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Patterns and Determinants of Intra Industry Trade for the Mexican Non-Maquiladora Manufacturing Industry

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This study proposes that a quantification of bilateral IIT executed without differentiation of the maquiladora component overestimates the IIT index for Mexico with its North American Free Trade Agreement (NAFTA) partners. The adjusted index performed in this paper shows that Mexican trade benefits from NAFTA are overvalued. After the non-maquiladora IIT index is differentiated according to its horizontal or vertical nature, this study finds that the Mexican non-maquiladora IIT is mainly of a vertical nature. In addition, an econometric estimation of the determinants encompasses several variables which differentiate between horizontal and vertical IIT. This work finds that differences in market size, Foreign Direct Investment (FDI), product differentiation and trade restrictions were significant determinants of this trade.

Keywords: Intra-Industry Trade, Maquiladora, Mexico, NAFTA

JEL Classifications: F13, F14

I. Introduction

During the second half of the nineteen-eighties until the end of the nineties (between 1988-91, 1992-95, and 1996-2000 specifically), Mexico stood amongst the countries with the highest growing intra-industry trade (IIT) indices (OECD, 2002). This enhanced performance emerged as a result of the economic liberalization process initiated during the mid-80s (Lustig, 1994). Some quantitative estimations called for an index of around 60 to 70 percent during these years, particularly for quantifications between Mexico and the Unites States (Globerman, 1992; González and Vélez, 1995; Clark et al., 2001; Ekanayabe et al., 2009). Ramírez (1999) concluded that the conditions of the North American Free Trade Agreement (NAFTA) favored further increase of IIT given the assembly characteristics of the maquiladora (in-bond) industry, which supported this type of trade. This article demonstrates, however, that previous calculations of the trade benefit Mexico gained from NAFTA have been overestimated due to the addition of the maquiladora trade data flows.

The maquiladora industry initially developed in the mid-1960s as an export oriented assembly industry based in the northern Mexican border as a part of a broad industrialization program for this region (González-Aréchiga and Barajas, 1989). Moreover, the maquiladora program was the result of an international globalization process that led corporations to relocate

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some stages of the production process to another country to reduce production costs and gain competitiveness in their domestic markets (Clark et al., 1993).

Maquiladora's trade was based on imports of parts and components which were dispatched primarily from the U.S. for assembly in Mexico and subsequently shipped back to the U.S. (*idem*) with little value added and without significant integration in the domestic market. For this reason, the maquiladora industry is largely described as a vertical specialization trade where the exchange of goods takes place at different stages of the production process (Hummels et al., 1998). Conversely, the IIT is characterized as the exchange of product varieties belonging to the same production process (Greenaway and Milner, 1986). An increase of IIT between trade partners is seen as a positive effect of trade integration which implies reduced adjustment costs (Balassa, 1979). Consequently, an accurate measurement of IIT would ultimately result in adjusted indices for Mexico's IIT and its NAFTA partners, implying that the benefits from this trade accord were not as significant as previously thought. Therefore, this paper maintains that a differentiation of trade flows derived from the maquiladora industry is necessary when analyzing IIT flows of the Mexican manufacturing industry.

Previous quantitative estimations present limitations when the maquiladora industry data is included within IIT index quantification.[1] Their main problem involved an overestimation of the index, resulting in inaccurate conclusions about the Mexican manufacturing industry trade performance as a result of the trade liberalization process and the NAFTA accord. Moreover, owing to the significance of the maquiladora industry in international trade as well as the added relevance of IIT due to a greater trade integration of Mexico into the world economy, Mexican international trade merits deeper analysis that takes into account the difference between this country and the NAFTA partners. Following this logic, the purpose of this article is as follows.

First and foremost, this article aims to provide an accurate measurement of IIT indices for Mexico and its NAFTA partners in demarcation of the maquiladora component. Relatedly, differences between horizontal and vertical IIT will also be critically explored with special consideration given to the determinants of these types of trade for the Mexican non-maquiladora industry and its NAFTA partners from 1994 to 2006. This investigation does not take into account data subsequent to the year 2006 because the National Institute of Statistics, Geography and Informatics (INEGI in Spanish) has not published any maquiladora trade data since 2006. This article also hypothesizes the need to distinguish between non-maquiladora and maquiladora trade for a quantification of IIT indices because of the vertical specialization and international fragmentation characteristic of the maquiladora industry[2] (Campa and Goldberg, 1997; Hummels et al., 1998). This point is of key relevance since if the most widely used definition of IIT (Grubel and Lloyd, 1975) is applied to Mexico.

Furthermore, although recent advances in the quantification of IIT indices seemed to differentiate trade flows according to their nature, either horizontal (same quality varieties) (Greenaway et al., 1994/1995) or vertical (varieties of different quality) (*idem*), few studies examined the Mexican case conducting such differentiation, including the maquiladora industry trade flows (Vogiatzoglou, 2005; Valderrama and Neme, 2011). This failure is particularly

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[1]Such has been the case in the case of Esquivel (1992), Globerman (1992), and Ekanayabe (2001) or more recently with Vogiazoglou (2005) and Valderrama and Neme (2011) where the IIT estimation has been done for the total manufacturing industry, including the maquiladora.

[2]It is also known as the dual production of international framework. It is worth noting that the new advances in the theoretical literature regarding firm heterogeneity and international trade appear to include characteristics of the trade of differentiated goods and the analysis of goods in different production stages. In this respect a greater understanding in terms of quantification is still needed.

surprising since distinguishing IIT indices according to their nature is chiefly important in the Mexican context where the trade between Mexico and its NAFTA partners is one between unequal partners (Salvatore, 2007). Moreover, it is largely accepted that North-South IIT flows are predominantly of a vertical nature (Tharakan, 1989). Consequently, a model examining the determinants of this type of trade should be essentially different from a model inspecting the determinants of horizontal IIT, a contribution this paper makes by precisely formulating an empirical model for the determinants of IIT differentiated by its horizontal and vertical natures.

Therefore, a patent research gap exists in relation to the maquiladora industry, a crucial component of Mexican foreign trade. Moreover, when an examination of the IIT have been performed without exercising a distinction between maquiladora and non-maquiladora flows as well as between horizontal and vertical IIT, an added problem in the quantification of indices has been carried forward , providing further validation for the objectives of the present investigation.

Hence, the differentiation of maquiladora components in the estimation of the Mexican manufacturing industry (from 1994-2006) will comprise one of the key focal points of this study. Relatedly, this article will distinguish the types of IIT—horizontal or vertical—according to the author, a likely prevalence in the bilateral exchange of non-maquiladora. Lastly, discussions linked to the estimation of non-maquiladora determinants of the IIT will also be explored.

Estimates of the indices will be performed using a six-digit breakdown, following the 1996 version of the international classification of harmonized system. In this way, the present investigation differs from previous studies which have typically made use of estimated indices with an aggregation of three digits or less, which created problems of statistical aggregation (Esquivel, 1992; González and Vélez, 1995; Brulhart and Thorpe, 2001). Furthermore, the IIT indices are quantified as bilateral to avoid geographical aggregation. This study follows the widely used Grubel and Lloyd (1975) index as well as the adjusted index developed by Greenaway and Milner (1984) to differentiate the IIT according to horizontal and vertical nature.

Based on the above argumentation, this article will discuss how the inclusion of the maquiladora component in the indices measurement results in the overestimation of bilateral IIT indices in relation to the United States and Canada. Subsequently, the focus of the article will shift to the analysis of non-maquiladora IIT indices, their differing horizontal and vertical components and how this results in a high percentage for the latter. The final sections of this article will deal with an econometric model specification to analyze the determinants of the horizontal and vertical IIT for the non-maquiladora industry and a series of concluding remarks.

II. Measurement of the Bilateral IIT Indices for the Mexican Manufacturing Industry

In order to highlight the significance of the maquiladora industry for Mexico's international trade, trade data was organized following a table format, ordering figures under origin and destination categories while concomitantly differentiating maquiladora and non-maquiladora data. This table highlights the significance of the U.S. market for Mexican products. On average, more than 80 percent of Mexican exports had the U.S. as their main destination. The increasing participation of the maquiladora products was also significant, for the rest of the countries listed in Table 1. These percentages support the argument of differentiating the maquiladora's flows from the total trade when estimating IIT flows.

The elevated percentages in the first three rows of the table corroborate the importance of the U.S. market for the Mexican export sector performance and the vulnerability in its demand due to high elasticity. It is also evident that while NAFTA was able to secure a market for products originating in Mexico, a fall in domestic demand in the U.S. (such as the ones that occurred in 1989 and in 2000) resulted in a disproportionate decrease of exports.

Table 1: Mexican Trade by Origin and Destination Main Trade Partners (%)

Countries	Exports			Imports		
	1993	*1998*	*2006*	*1993*	*1998*	*2006*
United States	**82.70**	**87.77**	**84.75**	**69.29**	**74.38**	**50.91**
Maquiladora	*50.56*	*52.20*	*49.22*	*33.71*	*43.39*	*31.93*
Non-maquiladora	*49.44*	*47.80*	*50.78*	*66.29*	*56.61*	*68.07*
Canada	**3.01**	**1.29**	**2.07**	**1.80**	**1.83**	**2.88**
Maquiladora	*1.37*	*4.74*	*36.33*	*1.02*	*6.20*	*17.17*
Non-maquiladora	*98.63*	*95.26*	*63.67*	*98.98*	*93.80*	*82.83*
European Union	**5.20**	**3.31**	**4.31**	**11.93**	**9.40**	**10.84**
Maquiladora	*1.44*	*7.41*	*14.51*	*1.20*	*2.47*	*9.74*
Non-maquiladora	*98.56*	*92.59*	*85.49*	*98.80*	*97.53*	*90.26*
Japan	**1.36**	**0.72**	**0.64**	**6.01**	**3.62**	**5.97**
Maquiladora	*0.87*	*6.40*	*12.13*	*14.25*	*25.67*	*51.59*
Non-maquiladora	*99.13*	*93.60*	*87.87*	*85.75*	*74.33*	*48.41*
Other Countries	**7.73**	**6.91**	**8.23**	**10.97**	**10.77**	**29.40**
Maquiladora	*2.24*	*4.39*	*18.93*	*7.07*	*15.66*	*45.16*
Non-maquiladora	*97.76*	*95.61*	*81.07*	*92.93*	*84.34*	*54.84*

Source: own calculation based on INEGI-BANXICO databases, several years

Although the Canadian contribution to Mexico’s total foreign trade was small, when this trade is differentiated between maquiladora and non-maquiladora, the latter increased both exports and imports. A similar scenario occurs in the case of European Union countries. Thus, the maquiladora industry represented a positive addition to Mexican foreign trade and in particular was of critical importance for its main trading partner, the U.S. Furthermore, the maquiladora industry also heavily impacted the quantification of IIT bilateral indices.

The following section will identify the data gathering sources used in this article and how the quantification of IIT bilateral indices was performed.

A. Data Gathering Sources

The construction of indices was made using the databases generated by the National Institute of Statistics and Geography (INEGI in Spanish) and the Bank of Mexico (BANXICO in Spanish)[3]. These institutions include in their trade flows register data differentiated between maquiladora and non-maquiladora for the years up to and including 2006, following the

[3]Since international trade statistics do not consider the unbundling of Mexican accounts between maquiladora and non-maquiladora, this study considered of greater relevance the Mexican sources of information.

classification of the 1996 version of Harmonized System (HS). This classification encompasses a level of disaggregation of the information of up to eight digits for exports and up to ten digits for imports.

In relation to bilateral manufacturing trade between Mexico and United States, the study made use of a total of 4,500 tariff subsections to six digits for exports. Imports were differentiated between maquiladora and non-maquiladora with approximately 3000 fractions for bilateral trade with Canada.

In addition, trade data was matched with the Mexican Classification of Activities and Products (CMAP in Spanish) following the 1994 Mexican version published by the INEGI. This version is in turn based on revision 2 of the International Standard Industrial Classification (ISIC). This correspondence was performed in order to facilitate the classification of trade in terms of its industrial counterparts. Therefore, the IIT indices were aggregated to six digits which resulted in 310 industrial activities which were subsequently added to a level of 27 branches (three digits) and 9 (two digits) industries.

B. IIT Indices Quantification

The construction of indices was performed according to the method proposed by Greenway and Milner (1984), who based their construction on the Grubel-Loyd index (1975):

$$IIT_i^k = 1 - \frac{\sum_j^n \left| X_{ji}^k - M_{ji}^k \right|}{\sum_j^n \left(X_{ji}^k + M_{ji}^k \right)} \qquad (1)$$

The index of IIT_i^k is represented as the residue from total trade to the inter-industrial component. The index value goes from 0 (non-existence of intra-industrial trade) to 1 (totally intra-industrial trade). More specifically, IIT_i^k is conceived as the index of *i* industries for the *k* industry, *k* representing either maquiladora, total (maquiladora and non-maquiladora) or non-maquiladora industry. Bilateral trade is aggregated from *j* products of HS classification to *i* CMAP industries.

As seen in the above table, the IIT for Mexico with the U.S. in its totality is higher than IIT non-maquiladora for the entire 1993-2006 period. However, a convergence between the two indices (total and non-maquiladora) is largely explained by changes in the type of commercial flow attributed to the maquiladora and the growth of the non-maquiladora IIT. For instance, in 1993 the total IIT was approximately 40 percent (including maquiladora), while non-maquiladora IIT was 25 percent, demarking a difference of 15 percentage points. However, 2006 demarcates a differing trend to the one from 1995. In this respect, the overall IIT and non-maquiladora IIT appear to be fairly similar. Indeed, the maquiladora component does not affect the total index to the degree it did previously, which can be explained by the fact that the maquiladora has shifted to become further inter-industrial in its nature. In addition, due to the slowdown in the U.S. economy and its immediate impact on the maquiladora industry, its trade suffered a reduction in volume after 2001 (Cañas and Gilmer, 2007). Thus, as Table 2 demonstrates, the total IIT remained around 40 percent for the entire period due to changes in the maquiladora industry (which became more inter-industrial) and the increase in the non-maquiladora IIT. This adjusted percentage is lower than indices calculated in previous estimations for the Mexican IIT (Brulhart and Thorpe, 2001; Leon and Dussel-Peters, 2001; Clark et al., 2001; Vogiatzoglou, 2005; Valderrama and Neme, 2011) due to its calculation included the maquiladora trade flows.

Table 2: Bilateral IIT indices for Mexico with United States and Canada 1993-2006 (%)

	United States		Canada	
	IIT Non-Maquiladora	IIT Total	IIT Non-Maquiladora	IIT Total
1993	25.02	39.52	4.35	4.84
1994	26.26	39.77	11.81	12.52
1995	28.03	38.96	8.68	9.48
1996	29.68	39.80	10.77	12.21
1997	32.34	41.73	14.06	15.46
1998	33.68	42.02	16.82	18.48
1999	34.28	41.42	14.21	16.14
2000	35.89	42.49	18.08	20.18
2001	37.19	42.48	16.95	19.03
2002	39.38	41.93	25.46	26.24
2003	39.65	41.11	27.80	29.29
2004	40.58	41.26	23.52	24.71
2005	39.26	40.39	28.32	27.10
2006	38.82	39.80	26.71	26.37

The maquiladora trade represented 50 percent of Mexico's total trade activities for the entire period, showing that the maquiladora industry played a significant role within the manufacturing trade. Additionally, the maquiladora's trade balance was largely positive whereas the non-maquiladora trade balance was predominantly in deficit for the examined period. It is worth highlighting this fact since the expression´s numerator (see expression 1) measures the absolute value of trade balance.

The index of IIT between Mexico and Canada is a good example of how both total and non-maquiladora IIT indices are quite similar (see Table 2), due to a reduced participation in the maquiladora trade by these two countries (see Table 1). Up until the year 2000, the maquiladora trade followed similar trends to those observed in non-maquiladora industries for which differences were detected in the trade between Mexico and the U.S. Nevertheless, the total IIT was not affected by the maquiladora industry since the average growth for the previously mentioned period was of 12 percent. Although the total IIT index overestimated the non-maquiladora IIT, the difference was not significant. Notwithstanding these results, it is evident a clear growth rates were witnessed in both economies for the non-maquiladora IIT indices. Finally, it is worth noting that the U.S. economic recession, which started in the year 2000, affected trade between Canada and Mexico and thus created a shift within the maquiladora trade, turning it increasingly inter-industrial for a period that lasted until 2004.

II. Measurement of Bilateral Horizontal and Vertical IIT for the Non-maquiladora Manufacturing Industry

As previously delineated, this article also aims to analyze the results for the bilateral non-maquiladora IIT indices by differentiating them according to their nature (horizontal and vertical). In order to perform this task, the author employed the expression outlined in expression (2). This expression redefines the adjusted index G-L (TIIT) to include the distinction between horizontal (HIIT) and vertical trade (VIIT):

$$\mathrm{TIIT}_{ji}^{p} = \frac{\sum_{j}^{n} \mathrm{IIT}_{ji}^{p}}{\sum_{j}^{n}\left(\mathrm{X}_{ji}+\mathrm{M}_{ji}\right)} * 100 = \frac{\sum_{j}^{n}\left(X_{ji}^{p}+M_{ji}^{p}\right)-\sum_{j}^{n}\left|X_{ji}^{p}-M_{ji}^{p}\right|}{\sum_{j}^{n}\left(X_{ji}+M_{ji}\right)} * 100 \qquad (2)$$

Expression (2) was applied to *j* products of the HS classification. Trade products were aggregated into *i* industries according to the CMAP classification, whereby *p* may refer to the horizontal trade (H) or vertical trade (V). Therefore, from expression (2) TIIT = HIIT + VIIT. According to the methodology suggested by Abd-el Rahman (1991), the unit values of exports and imports were used to distinguish each type of intra-industrial trade under the assumption that prices were the best approximation of the quality of a product. This allowed for a variety of goods of similar quality to be traded and classified as horizontal, provided they were within the following interval:

$$1-\alpha \leq \frac{UV_i^x}{UV_i^m} \leq 1+\alpha \qquad (3)$$

UV_i^x and UV_i^m were the ratios used for the unit values of exports and imports for the product *i* and α is the threshold value. Conversely, the trade of goods of different qualities (i.e. the vertical IIT) occurs when the unit value ratio falls outside the following ranges:

$$\frac{UV_i^x}{UV_i^m} < 1-\alpha \quad \text{or} \quad \frac{UV_i^x}{UV_i^m} > 1+\alpha \qquad (4)$$

The proposed threshold values (α) were 15 and 25 percent[4]. Expression (4) includes an additional disaggregation to analyze whether the vertical IIT is of low or high quality using the unit values of exports and imports to classify goods of high quality as well as those of low quality (Greenaway et al., 1994). Following this reasoning, one would expect that those countries with a high capital/labor ratio would specialize in the export of goods of high quality. Nevertheless, this was not entirely the case for a number of reasons. In order to demonstrate why this process was not realized in its entirety, the following table illustrates the disentanglement of the horizontal and vertical bilateral IIT (percentages) between Mexico and NAFTA partners.

The IIT figures shown in Table 3 highlight how significant vertical IIT was present throughout the 1994-2004 periods for non-maquiladora Mexican products, both at threshold values of 0.25 and 0.15. The well-differentiated indices underlined the North-South trade relationship character of Mexico with these countries and confirmed that the aforementioned

[4]Abd-el Rahman selected 15 percent as a threshold limit; however, this value was subsequently extended to 25 percent (Greenaway et al., 1994: Blanes and Martín, 2000; Sohn and Zhang, 2006).

trade was based on comparative advantages as contended by Neo-Heckscher-Ohlin's theory (or Neo-H-O) (Falvey, 1981; Falvey and Kierzkowski, 1987).

Conversely, the bilateral rates in relation to the U.S. seemed to suggest a slight increase in the horizontal trade for the last years of the examined period ($\alpha = 0.25$), despite the fact that vertical trade was dominant throughout most of this time. In turn, vertical IIT was characterized as being of high or low quality, the latter being predominant for Mexico and its trading partners.

Table 3: Horizontal (HIIT) and Vertical (VIIT) Bilateral IIT (%)

		α=0.25		α=0.15		VIIT	
	TOTAL	HIIT	VIIT	HIIT	VIIT	High α>1.15	Low α<0.85
United States							
1994	25.89	5.21	20.67	3.57	22.31	14.03	8.28
1995	27.80	4.73	23.07	2.95	24.85	14.59	10.25
1996	29.63	5.48	24.15	3.23	26.40	19.16	7.24
1997	32.32	6.36	25.96	4.20	28.12	18.49	9.63
1998	33.58	5.33	28.25	3.40	30.18	11.71	18.47
1999	34.13	8.00	26.13	5.55	28.58	16.23	12.35
2000	35.81	7.81	27.99	3.12	32.69	25.94	6.74
2001	37.28	7.11	30.18	2.76	34.52	28.53	5.99
2002	38.03	8.04	29.99	2.65	35.38	19.72	15.66
2003	38.98	17.05	21.94	14.10	24.88	10.27	14.62
2004	39.56	17.05	22.51	11.20	28.36	10.17	18.19
2005	39.26	25.50	13.76	17.00	22.27	10.26	12.00
2006	38.82	22.23	16.58	13.12	25.69	12.24	13.45
Canada							
1994	11.83	0.79	11.04	0.50	11.34	8.45	2.88
1995	8.71	0.62	8.09	0.42	8.29	4.26	4.03
1996	10.80	1.09	9.71	0.77	10.03	5.63	4.40
1997	14.03	2.15	11.88	0.80	13.23	5.60	7.63
1998	17.26	3.00	14.26	1.55	15.71	7.51	8.20
1999	14.27	1.90	12.37	1.31	12.96	6.91	6.06
2000	18.12	0.77	17.34	0.61	17.50	15.82	1.68
2001	17.09	2.48	14.61	0.49	16.60	13.18	3.42
2002	25.54	6.19	19.34	5.46	20.08	9.74	10.34
2003	27.88	15.77	12.11	14.66	13.22	4.87	8.34
2004	23.71	11.28	12.42	10.02	13.68	7.60	6.08
2005	28.32	20.48	7.85	14.65	13.67	7.93	5.75
2006	26.71	19.13	7.58	14.80	11.91	7.38	4.53

Source: own calculation based on INEGI-BANXICO databases, several years.

Similarly, Table 3 illustrates how percentages for the horizontal IIT as related to Mexican trade with the U.S. seemed to be higher than those for trade with Canada. In this regard, even though horizontal IIT with Canada increased during the years of the treaty (as percentages of the rate of total IIT), there was a visible predominance of trade of a vertical nature. A further perceptible change also took place in relation to the vertical IIT for both the U.S. and Canada in equal manners. In correlation, the low quality vertical IIT dominated the entire period with the exception of the final two years when changes in the automotive industry (which represents nearly 50 percent of the total traded with Mexico) affected the final balance.

On the whole, the data confirmed the vertical nature of the IIT of Mexico with these two countries. Likewise, the percentages obtained were consistent with the findings obtained in studies for the IIT of North-South countries which showed a predominance of the vertical IIT (Fukao et al., 2003; Byun and Lee, 2005; Ando, 2006).

On this note, it is surprising that although one might expect the trade of goods to be vertically differentiated, the trend actually reflected an increase of horizontally differentiated products (Table 3). An analysis by industrial sectors showed that the main explanation for this trend was the changes in the NAFTA tariff schedule for the automotive industry.[5]

Establishing the IIT indices shows the need to differentiate the indices from the maquiladora component and more particularly, to examine the bilateral IIT between Mexico and its NAFTA partners. Accordingly, the following section will examine the empirical hypothesis, the proposed variables and its predicted signs.

III. Determinants of the Non-maquiladora IIT of Mexico with NAFTA Partners

This section analyzes the IIT determinants following the distinction proposed by Loertscher and Wolter (1980) and Balassa and Bauwens (1987), in which the authors suggest the need to differentiate between country-specific and industry-specific variables. This distinction is of key importance since the state of the economy in aggregate terms has an impact on the trade flow, whereas economies of scale, product differentiation and capital intensity are industry specific factors (*idem*).

A. Country-specific Variables

A.1. Differences in the Market Size (dgdp)

Linder (1961), citing Chamberlain-Heckscher-Ohlin's (C-H-O) theory, postulated that countries with similar market structures tend to share similar demand patterns. This similarity favored a trade of varieties of same quality or horizontal IIT (Greenaway and Milner, 2002). Therefore, the expectation would be that the narrower the disparity in the size of the markets, the greater the flow of goods horizontally differentiated. Likewise, Melitz (2003), while discussing the models of firm heterogeneity, argued that countries with similar demand structure tend to establish a trade of differentiated goods.

Conversely, given that the trade between Mexico and its NAFTA trading partners is characterized as a North-South trade (Clark and Stanley, 1999), the Neo-H-O framework postulates that an IIT of different quality between countries of different sizes should be used to examine behavior of trade flows between such countries.[6] In such a case, the assumption would

[5]The automotive industry represents close to 14 percent of total trade with the U.S. The tariff for automobiles went down from 20 percent in 1993 to 0 percent in 2003.
[6]Falvey (1981), Falvey and Kierzkowski (1987) and Flam and Helpman (1987) are considered as proponents of the monopolistic competition Neo-H-O framework, while Shaked and Sutton (1984) favored the oligopolistic market framework.

be that differences in market size would be positively related with trade of different qualities (horizontal or vertical trade). In this respect, a proxy variable, *dgdp*, which represents the differences in market size, is built with the GDP of each country, following Balassa and Bauwens (1987) who postulated the following:

$$dgdp_{fht} = 1 + \frac{[w * \ln w + (1-w) * \ln(1-w)}{\ln 2} \tag{5}$$

$$w = \frac{gdp_{ht}}{gdp_{ht} + gdp_{ft}}$$

The expression *w* in equation (5) illustrates a ratio of incomes (GDP) between trade partners. The subscript *f* refers to the Mexico's partner, *h* refers to Mexico and *t* represents the time period (1994-2006). This study assumes that the difference in income might be positively related to vertical IIT and total IIT (since the vertical IIT represents a high proportion of the total IIT), while conversely being negatively linked to horizontal IIT.

A.2. Differences in Per Capita Income (dpcgdp)

The variable *dpcgdp* represents the difference in per capita incomes between the two countries; it is constructed in the same way as in (5) with the difference that *w* refers to per capita GDP for Mexico and its trading partners.

As attested by numerous empirical estimates (Blanes and Martín, 2000; Durkin and Krygier 2000; Gullstrand, 2002; Sohn and Zhang, 2006; Turkcan and Ates, 2010), the *dpcgdp* can be largely viewed as a determinant of the IIT. Indeed, Linder (1961) postulated that the C-H-O theories could be used to explain how small differences in per capita income between countries might positively affect the IIT (horizontal IIT). Similarly, Flam and Helpman (1987) concluded that the IIT of vertically differentiated goods is determined by country size and income distribution variables. In effect, differences in income distribution produce a demand for trade of both low and high quality products.

Taking into consideration demand factors, this study predicts that differences in per capita income are negatively associated with the horizontal IIT and positively correlated with per capita income of vertical IIT and total IIT. In the latter case, this positive correlation will be due to the high percentage share of the vertical IIT in the total IIT.

A.3. Differences in Factor Endowments (dkl) and *(dedu)*

This study proposes the capital-labor ratio as an alternative variable for factor endowment differences between countries. The purpose is to verify whether these differences, seen from the supply side, have any effect on the performance of the IIT. The variable is based on the same theoretical framework as the *dgdp* and *dpcgdp* variables.

The study assumes that countries with similar factor endowments (similar capital-labor ratios) are likely to focus on the trade of varieties with similar qualities (horizontal IIT), whereas countries with different factor endowments tend to specialize on the trade of varieties of different quality (vertical IIT) (Falvey, 1981). Furthermore, this study proposes that differences in factor endowments, when referring to North-South countries (a relationship analyzed in this article), might explain the behavior of IIT flows (particularly those of a vertical nature).

More specifically, this study postulates that the variable *dkl* quantifies the differences in the capital-labor relationship between trading partners, known similarly as the differences in the capital intensity. However, it is worth highlighting that due to data availability restrictions, *dkl* was constructed out of data pertaining to the gross fixed capital formation (corrected by inventories depreciation).

A further measure which in conjunction with *dkl* intends to quantify differences in factor endowments is the difference in human capital endowments (*dedu*). Factor endowments have been commonly linked to differences in physical capital endowments (Falvey, 1981; Falvey and Kierzkowski, 1987). Although Torstensson (1991, 1996) has criticized the empirical estimates of the IIT determinants that only consider the physical capital as the main variable that explains a trade in goods of different qualities, the empirical analysis conducted by Torstensson (1996) concluded that human capital, rather than physical capital, was the main determinant of the vertical IIT (*idem*, 1991). This study therefore employs *dedu* as a proxy of the difference in the human capital endowments between trade partners. This variable is built as the difference in absolute values, of the percentage of the population between 25 and 64 years who have reached at least university, college or technical education. In terms of signs, the study expects the difference in factor endowments to have a negative effect on the horizontal IIT, and for this same difference to account for a boost in vertical IIT, based on the understanding that a skilled workforce is related to the production of high-quality goods.

A.4. Trade Orientation (to)

This variable *to* reveals that with a greater participation of a particular country in the world market, an increase in the flow of horizontally or vertically differentiated goods is likely to take place. The variable *to* is constructed following the methodology of Balassa and Bauwens (1987) out of the residuals of a regression in exports per capita with respect to income per capita and population:

$$\log\left(\frac{X_{hf}}{P_h}\right) = \alpha + \beta \log\left(\frac{Y_h}{P_h}\right) + \delta \log P_h + \varepsilon_h \tag{6}$$

Where $to = \varepsilon X$ represents bilateral exports between *h* home country and *f* foreign country. *P* represents per capita income and *Y* is a variable for the GDP.

According to Balassa and Bauwens (1987) *to* is an indicator of trade openness. Thus the contention would be that greater openness of trade might yield positive effects for the horizontal and vertical IIT. Additionally, since the variable is constructed from exports, it makes it possible to differentiate total trade from its maquiladora component.

Empirical evidence supporting the argument of trade orientation as one of the IIT determinants can be found in the works of Thorpe and Zhang (2005) for the East Asian economies, Ekanayabe (2001) for the Mexican economy and Clark and Stanley (1999, 2003) for the U.S. economy.

B. Industry-specific Variables

IIT flows cannot be solely explained according to differences or similarities between trade countries since factors at industry level also influence IIT performance (Balassa and Bauwens, 1987). The theory of IIT flows is based on the monopolistic competition theory in which product differentiation facilitates the explanation of trade of similar varieties of goods (Krugman, 1979; Lancaster, 1980). Accordingly, product differentiations, economies of scale and capital intensity, among other factors, are analyzed as determinants of trade of differentiated goods (Greenaway, 1984). Hence, this study proposes a set of explanatory variables of industrial attributes as determinants of the IIT indices for Mexico and its NAFTA partners.

B.1. Horizontal Differentiation of the Product (pdi)

The new theory of international trade indicates that industries specialize in a line of varieties of goods to such a degree that trade between countries takes places according to the demand for varieties that are not locally produced (Krugman, 1979, Lancaster, 1980). However, problems arise in the selection of an adequate measurement of a product differentiation variable (Greenaway and Milner, 1986). Taking this measurement problem into account, this study formulates a variable proxy as the difference in the ratio of unit values of exports. This variable is also built at the level of industry and on a bilateral basis as an index of similarity of unit values. This proxy is based on the work of Hufbauer (1970), who argues that if the products become increasingly homogeneous, the variation in unit values should be small. An approximation method can be obtained through the use of a modification proposed by Blanes and Martín (2000), which has the added advantage of being more manageable.

$$pdi_{ifht} = \sum_{j \in i} \left[\frac{V_j}{\sum V_{jt}} \times \frac{min\left(VU_{jht}, VU_{jf`t}\right)}{max\left(VU_{jht}, VU_{jf`t}\right)} \right] \quad (7)$$

In expression (7), *pdi* represents the index of homogeneity, *V* stands as the export value of the *j* product at *i* industry level and *VU* represents the unit value of exports. Lastly, *h* and *f* refer to the local and foreign country respectively.

As attested by expression (7), this study hypothesizes a greater product differentiation as linked to an increased trade of a horizontal nature. Likewise, the expectation would be for an enhanced differentiation of the product that would to negatively affect vertical IIT. Indeed, these two signs are both expected for total trade.

B.2. Economies of Scale (ee)

The heterogeneous industrial structure of Mexico as well as the presence of a large national and foreign capital in trade activities implies that the inclusion of various economies of scale in the model is of vital importance. In this regard, this article follows the methodology developed by Caves (1981) which has been recurrently used in studies dealing with the Mexican industrial structure (Casar et al., 1990; Dominguez and Brown, 2003). Thus, following Caves's (1981) methodology, the variable *ee* stands as the ratio between the minimum size efficient plant, *tme*, in relation to the relative disadvantage of costs, *drc*.

$$ee_{it} = \frac{tme_{it}}{drc_{it}} \quad (8)$$

As illustrated by expression (8), a positive relation is expected to occur between economies scales and horizontal IIT. Nonetheless, when referring to vertical IIT, signals are not as straightforward given that this variable is constructed to prove horizontal IIT. Cave's methodology (1981) has been applied in several empirical studies on IIT determinants, including research conducted by Balassa (1986a), Balassa and Bauwens (1987), Bano (1991) and Blanes and Martín (2000).

B.3. Technology Intensity (ryd)

This variable is defined as the average percentage of sales set aside for research and technological development by manufacturing firms (Martín-Montaner and Orts, 2002). The *ryd* variable denotes that spending on research and development could be a reflection of efforts by firms to offer a greater number of varieties for the local market and exports industry (horizontal IIT). In the same way, the *ryd* variable could also denote efforts realized by companies to provide a wider number of varieties in the improvement of the quality of the products traded by a country (vertical IIT) (Faruq, 2006). Thus, this study posits that the relationship concerning the horizontal and vertical IIT is a positive one.

Since the trade opening of the Mexican manufacturing industry at the end of the eighties, export firms increased their expenditure on plant modernization resources in order to achieve enhanced global competitive advantage (Dominguez and Brown, 2004). Owing to this fact, the present study considered the inclusion of the ryd variable essential to its integrity. Furthermore, this variable can be seen as one of the variables which represent firm heterogeneity and can provide an explanation of firm participation in international trade (Melitz, 2003).

B.4. Presence of Foreign Capital (fdi)

Participation in foreign investment has been part of the Mexican industrial development strategy since the onset of the industrialization process in the forties and fifties (Villarreal, 1997). During this period, foreign capital turned to the production of goods for the domestic market (Villarreal, 1997; Máttar et al., 2002). Concomitantly, trade liberalization and the promotion of exports by the government boosted the development of the sector with a significant presence of foreign investment (Lustig, 1994). This took place even in areas such as the automotive or chemical industries, where foreign capital was traditionally restricted.[7]

The *fdi* variable has been empirically used as one of the main determinants of trade flows between developed and developing countries as well as in IIT studies (Blanes and Martín, 2000; Fukao, et al 2003; Melitz, 2003; Sohn and Zhang, 2006; Turkcan and Ates, 2010). This variable was obtained through the average percentage of the participation of foreign capital in the manufacturing industry. This variable was calculated to three digits resulting from the National Survey of Employment, Wages and Technology and data from INEGI. The study predicted the relationship between the presence of foreign capital and the different types of IIT to be a positive one.

[7]Dussel-Peters (2000) showed that since 1988 FDI had a high association with the most dynamic exports. The NAFTA helped to increase exports years after the accord was signed. However, this author pointed out that FDI was concentrated in a small number of industrial sectors without any significant generation of new jobs. Máttar et al. (2002) also found a strong relationship between exports and FDI, however, exports had a high import content, which affected the trade balance.

B.5. Intensity of Human Capital (khum)

The *khum* variable is proposed in order to explain the vertical IIT, especially in reference to a North-South trade. Differences in factors endowments would increase trade in products of different qualities, in this case, the vertical IIT. More explicitly, the interest lies in denoting evident changes for a significant part of the IIT which is of a vertical nature. In so doing, this study follows the methodology of Martín-Montaner and Orts (2002) for the construction of the variable *khum*. This variable is defined as the difference between the salaries paid to skilled workers and wages paid to unskilled workers. This difference is in turn multiplied by the total number of workers qualified at the industrial branch level which is expressed in equation (9):

$$khum_{it} = (w - s)L_{it} \tag{9}$$

w refers to the salaries of skilled workers; s represents the wages of unskilled workers and L corresponds to the number of skilled workers. The amounts are expressed in constant 2000 dollars and at the industrial branch level. In this case, the study expects *khum* to be positively related with different types of IIT, including the vertical IIT.

B.6. Tariff (tar)

The tariff *(tar)* is a dummy variable which takes the value of 0 for the 1994-1999 period and 1 for the 2000-2006 period. Previous sections underlined how the NAFTA tariff schedule was one of the reasons behind the 2000-2001 IIT indices changes. More specifically, the reduction in transportation and machinery tariffs, which was initiated in 2000, impacted trade flows. Furthermore, an increase in competition within the textile industry due to Chinese products flooding the U.S. market also had an influence on Mexican bilateral trade with the U.S.A. Consequently, this study proposes the inclusion of a dummy variable to differentiate these two periods, denoting the changes which took place prior and following the NAFTA tariff schedule.

The next section presents a proposed model to test the IIT determinants for the Mexican non-maquiladora industry, differentiating IIT according to horizontal and vertical nature. The explanatory variables are proposed following the theoretical foundations of IIT and previous empirical evidence for trade between North-South countries.

C. Econometric Specification

The econometric specification model boasts total bilateral IIT percentages which are differentiated by their horizontal and vertical natures. The source of information used for the construction of the dependent variable was INEGI, since it differentiates between maquiladora and non-maquiladora in its provision of import and export data. The explanatory variables were obtained through the use of multifarious data sources (aggregated by countries) such as the World Bank, Penn World Tables, United Nations and the Organization for Economic Cooperation and Development (OECD). The industrial level data was gathered from statistics published by the INEGI and the United Nations Conference on Trade and Development (UNCTAD). The collected data covers the period relating to 1994-2006 and refers to 27 different manufacturing industries while also covering Mexican bilateral trade with the United States and Canada. As was mentioned earlier, INEGI ended the publication of trade data disaggregated between maquiladora and non-maquiladora in 2006.

The data for the dependent variable *iit* presents a set of challenges, amongst which the presence of zeros in the dependent variable stands out. Given that this variable is a percentage, which ranges from 0 to 1 (in this case the maximum value goes to only 75 percent), a predominance of zeros could lead to performance transformations on the variable, which would consequently result in problems of interpretation.

In regards to explanatory variables, this study proposes a set of explanatory variables which represent the country-specific variables making use of two-dimensional data (period and country). Additionally, a set of explanatory industry-specific variables consisting of three dimensions (period, country and industry) are put forth. With regards to econometric estimations, these include time series and cross-section data (13 years, 27 industries, 2 countries).

Furthermore, this article has opted to employ Non-Lineal Squares (NLS) estimation with a logistic probability function, since the dependent variable is a percentage, with values ranging from zero to one. A standard Ordinary Least Square (OLS) has the problem that it predicts values outside this range which would result in inconsistent parameters. Balassa (1986b) proposed a cumulative logistic distribution function with NLS, which allows for extreme values such as zero or one. It is possible to preserve some valuable information that otherwise would have been lost when a simple logarithm is applied on the dependent variable. Gullstrand (2002) pointed out that another advantage of using NLS estimation is that there is no need for a specific distribution of the error term.

The NLS estimation has been employed in several empirical applications on the subject, such as in case studies published by Balassa and Bauwens (1987), Greenaway et al. (1999), Blanes and Martín (2000), and Gullstrand (2002). All these studies also included determinants which correspond to the characteristics of the country as well as industrial characteristics, in order to differentiate both the horizontal and vertical IIT. Following this logic, the function of logistics distribution by NLS stands as:

$$IIT_{fhit} = \frac{1}{1+\exp\left(-\beta' X_{fhit}\right)} + \nu_{fhit} \tag{10}$$

$$\beta' X_{fhit} = \beta_0 + \beta'_1 X_{fht} + \beta'_2 X_{it} \tag{11}$$

X_{fhit} represents the matrix containing the variables which correspond to the country—and industry—specific characteristics. In turn, industrial β stands as the vector of coefficients while v_{fhit} encompasses the terms of errors. Furthermore, as can be seen in expression (11), the matrix of explanatory variables can be decomposed in order to differentiate variables according to country-specific characteristics ($\beta'_1 X_{fht}$,), as well as industry-specific characteristics ($\beta'_2 X_{it}$). The estimation of parameters was performed through NLS while estimators were of a consistent and efficient maximum likelihood (provided that the residual was normally distributed). Finally, the explanatory variables were estimated in their logarithmic form (except for the variables *to* and *tar*).

In addition, the study illustrated the results of an alternative estimation in combination with an estimation by NSL using a Generalized Linear Model (GLM). This model allowed the estimation of the dependent variable in the form of a proportion. In this respect, although there are no other studies on the IIT determinants using this approach to compare with this paper's results, it is useful to propose a GLM model as an additional option for the treatment of functions with fractioned dependent variables.

$$\mathbf{Y} = \mathbf{X\beta} + \boldsymbol{\mu} \tag{12}$$

According to the matrix model (12), a GLM *Y* contains an observable random vector whereby its elements are independent in regards to the function of the exponential family distribution. In addition, *Y* represents a systematic component given by the linear predictor $\eta = X\beta$. Finally, the GLM *Y* also has a link function $g(\mu)$ that relates the linear predictor η with the expected value of *Y* and $E(Y/X) = \mu$, as expressed in (13)

$$\mathbf{g(\mu) = \eta}. \tag{13}$$

The expressions (12) and (13) allow specific restrictions to be executed on *Y* (via g (μ)). In this case, the dependent variable stands as a percentage which ranges from 0 to 1, with a binomial distribution, making it suitable to a family of logit link as can be seen in expression (14):

$$\mathbf{\eta = \ln(\mu/(1-\mu))} \tag{14}$$

The optimization of the parameters is most plausible and the predicted values of these functions are maintained in the range of 0 and 1. Therefore, it is not necessary to perform any additional processing to the dependent variable. Overall, the main objective for the use of a GLM is to solve a sample reduction problem that occurs with NLS estimations as well as to obtain more reliable results, particularly with the horizontal IIT data. The following section covers the results obtained using both econometric specifications.

Table 4: Econometric Results

	First Specification						Second Specification					
	NL			GLM			NL			GLM		
Variables	*iit*	*hiit*	*viit*	*iit*	*hiit*	*viit*	*iit*	*hiit*	*viit*	*iit*	*hiit*	*viit*
dgdp	.10** *(2.91)*	-.20 *(-.54)*	.08* *(2.22)*	.07* *(2.10)*	.20*** *(3.80)*	.06 *(1.68)*	.14*** *(5.32)*	-.11 *(-.34)*	.11** *(3.06)*	.10*** *(4.52)*	.32*** *(7.24)*	.09** *(2.87)*
dpcgdp	4.24*** *(4.87)*	5.69* *(2.18)*	3.36** *(3.30)*	3.98*** *(4.90)*	8.33*** *(6.74)*	3.49*** *(3.66)*						
dkl	-.10 *(-1.09)*	.50** *(2.67)*	-.21 *(-1.82)*	-.10 *(-1.07)*	.10 *(.73)*	-.18 *(-1.68)*	-.40*** *(-8.36)*	.17 *(.81)*	-.45*** *(-6.94)*	-.37*** *(-8.28)*	-.54*** *(-6.70)*	-.45*** *(-7.30)*
dedu	1.77*** *(3.32)*	4.45* *(2.06)*	.73 *(1.16)*	1.36* *(2.56)*	5.41*** *(6.21)*	.44 *(.71)*	-.05 *(-.07)*	3.42 *(1.39)*	-.95 *(-.91)*	-.22 *(-.33)*	1.25 *(1.01)*	-1.18 *(-1.20)*
tonm	.25 *(.31)*	2.44 *(1.75)*	-.20 *(-.20)*	.29 *(.42)*	2.63* *(2.15)*	-.09 *(-.10)*	.63 *(.75)*	3.01* *(2.00)*	.09 *(.08)*	.64 *(.86)*	3.44** *(2.65)*	.22 *(.20)*
pdi	-.53*** *(-3.85)*	.003 *(.01)*	-.67*** *(-4.18)*	-.48*** *(-3.67)*	.22** *(3.07)*	-.63*** *(-4.07)*	-.37** *(-2.75)*	.36 *(.66)*	-.60*** *(-4.03)*	-.30* *(-2.53)*	.30** *(3.19)*	-.54*** *(-3.72)*
ee	.13*** *(4.50)*	-.18** *(-3.18)*	.24*** *(6.80)*	.12*** *(4.63)*	-.18*** *(-3.42)*	.19*** *(6.12)*	.14*** *(4.62)*	-.17** *(-3.00)*	.24*** *(6.77)*	.11*** *(4.24)*	-.19*** *(-3.46)*	.19*** *(5.80)*
fdi	.19*** *(5.35)*	-.06 *(-.89)*	.27*** *(6.52)*	.17*** *(5.37)*	.11 *(1.71)*	.23*** *(6.36)*	.16*** *(4.61)*	-.002 *(-.02)*	.24*** *(5.59)*	.11*** *(3.71)*	.12 *(1.92)*	.19*** *(4.81)*
ryd	.34*** *(6.48)*	.21* *(2.27)*	.34*** *(4.72)*	.31*** *(6.57)*	.14 *(1.73)*	.29*** *(4.61)*	.27*** *(5.38)*	.20* *(2.09)*	.28*** *(3.80)*	.22*** *(5.10)*	.17* *(2.26)*	.23*** *(3.46)*
khum	-.0007 *(-.04)*	.06 *(1.87)*	.01 *(.52)*	-.01 *(-.95)*	.07* *(2.32)*	-.01 *(-.48)*						
tar							.35*** *(3.79)*	.32 *(1.53)*	.31* *(2.23)*	.33*** *(3.88)*	.75*** *(5.23)*	.31* *(2.40)*
c	7.64*** *(5.34)*	11.8** *(2.66)*	4.22* *(2.39)*	5.93*** *(4.66)*	15.4*** *(7.50)*	3.4* *(2.12)*	-1.83 *(-1.69)*	2.61 *(.72)*	-3.6* *(-2.23)*	-3.00** *(-2.95)*	-2.99 *(-1.56)*	-4.81** *(-3.18)*
N	636	324	636	636	576	636	636	324	636	636	576	636
R2_a	.58	.11	.51	.08	.16	.10	.48	.09	.43	.04	.15	.07
F	87	5	67				65	5	55			
Chi2				477	638	528				401	532	398
AIC	-1260	-1160	-1490	494	97	398	-1223	-1149	-1369	527	102	416

D. Results from Econometric Estimations

Table 4 illustrates the results of two econometric specifications using NSL and GLM models, differentiating the IIT according to their horizontal and vertical natures, excluding maquiladora considerations. Therefore, the dependent variables are intra-industry trade *(iit)*, horizontal intra-industry trade *(hiit)* and vertical intra-industry trade *(viit)*, for the non-maquiladora industry. The first specification differs from the second specification through its inclusion of the variable *dpcgdp*, differences in per capita GDP, the *khum* variable, and intensity of human capital. However, the first specification does not include the tariff variable, *tar*, which is included in the second specification.

A first look at Table 4 denotes similar results for vertical IIT and total IIT, because vertical IIT accounts for most of the total IIT. Horizontal IIT coefficients seem to lack significance, in particular when these are estimated through NLS due to a problem with the sample data. This study overcomes this deficiency by applying a GLM estimation. In this respect, the above table seems to indicate that horizontal IIT coefficients seem to be more significant when linked to GLM estimation.

In relation to country-specific variables, the data contained in the table confirms that results are consistent with the hypothesis raised. Nevertheless, the differences between the first and second specification, regarding the variables denoting the dissimilarities in the size of the market (*dgdp*) and differences in economic development (*dpcgdp*, *dkl* and *dedu*), must still be accounted for. The first specification includes *dpcgdp* (differences in per capita income) in conjunction with variables of differences in factor endowments *dkl* (differences in capital-labor ratio) and *dedu* (differences in level of education). The second specification solely includes the differences in factor endowments. The variable for differences in market size (*dgdp*) indicates a better response (the coefficients are significant) when it is included in the second specification rather than the first one.

Furthermore, the *dgdp* variable is in most cases significant due to the two specifications related to the total and vertical IIT expected signs, while the expected sign for the horizontal IIT is not correct (although the NLS specification is correct, this is still not significant). This result can be explained to some extent by a risk of partial multicollinearity, although the pre-testing estimates indicated that these were within the allowed limit.[8]The results' implications for the Mexican non-maquiladora IIT reveal that the difference in market size to a large extent serves to explain the trade in varieties of different quality (vertical IIT). Thus, the results appear to substantiate evidence found in empirical evidence for countries whose trade is characterized by North-South flows (Blanes and Martín, 2000; Gullstrand, 2002; Fukao et al., 2003; Thorpe and Zhang, 2005).

The significance of variables in country size is related to economic distance. As previously mentioned, economic distance (*dpcgdp*) was devised by taking into account the characteristics of vertical IIT, predominating in North-South trade. Therefore, the coefficients for a vertical IIT and total IIT were expected to be positive. Conversely, the coefficients for the horizontal IIT were expected to be negative. The results for the first specification proved a positive relation for vertical and total IIT with highly significant coefficients. However, following a similar trend to the *dgdp* variable, difference of per capita income (*dpcgdp*) did not produce the expected signs

[8]Attempts were made to include an alternative variable to reflect the size of the markets, using example from empirical literature such as the average real GDP between partner countries. (Balassa, 1986a). Yet its inclusion caused problems of collinearity with other regressors.

for the horizontal IIT, even when this variable is estimated under the GLM model. Accordingly, these results support previous empirical findings on North-South trade and explain the performance of Mexico's commercial relationship with its NAFTA partners. Furthermore, these results confirm Greenaway and Milner (2002)'s findings, which recognized that the difference in per capita income promotes vertical IIT flows.[9]

In connection with the economic distance variable, this study acknowledged the potential risk that the difference in per capita income variable (*dpcgdp*) would encompass both demand and supply-side factors. Consequently, the study proposed separate variables to represent the differences in factor endowments as supply side variables. One of the variables was built as the difference in the physical capital endowments (*dkl*) and the other variable was constructed as the difference in human capital endowments (*dedu*). These two variables were added in order to compare whether either of these variables could provide an explanation for the proposed model. The second specification considers these two variables (*dkl*, *dedu*) without inclusion of the differences in per capita income (*dpcgdp*). This specification avoids a potential problem of instability of the coefficients.

The *dkl* variable appears significant, indicating the expected negative signs for total and horizontal IIT (in particular when it is estimated by GLM).The coefficients for the vertical IIT report the expected negative sign, which appear significant as well. Thus, these results seem more in accordance with the postulations made by Linder (1961) and Blanes and Martín (2000), who also proposed this same variable. Nevertheless, the difference in the allocation of human resources (*dedu*) does not seem to explain the IIT; it was only significant with the correct sign for the first specification. In the second specification, the expected signs only surfaced in a few cases, and most of these were not of great significance. It is worth mentioning, though, that the works cited for Mexico did not include physical and human capital endowment variables, which arguably made it difficult to compare these variables with other results.

Table 4 indicates the contribution of the *to* variable to the proposed model specification. The variable trade orientation (*to)* was included in the two specifications. However, the results indicate there was no contribution from this variable as a determinant of horizontal IIT. Nevertheless, the variable *to* does denote a positive relationship for all other cases (with the exception of the first specification, where it presents a negative sign) without this being significant. Even though the study expected the orientation of trade, as one of the determinants, to produce a positive influence, the sample used in this study only considered data from the year 1994 onwards, while trade liberalization occurred in 1987. Nonetheless, it is possible that the role of openness in a framework of trade integration could lead to the growth of trade flows regardless of the trade pattern among members.

In fact, another variable that indirectly showed how trade liberalization affected the IIT flows was the variable *tar* in the second specification. In this regard, Table 4 indicates that *tar* was highly significant for all types of trade and also demonstrates the expected positive signs for NLS and GLM models. The positive relationship of the variable with different types of trade would be consistent with that postulated by Markusen and Wiggle (1990) who argue that the elimination of tariff restrictions would foster the commercial relationship between North-South

[9]These results are not consistent with those obtained by Ekanayake (2001) since the author posited the income gap from the demand structure perspective. In addition, the author did not carry out the differentiation of IIT by its horizontal and vertical nature or the differentiation between maquiladora and non-maquiladora. Montout et al. (2002) postulated a positive relationship between the economic distance and vertical IIT; however, the coefficients had a negative sign for the horizontal and vertical IIT trade of automotive final goods.

countries. In this case, the variable *tar* showed the significance of the changes within the NAFTA tariff schedule to explain the different types of IIT.

Regarding the industry characteristics variables, Table 4 denotes a group of variables that express mostly the expected signs and whose coefficients are significant. These variables include the horizontal differentiation of the product, economies of scale, the presence of foreign capital and research and development. These results for the industrial level variables are noteworthy since previous empirical evidence for the Mexican manufacturing industry mainly focused on country-specific characteristics.

In particular, the economies of scale variable *(ee)* is significant and stands within the expected signs for the total and vertical IIT. Nonetheless, there is a negative sign associated to the horizontal IIT. This negative sign is related to the hypothesis of Ethier (1982), which examines high domestic plant scale economies resulting in a reduced number of companies and therefore a smaller number of varieties to trade. On the other hand, in reference to vertical IIT, the existence of economies of scale in the non-maquiladora industry reflects the presence of large companies in the external sector. These companies are linked with subsidiary companies in the United States and Canada, such as in the case of the automotive and pharmaceutical industries. However, it has only been possible to compare these results with the work of Montout et al. (2002). This study includes an economies of scale variable for the automotive industry (including maquiladora) while describing the coefficient as the negative sign.[10] Previous research by Arjona and Unger (1996) and Brown and Domínguez (1997) include economies of scale variables to explain the behavior of the industrial structure in a context of trade openness. Both works recognize the presence of large enterprises with national and foreign capital, and how these companies take advantage of production on a large scale which enables them to compete in an environment of open economy.

It is precisely the presence of foreign capital (*fdi*) which actually acted as a critical factor in explaining the total and vertical IIT but not the horizontal IIT. As can be seen in Table 4, the *fdi* variable is significant in all cases and denotes the expected signs. Moreover, when these results are compared with those found in other similar studies which include this variable to explain trade between unequal countries, the *fdi* is also a significant determinant for the vertical IIT. For the most part, works highlighting the determinants of the North-South IIT include foreign capital as one of the main determinants of this trade pattern (Blanes and Martín, 2000; Fukao et al, 2003; Sohn and Zhang, 2006). In the case of the Mexican manufacturing industry and the presence of FDI, Valderrama and Neme (2011) found a positive relationship between IIT and *fdi*; however, their trade data included the maquiladora industry. Lastly, according to models of firm heterogeneity, exporting companies can complement their activities with foreign investment. Owing to this perspective, the work of Helpman et al. (2004) elucidates, to some extent, the factors influencing the decisions of companies exporting or embarking on foreign direct investment abroad. In this sense, products that these companies export have an impact on patterns of trade and the opportunities to find new sources of comparative advantages.

Another variable that is highlighted in Table 4 is *ryd* (spending on research and development). This variable is highly significant and denotes the expected signs for the total IIT, the horizontal IIT (with the exception of the GLM first specification) and the vertical IIT. Following this logic, the promotion of research and development by the Mexican government has been proven effective to increase intra-industry trade. These activities were meant to increase competitiveness through

[10]It is worth noting that Montout et al. (2002) proposed a different proxy variable for economies of scale than this present study.

an increase in the quality of products targeting the foreign market.[11] In this regard, heterogeneity models highlight how companies producing goods for the local and foreign market convey discrepancies in the quality of goods depending on which market these goods are destined for. Interestingly, export goods seem to denote a higher quality than those produced for the local market.[12] Furthermore, the results in Table 4 seem to confirm a positive relationship between the *ryd* variable and the total and vertical IIT.

In addition, the variable intensity of labor, *khum*, submitted in the first specification, has only proven significant when modeled through a GLM for horizontal IIT, with a relatively small coefficient. This study expected this variable to prove that an increase in human capital would explain the trade flows of different quality products as Martín-Montaner and Orts (2002) proposed for the Spanish economy, but this was not the case in this study.

In sum, the estimates proposed for the non-maquiladora industry IIT highlight the significant disparities in terms of economic development between Mexico and its trading partners. The results also convey how IIT flows behave according to the concept of comparative advantage and the guidelines discussed in Neo-Herkscher-Ohlin's theory. The significance of the variables for the vertical IIT lies in the predictions they provide in terms of the behavior of North-South trade flows, as discussed by Flam and Helpman (1987) or Highfill and Scott (2006), among others. Furthermore, the proposed variables for varying quality IIT have been explanatory and have yielded the expected signs. These results foreshadow the kind of commercial relationship that Mexico has had with its NAFTA partners, in addition to anticipating the predictions made about the reduced costs of adjustment brought by the integration trade.

Thus, the set of variables that constitutes the industrial characteristics has been significant and has produced the expected signs. This article has also made special mention of horizontal product differentiation, as well as economies of scale. The presence of foreign capital in the industry was also found to be positive in relation to different types of trade, which was considered to be particularly relevant for vertical IIT. Moreover, spending on research and development was proposed along with alternative variable intensity in skilled labor. However, the latter was unable to explain the behavior of IIT. Concurrently, the *ryd* variable conveyed a highly significant coefficient. Therefore, the totality of these results supports the prediction of the firm heterogeneity model, which called for the introduction of elements from companies' strategies to explain the behavior of firms producing IIT within foreign trade.

Finally, this study has made use of econometric estimates to reflect on the position of a relatively small country such as Mexico in relation to its NAFTA partners. The article has particularly underlined how differences in the size of economies, factors endowments, and industrial heterogeneity along with the presence of foreign capital are significant factors in explaining the bilateral trade of different quality products.

IV. Concluding Remarks

In conclusion, the results of non-maquiladora IIT indices quantification for Mexico and United States reflected that in 1994 the index only stood at 25 percent. The investigation further

[11]The spending on Research and Development by sources of funding showed that Mexican Government participation was 66.2 percent while private investment was 17.6 percent in 1995. These percentages changed; in 2011 government spending was 52 percent and private investment increased to 43 percent (CONACYT 1996, 2012).
[12]Verhoongen (2008) pointed out the relation between high quality products with export for the Mexican manufacturing industry.

recorded a value of 40 percent for the year 2006, revealing that the performance of the indices was smaller than those found in other works on this issue. Furthermore, it denoted that starting from the year 2000, maquiladora trade flows tended to follow a one-way pattern, even in instances when maquiladora percentages were average for the 40 percent held. Conversely, non-maquiladora trade flows increased their intra-industrial participation as a proportion of total trade.

Although the IIT was predominantly of a vertical nature for most of the 1994-2006 period, a number of industrial branches began to reveal an increase in the trade of different varieties of goods (horizontal IIT). This was the case for the automotive industry due to the relaxation of the tariff schedule of the NAFTA treaty for automotive products, which took effect in 2001 and caused a shift in the nature of trade.

In this regard, this study draws attention to the disadvantages that may occur with the application of unit values to differentiate IIT according to its nature. In this case, the Mexican manufacturing industry trade went from being one characterized by different qualities in the year 2000 to one with different varieties in 2001. This occurred as a result of a relaxation in the automotive industry tariff schedule. The change from vertical to horizontal IIT would have been expected to take place as a result of productive reasons and not due to a change in the tariff regulations.

The second section of this article dealt with the study of the bilateral IIT determinants differentiated by their horizontal and vertical natures in regards to the non-maquiladora industry. Consequently, this study proposed a set of explanatory variables grouped into country and industrial characteristics.

Since the vertical IIT constituted a large proportion of the total trade, both total and vertical IIT portrayed similar results. The econometric results, both in relation to NSL and GLM estimates, denoted the significance of the differences in economic development and factor endowments as determinants of the vertical IIT. In this regard, these differences were shown to have played a key role in explaining how the vertical nature of IIT had been dominant as a main trade route between Mexico and its NAFTA partners. Furthermore, in the case of Mexico, this study indicated that Neo-Heckscher-Ohlin's theory represented a suitable framework to explain Mexico's bilateral trade with these NAFTA countries.

Moreover, the proposed specifications also stressed the significance of foreign capital presence and horizontal product differentiation. The model presented further emphasized the relevance of technology intensity and the importance of including dummy variables as the set of determinants of trade in regards to goods differentiated between Mexico and its NAFTA partner. This inclusion reflected key changes in the treaty tariff regulations.

Econometric estimates also constituted a substantial contribution to the provision of new empirical evidence for the study of impact of NAFTA on developing countries. Indeed, no other studies have been published on the determinants of IIT for the Mexican non-maquiladora manufacturing industry. Previous literature has only dealt with estimates of the manufacturing industry (including maquiladora) or for the automotive industry IIT determinants.

The potential research lines that flow from this article can be summarized as follows. Firstly, further discussion relating to the relationship between the theories explaining the IIT of final goods and international fragmentation of production is needed. Furthermore, given the increasing trade in intermediate goods, there is an evident need for the conception of models incorporating these goods, particularly since the maquiladora disappeared as tariff scheme and its trade can be considered intermediate products. This article has also argued that heterogeneity of firm models in international trade is an approach that encompasses numerous aspects of differentiated products in different productive stages. Nonetheless, this hypothesis requires further empirical research which specifically incorporates IIT differentiated by its horizontal and vertical nature, as well as trade in intermediate goods.

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