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Alternative Strategies of Dissecting Intra-Industry Trade into Horizontal and Vertical Trade Flows

Abstract
Theoretical literature clearly states that intra-industry trade should be divided into horizontal and vertical trade flows (or trade in products with homogeneous and heterogeneous quality) that are influenced by different factors. Yet, the economists have not found a proper empirical way to dissect intra-industry trade. Traditional approach relies on unit value as an indicator of product quality. However, it is associated with a number of problems such as instability of the results and arbitrariness of the threshold used to separate the types of trade. We propose the two alternative strategies of dissecting intra-industry trade – varying product quality indicators and applying a different theoretical basis for separating horizontal and vertical trade flows. We also develop a demo calculating scheme for each strategy to demonstrate the way it may be brought to data. The first approach applies PRODY (weighted per capita income) as a product quality indicator, and the second one uses comparative advantage (in the form of the net trade) as a theoretical basis for dissecting intra-industry trade. Pilot quantitative results for Italy and Hungary show that the net trade approach is preferable from the perspective of both stability of the results and accordance with the expectations that the share of horizontal trade with EU members and countries with a similar per capita GDP should be higher.

JEL classification: F10, F14

Keywords: intra-industry trade, horizontal trade flows, vertical trade flows, product quality, unit values, net trade, comparative advantage, per capita income

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1. Introduction

It was a long lasting tradition in the literature to consider that factors of inter-industry and intra-industry trade differ. Large volumes of intra-industry trade between developed countries was used as an argument in favor of the increasing role of factors originating from monopolistic competition in international trade, as opposed to comparative advantage (*Deardorff*, 1984, p. 500; *Helpman and Krugman*, 1985, p. 2). However, further research showed that intra-industry trade consists of the horizontal and vertical trade flows (intra-industry trade in goods of similar and different quality, respectively) that are driven by different forces. The former depends on economies from scale and consumers' preference for variety that are the factors attributed to monopolistic competition, and the latter is influenced by comparative advantage. This fact was demonstrated both theoretically (*Falvey and Kierzkowski*, 1987; *Flam and Helpman*, 1987) and empirically (*Blanes and Martin*, 2000; *Díaz Mora*, 2002). Moreover, *Fontagne, Freudenberg and Gaulier* (2006) showed that these two types of intra-industry trade differ in dynamics significantly.

The traditional method of dissecting intra-industry trade into horizontal and vertical trade flows relies on unit values that are typically considered as proxies for export and import prices (unit value is calculated as the ratio of trade value and trade volume in physical units). This approach dominates in the literature, though its particular form varies from study to study (*Abd-el-Rahman*, 1991; *Greenaway, Hine and Milner*, 1994, 1995; *Fontagne and Freudenberg*, 1997, 1999; *Azhar and Elliott*, 2006). High unit values reflect high product quality, and vice versa. If unit values of an exported and an imported good are close, quality of these goods is considered to be similar. However, *Gullstrand* (2002) demonstrates that the various forms of the unit value approach provide "fragile results," so that "further research on how to disentangle horizontal and vertical IIT [*intra-industry trade*] less arbitrarily is needed." (p. 335).

Surprisingly, the economists didn't try to use alternative indicators of product quality (that don't rely on unit values) for the purpose of differentiating between horizontal and vertical intra-industry trade, though, in our view, it can be considered as the promising alternative strategy for dissecting intra-industry trade. The second alternative strategy is applying a different theoretical basis for separating horizontal and vertical trade flows: as argued by *Lüthje and Nielsen* (2002), "using indices for revealed comparative advantages combined with the degree of intra-industry trade as measured by the Grubel-Lloyd index might be a more fruitful method empirically to make the separation." (p. 602).[1]

[1] The index measuring the degree of intra-industry trade was proposed by *Grubel and Lloyd* (1975).

In this paper, we demonstrate the nature of the two alternative strategies of dissecting intra-industry trade by developing a demo calculating scheme for each strategy (onwards, we use the term "strategy" to mark the general concept and the terms "calculating scheme," "approach," and "way" to mark the particular method used to obtain the quantitative results). The first calculating scheme uses PRODY proposed by *Hausmann, Hwang and Rodrik* (2007) as the product quality indicator instead of unit values. This indicator reflects the weighted GDP per capita of countries that export a particular commodity (as argued by *Sutton and Trefler* (2016), a country's GDP per capita and its export product mix are both determined by its capabilities). To detect the type of a bilateral trade flow, we compare the two trading countries' GDP per capita with the PRODY of a commodity. Note that the ratio of the two per capita GDP's is also important: as *Linder* (1961) emphasized, countries with a similar level of development are more likely to have trade in differentiated products, and quality of these products tends to be similar (*Hallak*, 2006).[2] The second calculating scheme deals with comparative advantage as a theoretical basis for dissecting intra-industry trade, as recommended by *Lüthje and Nielsen* (2002). We consider comparative advantage as the net trade concept, so we do not use traditional comparative advantage indices such as proposed by *Balassa* (1965). Instead, we suggest comparing the trading countries' signs of the trade balance.[3] The key advantage of this approach is the absence of an *a priori* threshold that is required to dissect intra-industry trade in all other methods. Additionally, we account for the per capita GDP gap between trading countries.

To check the validity of the calculating schemes, we propose two simple tests. First, the share of horizontal intra-industry trade of the EU member country should be higher for trade with other EU member countries and for trade with countries with a similar per capita GDP than for trade with the world on average. Second, the resulting decomposition shouldn't vary much from year to year for all of the three groups of trading partners outlined above. Note that a number of other ways to test the validity of the methods of dissecting intra-industry trade were proposed in the literature. For instance, *Gullstrand* (2002) tests econometrically if the factors that influence the two trade flow types are in line with the theory, while *Lüthje and Nielsen* (2002) look at the stability of the results by performing run tests at the product level. In further research, it would be reasonable to use all of these methods, while in this paper we limit our activity in this area.

[2] From the perspective of firm-level data, it has been showed by *Bastos and Silva* (2010) that export unit values are generally higher in shipments to richer nations. Interestingly, the direction of trade also affects the wage premium in the exporting country (*Brambilla and Porto*, 2016).

[3] *Hallak and Schott* (2011) showed that the trade balance reflects product quality: a country with the highest trade balance (*vis a vis* the world) should be considered to possess the highest product quality, assuming equal unit values.

For the empirical analysis, we choose two EU member countries with the different extent of trade integration – Italy and Hungary. Italy is the example of a country that has strong trading ties with non-member countries: its trade values with EU member and non-member countries are quite close (in 2014, around 46 per cent of Italy's exports was directed to non-member countries, and about 43 per cent of its imports originated from these countries).[4] The major non-member trade partners for Italy are USA, Switzerland, China, Turkey and Russia. Hungary is the example of a country that trades with the EU very intensively (in 2014, only 22 per cent of its exports was directed to non-member countries, and about 25 per cent of its imports originated from these countries).

The paper is structured as follows. In Section 2, we discuss the traditional approach based on unit values. Section 3 presents the two alternative strategies of dissecting intra-industry trade and the two demo calculating schemes that correspond to these strategies. Then, in Section 4, we calculate the shares of vertical and horizontal trade flows in intra-industry trade according to different methods for Italy and Hungary, and verify the calculating schemes using the two simple tests. Finally, Section 5 concludes and provides suggestions for further research.

2. Traditional approach

The standard approach to account for product quality is assuming that export and import prices reflect product quality. This idea was first adapted to dissecting intra-industry trade by *Abd-el-Rahman* (1991), and then developed by *Greenaway, Hine and Milner* (1994), *Fontagne and Freudenberg* (1997) and *Azhar and Elliott* (2006). Different strands of this approach are summarized in **Table 1**. Most of them are based on simple export-to-import unit value ratios. In contrast, *Azhar and Elliott* (2006) proposed PQH index:

$$PQH_{i,c} = 1 - \frac{UV_{i,c}^{X} - UV_{i,c}^{M}}{UV_{i,c}^{X} + UV_{i,c}^{M}}, \qquad (1)$$

where subscripts *i* and *c* stand for commodity and country, *UV* stands for unit value (trade value, US dollars per tonne), and superscripts *X* and *M* stand for exports and imports. PQH index varies from 0 to 2.

PQH index is calculated in the spirit of Grubel-Lloyd (*Grubel and Lloyd*, 1975) index that separates intra- and inter-industry trade by subtracting the trade overlap from unity:

[4] For a median EU country, only 37 per cent of trade is not associated with other EU members (this is true for both exports and imports). For exports, this figure varies from 16 per cent (Slovakia) to 72 per cent (Malta), for imports – from 20 per cent (Latvia) to 53 per cent (Greece). This means that all EU members use the common market as the dominant source of imports, though not all of them use it as the primary outlet for exports. Interestingly, Italy is the only country that directs at least 10 per cent of its exports of every HS 2-digit commodity to non-EU countries.

$$GL_{i,c} = 1 - \frac{\left|V_{i,c}^{X} - V_{i,c}^{M}\right|}{V_{i,c}^{X} + V_{i,c}^{M}}, \quad (2)$$

$$PQH_{i,c} = 1 - \frac{V_{i,c}^{X} - V_{i,c}^{M}}{V_{i,c}^{X} + V_{i,c}^{M}}, \quad (3)$$

where V stands for trade value (US dollars).[5]

Table 1 – Different strands of literature on dissecting intra-industry trade with unit values

Author(s)	Criteria for		
	Intra-industry trade (IIT)	Horizontal IIT	Vertical IIT
Abd-el-Rahman (1991)	Reversal import (export) flows are more than 10 percent compared with the other flows ("trade-type approach")	The difference between export and import unit values is less than 15 percent	The difference is more than 15 percent
Greenaway, Hine and Milner (1994)	Grubel-Lloyd index ("overlap approach")	The ratio of export and import unit values is within the limits of [0.85; 1.15]	The ratio is beyond the limits of [0.85; 1.15]
Fontagne and Freudenberg (1997)	Imports represent at least 10 per cent of exports or reciprocally ("trade-type approach")	The ratio of export and import unit values is within the limits of [0.8; 1.25]	The ratio is beyond the limits of [0.8; 1.25]
Azhar and Elliott (2006)	Not specified	PQH index is within the limits of [0.85; 1.15]	PQH index is beyond the limits of [0.85; 1.15]

Source: Compiled by the author.

To dissect intra-industry trade according to any of these methods, one should calculate the value of intra-industry trade first. We prefer to use Grubel-Lloyd index that indicates the share of intra-industry trade because it allows dividing a bilateral trade flow into two parts (the absolute value of trade overlap reflects intra-industry trade, and the absolute value of net export represents inter-industry trade).[6] The alternative method of comparing the reversal import (or export) flows with a threshold is problematic because this threshold is arbitrary: as shown by *Crespo and Fontoura* (2004), the level of intra-industry trade is very sensitive to the empirical overlapping criterion. Also, it would be impossible to divide a trade flow into two parts using the alternative approach. Hereinafter, we refer to intra-industry trade as the product of total trade value and Grubel-Lloyd index.[7]

[5] *Azhar and Elliott* (2006) intentionally skip the modulus operator to be able to distinguish between high-quality and low-quality vertical intra-industry trade. However, it forces them to use arbitrary thresholds for PQH index. It seems that this is not the optimal solution. A bit later, we propose a way to overcome this problem.

[6] *Gullstrand* (2002, p. 323) explains that using the "overlap approach" instead of the "trade-type approach" helps to account for relative factor endowment differences (that are important for inter-industry trade) more carefully, as the "trade-type approach" just ignores this factor if the reversal trade flows exceed a fairly low threshold of 10 per cent.

[7] Dissecting total trade value into intra- and inter-industry components is not the purpose of the paper. So, we do not discuss this problem in detail here.

The basic principle of the next step is comparing the ratio of unit values with a threshold. High export unit value compared to import one indicates that a vertical intra-industry trade flow is of a high-quality nature, and vice versa. If export and import unit values are more or less close, then an intra-industry trade flow is considered to be of a horizontal nature.

The most important advantage of using unit values to indicate product quality is that they are product specific. That is, they are available at the most disaggregated commodity level (for the worldwide analysis, 6-digit HS commodity groups).[8] Generally, unit values correlate with the abundance of capital and GNP per capita (and thus quality), as shown by *Schott* (2004, p. 647-648) and *Aiginger* (1997, p. 581), among others. However, associating unit values with quality directly was found to be an oversimplification.

Several problems are worth mentioning here. First, unit values may be affected by size or other characteristics of the product such as durability, finish and reliability (*Greenaway, Hine and Milner*, 1994). Second, they may reflect monopolistic markups and international trade costs that differ among the pairs of trade partners (*Szczygielski and Grabowski*, 2012). Third, the attribution of products to different types of trade flows using unit values is not stable, while a proper quality measure should not vary much from year to year (*Lüthje and Nielsen*, 2002). Fourth, the hypothesis of proportionality of equilibrium prices and equilibrium qualities that should hold theoretically if unit values reflect quality is contradicted by the data (*Szczygielski and Grabowski*, 2012). Fifth, prices may also vary due to differences in the product mix, even at fine levels of disaggregation (*Durkin and Krygier*, 2000). And finally, the threshold of 15 or 25 per cent used to separate vertical and horizontal intra-industry trade is arbitrary. So, its choice severely affects the results (*Fontagne, Freudenberg and Gaulier*, 2006). Moreover, mean ratios of export-to-import unit values for many countries may differ substantially from this standard threshold: for example, the mean ratio for China is 2.84 (*Ito and Okubo*, 2014).

It is possible to overcome the latter of these issues by modifying the procedure proposed by *Azhar and Elliott* (2006). To calculate the value of horizontal intra-industry trade, one should simply multiply the value of intra-industry trade by the version of PQH index with the modulus operator in the numerator:

$$HIIT_{i,c} = IIT_{i,c}\left(1-\frac{\left|UV_{i,c}^{X}-UV_{i,c}^{M}\right|}{UV_{i,c}^{X}+UV_{i,c}^{M}}\right), \tag{4}$$

[8] As *Greenaway, Hine and Milner* (1994) note, unit values are "certainly the most accessible source of information about consumer assessments of products."

where *IIT* stands for the value of intra-industry trade (US dollars), and HIIT stands for the value of horizontal intra-industry trade (US dollars).

The remainder part of intra-industry trade should be considered as vertical:

$$VIIT_{i,c} = IIT_{i,c} - HIIT_{i,c}\,, \tag{5}$$

where *VIIT* stands for the value of vertical intra-industry trade (US dollars).

A vertical intra-industry trade flow should be marked as a high-quality trade flow if the difference between export and import unit values is positive. Otherwise, it should be considered as a low-quality trade flow.

However, the large number of other problems forces us to examine the alternative ways of dissecting intra-industry trade. In the next section, we present the two calculating schemes that correspond to the two alternative strategies outlined in the Introduction.

3. The two calculating schemes

3.1. Altering product quality measures: weighted per capita income (PRODY)

One of the most obvious proxies for product quality presented in the literature is weighted per capita income of countries exporting a product. It is assumed that rich country is more likely to export a high-quality product than poor country, as higher wages in richer country should be compensated by higher quality to retain competitiveness. *Lall, Weiss and Zhang* (2006) proposed to use countries' shares of world exports as weights for calculating the so-called sophistication score of a product (expressed in US dollars):

$$S_i = \sum_c \frac{V_{i,c}^X y_c}{\sum_c V_{i,c}^X}\,, \tag{6}$$

where V^X stands for the value of exports (US dollars), y stands for per capita GDP, and S_i is sophistication score.

These scores are then used to construct the normalized sophistication index:[9]

$$SI_i = \frac{S_i - S_{MIN}}{S_{MAX} - S_{MIN}}\,, \tag{7}$$

where S_{MIN} and S_{MAX} stand for the minimum and maximum sophistication score.

[9] Note that a product may be produced mainly by rich countries due to various reasons: it may require the high state of technology, or the capital-intensive (skill-intensive) production scheme, or perfect infrastructure (*Lall, Weiss and Zhang*, 2006, p. 227).

Hausmann, Hwang and Rodrik (2007) proposed to use revealed comparative advantages of each country as weights. This insight helps to eliminate the scale effect (for this aggregation procedure, countries with higher relative, not absolute, shares of world exports affect the result). The proposed indicator is called PRODY:[10]

$$PRODY_i = \sum_c BI^X_{i,c} y_c \,, \tag{8}$$

where BI^X is the revealed comparative advantage index developed by *Balassa* (1965):

$$BI^X_{i,c} = \frac{V^X_{i,c}}{\sum_i V^X_{i,c}} \Bigg/ \frac{\sum_c V^X_{i,c}}{\sum_i \sum_c V^X_{i,c}} \,, \tag{9}$$

where V^X stands for the value of exports (US dollars), and the indices *c* and *i* are used for aggregation across countries and products, respectively.

The disadvantage of this measure is its inability to differentiate quality by country of origin (PRODY varies across products but not across countries). So, it is necessary to complement this indicator with a country-specific variable to use it in intra-industry trade calculations.

Conceptually, one should compare PRODY of a commodity with per capita GDP's of the exporter and the importer (for each bilateral trade flow). We suppose that country is more likely to participate in a horizontal intra-industry trade flow if it's GDP per capita is close to its trade partner's one, or if PRODY of the commodity ranges between the two values.[11]

Technically, we propose to calculate the lower and the upper bounds of the range between per capita GDP's that corresponds to horizontal intra-industry trade (**Fig. 1**) as follows:

$$LowerBound_{c,p} = \frac{y_c + y_p}{2} - 0.25 \cdot \max\left(\left| y_c - y_p \right|; \frac{y_c + y_p}{2} \right), \tag{10}$$

$$UpperBound_{c,p} = \frac{y_c + y_p}{2} + 0.25 \cdot \max\left(\left| y_c - y_p \right|; \frac{y_c + y_p}{2} \right), \tag{11}$$

where *c* stands for the country of interest and *p* stands for the trade partner.

[10] *Corcoles et al.* (2014) shows that PRODY is a significant factor of export stability and survival. This result favors the assumption that PRODY is (at least moderately) correlated with products' quality.

[11] PRODY is calculated based on per capita GDP's of all exporting countries, so it would be reasonable to compare it with per capita GDP's of the two countries participating in a certain bilateral trade flow. According to *Corcoles et al.* (2014), the key limitation of PRODY is its circularity (based on per capita GDP, it is often used to make projections about growth of per capita income). However, this fact is rather an advantage for our case, because it validates the comparison between PRODY and per capita income.

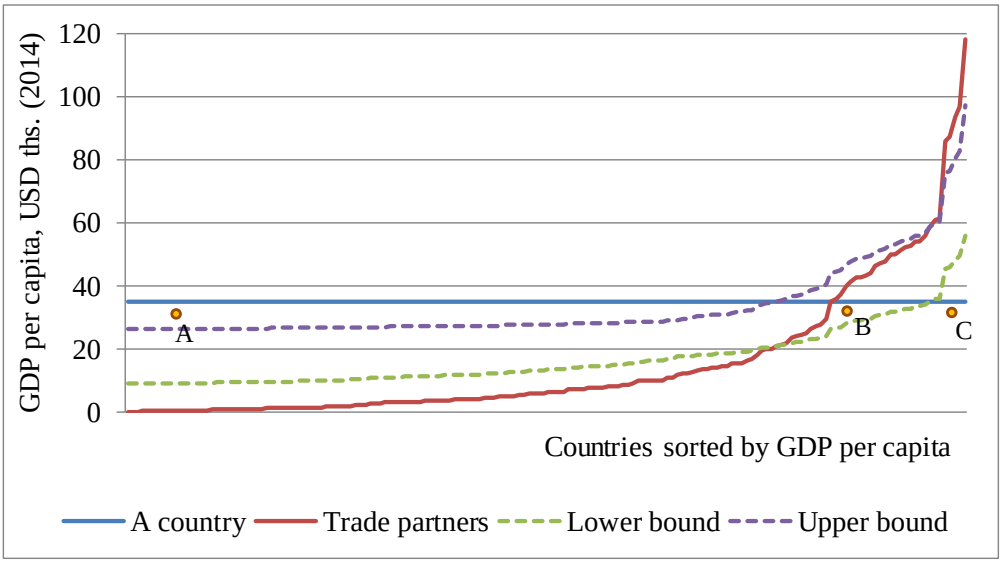

Fig. 1 – The range that corresponds to horizontal intra-industry trade for Italy

If PRODY of the commodity falls within this range, the intra-industry bilateral trade flow should be considered as horizontal. There are two general cases. The first is trade with a country of a considerably different per capita income. We suppose that per capita GDP's of two countries are considerably different if the average of the two values is lower than the absolute value of the difference between them. In this instance, the range that corresponds to horizontal intra-industry trade is strictly within the range between per capita incomes. The second case is trading with a country of a similar level of economic development. Then the range that reflects horizontal intra-industry trade may fall outside the values of the two countries' per capita GDP's.

Product with the same PRODY may relate to the different types of the intra-industry trade flow depending on per capita GDP of a trading partner. For example, if PRODY of the product under consideration is close to a country's per capita GDP, then this country is considered to be an exporter of higher-quality varieties of the product to lower-income countries (**Fig. 1**, point A), an importer of higher-quality varieties from higher-income countries (**Fig. 1**, point C), and a participant in a horizontal intra-industry trade with countries of a similar per capita GDP (**Fig. 1**, point B). Note that, in the latter case, there is some possibility that PRODY would fall outside the values of the two per capita incomes while the trade flow would be still considered as horizontal. This is an important feature of the proposed method that helps to mitigate the influence of small variations of PRODY around per capita income on the result.

Of course, the threshold of 0.25 used in (10) and (11) is set arbitrarily (this threshold may vary from zero to 0.5). However, it looks like a natural threshold that dissects the range between per capita GDP's on four equal parts[12] (**Fig. 1**).

[12] The range between the bounds is divided into two parts (above and below the average of the two countries' GDP).

Finally, it is necessary to emphasize that using PRODY as an indicator of product quality is only one of the many possible ways to bring this strategy to data. One may use other product quality measures, or apply a modified version of PRODY: for example, *Huber* (2016) proposes 75 variants of PRODY measurement, and *Tacchella et al.* (2012) develop an iteration process to calculate a version of PRODY that gives more weight to exports by developing countries. In this paper, we do not strive to find the best indicator. Rather, we sketch the two demo calculating schemes to clarify the proposed strategies.

3.2. Applying a different theoretical basis: comparative advantage (net trade)

After finishing the critique of the traditional approach to dissect intra-industry trade, *Lüthje and Nielsen* (2002, p. 602) state that "an alternative method worth considering would be to take point of departure in comparative advantages as the theoretical basis for separating trade in horizontally from trade in vertically differentiated goods." Starting from this notion, we try to add the dimension of comparative advantages to the whole story.

It has been shown empirically that difference in comparative advantages between countries (measured as human and physical capital endowments and technological levels) is an important driver of inter-industry and vertical intra-industry trade (*Díaz Mora*, 2002), while the economies of scale, number of firms within an industry and per capita income influence horizontal intra-industry trade (*Gullstrand*, 2002). That's why, conceptually, it is important to know if there is a difference in comparative advantage between countries.

Suppose that countries have wide set of capabilities defined in the spirit of *Hausmann and Hidalgo* (2011) that influence their net export at the commodity level. By capabilities, we mean numerous country-specific factors, both tangible and intangible, including capital, labor, skills, infrastructure, location, tastes and anything else. The number of capabilities is unknown and may even exceed the number of commodities, so that it is impossible to formalize them.[13]

Then it is reasonable to treat countries with similar signs of net trade of a commodity as having close capabilities specific for this particular commodity. This argument is close in nature to the classic statement that the capital abundant country generally should have positive net export of the capital intensive good and negative net export of the labor intensive good (see *Leamer* (1984), for example). In the case of capabilities, this reasoning is extended on the almost infinite number of factors.

[13] Here, we mean that it is impossible to account for all these factors econometrically, though it is possible to make a theoretical model that account for such unobservable factors in general – see *Hausmann and Hidalgo* (2011).

So, if the two countries have close comparative advantage (roughly measured as the sign of the net trade of the commodity)[14] but still participate in the intra-industry trade with each other, they are likely to export goods of a similar quality (participate in a horizontal intra-industry trade flow) because their positioning in the global market is close.

However, there is strong theoretical evidence that richer countries tend to be net exporters of higher-quality goods and net importers of lower-quality goods (*Fajgelbaum, Grossman and Helpman*, 2011). So, the above reasoning about dissecting intra-industry trade is valid for those trade partners with similar per capita income, and may be violated for trade partners with a great difference in the level of economic development. This may happen because a country can gain a strong position in the global market due to both price and non-price competitiveness.[15] Therefore, if one ignores this theoretical evidence, the intra-industry trade flow between the two countries that base their positive net export on different competitiveness strategies would be mistakenly recorded as horizontal (while the product quality may differ significantly).

So, for every bilateral intra-industry trade flow, we propose to calculate the following:

$$type_{c,p} = \left| \frac{\frac{y_c + y_p}{2} - \left| y_c - y_p \right|}{\left| \frac{y_c + y_p}{2} - \left| y_c - y_p \right| \right|} - \left(\frac{V_{i,c}^X - V_{i,c}^M}{\left| V_{i,c}^X - V_{i,c}^M \right|} \cdot \frac{V_{i,p}^X - V_{i,p}^M}{\left| V_{i,p}^X - V_{i,p}^M \right|} \right) \right| \cdot \frac{1}{2}, \qquad (12)$$

where $type_{c,p} = 0$ stands for horizontal intra-industry trade, and $type_{c,p} = 1$ reflects vertical intra-industry trade.

For countries with close levels of economic development (the first term in (12) equals +1), the signs of the net trade should coincide (the second term in (12) should equal +1) in case of a horizontal trade flow and differ (-1) in case of a vertical trade flows. For countries with different levels of per capita income (the first term in (12) equals -1), the opposite is true. However, note that this approach does not allow one to identify which country exports a higher-quality product (for a vertical trade flow); it simply points that the quality is likely to be different. In this paper, we do not aim to dissect vertical intra-industry trade flows on higher-quality and lower-quality

[14] As we show in *Gnidchenko and Salnikov* (2015), a proper comparative advantage index should reflect net trade. Like *Ferrarini and Scaramozzino* (2015), we replace the export-based index of revealed comparative advantage by an indicator based on net exports that helps to account for intra-industry trade. *Ferrarini and Scaramozzino* (2016) demonstrate that such an operation does not change the general result of *Hausmann and Klinger* (2006, 2007) that a country's positioning in the product space is important for its subsequent economic growth.

[15] Distinguishing between price and non-price competitiveness is important. For example, traditionally it is assumed that developing countries gained their positions in the global market due to low costs. However, it has been showed that many developing countries including China improved their international competitiveness mainly due to non-price factors (*Benkovskis and Wörz*, 2016), though price competitiveness related to cost reduction is also important.

parts. This can be done with additional indicators. Rather, we try at least to find a proper way to separate vertical and horizontal intra-industry trade flows.

Note that we intentionally select to compare signs of the net trade, not its values, as it is extremely difficult to decide what threshold should be chosen to distinguish between vertical and horizontal intra-industry trade. The absence of an *a priori* threshold is an important advantage of the approach. However, the researcher is not able to observe the product quality explicitly, that is the disadvantage of the proposed calculating scheme.

Similarly as for the PRODY approach, we do not insist that our version of the comparative advantage approach is the only one or the best one: a researcher may apply various comparative advantage indices, such as proposed by *Balassa* (1965), *Bowen* (1983), *Vollrath* (1991), *Lafay* (1992), *Leromain and Orefice* (2014) and others.[16] We hope that the strategies outlined in the paper would stimulate a further discussion on the empirical separation of horizontal and vertical intra-industry trade.

4. Data and empirical results

The bilateral trade data for our empirical analysis comes from UN COMTRADE database. We calculate the shares of horizontal and vertical intra-industry trade at the 6-digit commodity level according to HS 2007 classification. The data on per capita GDP comes from IMF World Economic Outlook (April, 2016).[17]

To calculate the shares of horizontal and vertical intra-industry trade according to the unit value approach, we first obtain the share of intra-industry trade as the product of trade turnover and Grubel-Lloyd index. Then we get the value of intra-industry trade and dissect it into three parts – horizontal, vertical and non-allocated trade flows.[18] In doing this, we follow *Greenaway, Hine and Milner* (1994) who use the "overlap approach" recommended by *Gullstrand* (2002). Then we calculate the shares of horizontal and vertical intra-industry trade for the cases of trade with other EU member countries and trade with countries with a similar per capita GDP (for this purpose, we consider the two trading countries' per capita GDP similar if the maximum of their ratios does not exceed 1.5). Technically, we separately sum up the values of horizontal and total intra-industry trade over trading partners that meet the outlined conditions, and then calculate the resulting shares.

[16] For an overview, see *Gnidchenko and Salnikov* (2015).

[17] We make all calculations for both GDP per capita in current prices and GDP per capita based on purchasing power parity (PPP).

[18] The trade flow is considered as horizontal if the ratio of unit values calculated from export and import data ranges between 0.85 and 1.15, and vertical if it lies outside this range. The trade flow is considered as non-allocated if it is impossible to calculate the unit value (there is no reported data in physical quantities).

To calculate the shares of horizontal and vertical intra-industry trade according to the two approaches developed in this paper, we also first obtain the value of intra-industry trade with the help of standard Grubel-Lloyd index. Then we follow the procedures specified earlier in Sections 3.1 and 3.2.

According to the unit value approach (**Fig. 2**), horizontal intra-industry trade accounts for about 22-25 per cent of total intra-industry trade for both Italy and Hungary. For trade with other EU member countries, this share is a bit higher that is in line with our expectations. However, for trade with countries with a similar per capita GDP, the share of horizontal intra-industry trade meets the expectations only for Hungary. In the Italian case, this share for trade with countries with a similar per capita GDP is even lower than for trade with the world on average except for trade in 2014. This means that the unit value approach fails to pass our first simple test. As for the second test, variation across years is quite moderate, but Hungarian trade with countries with a similar per capita GDP is an exception: coefficient of variation for this case exceeds 0.1.

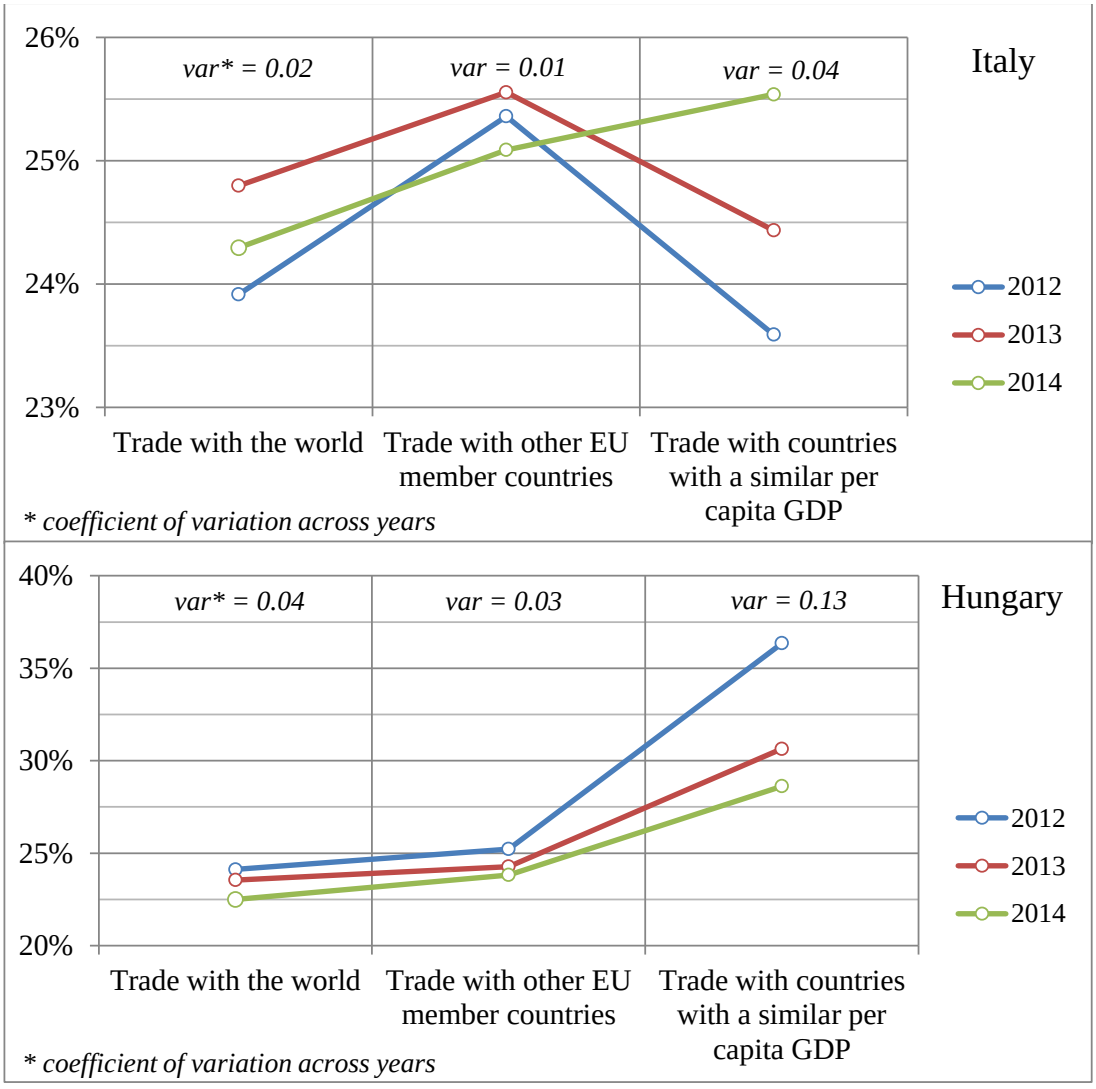

Fig. 2 – The share of horizontal intra-industry trade (unit value approach)

According to the PRODY approach (**Fig. 3**), horizontal intra-industry trade accounts for about 33-34 per cent of total intra-industry trade for Italy and 52-55 per cent for Hungary if GDP per capita in current prices is used in calculations (these figures are much higher if GDP per capita based on PPP is applied). The results show that PPP GDP should be preferred, as the other option provides an extraordinary outcome for the case of Hungarian trade with countries with a similar level of per capita GDP that contradicts with our expectations. For trade with other EU member countries, the share of horizontal intra-industry trade according to the PPP data is higher than for trade with the world on average that is in line with our expectations. Unfortunately, the PRODY approach also does not pass our first simple test, because the share of horizontal intra-industry trade for trade with countries with a similar per capita GDP is a bit lower than for trade with the world on average in many cases. As for the second test, the variation of the results across years is higher on average than in the unit value approach. However, its maximum value is lower: coefficient of variation does not exceed 0.1 (of course, for the case of PPP GDP).

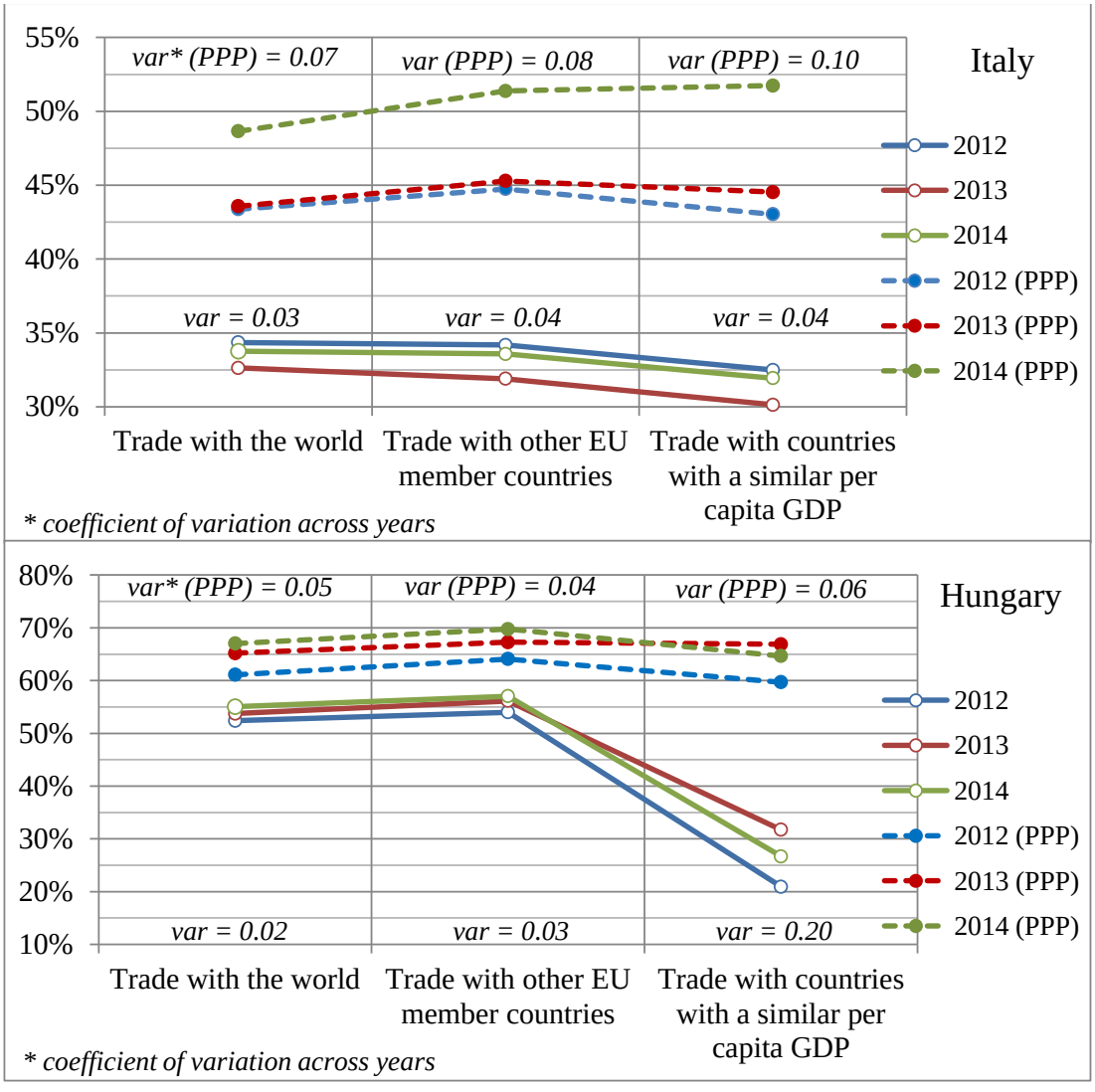

Fig. 3 – The share of horizontal intra-industry trade (PRODY approach)

According to the net trade (or comparative advantage) approach (**Fig. 4**), horizontal intra-industry trade accounts for about 57-59 per cent of total intra-industry trade for Italy and 51-52 per cent for Hungary if GDP per capita in current prices is used in calculations (these figures do not change much if GDP per capita based on PPP is applied). There is slight evidence that PPP GDP should be preferred, as the share of Hungarian horizontal intra-industry trade (calculated from the per capita GDP in current prices) for the case of trade with other EU members is lower than for the case of trade with the whole world, that does not go in line with expectations (for PPP GPD, this problem is eliminated). It is important that the share of horizontal intra-industry trade for trade with countries with a similar per capita GDP is higher than for trade with the world on average in all cases. This means that the net trade calculating scheme passes our first simple test. Moreover, it is also a champion according to the second test: the variation of the results across years is low for all groups of trading partners for both Italy and Hungary, and coefficient of variation does not exceed 0.04.

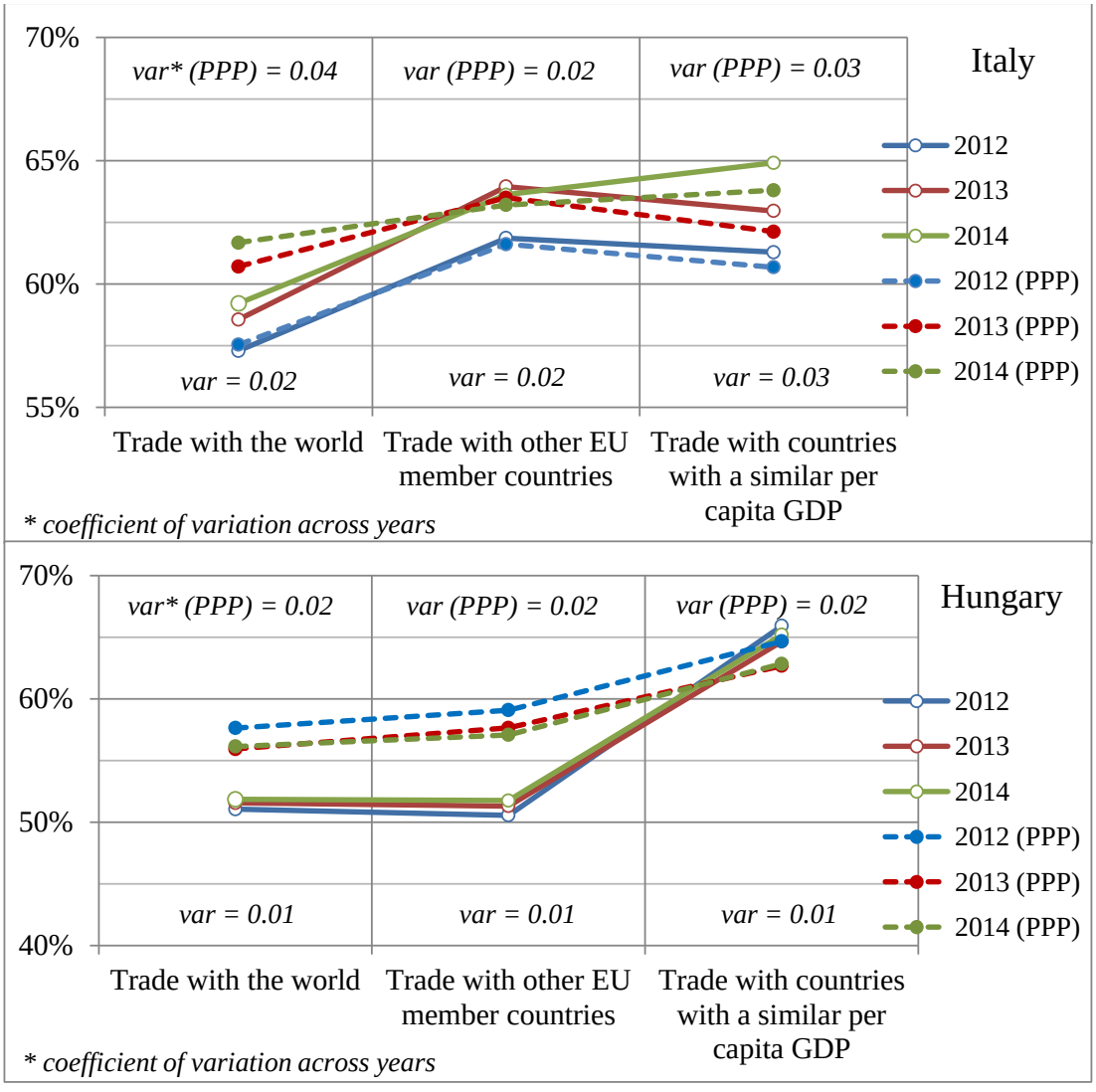

Fig. 4 – The share of horizontal intra-industry trade (net trade approach)

So, we consider that the net trade approach is preferable from the perspective of both first and second tests. However, this calculating scheme yields the results that are strikingly different from the standard decomposition: in the traditional unit value approach, the share of horizontal intra-industry trade for Italy and Hungary does not exceed 25 per cent, while it ranges between 50 and 60 per cent according to the net trade calculating scheme! Of course, we understand that the evidence presented in this paper is not sufficient to say that the unit value approach should be rejected. However, our results raise the question about the importance of choosing a particular calculating scheme and clearly indicate that a careful analysis is needed to find a proper way to dissect intra-industry trade empirically.

5. Conclusion

In the empirical literature, intra-industry trade is dissected using unit values. However, the association of unit values with product quality that underlies the decomposition was found to be an oversimplification (at least six problems mentioned by different economists are summarized in the paper, such as instability of the results and arbitrariness of the threshold used to separate the types of trade).

To overcome this limitation, we propose the two alternative strategies of dissecting intra-industry trade. The first one is using alternative product quality indicators instead of unit values, and the second one is applying a different theoretical basis for separating horizontal and vertical trade flows, such as comparative advantage, as recommended by *Lüthje and Nielsen* (2002). We bring these strategies to data by developing a demo calculating scheme for each of them. The first scheme applies the insight that a country's per capita GDP correlates with its export product mix (*Hausmann, Hwang and Rodrik*, 2007; *Sutton and Trefler*, 2016). The second exploits the concept of comparative advantage as a theoretical basis for dissecting intra-industry trade: two countries with similar signs of the trade balance for a particular product are supposed to have close comparative advantage.

Our quantitative results show that the net trade approach is preferable from the perspective of both stability of the results and accordance with the expectations that the share of horizontal trade with other EU members and countries with a similar per capita GDP should be higher. However, the resulting decomposition according to this calculating scheme is strikingly different from the standard decomposition, so that a careful analysis is needed to find a proper way to dissect intra-industry trade empirically. Such analysis may include an econometric study of the factors that impact the two types of intra-industry trade.

It is important to bear in mind that there are many other possible ways to bring the two strategies outlined in the paper to data. One may apply modified versions of PRODY (*Tacchella et al.*, 2012; *Huber*, 2016), use other measures of product quality[19] or apply various comparative advantage indices starting from the standard revealed comparative advantage index proposed by *Balassa* (1965). So, there is really large scope for further research on the empirical separation of horizontal and vertical intra-industry trade.

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[19] For example, one may rely on trade diversification to detect both products' and countries' sophistication, in line with the following stylized fact established by *Hausmann and Hidalgo* (2011, p. 318): "poorly diversified countries export products that are, on average, exported by many other countries, whereas highly diversified countries make products which are made, on average, by fewer other countries," because such products require specific capabilities that are not wide-spread (have low "ubiquity"). One may also obtain product quality econometrically – for example, derive it from a variety fixed effect, a time dummy and a residual term of the estimated demand functions (*Pula and Santabarbara*, 2011).

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