Parts for vehicles and tractors	0.64	0.84	0.19

Source: Own elaboration with data from United Nations COMTRADE, in: http://comtrade.un.org/data/.

The major intra-industry trade manufactures of Mexico have continued growing during the period 2004-2014. These include manufacturing activities such as passenger motor vehicles (781), motor vehicles for transport of goods (782), road motor vehicles (793) and motor vehicle parts (784), which experienced an average annual rate of growth of 10.1, 11.7, 17.8 and 10.2%, respectively. Because of this rapid growth the automobile industry in Mexico has reached an important place in the international trade of that industry. However, economies such as China and less developed Southeast Asian countries, such as Thailand and Malaysia, have become major competitors in the international production of automobiles. In particular, Thailand has shown rapid growth in the above mentioned automobile commodities of 17.5, 14.4, 17.4 and 15.7%, respectively in the same period.[2]

As a result, the Asian countries of China, Thailand, Malaysia, Viet Nam and Singapore, increased their combined share in the sectors of passenger motor vehicles (781), motor vehicle for transport of goods (782), road motor vehicles (793) and motor vehicles parts (784), in the international world trade, from 0.41, 3.9, 0.93 and 3.5% in 2004 to 1.7, 12.0, 8.4 and 10.5% in 2014, respectively. Meanwhile, Mexico continued to expand in those activities, but its shares increased at a slower pace, from 2.6, 8.3, 4.5 and 3.9% to 4.7, 15.8, 14.9 and 6.1%, in the same period. Therefore, the Mexican economy has been losing ground to the Asian production of automobiles, particularly in auto parts. This trend probably has had a slightly negative effect on the intra-industry trade between Mexico and the USA.

Also, it is worth mentioning that other exports showed increasing intra-industry trade, particularly manufactures of leather, cork, paper and cardboard, textiles and minerals. These activities are related to the mining sector and consumer goods sector and they revealed the importance of the integration of trade in economic activities related to consumption or mineral commodities. However, the value of trade of those commodities is well below the amounts registered in the automobile industry.

Finally, in large part, the international trade between China and Mexico is characterized by inter-industrial trade. However, there is a share of 17.4% that can be considered intra-in-

[2] According to own estimations based on trade information of the SITC classification at three digits from COMTRADE, United Nations.

dustry trade which is mainly concentrated in the manufacturing industries (table 4).

Table 4. Mexican manufacturing exports to China with the highest intra-industry trade 1994-2012

Code	Commodity	1994	2014	2014-1994
593	Explosives, pyrotechnics	0	0.94	0.94
265	Vegetable textile fibers		0.92	0.92
722	Tractors	0	0.87	0.87
533	Pigments, paints	0.51	0.81	0.3
714	Engines, motors non-electric	0	0.78	0.78
511	Hydrocarbon	0	0.76	0.76
682	Cooper	0	0.72	0.72
278	Other crude minerals	0	0.68	0.68
572	Polymers of Styrene	0.03	0.66	0.64
611	Leather	0.02	0.57	0.55
882	Photo and cinema	0	0.54	0.54
784	Parts of motor vehicles	0.53	0.53	-0.01
421	Vegetable oils		0.43	0.43
248	Wood simply worked		0.39	0.39
685	Lead	0	0.33	0.33
792	Aircraft equipment	1	0.33	-0.67
712	Steam turbines		0.32	0.32
431	Animal oils	0	0.3	0.3
551	Oil, perfume	0.04	0.28	0.24
667	Pearls, precious stones	0	0.26	0.26
292	Crude vegetable materials	0	0.24	0.24
727	Food machines	0.58	0.24	-0.34
542	Medicaments	0	0.24	0.24
713	Internal combustion engines	0.01	0.23	0.22
874	Measure control instruments	0.02	0.22	0.2
232	Synthetic rubber		0.22	0.22

Source: Own elaboration with data from United Nations COMTRADE, in: http://comtrade.un.org/data/.

Vertical and horizontal trade between Mexico and the USA and China

As mentioned previously, horizontal trade is characterized by the exchange of commodities of comparable unit cost, and quality, based on similar technologies. Vertical trade represents the trade of commodities of the same industry but with different unit costs that can be the result of different factor endowments, consumer preferences and income distribution (Flam and Helpman, 1997). Generally, commodities of the same industries with different unit costs are exchanged between industrialized and underdeveloped economies.

The estimations for the US and Mexican trade indicate that the commercial relations of these two economies are characterized by an important level of vertical trade. In 2014, 36.7% of total trade between the two economies was considered vertical trade (table 5). In particular, the most important manufacturing activities with intra-industry and vertical trade were motor vehicles, car engines, parts and accessories for motor vehicles and power generating machinery. Thus, the results show that trade between the US and Mexico has become increasingly concentrated in the automobile and electrical industries and that it has generated an important flow of commodities within the same industries with different unit costs, level of quality and technology. The estimations also suggest that the IIT of those industries is predominantly concentrated on Mexican exports of inputs and commodities of low unit cost and with a comparatively low level of technology with respect to the commodities imported from the same industry. Therefore, this vertical trade indicates that an important share of the US-Mexican trade is based on American firms looking to reduce production costs by moving chains of production to Mexico.

Table 5. Vertical and horizontal intra-industry trade between Mexico and the USA, 2014

Code	Commodity	Export value (US $)	Trade balance	IIT	Vertical trade
716	Electric plant and parts	3,010,842,161	1,736,144,638	0.81	9.44
772	Electrical apparatus for switching or protecting electrical circuits	8,421,077,347	2,401,686,093	0.701	6.15
746	Ball- or roller bearings	306,595,101	-121,443,688	0.779	4.56
656	Tulles, lace, embroidery, ribbons, trimmings and other smallwares	75,799,369	-106,181,821	0.876	4.56
692	Metal containers for storage or transport	272,255,090	33,733,321	0.835	3.25
747	Taps, cocks, valves and similar appliances for pipes, boiler shells	2,091,887,808	290,538,826	0.772	3.03
748	Transmission shafts flywheels and pulleys	856,897,311	-621,980,617	0.771	2.24
699	Manufactures of base metal	4,071,349,461	28,935,145	0.833	2.04
762	Reception apparatus for radio-broadcasting	1,637,795,962	1,373,125,875	0.749	1.22
784	Parts and accessories of motor vehicles	20,206,642,938	5,628,875,833	0.588	0.84
783	Road motor vehicles,	6,772,662,241	6,512,420,928	0.595	0.79
671	Pig-iron, spiegeleisen, sponge iron, iron or steel granules and powders and ferro-alloys	47,207,533	-29,306,069	0.723	0.79
781	Motor cars and other motor vehicles principally designed for the transport of persons including station-wagons and racing cars	22,591,940,047	19,306,626,209	0.618	0.77
612	Manufactures of leather or of composition leather	105,300,779	-51,848,887	0.905	0.76

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791	Railway vehicles (including hover trains) and associated equipment	3,821,655,306	592,971,411	0.542	0.73
723	Civil engineering and contractors' plant and equipment; parts	1,255,327,249	277,791,813	0.809	0.7
676	Iron and steel bars, rods, angles, shapes and sections (including sheet piling)	371,676,198	-317,713,895	0.868	0.66
651	Textile yarn	353,824,579	-107,247,831	0.881	0.64
711	Steam or other vapor-generating boilers, superheated water boilers	32,904,096	6,985,550	0.826	0.59
679	Tubes, pipes and hollow profiles, and tube or pipe fittings, of iron or steel	1,200,049,690	—	0.842	0.52
775	Household-type electrical and non-electrical equipment	4,087,108,716	3,747,917,061	0.678	0.51
764	Telecommunications equipment and parts	16,235,492,482	12,823,885,619	0.729	0.5
678	Wire of iron or steel	175,423,118	51,976,085	0.849	0.41
663	Mineral manufactures	714,355,660	194,918,430	0.872	0.36
785	Motor cycles (including mopeds) and cycles, motorized and non-motorized	135,270,698	65,913,962	0.574	0.32
714	Engines and motors, non-electric parts of these engines and motors	1,885,580,136	396,593,064	0.821	0.21
633	Cork manufactures	1,956,489	-920,761	0.882	0.16
773	Equipment for distributing electricity	10,523,501,929	7,276,034,283	0.687	0.14
	% total exports	36.67%			

Source: Own elaboration with data from UN COMTRADE.

Also, the estimations indicate that around 12% of total trade can be considered horizontal trade. In particular, the activities associated with paper and paperboard, agricultural machinery, monitors and televisions, sound recording, electrical plants, electrical apparatus, radio broadcasting and metal manufactures such as metal containers, valves and transmission shafts, engaged in horizontal trade (table 6).

Table 6. Horizontal intra-industry trade between Mexico and the USA, 2014

Code		Exports	Trade balance	ITT	Horizontal ITT
642	Paper and paperboard, cut to size or shape and articles of paper or paperboard	1,010,306,269	-485,099,938	0.804	1.08
782	Motor vehicles for the transport of goods and special-purpose motor vehicles	19,194,326,845	18,133,075,070	0.6	1.01
718	Power-generating machinery and parts thereof	139,889,083	-93,661,720	0.809	1
721	Agricultural machinery (excluding tractors) and parts	363,268,401	37,469,499	0.809	0.98
761	Monitors and projectors, not incorporating television reception apparatus; reception apparatus for television	13,987,493,916	12,032,751,248	0.751	0.92
742	Pumps for liquids, liquid elevators; parts for such pumps and liquid elevators	1,565,702,621	411,647,448	0.804	0.9
763	Sound recording or reproducing apparatus	279,104,503	252,575,831	0.734	0.86
	% total exports	12.04%			

Source: Own elaboration with data from COMTRADE.

Consequently, it can be concluded that the trade between the USA and Mexico is dominated by vertical trade based on Mexican imports from the USA with higher unit costs and exports based on low unit costs. However, it is important to point out that around half of the trade between the two countries is inter-industrial trade. These commercial flows are based on comparative advantages such as abundant labor and lower costs of transportation.

Is there IIT between Mexico and China?

As mentioned before, the international trade between China and Mexico shows a relatively small intra-industry trade concentrated in the manufacturing industries. Not surprisingly, among other sectors, there is IIT in industries such as motor vehicle parts, engines and motors and textiles. However, there is also IIT in mining activities such as copper, hydrocarbons and other crude minerals (table 7). Hence, the estimates suggest that, although not predominant in the China-Mexico trade, there is an increasing intra-industry trade in the mining industries and some light manufacturing activities like leather and textiles. The results support the argument regarding the existence of IIT between underdeveloped economies based on comparative advantages.

However, it is important to point out that all estimates of the intra-industry commodities traded by these two economies are considered vertical IIT (table 7). Consequently, it can be concluded that the total value of IIT between Mexico and China is still not very significant. In addition to mineral and primary exports, the specialization of the Mexican manufacturing sector in the production and exportation of cars, automotive engines and auto parts also has become a relevant component of the Mexican exports to China.

Finally, the IIT between these economies suggests that both economies are trading commodities from the same industries with different quality features. As pointed out by Greenaway, Hine and Milner (1995), vertical trade could be better explained by the classical theory of comparative advantages while horizontal trade could be explained by more modern theories of trade.

Table 7. Mexican intra-industry trade with China, 2014

Code	Commodity	IIT	Exports	Trade balance	Vertical
593	Explosives	0.94	1,634,415	-197192	NA
265	Vegetable textile fibers	0.92	62,873	-10,746	0.11
784	Tractors	0.87	1,042,980	-978,669,655	0.184
533	Pigments, paints	0.81	26,842,230	-12,656,687	0.09
714	Engines, motors non elect.	0.78	1,332,419	-768,231	NA
511	Hydrocarbons	0.76	16,428,187	-10,656,288	0.132
283	Cooper	0.72	1,032,430,372	1,032,429,579	0.133
278	Other crude minerals	0.68	8,784,455	-8,142,593	0.228
572	Polymers of styrene	0.66	5,851,123	2,960,947	0.163
611	Leather	0.57	24,345,547	14,645,820	0.006
882	Photo	0.54	538,778	-102,142,229	NA
784	Parts, tractors, motor vehicles	0.53	541,222,679	-978,669,655	0.16
	% Total exports to China		27.95%		

Source: Own elaboration with data from United Nations COMTRADE, in: http://comtrade.un.org/data/.

Revealed comparative advantages and Mexican exports to the USA and China

The estimations of revealed comparative advantages (RCA) are a helpful instrument for studying the comparative advantages of the Mexican exports resulting from factor endowments and other factors such as unit costs and economies of agglomeration. The index was constructed by estimating the ratio of industry exports to the total exports of Mexico divided by the ratio of world industry exports to total world exports. The estimation of that index represents the level of relative concentration of Mexican exports with respect to the world.

The determinants of the concentration of Mexican exports to the USA are associated to both relative factor endowments, such as natural resources and labor, and to internal and external economies of scale, encouraged by foreign direct investment. In the case of the Mexican economy, the value of exports the USA and to China showed a positive correlation with the RCA (Figures 4 and 5). In particular, correlations estimated for the year 2014 revealed that several commodities exhibited both a high value of exports and also a high level of RCA.

Among those commodities, the following stand out: oil, telecommunication equipment, radio and video devices, motor vehicles, road vehicles, equipment for electrical distribution, auto-parts and alcoholic beverages. In fact, the ten highest value exports from Mexico to the USA also exhibited RCA and they represented 45.5% of the total value of exports[3]. Therefore, the analysis of the RCA for the case of Mexican exports to the USA suggests that RCA are concentrated in manufacturing activities related to the electronics and automobile industries, which have been increasing in the Mexican economy and are characterized by IIT that resulted from FDI made by multinational firms in Mexico.

As discussed previously, the international trade between Mexico and China has increased exponentially since the early 2000s, mainly based on primary exports and horizontal trade from Mexico and light manufacturing exports from China. With respect to the RCA of Mexican exports to China in 2014, it is worth noting that the most important export was motor vehicles, which accounted for 27% of total exports to China and is considered to exhibit both RCA and IIT. However, it was followed by copper exports, which represented 17.5% and is a primary export not exhibiting IIT and RCA. Of the ten highest value exports, only 4 are considered to have RCA and the rest are related to the exporting activities of primary commodities such as oil, ores and concentrates of base metals and non-ferrous base metal waste and scrap. Hence, it can be concluded that Mexican exports to China, on the one hand, reflect both intra-industry trade and RCA in manufacturing activities and on the other hand, is based on the classical pattern of comparative advantages generated by factor endowments.

Determinants of the intra-industry trade between Mexico and EUA and China

Methodological aspects

In order to estimate the main determinants of Mexican IIT with its two trading partners, an empirical model considering RCA and exporting industry characteristics was established. The

[3] Own estimations based- on information from Comtrade, Standard International Trade Classification (SITC) classification at the 3-digit level.

methodology of estimation follows the specification of previous studies that have measured those factors affecting the IIT (Greenaway, Robert and Milner, 1995) and (Leitao, 2012). The empirical equation that is econometrically tested considers that IIT is affected by the market structure of the exporting industry, its volume of production, and by indicators of product differentiation and a measure of economies of scale. In this study, the functional specification of the econometrical model is formalized as follows:

$$ln(ITT_{i,c}) = \alpha_{i,c} + \ln(MS_{i,c}) + \ln(RCA_{i,c}) + \ln(SK_{i,c}) + \ln(DVH_{i,c}) + \ln(DIFVA_{i,c}) + \epsilon_{i,c}$$

where:

ln(IIT)= is the logarithm *ln* of the index of intra-industrial trade for the commodity at the three digit level according to the SITC classification *i*, for countries *c*. Following the papers of Hummels and Levinsohn (1995) and Leitao (2012), in order to avoid zero to one values a logistic transformation was applied in this fashion: ln[IIT/(1-IIT)].

MS = a proxy of market structure based on the relative plant size of the commodities included with respect the average size of plants in Mexico.[4]

RCA = is the index of relative comparative advantage.

SK = is the stock of capital for the Mexican exporting industries.

DVH = dummy variable for vertical and horizontal Intra-industry trade for the commodities and countries considered.

DIFVA = difference valued added between Mexican exporting industries and the ones in the USA and China.

The trade data was obtained from the United Nation's information center COMTRADE; the stock of capital for Mexican economic activities was obtained from the national accounts of Mexico published by the Bank of Economic Information (BIE); the data for estimating the value added for Mexico was acquired from the Economic Census of Mexico, for the USA from the Bureau of Economic Analysis and for China from the China Statistical Yearbook.

The econometric analysis was carried out by estimating a robust least squares model. This methodology avoids the sensi-

[4] The relative size of plants was obtained by dividing total value-added by the total employment.

tivity of the regression analysis to outlier observations that can yield inaccurate coefficient estimations and statistical relationships. Given the different sources used to construct the data base it is considered that the procedure would deal with possible outliers in the dependent variable, the independent variable and in both variables.

The first estimation (M) was developed by Huber (1973), who modified the way to solve the least squares problem by changing the procedure of minimizing the sum of the squares by a robust alternative to the correlation coefficient, and therefore the minimized expression is less sensitive to extreme values of the residuals.[5] This method of estimation offsets the effects of outliers on the variance of the residuals and, as a consequence, on the efficiency of the least squares estimates. The second estimation is also used for robust analysis variance by comparing estimators obtained from S-estimators that are derived from a scale statistic and possess a high breakdown point and are asymptotically normal (Rousseeuw and Yohai, 1984). Finally a methodology was applied for estimating a regression in the presence of outliers measured by breakdown-point as established by Yohai (1987).

Econometrical results

An OLS regression was estimated and influence statistics were obtained in order to determine the existence of outlier observations. This method consists of several statistics that determine significant observations by measuring their effect on the regression estimations.

Subsequently, RStudent, the Hat Matrix, the DFFITS and COVRATIO statistics were estimated. The first statistic is the residual of the equation divided by the standard deviation estimated, the second displays the i-th diagonal element of the Hat Matrix and the third is the scaled difference between the original fitted values for that observation and an equation estimated without that observation. Finally, the fourth statistic is the ratio of the determinant of the covariance of the determinant to the covariance matrix from an equation without that observation and

5 The procedure substitutes, $\sum_{i=1}^{n}\left(X_i - \sum_{j=1}^{p} c_{i,j}\,\theta_2\right)^2 = Min$, by $\Delta_i = X_i - \sum_i c_{i,j}\,\theta_j$, where θ are unknown parameters, X are observations to the n, c_{ij} are known coefficients, Δ is the residual vector.

the matrix of the coefficients from the original equation. Explicitly, it is possible to detect the outliers where there are spikes in the figures of the four statistics.

Given the strong evidence of possible influence of outliers on the results of the estimation, the econometric model was re-estimated using a robust M-estimation based on the Huber covariance that uses a bi-square function and the z-statistics. The results of the first estimation showed that, by applying this technique, the goodness of fit and the R squared and Rw squared improved substantially, suggesting that the model accounts for a range between 22-44% (table 8).

Table 8. Dependent variable: LNIIIT

	Method: Huber type I standard errors and covariance					
Variable	**M-estimation**		**S-estimation**		**MM-estimation**[1]	
	Coefficient	z-statistic	Coefficient	z-statistic	Coefficient	z-statistic
C	1.797	1.443**	-2.053	-3.181*	-0.357	-0.3133
LNMS	-0.144	-2.174*	-0.152	-4.424*	-0.146	-2.403*
LNDXIVDIF	0.116	1.146	0.616	11.699*	0.453	4.886*
DVHIIT	0.131	0.593	-0.111	-0.972	0.059	0.293
LNSK	-0.042	-0.62	0.069	1.983*	0.001	0.022
LNRCA	0.133	1.798*	0.038	0.998	0.034	0.499
R-squared	0.308	—	0.495	—	0.321	—
Rw-squared	0.441	—	—	—	0.545	—
Adjusted R-squared	0.222	—	0.432	—	0.237	—
Adjust Rw-squared	0.441	—	—	—	0.545	—
Schwarz criterion	—	—	—	—	85.426	—
Scale	10.32	—	0.386	—	0.386	—
Akaike info criterion	59.796	—	—	—	72.524	—
Deviance	10.32	—	0.149	—	9.298	—
Rn-squared statistic	22.109	—	173.55	—	39.183	—

LNIIT = log of intra-industry trade. LNMS= log of market structure. LNDXI-VDIF= log of the difference of value added of the exporting industries of Mexico, the USA and China, log of horizontal and vertical intra-industry trade. LNSK= log of capital stock of Mexican exporting industries and LNRCA= log of revealed comparative advantages index.
* Level of confidence at 1%. ** Level of confidence at 5%.
[1] Huber type I standard errors and covariance.

Statistically significant coefficients were obtained for market structure and the revealed comparative advantages variables. The first showed a negative coefficient and the second a positive coefficient, respectively (table 8). The other variables included had a positive effect on intra-industry trade (IIT), but were not statistically significant. However, the difference of value-added generated by Mexican exporting industries and the exporting industries of the USA and China (LNDXIVDIF) and market structure (LNMS) had a negative effect and the coefficients were statistically significant.

The S-estimation addressing the outliers in the dependent variable exhibited positive effects of the dummy variable for vertical and horizontal trade, capital stock accumulation and revealed comparative advantages, although only the first two were statistically significant. The coefficients of the variables that presented statistically significant negative signs were the log of market structure (LNMS) and the dummy variable for horizontal or vertical trade (DVHIIT).

Finally, a MM-estimation was calculated by using the S-M results that take into consideration the outliers in both dependent and independent variables. Therefore, it uses the scales of both methods to determine the tuning parameters. The results obtained are similar to the SS estimation and present a scale superior to the M-estimation. The value of the coefficients were higher but presented the same signs for the case of market structure, the difference of value added in the exporting industries of Mexico, the USA and China (LNDXIVDIF), the dummy for vertical or horizontal trade and the capital stock (LNMS), but the last coefficient was not statistically significant. The overall goodness of fit was higher than that of the M-estimation. Therefore, the results indicate that the market structure of the Mexican economic sectors is not a relevant factor in the IIT activities and revealed comparative advantages. The pull-effect of the economies of China and the USA, and capital stock could be positively impacting the dynamics of the IIT. Those variables could be representing the effect of external factors such as FDI and technology, the trade strategies of multinational corporations and the demand for low skilled and primary exports from Mexico.

Conclusions

The USA is the main trading partner of Mexico; however, Chinese exports to Mexico have increased exponentially. Even though the Mexican exports to China represent a small share of total Mexican exports, they have increased rapidly, particularly in the mineral and automobile sectors. As a result, the Chinese economy has taken a gradually increasing role in the international trade of the Mexican economy.

The main exports from Mexico to the USA are based on IIT, both horizontal and vertical. They are concentrated in the automobile industry, auto parts, telecommunications and televisions. In contrast, Mexican exports to China are based on inter-industrial trade based on comparative advantages and factor endowments and also on horizontal intra-industry trade.

Encouraged by the establishment of NAFTA, Mexico experienced an increase of intra-industry trade between 2001 and 2014, particularly in the automobile and auto parts industries and in electronics; although in recent years its growth has been rather slow or stagnant. Additionally, during the same period, the emergence of the Asian economies particularly China has slowed down the commercial integration between Mexico and the USA and has encouraged increasing intra-industry trade between Mexico and China.

Although the bulk of Mexican exports to China are based on factor endowments, it is important to underline that a significant part of them correspond to horizontal intra-industry trade particularly with respect to the automobile industry. The specialization of the Mexican economy in that manufacturing sector has generated the possibility of a traditional IIT trade based on manufacturing exports and imports between the two countries that can be considered of the same type and characteristics, which is a traditional type of low value-added trade between developing countries.

Therefore, besides natural resources advantages, the specialization of the Mexican exporting sector in the automobile and electronic industries has created revealed comparative advantages in approximately half of the value of Mexican exports, particularly, in sectors such as oil, telecommunication equipment, vehicles engines and copper. As result, the Mexican economy has been able to increase exports both to the USA and to China.

The results of the econometric models suggest that market structure has a negative effect on the development of IIT while the variable revealed comparative advantages has a positive impact on IIT. Additionally, the coefficients of capital stock and the effect of the larger value added of the USA and China exhibited a positive impact on the IIT growth. Therefore, the results suggest that external factors such as the pull effect of trading partners, FDI and technology, the trade strategies of multinational corporations and the demand for low skilled and primary exports from Mexico, that generate comparative advantages, have had an important impact on the development of Mexican intra-industry trade.

Finally, it is important to point out that the establishment of the Trans Pacific Partnership trade agreement signed by Mexico, the USA, Canada, Japan and other Latin American and Asian countries in 2015, has explicitly excluded China. As a consequence, the multilateral agreement will probably impose limits on the increasing trade and IIT between Mexico and China, since the rules of origin will put caps on the amount of trade between the two economies.

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