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Iran`s Intra-Industry Trade Based on a Schumpeterian Factor Endowment Model

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Abstract
The role of intra-industry trade has been emphasized in international commerce since the 1960s. Innovation and government size, which affect goods and services production and government presence in international commerce, have also been highlighted since then. This study examines the influence of these two factors on international trade and estimates their effects in linear and logistic transformation models from the years 2000 to 2016 using HS four-digit codes. This research focuses on 20 main import and export industries of Iran and selected commercial partners. The authors estimate the model using the bidirectional panel data method and analyze the data using Stata 15 software. Results indicate that in both models there is a U-shaped relationship (non-linear) between innovation and intra-industry trade. However, government size increases intra-industry trade in these models. Linder variables decrease intra-industry trade but GDP per capita increases intra-industry trade. Other control variables (geographical distance and membership in economic organizations) show the expected impact on intra-industry trade.

Keywords
Intra-industry trade, Innovation, Government size, Panel-data, Schumpeterian model.
JEL: C_{23}, F_{14}, L_{60}, H_{50}

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Introduction

The study of intra-industry trade is important because it has fundamental implications for what drives trade. The existence of overlapping trade where countries buy and sell the same product implies that factor endowment differences need not necessarily drive all trade. In the present day, intra-industry trade implies direct competition among countries, and this is an important consideration in evaluating the implications of global integration of an increasing number of economies (Mukerji & Panagariya, 2019).

The theory of intra-industry trade was developed based on the empirical studies of international trade and the unification consequences of Western Europe at the end of 1970s (Balassa & Bauwens, 1973; Clark, 1993,1998; Davis, 1995; Greenaway & Minler,1983; Grubel & Lloyd, 1975; Lee & Lee, 1993; Stone & Lee, 1995; Lundberg, 1992; Loertscher & Wolter, 1980). This study investigates the nature of intra-industry trade and the contributing factors to it in both developed and developing countries. We emphasize that the dramatic increase in international trade and the share of multinational companies influenced by globalization had effects on comparative production factors, production technology, and identical preferences in a specific industry in different countries (Egger et al., 2007; Xing, 2007; Yarbrough & Yarbrough, 2006).

According to Bulhart (2008), intra-industry trade plays such an important role in trading industrial goods in developed countries that it accounts for 44% of total world trade. Given that most countries consider the real comparative advantage of their products of great influence on trade with other countries, intra-industry trade under the influence of technology and manufacturing methods could be a significant topic for further investigation (Najafi et al., 2018).

The very nature of intra-industry trade helps with the recognition and attainment of the dynamic achievements of trade, and in so doing, various countries can use technologies that are unavailable in host countries. Technological advances also increase the productivity of all involved countries. Intra-industry trade limits the income per capita division between trading countries and provides developing countries with the chance to increase their exports (Sedgley & Tan, 2015). Intra-industry trade also facilitates using top technologies in manufacturing products through decreasing the commercial cost of products. In this way, intra-industry trade improves the export industry (Feng, 2018).

Asian empirical studies on intra-industry trade can be divided into two main categories. The first category mainly focuses on China, its value of intra-industry trade, and the contributing factors to its intra-industry trade (e.g., Zhang & Li, 2006). Some other studies have focused on China`s bilateral commercial relationship with the United States (Shen & Gu, 2007), Japan (Xing, 2007), and Korea (Lee & Han, 2008). Korea (Bhattacharyya, 2005; Byun & Lee, 2005), Japan (Wakasugi, 1997), India (Das, 2005; Veeramani, 2002), and Iran (Afshari & Soleimani Movahed, 2010; Azarbaiejani & Taati, 2011) are the other focused countries in this first category of studies.

The second category focuses on Asian commercial unions (mainly in east and Southeast Asia (ASEAN[1])). Thorpe and Zhang (2005), for example, investigated influential factors in the intra-industry trade of South East Asia and stated that its index has changed from 25% to 50%. This increase is due mainly to the cooperation of the focused countries in assigning vertical intra-industry trade and international shares (Ando, 2006; Wakasugi, 2007). In other words, more relations were found in the international devotion of Eastern Asia compared to North America and Europe (Athukorala &Yamashita, 2006). Intra-industry trade also increased economic assimilation in Eastern and South Eastern Asia.

A number of studies examined intra-industry trade using the weight index of ten different goods in relation to 22 countries in the East, South East, South, and Middle East (e.g., Cortinhas, 2007; Sohn & Zhang, 2005; Sawyer et al., 2010). According to these studies, ASEAN and the wealthy countries of the Eastern Asia have the highest levels of intra-industry trade. Other explanatory variables such as geographical distance and the differences in economy size have negative effects on intra-industry trade, although the commercial agreement between the middle and south parts of Asia has influenced it positively. Iran`s intra-industry trade and that of other Asian countries have also been investigated in a number of studies (e.g., Falahati & Soleymani, 2010; Souri & Tashkini, 2014).

1. Association of Southeast Asian Nations

Our study of intra-industry trade aims at being a pioneering one in presenting a basis for intra-industry trade based on innovation and labor force (As an innovative production agent). Most previous studies[1] were theoretical in nature. Our study relies on the existing literature to show the differences in comparative innovation per capita and to answer this question: *Can differences in economic factors be explained by the ratio of innovation to the labor force between countries?* Our study expands the Schumpeterian model in order to provide a different account of the ratio of innovation to the labor force[2] and explain the differences in factors related to intra-industry trade.

The next section discusses the theoretical framework of the relationship between innovation and government size in intra-industry trade. Following that, the research methodology and the theoretical estimated model of the study are explained and the factors that might affect them are considered. Finally, findings and results are presented.

The present study uses the findings of related literature to develop the Schumpeterian basis model, to explain the theoretical foundations of intra-industry trade, innovation, and government size, and to present a beneficial view of the difference in production factors using relative innovation. It is the first study set to focus on the significance of innovation, intra-industry trade, and government size based on the Schumpeterian model in Iran. As a developing country with vast natural resources, Iran needs to invest in these resources as a fundamental prerequisite to international competition.

Intra-Industry Indexes

Empirical studies show that intra-industry indexes have changed over time. Some of the most important indexes of intra-industry trade[3] are discussed here.

1. Grubel and Lloyd (1975): This index focuses on the distinguishing features of trade goods. It defines intra-industry trade as

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1. Based on the studies of Ethier (1982), Helpman and Krugman (1985), Davis (1995), Bernard et al. (2007)
2. Based on the view of Sedgley and Tan (2015)
3. see Nafari & Rasekhi (2002), Azarbaiejani et al. (2005), Rasekhi (2008), Falahati and Soliemani (2009).

the difference between the balance of trade and the total trade as calculated from the following equation.

$$GL_{ij} = \frac{\sum_{k=1}^{n}\left(X_{ijk} + M_{ijk}\right) - \sum_{k=1}^{n}\left|X_{ijk} - M_{ijk}\right|}{\sum_{k=1}^{n}\left(X_{ijk} + M_{ijk}\right)} * 100 \tag{1}$$

GL_{ij} in this equation refers to Grubel and Lloyd`s balance index for the i and j countries. $X_{jk}$ and $M_{jk}$ refer to the i country`s import from and export to the j country. The index ranges from 0 to 1, referring to the lack of and total degree of intra-industry trade, respectively.

2. Grubel and Lloyd modified index: This index includes a country's independent intra-industry trade index with other countries' and covers imbalanced trade as well. It is calculated from the following equation:

$$GL_{j} = \frac{\sum_{k=1}^{m}\left(X_{jk} + M_{jk}\right) - \sum_{k=1}^{m}\left|X_{jk} - M_{jk}\right|}{\sum_{k=1}^{m}\left(X_{jk} + M_{jk}\right)} * 100 \tag{2}$$

GL_{j} in this equation refers to Grubel and Lloyd modified index for the j country with the rest of the world. X_{ijk} and M_{ijk} also refer to the industrial export and import of the j country in the i industry. According to the above equation, $\sum\left(X_{jt} + M_{jt}\right)$ is the total degree of trade and $\sum\left|X_{jt} - M_{jt}\right|$ equals the intra-industry trade. As the first equation GL here ranges from 0 to 1.

3. Aquino index (1978): this index covers bilateral or unilateral relations. It is calculated in this way:

$$AQ_{ij} = \frac{\sum_{k=1}^{n}\left(X_{ijk} + M_{ijk}\right) - \sum_{k=1}^{n}\left|X_{ijk}^{e} - M_{ijk}^{e}\right|}{\sum_{k=1}^{n}\left(X_{ijk} + M_{ijk}\right)} * 100 \tag{3}$$

$$AQ_{j} = \frac{\sum_{k=1}^{m}\left(X_{jk} + M_{jk}\right) - \sum_{k=1}^{m}\left|X_{jk}^{e} - M_{jk}^{e}\right|}{\sum_{k=1}^{m}\left(X_{jk} + M_{jk}\right)} * 100 \tag{4}$$

AQ_{ij} is the Aquino index for the j and i countries. AQ_{j} is the Aquino index for the j country only.

X_{ijk} and M_{ijk} are the i country`s value of exports and imports to the j country in the K industry. $X^{e}_{ijk}$ and $M^{e}_{ijk}$ are the i country`s theoretical value of exports and imports to the j country in the K industry.

X_{jk} and M_{jk} are the j country`s total value of exports and imports in the K industry. $X^{e}_{jk}$ and $M^{e}_{jk}$ are the j country`s estimated values of the exports and imports in the K industry, which are calculated in the following ways:

$$X^{e}_{jk} = \frac{1}{2}\left(X_{jk}\right)\frac{\sum_k\left(X_{jk}+M_{jk}\right)}{\sum_k X_{jk}} \quad \text{and} \quad M^{e}_{jk} = \frac{1}{2}\left(M_{jk}\right)\frac{\sum_k\left(X_{jk}+M_{jk}\right)}{\sum_k M_{jk}}$$

Vona (1991) argues that the Aquino index does not necessarily increase the Grubel and Lloyd index. The Aquino index was, at first, an index of the similarity between export and import structures, rather than an index of intra-industry trade. Rasekhi (2008) also states that the Aquino index was not very useful because it only showed the commercial combination of given countries. Literature related to intra-industry trade also shows that most studies conducted up to now have used the Grubel and Lloyd index.

Intra-Industry Trade and Innovation

The "innovation–trade" interrelation has been a subject of research for decades and international trade has always been considered as a channel for transfer of technology from industrial to relatively less developed countries (Gallucci et al., 2019). In other words, given the technological and economic advances of the third thousandth, the main issue to be investigated is the relationship between business patterns of different countries and their technological behavior and innovations. A number of studies have examined the relationship between innovation and international trade using macroeconomic models and analyses[1]. Some other studies have investigated, directly or indirectly, the indexes of innovation and the export behavior of enterprises (Rodil et al. ,2015).

1. Some primary studies such as Caldera (2010) and Salomon & Byungchae (2010) can be referred to in this case.

Innovation was first introduced by Schumpeter (1934) as "creative destruction." He regarded innovation as an irreversible historic change that happens during the process of economic activities. It disturbs the existing economic status and leads to a new economic stability (Fagerberg, 2009). In fact, Schumpeter`s hypothesis was based on the close relationship between innovation and market structure. It states that only the best monopolistic companies can afford innovation expenditures and use the temporary monopoly profits. The more the innovator uses knowledge cycles, the higher monopoly position he can achieve and the more motivation he will have for innovation (Laino, 2011).

There are many theoretical frameworks explaining the relationship between innovation and intra-industry trade. Some studies conclude that innovation can greatly influence trade (Caldera, 2010; Cassiman et al, 2010). Other studies believe that technical skills can be improved through manipulating technology and innovation, which in turn increase trade (Bastos & Straume, 2012; Beaulieu et al, 2011). Moreover, Yin and Tang (2006) state that two main reasons explain countries' willingness to use higher levels of technology and innovation, namely increasing product quality and producing various forms of products (Feng, 2018).

Coccia (2013) argues that the increasing international relationship between countries increases the need to innovation because the big networks of connection and the specialization of affairs would facilitate the formation of new ideas and the production of new facilities.

A good many of studies have shown that there is a close relationship and noticeable correlation between registered inventions and economic successes at international markets (e.g., Gehrke et al. 2007; Grupp et al. 1996; Münt, 1996; Porter 1998; Wakelin 1997, 1998). Having examined the registered inventions in a number of industrial countries, Blind and Frietsch (2006) stated that it clearly justifies the degree of export in those countries and their highly technological cities. On the other hand, patent in those countries denotes technological inventions, and registering an invention in a market or patent register office means combining the products of exclusive technologies (Frietsch et al., 2014).

Zhang and Clark (2009) consider innovation as one of the influential factors on intra-industry trade and believe that the nature of the produced goods in trading countries depends on the degree to which they use innovative technological processes. According to Łapińska (2016), positive relationship between different indexes of innovation and intra-industry trade has been confirmed by other empirical studies, too (Xing, 2007; Leitao & Faustino, 2008, 2009; Sawyer et al., 2010; Salamaga, 2012).

The relationship between trade and innovation is based on a consolidated macroeconomic framework. The first view of neo-endowment models investigates relationships between innovation and trade in terms of devoting and endowing factors as the sources of competitive advantages (Davis, 1995). Based on this view, using different production factors such as resources and materials, labor forces (skilled and unskilled), capital, and technology should explain the export ability of different countries. A second view was developed based on neo-technology models in relation to such theories as the product-life cycle (Vernon, 1966) and the theory of technological division (Posner, 1961). The former investigates the effects of the life cycle on decisions made on innovation, whereas the second examines the status of countries influenced by permanent technological division. The main assumption behind models of the second view is that business patterns of different countries are affected by their differences in using technology, which is in its turn related to their route of innovation and diffusion (Greenhalgh, 1990; Greenhalgh et al., 1994). Other macroeconomic models have recently stated the possibility of heterogeneity of companies in a country. In this case, companies can boost their exports if they improve the quality of their products (Grossman & Helpman, 1991).

Registering an invention in a specific market or patent office implies producing goods with an exclusive technology. Therefore, registered inventions are highly related to the export functions of each country, although it does not necessarily mean that invention is the only contributing factor to export. In other words, innovation may not result in a growth in exports, whereas higher export rates can affect innovation actions (Chang et al., 2013; Hsu & Chuang, 2014; Madsen, 2007; Sun & Du, 2010).

A number of empirical studies have emphasized the noticeable correlation between registered inventions and economic success at international markets (Gehrke et al., 2007; Grupp et al., 1996; Münt, 1996; Porter, 1998; Wakelin, 1997; Wakelin, 1998a, 1998b). Having analyzed time series intervals of some industrial countries, Blind and Frietsch (2006) indicated that registered inventions explained their trade process especially in relation to their most and least technological areas. Registering an invention in a specific market or a patent office implies producing goods with an exclusive technology. Therefore, it can be claimed that registered inventions are highly related to the export functions of each country, although it does not necessarily mean that invention is the only contributing factor to export. In other words, innovation may not result in growth in exports, whereas higher export rates can affect innovation actions (Chang et al., 2013; Hsu & Chuang, 2014; Lachenmaier & Wobmann, 2006; Madsen, 2007; Sun & Du, 2010).

There is some evidence that reinforcement of the patent system not only attracts the export of other countries (this is especially the case in relation to low-income and average-high income countries (Briggs, 2012, 2013), but also increases export to other countries (Briggs & Park, 2013). Many studies investigated innovation indirectly (e.g., in relation to such indexes as products innovation and process innovation) in order to determine the way it influences the export behavior of enterprises (e.g., Caldera, 2010; Esteve-Perez & Rodriguez, 2013; Salomon & Byungchae 2010; Senturk & Erdem, 2008).

A large number of studies have highlighted the relationship between innovation and knowledge efficiency and trade (Fagerber, 1988; Salim & Bloch, 2009; Verspagen & Wakelin, 1997; Wakelin, 1998a). Others have shown that the relationship between innovation and exports has a lot to do with the technological competitiveness of enterprises as they focus on innovation (Aw et al., 2011; Bustos, 2011; Constantini & Melitz, 2008; Rodil et al., 2015).

After investigating the performance of a number of enterprises in the highly technological areas of China, Li et al. (2013) claim that there is a positive relationship between patents and development of new products and their export trade. Another study by Chen (2013), which examined the exports of 105 countries during 1975-2001, showed that the relationship between innovation and exports is more noticeable with low-income countries.

A large number of empirical studies have also examined the relationship between innovation and the level of trade (e.g., Becker & Egger, 2009; Dhanaraj & Beamish, 2003; Harris & Li, 2009; Harris & Moffat, 2011; Roper et al, 2006). Some recent studies investigated the effects of innovation on the performance of Spanish companies (e.g., Caldera, 2010; Cassiman et al., 2010; Lopez & Gracia, 2005). With the exception of Harris and Li (2009) and Harris and Moffat (2011), these studies, generally, examined the performance of productive enterprises and emphasized the influences of innovation on their export behavior. In fact, some studies have allowed for inducing an endogenous relationship between innovation and export (e.g., Caldera, 2010; Cassiman et al, 2010; Lopez & Garcia, 2005; Vargas, 2003).

According to Sedgley and Tan (2015), intra-industry trade is a function of the difference between countries in terms of production factors, and trade reaches its highest level when countries enjoy the same level of production. In this study, the production factors of innovation and labor force are regarded as Schumpeterian. Given that, the high proportion of innovation to labor force in comparison with its global proportion influences trade through exporting intermediate goods for the purpose of getting ultimate goods. The low proportion of innovation in comparison with its global proportion, however, influences trade through exporting ultimate goods for the purpose of getting intermediate goods. This proves that there is a non-linear relationship between relative innovation and its global amount and intra-industry trade.

Najafi et al. (2018) investigated the linear and non-linear relationship between innovation and intra-industry trade in relation to automobiles produced from 2000 to 2015. The results of their study indicate that innovation positively influences intra-industry trade in Iran and its selected commercial partners in the linear model, although this variable is not statistically significant. In the non-linear model, however, based on the positive and negative coefficients of the innovation factor (RP & RP^2), a reversed U shape relationship was found between innovation and trade. Moreover, the government size variable has a positive and significant effect on intra-industry trade. The Linder variable and the geographical distance do not have a statistically significant effect on the automobile trade.

Intra-Industry Trade and Government Size

There has been a dramatic increase in international trade relations around the world during the last 50 years, coinciding with globalization. Because of this, the consequences of trade and the macro economy should be examined in more detail. In so doing, it is important to consider the government size factor (Afonso & Furceri, 2010; Bergh & Henrekson, 2011; Jetter & Parmeter, 2015) because governments can affect the production of different goods through applying a number of political rules, both encouraging and limiting. They can also improve the innovation and performance of enterprises by applying regulations that lead to production profits.

A few studies have implicitly examined government intervention on international trade patterns (e.g., Anwar, 1995, 199٨, 2001; Clarida & Findlay, 1992; Ishizawa, 1988). Anwar (2001) examined the effects of changes made by the government in public infrastructure on goods production, relative price, distinction rate, and trade pattern within the model of general equilibrium. He used the exclusive competition model for intermediate goods and the perfectly competitive market model in relation to ultimate goods. Based on the results of the study, providing infrastructure changes trade patterns by decreasing the final prices of intermediate and ultimate goods.

In Saadati`s (2010) study, the effects of government size on intra-industry trade was examined using the total current expenditures and transferred payments indexes on GDP. This study used the models of linear and logistic transformation for estimating intra-industry trade in selected developing countries. Results indicate positive and meaningful relationships between government size and intra-industry trade.

Another study by Dahmarde and Jofreh (2016) examined the relationship between government size and trade openness and country size for developing D8 and ECO member countries using panel data. Results confirmed the positive relationship between the proportion of total expenditures by the government to GDP as an index of government size and trade openness. The relationship was meaningful for D8 countries and meaningless for ECO member countries.

We mentioned earlier that a few studies have implicitly examined government interventions on international trade models. Other studies indicated the existence of a positive relationship between government size and intra-industry trade (e.g., Benarroch & Pandey, 2011; Kueh et al., 2008). Rasekhi et al (200٩) and Hanslin (2008), however, believe that the relationship between these factors is negative. Still, studies such as Aydogus and Topcu (2013) have shown no relationship between them at all.

Despite the diversity of studies on intra-industry trade and its contributing factors, to our knowledge, no study has investigated the effects of innovation on Iran and its selected business partners` intra-industry trade based on a Schumpeterian factor endowment model within linear and logistic transformation frameworks. Our study examines this issue along with government size since it is one of the main economic factors influencing intra-industry trade.

Research Methodology

Most countries consider the comparative advantages of their products of great influence on their trade with other countries. Iran is among the countries that need the influence of import and export goods and services on its beneficent industries to improve its international commerce. The lack of experts in producing and transferring competitive goods at the international level negatively influences its role in global trade. We hope that our analytic study on Iran’s intra-industry trade will help improve this situation.

We examined (1) the non-linear (reversed U) relationship between innovation and intra-industry trade and (2) the relationship between government size and intra-industry trade using four-digit HS codes in relation to the 20 main industries of Iran that have the highest effects on its import and export trade.

Generalizing the gravity pattern and considering previous research by Sedgley and Tan (2015) on the effects of innovation and government size on Iran’s intra-industry trade and 24 of its selected commercial partners[1], our study used the following model:

1. The list of the specific commercial partners of Iran was taken from the report of the Business Development Organization, which specifies them based on the most accurate available information. The list includes. Germany, France, Netherlands, India, Indonesia, China, Russia, Kazakhstan, Tajikistan, Turkey, Azerbaijan, Italy, Armenia, Uzbekistan, United Arab Emirate, Singapore, Switzerland, South Africa, Thailand, Malaysia, Japan, Sweden, United Kingdom, and Belgium.

$$Y_{jt} = \beta_1 + \beta_2 Rp_{jt} + \beta_3 Rp_{jt}^2 + \beta_4 size_{jt} + \beta_5 X_{jt} + \gamma_j + \varepsilon_{jt} \qquad (5)$$

Two dependent variables in this study are the Grubel-Lloyd index (GL_{jt}) and the log-odds ratio of the Grubel Lloyd index $loddGL_{jt}$, which is regarded as logistic transformation, and defined as follows[1]:

$$LoddGL_{jt} = \ln\left[\frac{GL_{jt}}{(1 - GL_{jt})}\right] \qquad (6)$$

Based on the many studies that have measured intra-industry trade, the most common variable is that of Grubel and Lloyd (GL), which varies from 0 to 1. The value 1 shows perfect intra-industry trade and the value 0 shows the perfect inter-industry trade (Najafi et al., 2018).

The intra-industry trade index in relation to export (X_{ijt}) and import (M_{ijt}) amounts between Iran (j) and its selected commercial partners in the year t and the industry i with the HS four digits code is calculated as follows[2]:

$$GL_{jt} = \frac{\sum_j (X_{ijt} + M_{ijt}) - \sum_i |X_{ijt} - M_{ijt}|}{\sum_i (X_{ijt} + M_{ijt})} = 1 - \frac{\sum_i |X_{ijt} - M_{ijt}|}{\sum_i (X_{ijt} + M_{ijt})} \qquad (7)$$

X_{ijt} and M_{ijt}, here, refer to export and import between the j country and the rest of the world. Numerator is intra-industry trade. $\sum(X_{ijt} + M_{ijt})$ is the total amount of trade, and $\sum|X_{ijt} - M_{ijt}|$ equals intra-industry trade.

Given that Iran is not capable of producing a wide variety of products and is in need of efficient import and export patterns, recognizing trade opportunities and relative benefits is essential for developing its international relationships. In doing so, international production industries that have the greatest potential for contributing to Iran’s trading policy should be identified carefully.

1. Results of the linear or log-linear equations may not be within the range of 0-1. In such cases, the function of logistic transformation may be used. Logistic transformation cannot be used for the results within the 0-1 range. The value 1 refers to the total amount of intra-industry trade, which is very unlikely to happen. The value 0 that refers to the total amount of inter-industry trade, however, is very likely to happen. The function of logistic transformation was used in Falahati and Soleymani (2010) and Saadati (2010).
2. Refer to Azarbaiejani and Taati (2011), Rodil et al. (2015), Łapińska (2016), Sledziewska and Czarny (2016), Feng (2018), and Najafi et al. (2018).

Moreover, the idea of investigating intra-industry trade separately in relation to selected products is another unique feature of our study, although calculating intra-industry trade for constructing the GL index in relation to all investigated products was more difficult than constructing the GL index in relation to the whole or a part of industry. Another study by Azarbaiejani and Izadi (2006) examined the intra-industry trade of Iran and China in only eight groups of four-digit codes of STIC. However, selected industries in this study are the ones that export 10 main goods from Iran and import 10 main goods from other countries to it. They were taken from the website of the Ministry of Industry, Mine and Trade (http://intra.tccim.ir). The rest of the employed data were taken from http://intra.world bank.ir.

The selection of the first 10 industries was done by identifying the share of intra-industry trade products between Iran and its commercial partners. The fact that Iran`s economy has always been dependent on oil and oil derivation products can be considered a relative benefit. These products include traditional and agricultural ones that can influence its trade greatly1.

The key variables in the model are innovation ($\mathrm{Rp_{jt}}$) and government size. The first variable refers to the number of patent[2] programs of the j country in the t year. The second one refers to the ratio of the government expenditure to GDP[3].

$$\mathrm{GL_{jt}} = \beta_0 + \beta_1 Rp_{jt} + \beta_2 Rp_{jt}^2 + \beta_3 size_{jt} + \beta_4 Pcgdp_{jt} + \beta_5 Dist_{jt} + \beta_6 Lin_{jt} + \beta_7 WTO_{jt} + \beta_8 ECO_{jt} + \gamma_j + \varepsilon_{jt} \quad (8)$$

$$\mathrm{loddGL_{jt}} = \alpha_0 + \alpha_1 Rp_{jt} + \alpha_2 Rp_{jt}^2 + \alpha_3 size_{jt} + \alpha_4 Pcgdp_{jt} + \alpha_5 Dist_{jt} + \alpha_6 Lin_{jt} + \alpha_7 WTO_{jt} + \alpha_8 ECO_{jt} + \gamma_j + \varepsilon_{jt} \quad (9)$$

1. According to Azarbaiejani and Izadi (2006), inflation rises when a subgroup of a large number of products is combined with one group of products. Generally, the more combination happens (e.g., in one-digit groups of STIC), the higher levels of intra-industry trade are achieved, and this process continues until the products group is divided into very smaller subcategories. In that case, trade relation information is not reported because there is not much information about it.
2. It has been considered an index of innovation in Fontana et al. (2012), Fritsch et al. (2014), and Cavdar & Aydin (2015).
3. Refer to Epifani and Gosina (2009), Shahbaz, Rahman and Amir (2010), Lin, Li and Sim (2014), Martinz and Veika (2014).

According to Sedgley and Tan (2015), the total amount of innovation per capita within the investigated countries in the t year is calculated as:

$$\mathrm{totalpcRp_t} = \sum_j \frac{\mathrm{Rp_{jt}}}{\mathrm{pop_{jt}}}$$

Wherein $\mathrm{pop_{jt}}$ is the population of the j country (in terms of million) in the t year.

Finally, the innovation relative variable (the ratio of innovation per capita of each country to the total innovation of all investigated countries) is defined as:

$$\mathrm{Rp_{jt}} = \frac{\mathrm{pcRp_{jt}}}{\mathrm{totalpcRp_t}} \tag{10}$$

Based on this index, if patent is more than 1 $(\mathrm{Rp} > 1)$, the innovation of each country is more than the innovation per capita worldwide. If it is less than 1 $(\mathrm{Rp} < 1)$, the innovation of each country will be less than the innovation per capita worldwide.

Also based on the 8 and 9 equations, if $\beta_1 = \beta_2 = 0$, there is no relationship between the innovation index and intra-industry trade. If $\beta_2 = 0$ and $\beta_1 \neq 0$, there is a linear relationship between the mentioned indexes. If $\beta_1 > 0$, the linear relationship will be positive (increasing). Otherwise, if $\beta_1 < 0$, the linear relationship will be negative (decreasing). If $\beta_2 \neq 0$ and $\beta_1 \neq 0$, it would be a quadratic function. In this case, if $\beta_2 > 0$ and $\beta_1 < 0$, there would be a u-shaped relationship between the focused variables, and if $\beta_2 < 0$ and $\beta_1 > 0$, there would be a reversed u-shaped relationship between them. Therefore, the maximum point of the function would be calculated in the following way:

$$\widehat{Rp}_{it} = exp\left[-\frac{\beta_1}{2\beta_2}\right] \tag{11}$$

There are also a number of control variables $(\mathrm{X_{jt}})$ which can influence intra-industry trade. As an indicator of the Linder index for the j country in the t year, $\mathrm{lin_{jt}}$ is calculated as the absolute value of the difference between GDP per capital of Iran and its selected commercial partners[1]

$$\mathrm{Lin}_{jt} = \left|\mathrm{Pcgdp}_{jt} - \mathrm{Pcgdp}_{kt}\right| \tag{12}$$

According to Kim and Oh (2001), this equation is valid for both developing and developed countries. It is expected that the coefficient of the Linder variable is negative in the equation, meaning that the more similar the economic structures of the two countries, the more trade and intra-industry trade they have (Łapińska, 2016).

Following Balassa and Bauwens (1987) and Stone and Lee (1995), Turkcan and Ates (2010) operationalized DIST_{jt} or the geographical distance using the GDP of the given countries in the following way:

$$\mathrm{Dist}_{jt} = \frac{\mathrm{INTRA}_{jt} * \mathrm{DISTANCE}}{\sum \mathrm{INTRA}_{jt}} \tag{13}$$

Y_{jt} in the equation above refers to the GNP of the j country in the t year and Distance shows the amount of space between Iran`s capital and those of its selected commercial partners in terms of Kilometer.

WTO_{jt} is the index of tariff similarity of the j country in the t year. If the country is a member of WTO_{jt} will be 1. Otherwise, it equals 0.

ECO_{jt} is the index of the economic coherence of the j country in the t year. The index equals 1 if the j country is a member of ECO. Otherwise, it would equal 0.

γ_j is the fixed effects of the country but μ_t is the fixed effects of the year.

Findings

The first stage of panel data econometrics is the recognition of cross-section dependence between data. The study used Pesaran's CD Test and based on the gained results, it rejects the null hypothesis of cross-section dependence in both models for all variables. The durability of variables was then investigated using Cross-sectionally augmented Im-Pesaran-Shin (CIPS) unit root test. Table 1 presents the results as follows.

1. The index has been emphasized in Ferto and Sous (2008), Leitao and Faustino (2009), Shahbaz and Leitao (2012), and Sledziewska and Czarny (2016).

Table 1. Unit Root Test (CIPS)

Unit root test	1%	5%	10%	Statistic	Variables
I(0)	-2/45	-2/25	-2/14	-3/846	GL
I(0)	-2/45	-2/25	-2/14	-2/18	loddGL
I(0)	-2/45	-2/25	-2/14	-2/266	Rp
I(0)	-2/45	-2/25	-2/14	-2/320	Size
I(1)	-2/45	-2/25	-2/14	-2/458	Pcgdp
I(1)	-2/45	-2/25	-2/14	-2/763	Dist
I(1)	-2/45	-2/25	-2/14	-2/439	Lin

Source: Researcher findings

As the table shows, the GL, loddGL, Rp and Size variables in both models are static. Other independent variables were found to have 99% staticity after differentiating once.

Two-Way Regression Model

Given the mentioned theoretical considerations, this study used the Chow test for selecting the type of estimation using polling data and panel data approaches. Null hypothesis of the test implies non-existence of fixed effects. It shows the intercept is fixed. After that, for estimating the model and selecting patterns, panel-data two-way and one-way tests were used. The Hausman test was then used for selecting fixed or random effects. The null hypothesis of the test implies that there is no correlation between individual and random effects (Souri, 2015).

During the process of estimating models, data panels were analyzed for selecting the patterns of the two-way and one-way panel-data. Table 2 as follows presents the results.

Tables 2. Results of Chow and Hausman Tests

	Statistic	Value	Probe	Result
GL Model	Chow test	9/04	0/000	Verify panel data
	Two-way panel-data test	2/82	0/0008	Verify two-way panel-data
	Hausman test	3/24	0/663	Verify random effects method
LoddGL Model	Chow test	5/92	0/000	Verify panel data
	Two-way panel-data test	1/91	0/032	Verify one-way panel-data
	Hausman test	2/63	0/757	Verify random effects method

Source: Researcher Findings

This table shows that at the 99% confidence level, the null hypothesis of the polling data approach is rejected for the benefit of the panel data approach. Therefore, both models were estimated using the panel data approach. Then, based on the analysis of the first and second models, the estimations were checked using two-way and one-way panel-data tests. However, based on the Hausman test, the null hypothesis fixed effects are rejected for the benefit of the other estimation or random effects. Therefore, the results show that the first model is estimated using two-way panel-data random effects test, while the second model is estimated using one-way panel-data random effects test. Table 3 shows the results of estimations within the GL and LoddGL.

Tables 3. Results of Estimations at Both Models

Probe	Statistic	Coefficients	Variables	Models Types
0/098	1/65	3/58	Cons	GL Model
0/016	2/40	20/933	Rp	
0/000	-6/64	-39/249	Rp^2	
0/006	2/72	0/0087	Size	
0/066	1/84	0/0009	dPcgdp	
0/092	-1/68	-0/0062	dDist	
0/031	-2/16	-0/0011	dLin	
0/011	2/53	2/96	WTO	
0/800	0/25	-0/0096	ECO	
0/000	-9/87	-6/77	Cons	LoodGL Model
0/001	3/39	10/538	Rp	
0/000	-7/90	-16/11	Rp^2	
0/024	2/25	0/0019	Size	
0/005	2/79	0/00046	dPcgdp	
0/031	-2/16	-0/0028	dDist	
0/002	-3/14	-0/0005	dLin	
0/000	5/65	2/41	WTO	
0/882	0/15	0/169	ECO	

Source: Researcher findings

The estimated coefficients of Rp and Rp^2 in the innovation index in both models are positive and negative, respectively. These initial results confirm our theoretical prediction: There is a non-linear relationship between innovation and the intra-industry trade variable. It also shows that there is a reversed U-shaped relationship between innovation and intra-industry trade in the investigated countries. To be more precise, an increase in the level of innovation increases intra-industry trade up to a specific level. After getting to that level, however, the intra-industry trade decreases. The obtained results show that innovation in the first model contributes much more to intra-industry trade.

Discussion

The maximum point between innovation (based on (8) and (9) equations), GL and LoddGL are calculated in this way:

$$\widehat{Rp}_{it\_Gl} = \left[-\frac{\beta_2}{2\beta_3}\right] = \left[-\frac{20/93}{2(-39/24)}\right] = 0/26\% \qquad (14)$$

$$\widehat{Rp}_{it\_loddGl} = \left[-\frac{\alpha_2}{2\alpha_3}\right] = \left[-\frac{10/53}{2(-16/11)}\right] = 0/32\% \qquad (15)$$

The resulting maximum points of 0/27% and 0/26% in both estimated models show that most selected trading partners (except Japan) have not reach their highest point of innovation. These results are located on the ascendant part of the U curve. Increasing innovation in these conditions would increase intra-industry trade for the investigated countries. The positive effects of innovation on trade have been emphasized in other studies as well (Caldera, 2010; Cassiman et al., 2010; Harris & Li, 2009; Harris & Moffat; 2011).

Results show that innovation with RP and RP^2 variables and the coefficients of 20/93 and -39/24 in the first model and 10/53 and -16/11 in the second model is meaningfully related to intra-industry trade. This confirms a non-linear relationship between innovation and intra-industry trade. When innovation is at its maximum point, the maximum amount of intra-industry trade is possible.

As another key variable, government size was measured as an index of the ratio of government expenditure to GDP, with coefficients of 0/008 and 0/001 in the first and second models increasing intra-industry trade.

The government size variable has a positive mark and is meaningful at 99% and 95% in the models used. This shows that the more government expenditures increase in relation to GDP, the more intra-industry trade increases. Since the private sector in Iran is small and the government has a much bigger share of oil income, it can increase intra-industry trade by importing more such goods. This is especially the case in relation to the auto industry that exclusively belongs to the government.

Different studies have come to different conclusions on the relationship between innovation and intra-industry trade. Some of them showed a positive relationship between these two factors (e.g., Alesina & Wacziarg, 1997; Benarroch & Pandey, 2011; Dahmarde & Jofreh, 2016; Epifani & Gancia, 2005; Kueh et al., 2008).

GDP per capita also has a positive coefficient and meaningful effect on intra-industry trade in both estimated models. Based on the data, we believe that if countries develop economically, their intra-industry trade develops as well. The negative effect of the Linder index on intra-industry trade was confirmed (e.g., Azarbaiejani & Taati, 2011; Lapinska, 2016; Sawyer et al., 2010; Shahbaz & Leitao, 2010; Sledziewska & Czarny, 2016; Souri & Tashkini, 2014).

Another contributing factor to intra-industry trade is the Linder variable that has a negative mark and is meaningful at 95% and 99% confidence levels in both models. Thus, more similarity between business partners in terms of per capita income can lead to their higher amount of Intra-Industry Trade. The negative effect of the Linder index on intra-industry trade has been confirmed (e.g., Azarbaiejani & Taati, 2011; Łapińska, 2016; Sledziewska & Czarny, 2016).

The geographical distance variable also has a negative and meaningful coefficient in both models. The greater the geographical distance between Iran and its selected commercial partners, the less GL and intra-industry trade there is. This negative correlation between geographical distance of distant commercial partners and the level of intra-industry trade was already reported in previous research (Azarbaiejani & Taati, 2011; Łapińska, 2016; Leitao & Shahbaz, 2012; Śledziewska & Czarny, 2016).

The two dummy variables employed in the investigated models are the similarity of tariff (WTO) and membership in economic organizations (ECO). The WTO dummy variable has a positive effect on intra-industry trade, meaning that similar tariffs charged by members of the WTO encourage intra-industry trade. This relationship has been shown in other studies (Rasekhi, 2007; Sedgley & Tan, 2015).

The dummy variable ECO has a negative and meaningless coefficient in the first model (as mentioned in Falahati & Soleimani, 2010), showing that the two-way trade between Iran and its selected business partners decreased with membership in economic organizations. This may be because of these organizations' inability to use their potential to influence intra-industry trade (Rasekhi, 2007). In the second model, this variable has a positive but meaningless coefficient. Membership in the WTO results in a larger and more meaningful coefficient. It is clear that the membership of Iran`s business partners in the WTO has more influence on intra-industry trade.

Considering the intra-industry trade of Iran at the product level, the country rarely enjoys a high level of intra-industry trade in the production of goods that need innovation. The high level of intra-industry trade in Iran is more noticeable when it comes to the production of goods needing bigger government size and influence. Thus, focusing on innovation in order to increase Iran's contribution to intra-industry trade is necessary (although this conclusion only applies to the products investigated in this study).

Comparing the average of Iran`s intra-industry trade of various product groups shows 10 main export industries—7208 (flat-rolled products of iron and steel), 2713 (bitumen), and 2523 (different kinds of cements)— as well as 10 main import industries—8474 (screening equipment and machinery), 8703 (cars), and 3004 (medicine) had the highest values during the years researched in this study.

Conclusions

The role of intra-industry trade has been emphasized in international commerce since the 1960s, and it will continue to be highlighted in future research. Intra-industry trade, as a proportion of total trade, rises when countries have the same economic endowments. Currently, there is a non-linear relationship between industry innovation in one country and that of the rest of the world.

This study examined intra-industry trade and the effects of innovation and government size in Iran and a number of its most important commercial partners using the Schumpeter model for the years 2000 to 2016. We identified Iran`s economic and business potential with its main commercial partners and reported on its major imports and exports. We focused on Iran`s 20 largest industries (using four-digit HS code) to investigate the value and combination of its international trade and to influence its production policies.

The main gap this study covered is the relationship between innovation and intra-industry trade between Iran and a number of its selected trading partners in greater detail. This study also considered government size as a variable that can affect trade in different ways for different countries and industries.

Results show that innovation with RP and RP^2 variables is meaningfully related to intra-industry trade. This confirms a non-linear relationship between innovation and intra-industry trade.

The other key variable, i.e., government size, was measured as an index of the ratio of government expenditure to GDP, increasing intra-industry trade.

The Linder index, however, has a negative effect on intra-industry trade. Geographical distance also has a negative influence on and a meaningless relationship with intra-industry trade in both models. The dummy variable WTO (membership in the WTO) has a positive and meaningful coefficient in both models and contributes the most to intra-industry trade. Membership in economic organizations (ECO), however, is not meaningful in both models.

Given the low potential of Iran to produce various products, it should seek a more practical model of producing, importing, and exporting goods to improve its international trade relations, especially with other member countries of the WTO. The country needs to recognize its commercial opportunities and their comparative advantages in order to develop the best economic and business policies.

Oil and its derived products, cement, and steel constitute a high proportion of Iran`s industry. Given that these products are government controlled, we suggest that the government itself exert influence to decrease raw material extraction expenses and increase the quality of produced goods. In this way, the government will be acting efficiently to improve intra-industry trade. Moreover, it can use the successful experience of researchers and innovators in other countries to increase Iran`s competitiveness at the international level.

Based on the results of this study, we believe that more attention should be paid to innovation and creative ideas in Iran. We also recommend moving toward the knowledge-based economy to benefit from national and international cooperation.

Research Implications

Results of this study could benefit organizations in charge of making economic and commercial policies. This study could also positively affect the commercial relations of developing countries, including Iran and its main commercial partners, in producing goods that need high levels of innovation. Specifically, this study suggests that Iran`s main commercial partners should be identified by the Tehran Chamber of Commerce, Industries, and Mines and the Institute for Trade Studies and Research in order to follow Iran`s macro-economic policies. Moreover, Iran`s Trade Promotion Organization could use the practical results of this study to contribute to the development of Iran`s industry at the international level using new inventions and innovations.

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