Determinant factors of the vertical intra-industry trade in agricultural sector: A study of Iran and its main trading partners

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Abstract: The present study has investigated the country specific determinants of the vertical and total intra-industry trade between Iran and its main trading partners (including 24 countries) in the agricultural products group during the time period 2001–2007. For this purpose, first we have measured the types of the intra-industry trade. Then we have examined the determinants of the vertical and total intra-industry trade in the agricultural sector by using the panel technique. Based on the obtained results, it has confirmed that economic development (both per capita income and HDI) has a positive and significance effect on the Iran's bilateral intra-industry trade. Also, the results verify the Linder hypothesis. In sum, the Iran's foreign trade in agricultural sector is mainly based on comparative advantage. Specifically, there is a negative and significant relationship between the revealed comparative advantage and the industry trade. In addition, the endowment of land affects positively the high vertical intra-industry trade. Also according to the results, the size market differences impact the intra-industry trade negatively.

Key words: total and vertical intra-industry trade, agricultural products, Human Development Index, Linder, revealed comparative advantage, Iran

Theoretical shortcomings in the traditional theories of international trade along with the incompatible stylized facts led to many efforts to remove these shortcomings and to present appropriate and complementary explanations for empirical observations in the late 1970s and especially the early 1980s. Further, by separating the intra-industry trade (IIT) into the horizontal and vertical IIT, it was clear that the determinants of these types of trade are different. Obviously the horizontal intra-industry trade (HIIT) indicates similar goods exchange with the same quality. This type of trade is explained by new trade theories. In contrast, Falvey (1981) and the following investigations like Gabszewicz et al. (1981), Falm and Helpman (1987), Falvey and Kierzkowski (1987) showed that IIT in qualitatively differentiated products occurs because of the difference in the factor endowment and income between countries.

Most IIT studies have been focused on manufacturing products and little attention has been paid to agricultural products. The reason is probably that the agricultural markets are usually based on perfect competition (Fertő 2005; Rasekhi 2008).

The intra-industry trade has also some important implications. First of all, based on smooth adjustment hypothesis, the intra-industry trade is less disruptive than the inter-industry trade, as the adjustment costs take place as a result of any change in the economy such as trade liberalisation. This aspect of IIT is important for all countries, but in particular for countries which face more adjustment challenges than the developed countries. In other words, increasing IIT decreases the adjustment costs (Ruffin 1999). Dividing the IIT to its types is an important issue, too. The reason is that the vertical intra-industry trade as well as the inter industry trade depends on the factor endowment difference (e.g. Technology and R&D) and thus it has a higher costs compared with other trade types.[1] Iran began trade liberalization since about 1989. It seems that this policy has adjustment costs as a result of the moving production factors, especially labour, among different sectors. The share of agriculture in employment was about 21% in 2009. Also the IIT enhance more the trade benefit than the inter-industry trade. It makes gains the trade via a better exploitation of the economies of scale and also the variety of goods. Furthermore, the IIT promotes innovations. Producing a greater variety and number of goods increases the general knowledge about technology, and a greater knowledge implies smaller costs of the knowledge

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[1]For more details about welfare effects of intra industry trade types, see Blanes and Martin (2000).

accumulation (Ruffin 1999). Also, the IIT may be important because it may imply competitiveness and the degree of readiness to integrate into the world economy (Rasekhi 2008). Specifically, the commodities with the intra-industry trade have a high competitiveness compared with the others. And integrating into the world economy makes probably a higher specialization for the former commodities. Beside this, one of the most important non-oil exports of Iran is agricultural products. Specifically, the share of this sector in the non-oil export was about 23% in 2009. Iran is trying to develop the non-oil export and one of the important ways for this is developing agricultural export. It seems that developing the agricultural intra-industry trade may increase the non-oil export of Iran.

Regarding the above mentioned points and also several studies done on the topic, the present study has used important indices of the Greenaway, Hine and Milner (GHM) in order to estimate the Iran's agricultural products IIT with Belgium, Sweden, Italy, Hong Kong, France, Pakistan, Saudi Arabia, India, Germany, Kuwait, Azerbaijan, Switzerland, Syria, Kenya, United Arab Emirate, United States, Turkey, Spain, Malaysia, Australia, Canada, the Netherlands, Austria and the UK. Agricultural sector in this study is based on the definition of the Uruguay Round Agreement Act (URAA) in the WTO which includes the chapters 1–24 (aquatic products exclusive) of the HS and also the list of goods in the chapters 29, 33, 35, 38, 43, 50–53 and the aquatic products are considered to complete the sector.

REVIEW OF THE THEORETICAL AND EMPIRICAL LITERATURE

Traditional theories explain trade between countries based on their structural differences such as the differences in productivity and endowment. Regarding these theories, the trade which happens between different countries and between different products is called the inter-industry trade. However, the unrealistic assumptions of traditional theories such as perfect competition and constant returns to scale as well as the realized facts such as the existence of trade between similar countries and the simultaneous export and import in similar products motivated researchers to study and introduce new trade theories since 1960s. Verdoorn (1960) and Balassa (1966) presented some evidence on the phenomenon of the IIT in trade among the members of the EEC. Later studies revealed the IIT in other countries. Although Linder emphasized the role of differentiated products

in the international trade among similar countries, the study of Grubel and LIyod (1975) on the measurement and conception of IIT motivated the empirical and theoretical research on this type of trade.

Intra-industry models are mainly based on imperfect competition, increasing the return to scale and product differentiation (as developed by Krugman 1979, 1980; Lancaster 1980; Helpman 1984). Based on these models' assumption, goods are horizontally differentiated and the IIT develops in monopolistically competitive markets. On the demand side, the IIT is driven by diverse consumers' preferences and on the supply side, it is driven by the increasing returns to scale. Of course, some models such as Helpman and Krugman (1985) explain both intra- and inter-industry simultaneously. The subsequent models, especially Falvey (1981), Falvey and Kierzkowski (1987) and Flam and Helpman (1987), introduced the vertical intra-industry trade. These studies showed factors such as the differences in endowments, technology, income levels and income distribution to have a significant effect on the VIIT.

Abd-el-Rahman (1991), Greenaway et al. (1994, 1998) and Fontagne and Freudenberg (1997) introduced a method to separate the vertical from horizontal IIT and showed that the dominant part of the IIT is devoted to the VIIT. Subsequent researches showed that the determinants of these are rather different. In particular, the HIIT is mainly driven by the economies of scale and the consumers' preferences for variety, while the VIIT is mainly driven by the different factor endowment. The determinants of the IIT are presented in more details in the following.

One of the most important factors affecting the intra-industry trade is the level of development. This factor on the demand side indicates the potential demand for different products, and on the supply side, it indicates the ability of supplying these products and also the economies of scale degree (Balassa and Bauwens 1987, Kenen 1994, Anderson 2002). So the expected relationship of Vertical (total) IIT and level of development has been evaluated as positive. On the other side, based on the Linder (1961) theory, the countries with a similar income structure have a similar demand structure (but differentiated). Falvey and Kierzkowski (1987) model has predicted an inverted relationship for the VIIT. That is, we expect the less developed countries with a low per capita income to specialize in low quality products and the developed countries with a high per capita income to specialize in high quality products. For this, the Linder hypothesis implies that the higher differences in income, the greater the VIIT (Faustino and Leităo 2007). The other determinant is factor endowment

differences. According to Falvey (1981) and Falvey and Kierzkowski (1987) models, the higher the difference in the relative factor endowment, the higher the VIIT. Also Falm and Helpman (1987) with the emphasis on the technology factor, Gabszewicz et al. (1981) by focusing on the Research and Development (R&D) expenditure, evaluated the relationship between the difference of the factor endowment and the VIIT share as positive. The other variable which has been frequently used in the IIT studies is the market size. Large Market size development on the demand side means demand development for different products (Balassa 1986), and on the supply side it means the wider range of producing different products and as a result, this leads to more chances to use the economies of scale effects (Loertscher and Wolter 1980), a higher number of different products (Lancaster 1980) and it increases the potential for IIT. So the relationship between the IIT and market size is evaluated as positive. Also similar levels of the market size indicate the similar ability to produce different products and therefore the increase of the IIT (Helpman 1981). So by decreasing the difference of the market size of two countries, the VIIT will increase between them. Of course, the difference in the market size cannot be the only cause of the IIT and the effects of difference in the market size will be considered beside the fundamental factors like economic development. Another important factor that is considered directly or indirectly is the product differentiation. It is worth mentioning that products can be differentiated in three main forms: horizontal, vertical and technological differentiation (Sharma 1999). Intra-industry differences in the IIT can be affected by all three types of differentiation and specifically it is expected that the relationship between the IIT and the country-level product differentiation (CPD) will be positive. Another variable that is used in some intra-industry trade studies is the exchange rate. There is no agreement in the literature on how the exchange rate changes affect the share of IIT. But it seems that an increase in the exchange rate causes the decrease in export and increase in import and following that, the IIT possibility will decrease. Also, Ricci (1997, 1998, 2006), based on the location choices of firms, showed that the exchange rate liberalization increases the inter-industry trade and reduces the intra-industry trade. The reason is that under flexible exchange rates, the countries tend to be more specialized compared with the fixed case. Furthermore, Ricci (2006) indicated that the pattern of specialization is not uniquely influenced by trade models but it also depends on the exchange rate regime.

Most studies of the IIT focused on manufacturing products of developed countries. Agricultural sector is usually neglected in empirical works.[2] The main reason is probably that agricultural markets are usually characterized by perfect competition. But the recent studies support that the IIT has an increasing role in agricultural sectors, especially among developed countries (Fertö 2005). One of the first studies in agricultural products IIT performed by McCorriston and Sheldon (1991) estimated the extent of IIT in the EC and in the United States during the period of 1977–1986. In their explanation of the difference of specialization and trade in processed agri-food products in the EC and the United States, they have emphasized the role of the distance of foreign market and economic ties with the former colonies. Based on the results, the IIT in food processing is a positive function of the country's GDP per capita and the equality of GDP per capita between countries. In addition, it is also found that such trade is strongly influenced by the distance between the trading partners, the membership in custom unions and free trade blocks and also the exchange rate volatility. Christodoulou (1992) measured the IIT in meat and processed meat products (pork and beef) industry in the EC countries in1988. The results showed that the taste overlap and imperfect competition were the most important factors in explaining the variation of the studied products IIT. Hirschberg et al. (1994) investigated the IIT determinants in processed food products by using 30 countries data during the period of 1964–1985. The results suggest that IIT increases with the increase in GDP per capita and a more similar GDP per capita between two countries. The results also suggest that a common border helps the IIT, while the distance and the fluctuating exchange rates do not.

Pieri et al. (1997) examined the IIT determinants of dairy products in 10 member countries of the EU from 1988 to 1992. According to the results of this study, a higher similarity in most countries and also the presence of large farms increase the IIT. Henry de Frahan and Tharakn (1998) studied the determinants of the types of the intra-industry trade in processed food among 20 European countries and their major partners during 1980s and 1990. Based on the most important results, there is a positive and significant effect of the market size and the level of economic development, the trade preferences and the geographical proximity on the HIIT. On the other hand, there is a negative and significant effect of the factor endowment, the difference in market size and the economies of scale on this type of trade. Qasmi and Fausti (2001) studied the

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[2]For instance, Balassa and Bauwens (1987) explicitly eliminated food products from their sample.

effect of the NAFTA on the inter- and intra-industry trade in agri-food products in North America and in the rest of the world. The results showed that the IIT is higher for goods with a higher processing level. These authors also indicated that the IIT in agri-food commodities in the US with the rest of the world increased since the NAFTA agreement. Of course, no explanation is presented for this matter. Chan et al. (2001) investigated the IIT determinants in the agri-food sector between Taiwan and the ASEAN-5 by using the Ordinary Least Square (OLS) during the period of 1970–1995. According to the results of this study, the market size has a positive and significant effect on the IIT. Also, the coefficient of economic development variable is negative in almost all cases. In addition, the difference in the market size has a negative coefficient, but it is insignificant in most cases. However, the indirect effect arising from the income and the consumer preferences' overlap may be the main determinant in promoting the intra-industry agro-food trade among the Asian countries. Fertő and Hubbard (2002), by using the Ordinary Least Square (OLS) Method, measured and tested the types of the IIT determinants in agro-food products between Hungary and the EU during the period of 1992–1998. In this study, the coefficient of distance variable was negative and significant, the coefficient of market size was positive but insignificant and also the coefficients of the Linder variable and the difference in market size did not have the expected sign and were estimated insignificant. Sun and Koo (2002) studied the intra-industry trade in the US food processing industry by using the GL Index during the period of 1989–2001 with a special emphasis on 1997. Based on the results of this study, the product differentiation, the market structure and the economies of scale variables have significant effects on the types of the intra-industry trade. They showed that the HIIT model describes observations better than the other models. Fertő (2005) studied the relationship between the factor endowment and the vertical IIT in agro-food products in Hungary and 14 member countries of the EU from 1992 to 1998. The results showed that there is a positive relationship between the VIIT and the difference in factor endowment. In this study, the author used the differences in the endowments of different types of factors such as land, human capital and physical capital. Leitão and Faustino (2008) have analyzed the IIT determinants between Portugal and the EU (EU-15) in the Portuguese food processing sector by using a balanced panel during the period of 1996–2003. This study has used both the industry and country-specific characteristics as explanatory variables. Based on the results of this study, the economies of scale and the

product differentiation are the main determinants of the two-way trade. Also the coefficient of the physical capital endowment, the higher/highest value of GDP per capita and the distance variables had the same sign of theory and the coefficients of difference in GDP per capita, the energy consumption and the lowest value of GDP per capita variables had the unexpected signs. In the meantime, all these variables were significant. In addition, the foreign direct investment inflows had a positive effect on the Portuguese bilateral IIT, although the coefficient of this variable was not statistically significant.

IRAN INTRA-INDUSTRY TRADE OF AGRICULTURAL SECTOR

The present study has used the GHM Index to measure the intra-industry trade. Specifically, Greenaway et al. (1994, 1995) firstly separate the intra-industry trade to its types, namely the HIIT and VIIT based on the following relation:

$$1 - \alpha \leq \frac{UV_j^x}{UV_j^m} \leq 1 + \alpha \tag{1}$$

where α is the dispersion factor usually 0.15 and UV_j^x and UV_j^m are respectively the unit value of export and import for jth trade partner. If the ratio is within the limit, the trade is considered as the HIIT, and otherwise as the VIIT. Furthermore, if the relative value of product is bellow (over) the limit $1 - \alpha$ $(1 + \alpha)$, it is considered a low (high) quality vertical IIT (Fertö 2005). Then, we can estimate the intra-industry trade for its types for jth trade partner (GHM_j^k) by the following relationship:

$$GHM_j^k = \frac{\sum_p \left[(X_{jp} + M_{jp}) - \left| X_{jp} - M_{jp} \right| \right]}{\sum_p (X_{jp} + M_{jp})} \tag{2}$$

Table 1. Agricultural export of Iran during the time period 2001–2009 (million dollars, %)

Export	2001	2004	2007
Total export	23 904	44 403	97 667
Non-oil export			
Value	4 223.9	6 383.7	13 162
Share of total export	17.67	14.38	13.47
Agricultural export			
Value	1 603.2	1 742.2	3 482
Share of non-oil export	38	27.3	26.5

Source: Trade Promotion Organization of Iran (www.tpo.ir)

in which X_{jp} and M_{jp} are the export and import values of jth country in p^{th} product group of agriculture respectively.

Table 1 shows agricultural export of Iran during the time period 2001–2009. Based on this table, Iran has exported mostly oil and gas amounted to 97 667 million dollars in 1997. Also in this year, about 13 162 million dollars of non-oil products were exported, which was about 13.5% of the total export at this year. As seen from the table, the share of non-export products was rather decreased during the time period. The table shows that the value of Iran agricultural export has increased from 1603.2 million dollars in 2001 to 3482 million dollars in 2007, which amounted for about 38 and 26.5% of non-oil exports in 2001 and 2007 respectively. Although the share of agriculture in the non-oil export was decreased during the studied time period, this share is yet considerable.

Table 2 shows the bilateral agricultural intra-industry trade of Iran and the selected countries during the time period 2001–2007. Based on this table, there are some important points. First, agricultural intra-industry trade of Iran is rather low but increasing in the studied period. Specifically, the share of this form

Table 2. Bilateral agricultural intra-industry trade of Iran and the selected countries in the period 2001–2007

Country	2001 IIT		GHM	Country	2004 IIT		GHM	Country	2007 IIT		GHM
	VIIT	HIIT			VIIT	HIIT			VIIT	HIIT	
Afghanistan	91.18	0	18.91	USA	96.78	0	96.78	Belgium	60.60	0	60.60
Italy	64.57	0	64.57	Kenya	63.18	0	63.18	Sweden	53.31	0	53.31
UK	26.35	0	26.35	France	47.26	0	47.26	Afghanistan	48.69	0	48.69
Germany	17.59	0	17.59	Australia	39.37	0	39.37	Italy	42.72	0	42.72
Kuwait	0	16.26	16.26	Afghanistan	23.84	0	23.84	Honk Kong	45.54	0	45.54
India	12.60	0	12.60	Turkey	23.18	0	23.18	France	39.62	0	39.62
France	11.21	0	11.21	UK	22.75	0	22.75	Pakistan	36.71	0	36.71
Austria	10.49	0	10.49	Italy	2.90	11.20	14.10	Taiwan	29.05	0	29.05
Turkey	9.04	0	9.04	Saudi Arabia	12.80	0	12.80	Saudi Arabia	22.96	0	22.96
Turkmenistan	6.02	0	6.02	Pakistan	11.12	0	11.12	Iraq	0.51	17.20	17.71
Iraq	2.23	0.17	2.40	Malaysia	10.22	0	10.22	India	15.72	1.73	17.45
Emirate	1.73	0.40	2.13	Germany	8.51	0.11	8.62	Germany	12.83	3.29	16.12
Netherlands	2	0	2	India	5.04	0.67	5.71	Kuwait	15.14	0	15.14
Kenya	1.03	0	1.03	Turkmenistan	3.99	0.12	4.11	Azerbaijan	1.55	12.20	13.75
Pakistan	0	0.97	0.97	Emirates	2.51	0.07	2.58	Turkmenistan	0.51	11.50	12.01
USA	0.51	0	0.51	Azerbaijan	0	2.04	2.04	Swiss	10.63	0	10.63
Belgium	0	0	0	Spain	1.86	0	1.86	Syria	10.24	0	10.24
Honk Kong	0	0	0	Netherlands	1.51	0	1.51	Kenya	10.07	0	10.07
Spain	0	0	0	Austria	1.24	0	1.24	Emirates	8.76	0.02	8.79
Swiss	0	0	0	Kuwait	0.04	0	0.04	USA	6.97	0	6.97
Australia	0	0	0	Swiss	0.01	0	0.01	Turkey	3.91	0	3.91
Azerbaijan	0	0	0	Syria	0	0	0	Spain	2.84	0	2.84
Malaysia	0	0	0	Taiwan	0	0	0	Malaysia	2.37	0	2.37
Saudi Arabia	0	0	0	Honk Kong	0	0	0	Australia	2.10	0	2.10
Syria	0	0	0	Belgium	0	0	0	Canada	1.99	0	1.99
Taiwan	0	0	0	Sweden	0	0	0	Netherlands	1.50	0.06	1.56
Sweden	0	0	0	Iraq	0	0	0	Austria	1.20	0	1.20
Canada	0	0	0	Canada	0	0	0	UK	1.05	0.03	1.08
Average	9.16	0.64	9.80	Average	13.50	0.51	14.01	Average	17.36	1.64	19.00

Source: Present study

of trade has increased from 9.80% in 2001 to 19% in 2007. Second, the dominant form of the IIT is the vertical intra-industry trade. In average, more than 90% of the intra-industry trade in 2007 is devoted to VIIT. However, the share of the HIIT increased during the time period from 0.64 in 2001 to 1.64 in 2007. Based on this result, it seems that Iran's competitiveness in agriculture increased in the studied period but this may reflect the more competitive pressure on the agriculture. Third, Iran has intra-industry trade with some countries, as Table 2 shows. Although the trade level is low, the existence of it may show the consumers' preferences of these countries are rather similar to those of Iran. Finally, based on the low level of the IIT, especially HIIT, it seems that the adjustment costs in the agricultural sector can be high as any change happens in the economy.

As Fertö (2005) has mentioned, if the IIT leads to higher quality products displacing the lower quality products, then the countries that produce the latter are likely to suffer the level of employment, which, if not compensated by lower prices and the access to higher quality products, will cause negative welfare effects. So it is important to separate the VIIT into the high quality and low quality VIIT. Table 3 shows the agricultural HVIIT and LVIIT of Iran during the time period 2001–2007. Based on it, most indices show the LVIIT and only two indices show a high quality export to Belgium and Sweden in 2007. So, the vertical type trade dominated the IIT with a low quality for almost all of the countries during the time period. In particular, the share of LVIIT in the total VIIT is estimated about 91, 72 and 55% in 2001, 2004 and 2007, respectively.

Table 3. Bilateral agricultural HVIIT and LVIIT of Iran and selected countries during time period 2001–2007

Country	2001		2004		2007	
	LVIIT	HVIIT	LVIIT	HVIIT	LVIIT	HVIIT
Belgium	0	0	0	0	0	60.6
Sweden	0	0	0	0	0	53.31
Italy	64.57	0	2.90	0	42.72	0
Hong Kong	0	0	0	0	0	42.54
France	11.21	0	47.26	0	36	3.62
Pakistan	0	0	0	11.12	0	36.71
Saudi Arabia	0	0	0	12.8	0	0
India	12.6	0	5.04	0	4.99	10.73
Germany	12.72	4.88	7.52	0.98	6.65	6.17
Kuwait	0	0	0	0.04	0	15.14
Azerbaijan	0	0	0	0	0.56	0.98
Switzerland	0	0	0	0.01	10.63	0
Syrian	0	0	0	0	0	10.24
Kenya	1.03	0	63.18	0	10	0.07
United Arab Emirates	1.05	0.67	2.03	0.48	8.03	0.73
United States	0.51	0	96.78	0	6.97	0
Turkey	5.81	3.23	23.18	0	3.21	0.70
Spain	0	0	0	1.86	0	2.84
Malaysia	0	0	0	10.22	2.12	0.25
Australia	0	0	39.37	0	2.10	0
Canada	0	0	0	0	1.99	0
Netherlands	2.03	0	0.53	0.99	1.36	0.13
Austria	0	10.49	1.24	0	0.05	1.15
United Kingdom	21.16	5.19	22.45	0.30	0.14	0.91
Average share	91	9	72	28	55	45

Source: Present study

Briefly, there is the evidence of the IIT, mainly VIIT, suggesting the exchange of products with a different quality. The dominance of the VIIT is consistent with the findings of the recent studies. Also, the major part of the VIIT is devoted to the LVIIT. Specifically, Iran mainly exports the low quality products to its trade partners and simultaneously it typically imports the quality products from them.

MODEL ESTIMATION

Regarding the theoretical and experimental principles of the IIT determinant, the general form of the IIT (total and vertical) equation is the form below:

$$IIT_j^k = f(DEV, LINDER, SIZE, DSIZE, AgRCA,$$
$$, DLAND, CPX, DEX) \qquad (3)$$

k = Total (T), Vertical(V)
$j = 1, 2, \ldots J$

The expected signs are:

$f_{DEV} > 0$, $f_{SIZE} > 0$, $f_{DSIZE} > 0$, $f_{CPD} > 0$, $f_{EX} \gtrless 0$,

$f_{LINDER}^{VIIT} < 0$, $f_{LINDER}^{IIT} < 0$, $f_{RCA}^{VIIT} > 0$, $f_{RCA}^{IIT} < 0$

where IIT_{ij}^K is the index of the intra-industry trade (Total and Vertical IIT) between i (Iran) and its trading partner country j, *DEV* represents the level of development, *LINDER* is the difference in the level of development, *SIZE* denotes the market size, *DSIZE* is the difference in the market size, *AgRCA* indicates the agricultural revealed comparative advantage, *DLAND* represents the difference in arable land, *CPD* is the country level of product differentiation, *DEX* is the proportional change in the exchange rate between Iran and its trading partner j.

The Panel method has been used to estimate the model. The ability to control the individual effects of every pair of trade partners that cannot be observed or measured, a higher freedom degree, to decrease in co-linearity possibility between the explanation variables and to increase the model efficiency are some of the Panel method advantages (Gujarati 2004).

With regard to the fact that the IIT Index changes between zero and one, the logistics transformation has been used:

$$IIT_{ij}^K = Ln\left(\frac{IIT_{ij}^K}{1 - IIT_{ij}^K}\right) \qquad k = \text{Total } (T), \text{ Vertical } (V) \ (4)$$

To measure the model explanation variables, different proxies have been used. Specifically for measuring the level of development (DEV), the average Human Development Index (HDI) has been used. To calculate this variable, the data have been collected from the Human Development Report (HDR). Few studies have used this proxy, for example Caetano and Galego (2007) can be pointed out.[3] To measure the Linder variable, the below relationship has been used (Balassa and Bauwens 1987):

$$LINDER_{ij} = 1 + \frac{\left[w_{ij} \ln w_{ij} + (1 - w_{ij})\ln(1 - w_{ij}\right]}{\ln 2}$$

where $w_{ij} = \dfrac{GDPPC_i}{\left(GDPPC_i + GDPPC_j\right)} \qquad (5)$

in which GDPPC is the gross domestic product per capita and based on purchasing power parity (PPP) and the initial data have been collected from the World Development Indicator (WDI).

To measure the difference in the pair of countries factor endowment, the Revealed Comparative Advantage (RCA) Index in agriculture and the difference in arable lands have been used. According to Chang (2009) which has used the RCA Index for IT industry, the RCA in agricultural sector has been measured like below:[4]

$$AgRCA = \frac{X_{ij}^p \Big/ \sum_{p=1}^n X_{ij}^p}{M_{ij}^p \Big/ \sum_{p=1}^n M_{ij}^p} \qquad (6)$$

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[3]Human Development Index as a composite statistic is calculated by the UNDP through the weighted averaging of three indices including income (GDP per capita), education and life expectancy. Education as a proxy of human capital probably develops vertically and horizontally differentiated products that promote the intra-industry trade. Also, a high (low) life expectancy implies the high (low) level of development and so the index may directly affect the IIT. For the certainty of the results, we have estimated the models with both variables.

[4]In the theoretical trade models, the comparative advantage is expressed in the terms of relative prices evaluated in the absence of trade, but these are not observed in practice. The RCA uses the trade pattern to reveal the comparative advantage. This index may show all factors affecting the comparative advantage, such as productivity and technology, the endowment like arable land on the supply side and demand intensity on the demand side. So, it seems that the RCA reflects the comparative advantage better than only arable land. Of course, the land is perhaps the most important factor in agriculture, especially in developing countries. Furthermore, the RCA has an important limitation. It is affected by anything that distorts the trade pattern, e.g. trade barriers and protection. To be sure, we have re- estimated the models without this variable.

in which X_{ij}^p (M_{ij}^p) is the total export (import) pth section (agricultural sector) of i (Iran) country to (from) j (trade partner) country, $\sum_{p=1}^{n} X_{ij}^p$ ($\sum_{p=1}^{n} M_{ij}^p$) is the total export (import) of i country to (from) j country.

The average GDP of two countries in constant price has been used to measure the market size and the data are collected from the WDI. The variable of the difference in market size (DSIZE) is calculated from the absolute difference of two countries population and the relevant data ate collected from the Penn World Table (Heston et al. 2009). In the present study, the country product differentiation (CDP) between Iran and its trade partner is calculated by using the Hufbauer Index (1970) as follows:

$$HUF_{ij} = \frac{SD_{ij}}{AV_{ij}} \tag{7}$$

in which SD_{ij} is the standard deviation of the export unit values of agricultural product from i country (Iran) to j country (trade partner country) and AV_{ij} is the unweighted average of those unit values. To measure the exchange rate variable (DEX), following by Hirschberg et al. (1994), the absolute value of one year proportional change in the exchange between the reporting country (Iran) and the partner country has been used as follows:

$$DEX_{ijt} = \left(\frac{|ex_{it} - ex_{it-1}|}{|ex_{jt} - ex_{jt-1}|}\right)\left(\frac{ex_{jt}}{ex_{it}}\right) \tag{8}$$

in which ex_{it} and ex_{ij} are the exchange rates for i and j countries at time t. To calculate this variable, the data of the United States Department of Agriculture, Economic Research Service (USDA/ERS) have been used.

Table 4 presents the estimation results of the total and vertical IIT determinant of Iran and its major trade partners during the period of 2001–2007 by using the panel fixed effects method. Based on these results, the coefficient of the level of development variable (HDI in model 1 and GDP per capita in model 2), which has showed the effectiveness of economic development on the consumers' different demand and differentiation products supply, has a

Table 4. Estimation results of total and vertical IIT between Iran and her major trade partners during time period 2001–2007 by using panel Fixed effects method

Independent variable	Models in category 1				Models in category 2		VIIT	
	Model 1		Model 2		IIT	VIIT	LVIIT	HVIIT
	IIT1	VIIT	IIT	VIIT				
Constant	−448.8	−519.66	−398.22	−421.30	−413.66	−538.29	−1 307.73	296.86
DEV	265.26*** (4.45)	313.58*** (6.33)	0.01*** (3.99)	0.01*** (4.56)	276.07*** (2.67)	317.32*** (3.70)	0.01*** (4.9)	0.01*** (6.6)
LINDER	206.71* (1.73)	198.34* (1.81)	229.84** (2.52)	211.92*** (2.50)	206.48* (1.86)	212.14** (2.10)	1066.82*** (5.21)	−1180.5*** (−3.29)
SIZE	−405.84 (−1.63)	−356.99 (−1.3)	−300.54 (−1.02)	−323.89 (−1.19)	−406.20* (−1.79)	−383.20 (−1.35)	91.26 (0.71)	694.1** (2.24)
DSIZE	−89.51** (−2.36)	−85.25** (−2.39)	−87.07** (−2.53)	−94.29** (−2.41)	−89.70 (−2.80)	−92.02*** (−2.78)	−64.62*** (−6.91)	4.75E−11 (0.91)
AGRCA	−0.12 (−2.74)	−0.09* (−1.89)	−0.13*** (−3.56)	−0.11** (−2.51)			−0.05* (−1.7)	−0.11*** (−3.15)
DLAND	2.22E−06*** (2.69)	2.78E−06*** (2.78)	1.91E−06** (2.08)	1.68E−06* (1.66)	2.35E−06** (2.26)	2.68E−06** (2.25)	−6.84E−0.6*** (−4.8)	1.96E−06* (1.78)
DEX	−0.46*** (−3.14)	−0.38** (−2.20)	−0.49*** (−2.82)	−0.44** (−2.28)	−0.17** (−2.03)	−0.31 (−1.56)	−0.44** (−2.29)	0.01 (0.05)
CPD	−0.03 (−0.28)	−0.01 (−0.07)	−305.82** (−2.05)	−0.04 (−0.36)	6.65 (0.04)	52.37 (0.49)	−0.36** (−2.21)	−105.1 (−0.55)
R-squared	62	61	63	58	58	58	62	52
F-statistic	4.65	4.5	4.89	4.01	4.35	4.40	4.78	3.16

The numbers in the parenthesis are t-statistic. The symbols *, ** and *** indicate statistical significance at 10, 5 and 1%, respectively

Source: Presented study

positive and significant effect on the VIIT. In other words, economic development, by influencing both supply and demand sides of the agricultural product group, improves the IIT quantitatively and qualitatively. Based on this and according to the present facts, it seems that the amount of IIT increases during time as a result of economic progress. This result is compatible with Henry de Farhan and Tharakn (1998). On the other hand, the Linder variable coefficient has the expected positive sign and it is significant. The result confirms Fertö and Hubbard (2002). This result verifies the Linder hypothesis. Specifically, it is expected that the less developed (developed) countries with a low (high) per capita income specialize in low (high) quality products and then the higher the differences in income, the greater the VIIT will be. As Table 3 indicates, Iran has exported both low and high quality differentiated goods. Furthermore, Iran has exported differentiated agricultural goods especially with a low quality to some countries with high income. The coefficient of market size variable in most selected equations has an unexpected negative sign, but it is insignificant. The coefficient of difference in market size has a negative sign in the estimated models and it is significant. This result is justifiable because the differences in market size may reflect the difference in demand for the differentiated goods. Also, the high demand may absorb domestic products and then there is less room for products to be exported to other countries. On the other hand, due to their small production, the countries with a low market size may not be able to export differentiated goods to the countries with a large market size.

The coefficient of the revealed advantage variable is negative and statically significant in the selected models. Based on this result, it seems that the comparative advantage has a negative effect on the VIIT. This result is not surprising because agricultural sector is characterized by the competition market. On the other hand, the coefficient of the Land variable is positive and statistically significant in the estimations. This is consistent with Fertö (2005) and Sun and Koo (2002). The coefficient of difference in the exchange rate which is included to control the effects of the exchange rate changes on trade patterns is negative and mostly significant. As it was said before, there is no agreement in the literature on how the exchange rate changes affect the IIT share. The coefficient of the product differentiation variable, which has taken much attention in the theoretical principles, is insignificant in the estimations. This result may be justifiable because the product differentiation is mostly linked to manufacturing industries, not

to agriculture, which is characterized by perfect competition.

The achieved results for the total and vertical IIT are similar. This finding is not unexpected because a considerable share of Iran IIT with its major trade partners in agriculture is allocated to the VIIT (more than 90% of the total IIT during the study time has been the VIIT).

Based on the results, especially of the RCA and the product differentiation, it seems that the comparative advantage in agricultural sector decreases the IIT in this sector. In particular, relatively homogeneous products as well as the comparative advantage make the trade the inter-industry trade. Clearly, the comparative advantage is not only affected by the land but it is also influenced by other factors such as productivity, technology and even the demand condition. For more detailed results, the two last columns of Table 4 present the estimations for the VIIT types, i.e. the LVIIT and the HVIIT. Again, as seen from this table, economic development has a positive and significant sign in both models. The coefficient of the Linder variable has a positive sign and it is significant in the LVIIT model. In other words, the per capita income differences between Iran and its trade partner increase the low quality intra-industry trade of Iran, while decreasing its high quality intra-industry trade. Based on this result, Iran has low competitiveness in the high quality agricultural products. Because of that, during the time period a low share of total agricultural trade is devoted to the intra-industry trade. Also, the dominant part of the intra-industry trade is devoted to the low quality vertical intra-industry trade. The RCA, that indicates the set factors affecting the comparative advantage, has a negative and significance effect on the vertical intra-industry trade. In other words, foreign trade of Iran in agricultural sector is mainly based on comparative advantages. Besides, based on the positive and significance effect of the land variable on the HVIIT, it seems that the HVIIT is directly influenced by relative endowments. This is expectable since the quality of products depends on land endowment as well as on other factors, such as productivity and technology. Another result is that the product differentiation has a negative and significant effect on the LVIIT. Beside other, this result indicates that this type of trade is mainly based on perfect competition.

CONCLUSION

This study has investigated the vertical intra-industry trade and the total intra-industry trade country

specific determinants of Iran and its major trading partners (24 countries) in the agricultural products group during the period of 2001–2007. For this purpose, by using the Method of Greenaway, Hine and Milner (GHM, the) total IIT is decomposed into the horizontal IIT and vertical IIT in 6-digit HS classification system and then the determinants of the TIIT and VIIT were estimated on the theoretical and experimental basis.

Based on the obtained results, it has been confirmed that economic development (both per capita income and HDI) has a positive and significant effect on Iran's bilateral intra-industry trade. Also, the results verify the Linder hypothesis. In particular, the vertical intra-industry trade is positively and significantly associated with the per capita income differences. It seems that Iran mostly exports the low quality agricultural products to its partners and simultaneously typically imports the high quality ones from them. Furthermore, the prominent part of the vertical intra-industry trade is devoted to the low quality vertical intra-industry trade. In sum, Iran's foreign trade in the agricultural sector is mainly based on the comparative advantage. Specifically, there is a negative and significant relationship between the revealed comparative advantage and the intra-industry trade. In addition, the endowment of land affects positively the high vertical intra-industry trade. Also according to the results, the size market differences impacts the intra-industry trade negatively.

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