New aspects of intra-industry trade in EU countries

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New Aspects of Intra-industry Trade in EU Countries

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Abstract

Using the HS eight-digit product level trade data of EU countries for the period 1988 – 2010, we analyse Intra-industry trade within EU countries as well as with Eastern European countries and with China. We find the Eastern European countries' rise up the quality ladder, and by contrast the substantially lower prices of China's exports to EU countries vis-à-vis China's imports from them. The contrast between EU trade with the Eastern European countries and with China is present even in very recent years.

Keywords: EU, Intra-industry trade, Horizontal and Vertical Product Differentiation, Quality, Unit price gap , China

JEL classification: F14

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New Aspects of Intra-industry Trade in EU Countries

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1. INTRODUCTION

It is widely documented that the process of worldwide trade liberalisation has led to a dramatic expansion in the volume of intra-industry trade (IIT) (i.e. two-way trade within a sector or a product) especially in the past few decades. However, inter-industry trade (i.e. one-way trade) remains substantial. The trade literature over the last few decades has seen many empirical studies on IIT, both in its measurement and determinant factors. In particular, the recent IIT literature has shed light on product level analysis and prices at a minute product level. Two facts in the current world trade underlie this. First, many developing countries have joined the world trade system. They export lower priced variety of the product. Second, more varieties of products with various unit prices within a particular product can be exported with each other. Focusing on the substantial variation of import-export prices in IIT, many previous studies decompose IIT into horizontal and vertical. Horizontal IIT (HIIT) is defined as IIT with no substantial import-export price gap, while vertical IIT (VIIT) is classified as IIT with a substantial import-export price gap.

Europe is now one of the more interesting areas to study IIT. Since EU-15 countries are similar in industrial structure, income and economic growth, HIIT is substantially large in within-EU countries trade. Deepening European economic integration has promoted the intra-EU IIT. Furthermore, European economic integration in recent years has geographically expanded to include the emerging

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market economies of Eastern Europe, who first joined European Union in 2004.[1] Since Eastern European countries generally produce lower price products through lower wages and lower technology, this has resulted in an inflow of low price products to EU-15 countries (in short "EU countries", henceforth).[2] This has substantially increased VIIT. Based on these incidents, we focus primarily on EU countries' IIT trade with Eastern European countries. From a policy point of view, it is of utmost concern whether or not IIT has increased, and whether or not Eastern European countries' deepened economic integration with the EU countries has led to their products climbing up the quality ladder.

The EU trade data used in our paper have a unique virtue compared with any other countries. First, they are available at highly disaggregated level of HS eight-digit, in which product classification is consistent across all EU countries. Second, and more importantly, the HS eight-digit code of the EU trade data are consistent for exports and imports, which allows us to compare the unit price of exports and imports of particular HS eight-digit products. This is not the case for other countries.[3]

Our contributions to the literature are three-fold. First, our paper provides some evidences on a drastic evolution in the EU's IIT with Eastern European countries, which contrasts sharply with intra-EU trade and IIT with China. Second, we discuss two missing aspects of the existing literature: 1) the export-import unit price gap threshold values used in the decomposition of HIIT and VIIT are arbitrary and 2) the upper and lower sides of the VIIT index are idiosyncratic and thus should be decomposed. Third, our paper provides an almost comprehensive picture of the evolution of the Grubel-Lloyd index over 20 years (1988-2010) for the top 30 trade partners of each EU country at HS eight-digit product level, which as far as we know, is one of the longest samples in the literature as discussed below.[4]

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[1] There are several definitions for Eastern European countries. We selected EU countries as of 2010 which are classified as Eastern European countries by the United Nations. The selected countries are: Bulgaria, Czech Republic, Hungary, Poland, Romania, Slovakia, and Slovenia. Czech Republic, Hungary, Poland, Slovak Republic and Slovenia joined the EU in 2004, while Bulgaria and Romania joined it in 2007.

[2] EU countries in this paper are defined as so-called EU-15 countries, i.e. the United Kingdom, Germany, France, Italy, Spain, Portugal, the Netherlands, Belgium, Luxembourg, Ireland, Greece, Sweden, Denmark, Finland and Austria.

[3] For example, the United States and Japan make publicly available their highly disaggregated trade data respectively at ten-digit and nine-digit. But the codes beyond six-digit are not consistent between imports and exports, which precludes us from computing unit price difference at ten-digit or nine-digit.

[4] For the sake of brevity and space saving, this paper provides the graphs and figures for some representative cases. The full results for all the analyses are available upon request to the authors.

a. Literature and our paper

Greenaway et al. (1995) gives a unified interpretation of the theories on the determinants of IIT, and points out that the determinants and/or expected signs are different between HIIT and VIIT. Thus, it proposes to decompose the conventional IIT index of Grubel and Lloyd (1975) into HIIT and VIIT by unit value export-import price difference. Using UK trade data for the year 1988 at SITC five-digit, the empirical part of the paper supports the above claim. While Greenaway et al. (1995) undertakes a cross-country analysis without any time dimension, Aturupane et al. (1999) studies the determinants of HIIT and VIIT using trade data between EU and eight Central and Eastern European transition economies from 1990 to 1995. Fukao et al. (2003) constructs a model where a crucial factor of VIIT is foreign direct investment (FDI) related trade. It shows that VIIT is fairly dominant in Asian trade, which is mainly driven by Japanese FDI.[5] Closer to our interest of quality and unit prices, Jensen and Luthje (2009) analyses the determinants of HIIT and VIIT using bilateral trade data between pairs of EU-15 countries and four Eastern European countries: Hungary, Slovakia, Poland and the Czech Republic at HS six-digit level for 1996-2005. It argues about the importance of the demand side for the study of IIT determinants, such as the overlap of income level. Another paper close to ours is Fontagné et al. (1997). Using European trade data at the same aggregation level as our paper, the paper shows an increase in IIT within EU countries and an ever increasing share of VIIT. Furthermore, Milgram-Baleix and Moro-Egido (2010) focuses on Spain's VIIT. Improving the previous literature in its data construction and estimation techniques, it shows the determinants of Spain's VIIT with developed and developing countries at HS eight-digit level. It finds that Spain is exporting low quality goods not only to high income European countries, but also to developing countries. In terms of its comprehensive treatment, Brülhart (2009) provides a description of global IIT and inter-industry trade patterns using worldwide trade data at HS six-digit.

Whereas all the above papers are focused on the determinants of HIIT/VIIT, our paper's scope is descriptive but it covers the longest period in the IIT literature (from 1988 to 2010). Moreover, our analysis is at a more disaggregated level (HS eight-digit), which is an important element for the analysis on the quality difference of products.

b. Plan of our paper

The rest of the paper is organised as follows. The next section explains the data and the Grubel-Lloyd IIT index and shows some stylised facts regarding the evolution of IIT. Section 3 presents the HIIT and VIIT index with various threshold values, pointing out a potential problem of using an arbitrarily

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5 Ando (2006) analyses HIIT/VIIT in machinery sector and finds that VIIT is rapidly increasing in that sector in Asia. The nature of this VIIT trade is not quality difference but the expanding back-and-forth trade of machinery parts and components. Okubo (2007) shows that Japan's IIT with non-OECD countries, especially Asian countries, are driven by technology transfer by Japanese FDI firms.

chosen threshold value. Based on these discussions, Section 4 studies the EU's IIT with Eastern European countries and China. The final section concludes.

2. DATA AND GRUBEL-LLOYD IIT INDEX

This section describes the evolution of the IIT index using the Grubel-Lloyd (GL) index. We use Eurostat trade data, which cover exports and imports of EU countries at eight-digit HS code with the maximum period of 23 years, from 1988 to 2010. There are 17,249 HS eight-digit codes in total. [6] Since our focus is IIT and its unit price difference, we confine our analysis to the manufacturing sector. 13,173 HS eight-digit codes correspond to the manufacturing sector.

First of all, the classical GL index of product category *k* is defined as:

$$IITindex_k = 1 - \frac{\left| Ex_k - \mathrm{Im}_k \right|}{Ex_k + \mathrm{Im}_k}$$

where the second term represents the index of *inter*-industry trade. The index of *intra*-industry trade is computed as one minus the index of *inter*-industry trade, namely as the residual.

To compute an aggregate index of total IIT between two countries, the usual way in the literature (e.g. Jensen and Lüthje, 2009) is to weight by the share of trade values. The GL index between country i and country j is defined as above, namely:

$$IITindex_{ij} = \sum_{k=1}^{K} \left(\left(\frac{Ex_{ijk} + \mathrm{Im}_{ijk}}{\sum_k \left(Ex_{ijk} + \mathrm{Im}_{ijk} \right)} \right) \left(1 - \frac{\left| Ex_{ijk} - \mathrm{Im}_{ijk} \right|}{Ex_{ijk} + \mathrm{Im}_{ijk}} \right) \right) \qquad (1)$$

Using (1), the IIT index is calculated for all EU countries. However, to save space only Germany's index is reported in the figure as a representative case.[7] Figure 1 plots the IIT index of Germany with its ten largest trade partners.[8] Germany's IIT indices with EU countries are high and steady over the period. This indicates that EU countries have kept a fairly active and stable IIT pattern for several decades, even before creating the EU commission and adopting the Euro currency.

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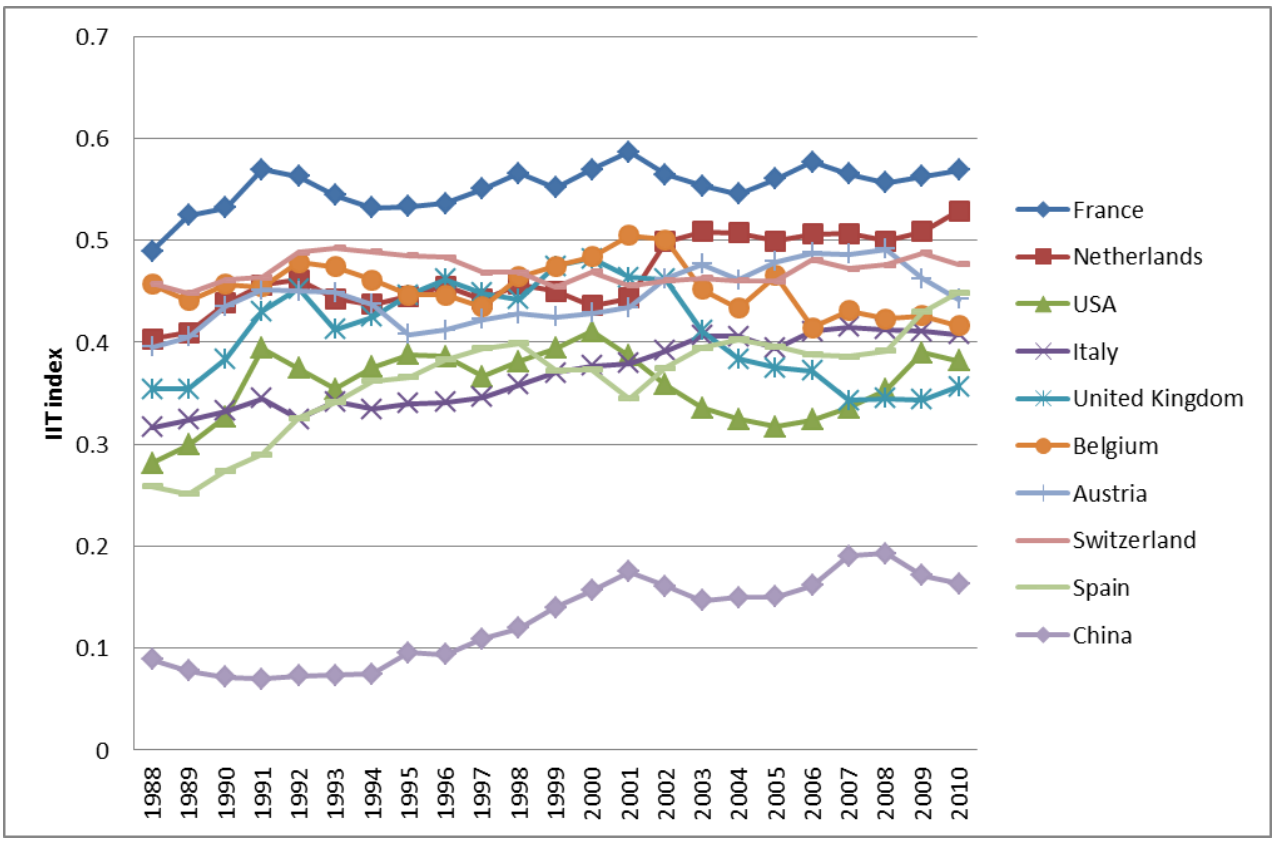
[6] Exports data are FOB basis while imports data are CIF (depending on whether suppliers provide insurance) basis. Thus, we should bear that in mind when we compare the unit price of IIT.

[7] Germany has the largest GDP in EU-15 countries and also is the biggest trade partner for all the Eastern European countries. For this reason we show only German results as a representative case in this section and next ones. All the results of IIT index in all the other EU countries are similar to German case.

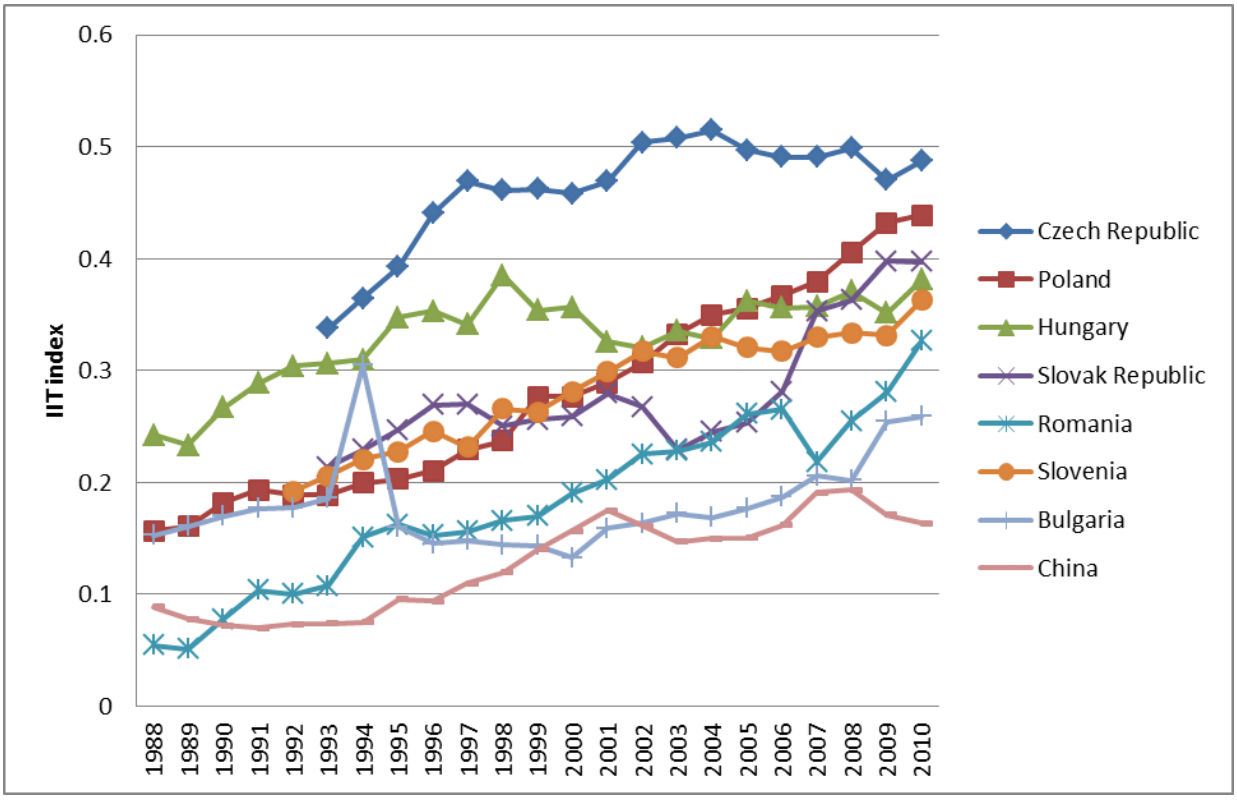
[8] The criterion for the largest partners is the average of the sum of total import and export values over the whole period, i.e., 1988-2010. The order of the country names in the graph represents the ranking as trade partners according to this criterion.

Figure 1: Germany's IIT index with the ten largest trade partners



Next, we turn to German IIT with Eastern European countries. Figure 2 shows the evolution of the GL IIT index. All Eastern European countries have considerably increased their IIT index over the period with recent years seeing a more drastic increase. Among them, Poland steadily increased its IIT index with Germany with little fluctuation. Figure 2 adds China for the purpose of comparison. China's IIT is lower than any Eastern European country. It shows a clearly increasing trend before around 2000. But after 2000 the level of IIT exhibits no substantial increase. China's IIT is in sharp contrast with the Eastern European countries. Another notable finding comes from a comparison with Figure 1. The IIT indices of most Eastern European countries with Germany have reached almost the same level as that of Germany's major trade partners such as France, Netherlands and Switzerland. This result suggests that Eastern European countries now represent a crucial part of the EU's IIT.

Figure 2: Germany's IIT index with Eastern European countries and China



3. HORIZONTAL AND VERTICAL IIT INDEX

Once we decompose IIT into HIIT and VIIT, two missing aspects in the IIT literature emerge. One is the arbitrariness of threshold values in export-import price difference. The other is the asymmetric and idiosyncratic behaviour found in the upper and lower sides of the VIIT index.

a. Threshold values in decomposition of horizontal and vertical IIT

Following the existing literature pioneered by Greenaway et al. (1995), we decompose IIT into HIIT and VIIT by per-unit export-import price difference at product level (*k*). The decomposition requires us to set a certain threshold value (*x*). Using the threshold value x, if product *k* is satisfied with $\frac{1}{1+x} < \frac{Export\,\mathrm{Pr}ice_k}{\mathrm{Im}port\,\mathrm{Pr}ice_k} < 1+x$, then it is classified as HIIT. On the other hand, if product *k* is satisfied with $\frac{Export\,\mathrm{Pr}ice_k}{\mathrm{Im}port\,\mathrm{Pr}ice_k} < \frac{1}{1+x}$ *or* $\frac{Export\,\mathrm{Pr}ice_k}{\mathrm{Im}port\,\mathrm{Pr}ice_k} > 1+x$, then it is classified as VIIT. [9]

[9] Here we adopt the lower threshold of $\frac{1}{1+x}$ proposed by Fontagné and Freudenberg (1997) instead of $1-x$ proposed by Greenaway et al. (1995). For the superiority of this formulation, see Fontagné and Freudenberg (1997).

The GL index of equation **(1)** can be decomposed into the HIIT and VIIT index:

$$\underbrace{\sum_{k=1}^{K}\left(\left(\frac{Ex_{ijk}+\mathrm{Im}_{ijk}}{\sum_k\left(Ex_{ijk}+\mathrm{Im}_{ijk}\right)}\right)\left(1-\frac{\left|Ex_{ijk}-\mathrm{Im}_{ijk}\right|}{Ex_{ijk}+\mathrm{Im}_{ijk}}\right)\right)}_{\text{IIT index}}=$$

$$\underbrace{\sum_{h=1}^{H}\left(\left(\frac{Ex_{ijh}+\mathrm{Im}_{ijh}}{\sum_h\left(Ex_{ijh}+\mathrm{Im}_{ijh}\right)}\right)\left(1-\frac{\left|Ex_{ijh}-\mathrm{Im}_{ijh}\right|}{Ex_{ijh}+\mathrm{Im}_{ijh}}\right)\right)}_{\text{HIIT index}}+\underbrace{\sum_{v=1}^{V}\left(\left(\frac{Ex_{ijv}+\mathrm{Im}_{ijv}}{\sum_v\left(Ex_{ijv}+\mathrm{Im}_{ijv}\right)}\right)\left(1-\frac{\left|Ex_{ijv}-\mathrm{Im}_{ijv}\right|}{Ex_{ijv}+\mathrm{Im}_{ijv}}\right)\right)}_{\text{VIIT index}} \quad (2)$$

where all IIT trade products must always be classified as either HIIT or VIIT, i.e. $K=H+V$.

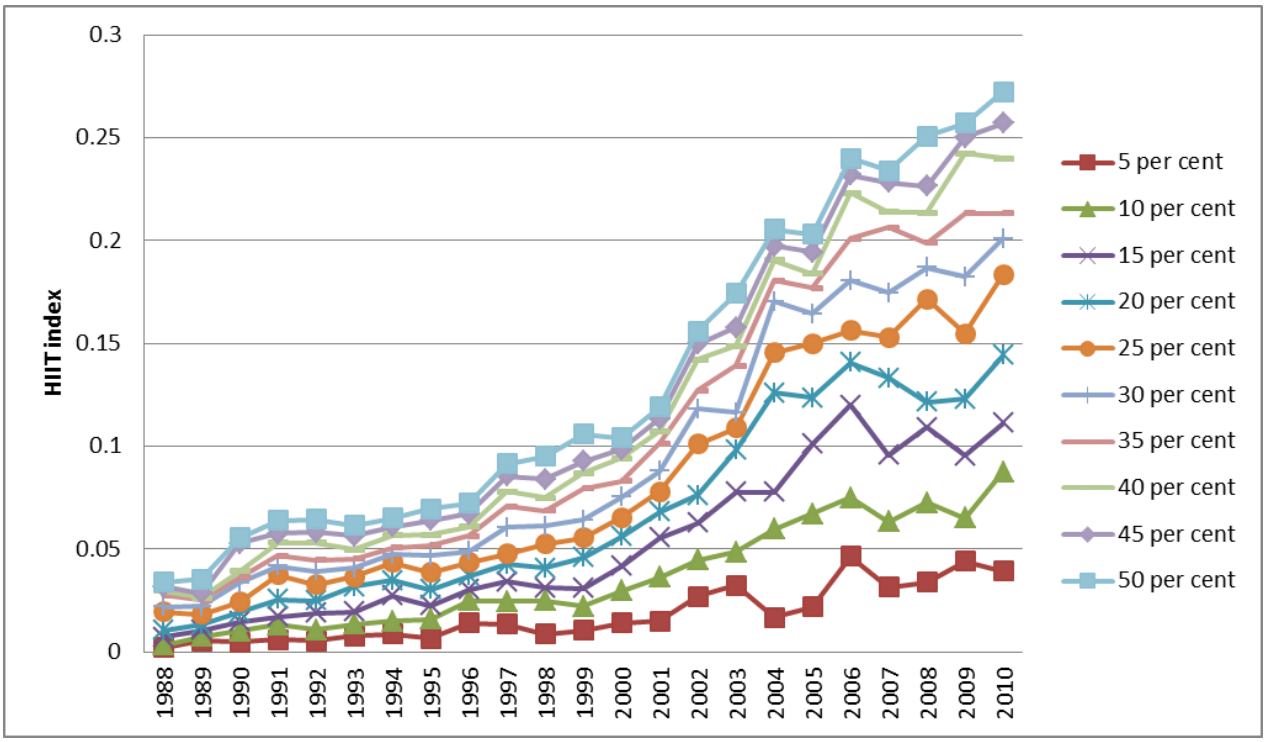
Here, one technical issue arises in the decomposition. The HIIT and VIIT index can be calculated with various threshold values, 5 per cent (i.e. x=0.05), 10 per cent (i.e. x=0.1), 15 per cent (i.e. x=0.15), ...50 per cent (i.e. x=0.5). Nevertheless, all previous studies utilise specific threshold values of 15 or 25 per cent.[10] There are no crucial reasons and no theoretical support for the choice of these threshold values.[11] Thus, we compute the index using various threshold values. Figure 3 shows the index at various threshold values. The Figure reports only Germany's HIIT index with Poland as a representative case.[12] As the threshold values become larger, the gap of the IIT index levels at different threshold values widens. Moreover, the growth rates differ substantially depending on which threshold values are chosen. This finding shows that the choice of threshold values matters. Thus, when we analyse HIIT/VIIT, it is important to do the analysis at various threshold values.

[10] Greenaway et al.(1995) uses two threshold levels, i.e. 15 and 25 per cent. Fukao et al. (2003) uses 25 per cent.

[11] Fukao et al. (2003) argues that they raise the threshold level in order to take into account the exchange rate fluctuation, but still the difference of 10% (35% minus 25%) has no firm reason. In other words, the additional allowance is not something endogenously computed but something exogenously given.

[12] For the sake of space saving, our paper provides the figure for a representative case. The full results for all other EU countries are available upon request to the authors.

Figure 3: Germany's HIIT index with Poland



b. Upper and lower sides of VIIT index

Another missing aspect in the existing literature is the upper and lower side of the VIIT index. As defined above, when a threshold level of say for example15 per cent is adopted, the products are classified according to whether IIT price differences are above 1.15 or below 1/1.15. We call products with a price difference above 1.15 the "upper side" VIIT and those below 1/1.15 the "lower side" VIIT. VIIT index in previous studies do not separately discuss the upper or lower sides. Figure 4 and Figure 5 show the upper side VIIT index and the lower side VIIT index of Germany with Poland as representative cases. Importantly, the trend in the upper side VIIT index is in sharp contrast with the lower side one. The upper side index slightly rises first and then falls in recent years. By contrast, the lower side index drastically increases over the period. This asymmetric and idiosyncratic trend in both indices tells us how important it is to decompose VIIT further into the upper and the lower side index and to discuss them separately.

Figure 4: Germany's upper side VIIT index with Poland at various threshold levels

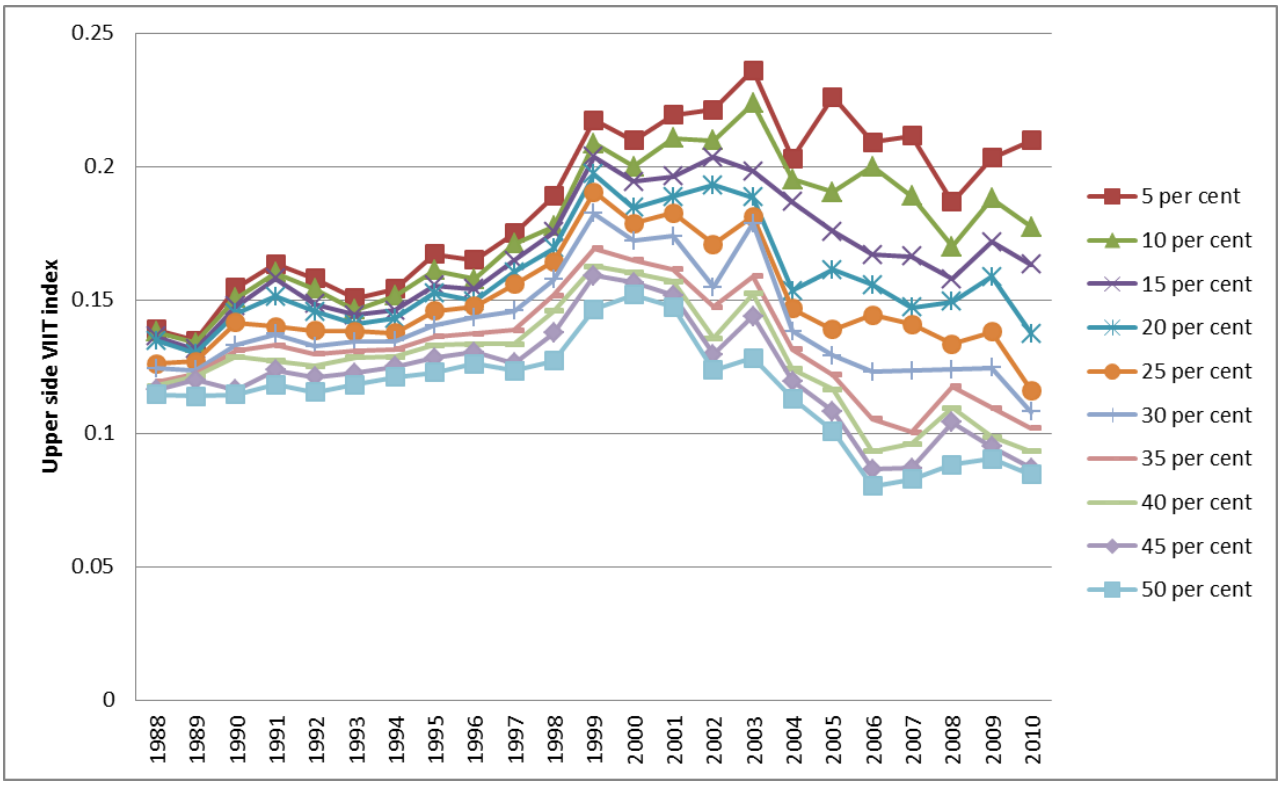
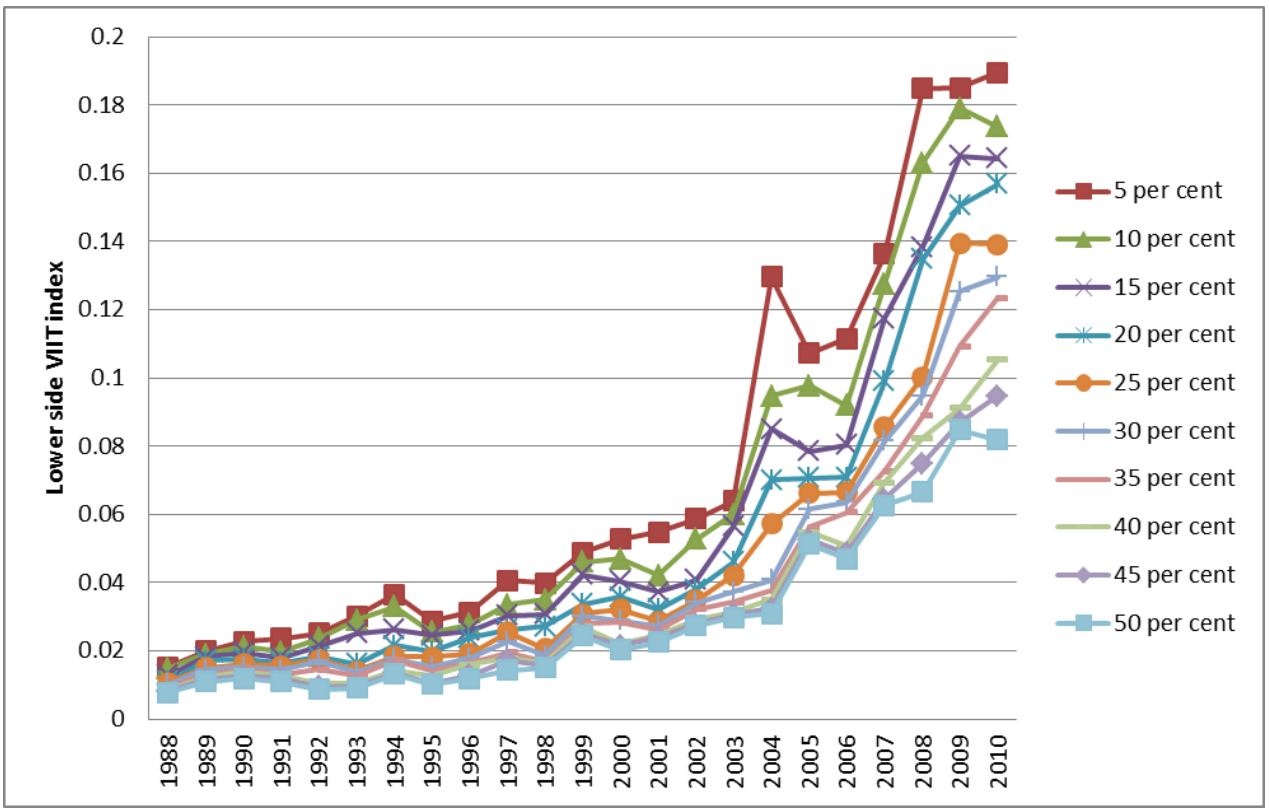


Figure 5: Germany's lower side VIIT index with Poland at various threshold levels



4. VIIT WITH THE EASTERN EUROPEAN COUNTRIES

Based on the discussion in the last two sections, we investigate IIT of EU countries with Eastern European countries. As seen in Figure 1 and Figure 2, Eastern European countries see a drastic increase in their IIT index with EU countries, whereas the IIT index within EU countries has no substantial change. To highlight the evolutionary change of Eastern European countries' IIT, and investigate how these countries' export prices behave vis-à-vis import prices, our main focus in this section is the upper and lower sides of VIIT.

Figure 6 and Figure 7 report the lower and upper sides of the VIIT index in Germany as representative cases.[13] These figures show the cases with a 15 per cent threshold value as a representative case. The upper side index (Figure 6) of all the Eastern European countries except Bulgaria rises until around 2000. After around 2000, the index of all the Eastern European countries except Slovenia falls. In particular Czech Republic and Hungary experience a sharp decline. On the other hand, the lower side VIIT is in stark contrast with the upper one. The index of all the Eastern European countries drastically increases. In particular, the latter half of the 2000s sees a huge increase (although Slovenia records a smaller increase than the other countries).

Both figures add the VIIT index with China as a reference. These are in clear contrast with the Eastern European countries. In the upper side VIIT index, China exhibits a long-term increasing trend although the index is almost stable after 2000. Differing from the upper side VIIT index, the lower one has no change over time, staying at a low level. Notably, the increase of the whole IIT index (Figure 2) of China over the period is attributed almost exclusively to the increase of the upper side VIIT index. On the other hand, the increase of the whole IIT index (Figure 2) of the Eastern European countries is mainly attributed to the increase of the lower side VIIT index.

We have completed the above analysis at various threshold values from 5 per cent to 50 per cent.[14] Results show that the overall *trend* mentioned above does not depend on the threshold value chosen. However, one notable difference emerging from the choice of threshold value is in the *levels* of the upper side VIIT index at the end of the sample period. For example, the level of German upper side index with China rises as the threshold value increases and it exceeds the index of German trade with Eastern European countries. In the lower side VIIT index, the level of German index with Eastern European countries rises as the threshold value increases while the level with China stays at a low

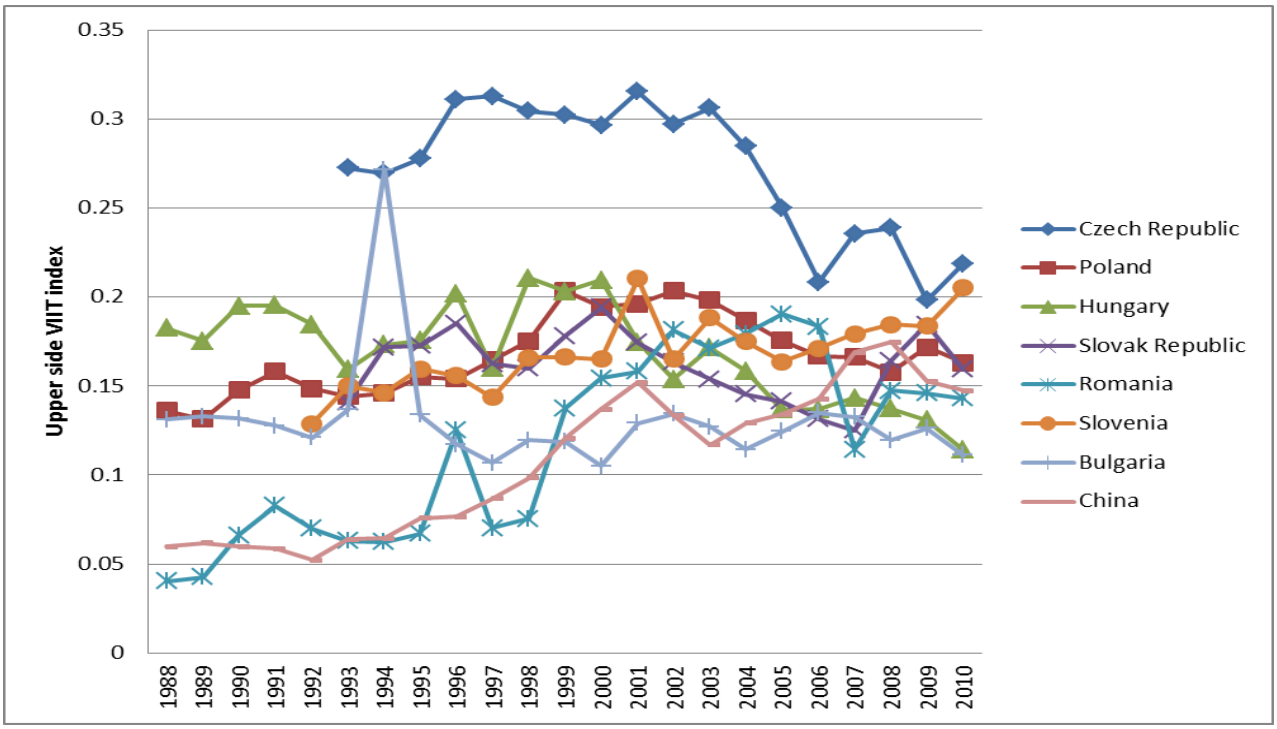
[13] We order the countries in the graph by average trade value (exports value plus imports value) for the whole period with Germany. Namely, among these Eastern European countries, Czech Republic has the largest average trade values with Germany. Poland and Hungary follow.

[14] To save the space we omit figures for all other results. The full results for all the threshold values are available upon request to the authors.

level regardless of the threshold values. These two findings indicate, as we argue below, that the contrast between EU-15's IIT with Eastern European countries and with China, has been intensified as years go by.

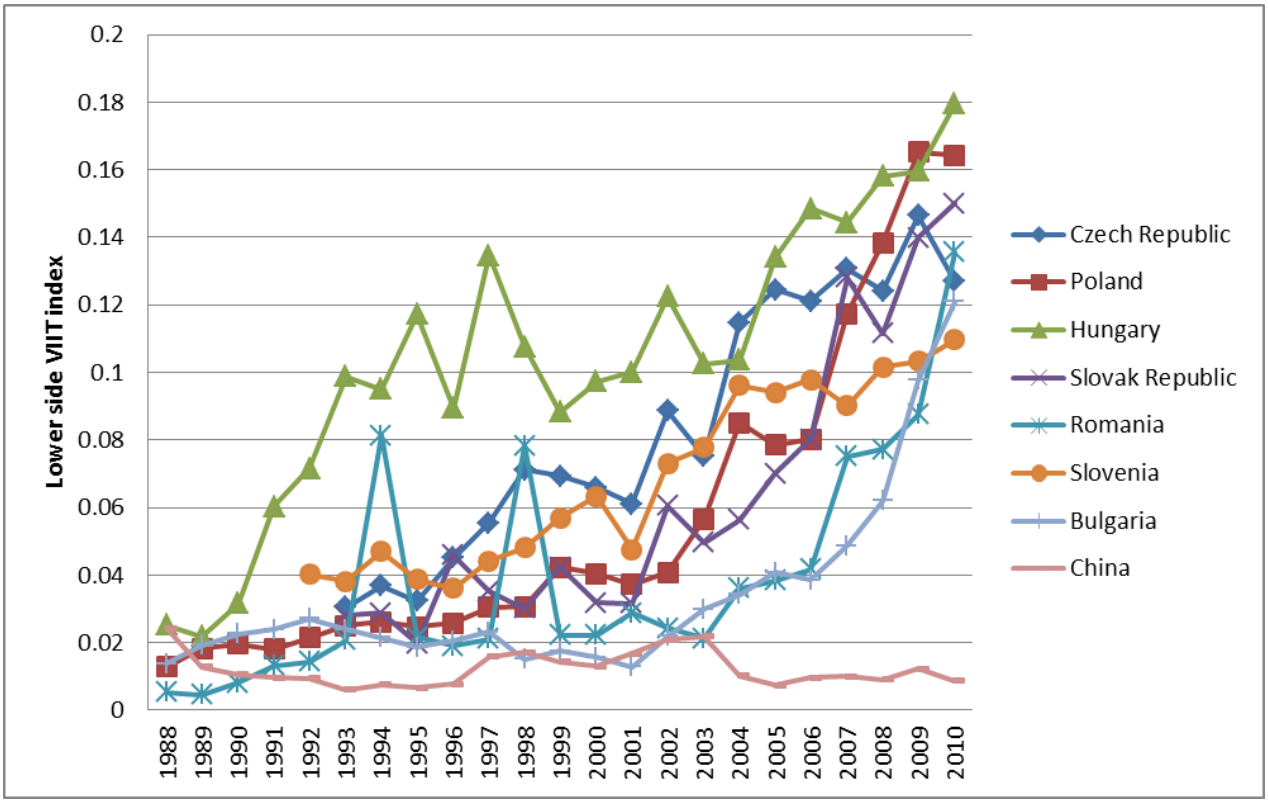
Reverting to the classification criteria for HIIT and VIIT, as EU import prices from the Eastern European countries gets higher with constant EU export prices, more products are classified as the lower side of VIIT.[15] One possibility to interpret this result is high quality products. As discussed in quality trade literature, higher per unit prices are interpreted as higher quality product. Thus, EU countries increase imports of high quality products from Eastern European countries. Namely, the Eastern European countries have climbed up the quality ladder in the late 2000s, which almost coincides with the timing of their accession to EU. On the other hand, China remains a low price product exporter. Unlike Eastern European countries, China keeps exporting low-skilled labour intensive products. China has not climbed up the quality ladder and might have expanded market access to EU by selling low price products.

Figure 6: Germany's upper side VIIT index with Eastern European countries



[15] Theoretically an opposite interpretation is possible. EU's export prices fall with a constant import prices from the Eastern European countries. However, this does not seem to be true. The growth in income leads to demand higher quality products in the Eastern European countries, which is likely to boost EU exports of higher price products.

Figure 7: Germany's lower side VIIT index with Eastern European countries



5. CONCLUSION

Using the HS eight-digit product level trade data of EU countries for the period 1988 – 2010, we analyse Intra-industry trade within EU countries as well as with Eastern European countries and with China. We find the Eastern European countries' rise up the quality ladder, and by contrast the substantially lower prices of China's exports to EU countries vis-à-vis China's imports from them. The contrast between EU trade with the Eastern European countries and with China is present even in very recent years.

APPENDIX: Details on the Computation of IIT Index

In the computation of the Grubel-Lloyd IIT index, for the sake of consistency we delete those observations whose unit is different across partner countries or over time. Since unit price is sometimes plagued with errors and shows extreme numbers, we delete those observations whose export price is more than 100 times higher than import price, or less than 1/100th of import price.

REFERENCES

Ando, M., 2006. Fragmentation and vertical intra-industry trade in East Asia., *North American Journal of Economics and Finance*, 17, 257-281.

Aturupane, C., Djankov, S., Hoekman, B., 1999. Horizontal and Vertical Intra-Industry Trade between Eastern Europe and the European Union., *Weltwirtschaftliches Archiv/Review of World Economics*, 135(1), 62-81.

Brülhart, M., 2009. An Account of Global Intra-industry Trade, 1962-2006., *The World Economy*, 32(3), 401-459.

Fontagné, L., Freudenberg,M., 1997. Intra-Industry Trade: Methodological Issues Reconsidered. *CEPII Working Paper* No. 97-01.

Fontagné, L., Freudenberg,M., Péridy, N., 1997. Trade Patterns Inside the Single Market, *CEPII Working Paper* No. 97-07.

Fukao, K., Ishido, H., Ito, K., 2003. Vertical intra-industry trade and foreign direct investment in East Asia., *Journal of the Japanese and International Economies*, 17 (4), 468-506.

Greenaway, D., Hine, R., Milner, C., 1995. Vertical and Horizontal Intra-Industry Trade: A Cross Industry Analysis for the United Kingdom., *The Economic Journal*, 105, 1505-1518.

Grubel, H. G. and J. P. Lloyd, 1975. *Intra-industry Trade: The Theory and Management of International Trade in Differentiated Products* (Macmillan, New York).

Jensen, L., Lüthje, T., 2009. Driving forces of vertical intra-industry trade in Europe 1996-2005., *Review of World Economics*, 145:469-488.

Milgram-Baleix, J., Moro-Egido, A., 2010. The Asymmetric Effect of Endowments on Vertical Intra-industrial Trade., *The World Economy*, 33(5), 746-777.

Okubo, T., 2007. Intra-industry Trade, Reconsidered: The Role of Technology Transfer and Foreign Direct Investment, *The World Economy*, 30 (12), 1855-1876.