Did the economic crisis change V4 trade patterns? The case of intra-industry trade

Patryk Emanuel TOPOROWSKI*

Abstract

This study revisits knowledge about the post-EU accession intra-industry trade development in the Visegrad countries (Czech Republic, Hungary, Poland, and the Slovak Republic). These countries—through trade liberalisation, European integration and EU accession—strengthened their position in the global value chains, part of which were located in Western Europe. This paper points out that during the global financial crisis, the changes in intra-industry specialisation were not coherent in the Visegrad countries. Moreover, in some cases, the specialisation even intensified. This paper also applies the Arellano-Bover/Blundell-Bond estimator to assess whether EU accession and the later global financial crisis were driving forces of the changing trade patterns of these countries. The results of the estimation proved the positive effect of European integration (before and after EU enlargement) and the negative effect of the crisis.

Keywords: intra industry trade, European integration, Visegrad countries, financial crisis

Introduction

Though the existence of intra-industry trade (or two-way trade, IIT), which is seen as the simultaneous import and export of similar categories of commodities, was questioned by some economists (Finger, 1975, pp. 581-582; Lipsey, 1976, pp. 312-314), who both argued that the commodities within the databases are too differentiated within industries), one would have difficulties with denying that in the modern world economy, such exchange of commodities or semi-products exists. These economists pointed to a problem of the imperfect aggregation of commodities in the statistical databases. Finger even stated this trade is only a 'statistical artefact' and tried to prove it – yet in a questionable way (Vona, 1990, pp. 396-397) – thus it still may be explained with the Heckscher-Ohlin-Samuelson model. Lloyd (1989, pp. 15-30) even stated that detailed-enough datasets regarding trade would show no

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intra-industry trade (though, i.e., Balassa (1979, p.2) pointed out that even more detailed dataset does not eliminate the problem of the appropriate definition of specific branches and products). Yet, even they admitted that the aggregation within some branches is appropriate (Lipsey, 1976, pp. 312-314), which indirectly points to the existence of intra-industry trade not being the effect of inappropriate aggregation. Brülhart (2009, p. 20) pointed to the steady growth of global intra-industry trade since the 1960s to 2006, which, indirectly, cannot be simply explained by the aggregation issues but by the changes in production on a global scale, i.e., by the growing fragmentation of production.

The issue of intra-industry trade is an important area of research since it accelerated the emergence and development of the new trade theory, but it also sheds light on the utility of consumers, and thus on the economic welfare, as mainly differentiated goods are exchanged within this trade. As the love of varieties (Krugman, 1980, pp; Dixit and Stiglitz, 1977, pp. 297-308) and preferred variety (Lancaster, 1979; 1980, pp. 151-175) approaches are of use to explain the existence of this trade, both of these approaches point to the fact that the utility of consumers may increase when more varieties (as a consequence of two-way trade) are available in the market. In particular, both cases gave grounds to develop research on a specific part of intra-industry trade—horizontal intra-industry trade (i.e., two-way trade in differentiated goods but having a similar quality).

These approaches are coherent with the existence of imperfect competition, and thus with growing economies of scale (yet, Gullstrand (2002, pp. 334-335) noted that the relation between intra-industry trade and economies of scale is not linear, and thus there are contradictory results in the literature). In practice, the economies of scale are linked with global value chains (OECD, 2013, p. 9) and thus a theoretical concept of trade in semi-products as a kind of two-way trade (Dixit and Grossman, 1981; Kol and Rayment, 1989) is in line with empirical evidence. The fragmentation of production may be described with the theoretical models explaining vertical intra-industry trade (that is, a two-way trade in differentiated goods characterised with a different quality, or goods being at a different stage of production of the final product-less and more processed semi-goods).

Since the intra-industry specialisation in trade reflects the similarity in factor endowment of the trading countries (Marques, 2002, p. 203), the changes in this specialisation may reflect changes in factor endowment, and thus a convergence process between the less-developed (or poorer) and more-developed (or richer) countries. In this context, the convergence between the "catching-up" Visegrad countries and "developed" EU-15 countries may be assessed using the evidence concerning their evolving intra-industry specialisation in trade.

The origins of research on two-way trade reach Balassa's studies on economic integration, which in the case of the analysis of Visegrad countries remains crucial to understanding their convergence process within the framework of the EU. Balassa (1967) pointed out that intra-industry specialisation may rise when economies are

integrating, as trade barriers limit the exchange of substitutes (which are characterised by high elasticity of substitution in demand for domestic goods). Thus, lifting these barriers enhances the two-way trade.

During the Visegrad countries' transformation in the 1990s, they began to gradually open their economies. Because of the small geographical distance to the European Communities/European Union, trade with bloc countries was intense, and this intensity grew in line with their integration with and consequently within the EU. The intra-industry specialisation of the analysed countries was more intense in trade with the EU-15 than with other relevant trade partners. Nevertheless, because of differences in factors of production, the trade was still mostly inter-industry, where EU-15 countries had an advantage in the production of capital-intensive goods while the Visegrad countries had a relative advantage in producing labour-intensive goods. The Visegrad countries started their opening process with that advantage (Czarny, 2002, p. 200; Kawecka-Wyrzykowska, 2009).

An analysis of these countries as they stood in the 1990s would enable a better understanding of the trade effects of their mutual opening (Aturupane *et al*., 1999, p.1). In the Visegrad countries, although there existed a technological gap, the level of industrialization was relatively high and there was also a relatively large stock of human capital, which facilitated the convergence process as well as inclusion into the global value chains (GVCs). As a result, two-way trade has grown rapidly, which took place due to the increase in exchange in intermediates (Aturupane *et al*., 1999, p. 2), being a natural effect of participation in GVCs. Also, the pre-accession intra-industry trade intensity increases are the result of the liberalization of trade between these countries and the EU.

The further dismantling of barriers to trade had a significant impact after their accession to the EU on rising intra-industry specialisation in trade amongst the Visegrad countries (Molendowski and Polan, 2009, pp. 10-11; Kawecka-Wyrzykowska, 2009). The EU accession trade effect occurred not only through the termination of tariff and non-tariff barriers but, in a broader perspective, through participation in the single market, which, for instance, enabled a less-restricted, cross-border flow of people, capital, and services, which created huge opportunities to create new patterns of trade. Ito and Okubo (2012, p. 2) noticed that the 2004 EU enlargement generated much of the vertical intra-industry trade between the EU-15 and the eastern EU states (through differences in wages and levels of capital and technology) and that the eastern EU countries rose on the quality ladder.

The link between the crisis and two-way trade development is opaque. Yet, there are contributions to this field, found in the empirical evidence from the emergence of regional crises. Notably, Obashi (2009, p. 19) assessed whether the value chains in Asia proved to be resilient during the Asian financial crisis, while Escaith *et al.* (2010) assessed the effect of GVCs on global trade during the global financial crisis. Also, Yong *et al.* (2015, pp 40-41) examined the China-Malaysia IIT during both these crises and drew two interesting conclusions: The Asian financial

crisis did not affect intra-industry trade, while the global financial crisis implied an inversion in intra-industry trade, and they stated that this result derives from the erosion during the global crisis of GVCs. They also argued that high IIT intensity may be a cushion against regional crises. Molendowski and Polan (2013, pp. 79-80) pointed to a slight weakening of the increasing trend in Visegrad countries' intra-industry specialisation in trade with the EU-10 (then new member states) and the EU-15 during the financial crisis compared to the pre-crisis period.

1. Measurement of intra-industry trade

Measurement methods started to appear in the literature simultaneously with the first empiric studies showing the existence of two-way trade, and thus undermining the Heckscher-Ohlin-Samuelson theory. Yet, instead of one coherent system of measurement, many separate and independent methods have been presented since the 1960s. The earliest and relatively simple measurement methods concentrated on the issue of the similarity between both flows (import and export) in a particular industry (Verdoorn, 1960; Michaely, 1962). Balassa's coefficient (Balassa, 1966) demonstrated a different approach to referring to the trade balance within a particular industry. It was advantageous compared to the earlier methods of measurement as it enabled assessments of the share of trade overlaps in the exchange of commodities. The problem with this measurement (pointed out by Grubel and Lloyd, 1975) was that it did not correctly reflect aggregated imbalances in trade, and that the aggregated measure gives the same weight to industries (even though some are bigger and others smaller).

The breakthrough method, yet quite similar to Balassa's coefficient (on an industry level) is the Grubel-Lloyd index (Grubel and Lloyd, 1975) (which was also applied in this study). The authors proposed the index, which determines the share of intra-industry trade in the country's total trade. Their formula can be understood as a share of balanced trade (or as shown in the formula below: total trade minus surpluses or deficits in trade) within industries to total trade. Its huge advantage is that the index is independent of the magnitude of total trade and it can be aggregated from the product-level to the industry-level to the country-level.

Their proposed formula is the following:

$$GL = \sum_i^n \frac{[(X_i+M_i)-|X_i-M_i|}{\sum_i^n (X_i+M_i)} \quad (1),$$

where *i* is the number of *n* traded commodities, X_i and M_i are the exports and imports, respectively, of the traded *i*-th commodity. The GL index may take values within [0:1] (or [0:100%]). When the GL index of a selected industry (or of the whole trade) equals zero, there is only inter-industry trade, while when the GL index equals one, the whole trade is two-way. This formula is applied in this study. In fact, when

industry level is concerned, this measurement was similar to the Balassa (1967) approach, since this measurement equals up to one minus the Balassa coefficient (so, if the Balassa coefficient equals zero, then the whole trade is two-way, and opposite when one). This formula was a reference point for the researchers, who presented their improvements of this measurement to i.e. limit the downward bias of the index (Aquino, 1978). Cieślik (2000) though stated that these improvements did not in fact improve the quality of the measurement results.

Fontagné and Freudenberg (1997, pp. 21-26) criticised the GL index because it did not provide information facilitating a separation of intra-industry trade from inter-industry trade, but only showed the trade overlap, which is not necessarily equal to the size of intra industry trade. They proposed an alternative method, which was based on the assumption that if both trade flows in a particular commodity are relatively significant, then the trade in this product is intra industry. In practice, the smaller trade flow needed to amount to at least 10% of the higher one (this threshold level was, however, arbitrary) to satisfy this condition.

Serious criticism of this index came from Hamilton and Kniest (1991), Greenaway *et al.* (1994b) and Brülhardt (1994) and Dixon and Menon (1997), who stated that the GL index is "static" (referring to the particular point in time). It thus did not explain the "smooth adjustment hypothesis" (saying that the labour-market adjustment costs are lower in the case of intra- than inter-industry expansion) and do not show the changes in the structure of trade. The "dynamic" (or marginal) IIT measurements are free from these weaknesses. Such class of indices is useful in analysing the labour market adjustment costs and trade patterns. Out of them, the most popular is the Brülhardt (1994, p 604) "A" index. Yet, even this measurement has flaws, out of which the possibilities of interpretation in the case of decline of the overall trade (just as during the global economic crisis) are limited.

One of the weaknesses of the GL index is its inability to distinguish between the horizontal and vertical two-way trade (Jambor, 2014), while the theoretic models refer predominantly either to horizontal or vertical IIT. Greenaway *et al.* (1994a, 1995) presented the approach that enabled them to divide intra-industry trade into these parts and their measurement is complementary to the GL index. Their method is convenient because it enables a precisely disentanglement of intra-industry trade to a horizontal and a vertical one. They proposed that the price per specified unit of a selected item (the unit value of a good) reflects the quality of a product. In two-way trade, the unit value of homogenous, or almost similar, goods are alike, so this means that the trade is horizontal. But in the case of strongly differentiated (in quality) goods, the unit values are diversified, so the trade is vertical. This method is relatively easily applied, as the datasets often provide not only data about the value of trade but also, e.g., weight or simply quantity.

According to Greenaway *et al.* (1994a, 1995), for each product within a specific statistic nomenclature, there exists its unit value[1]. The unit value of an exported good is described as UV_i^{Ex}, where *i* is the particular commodity. The unit value of the imported good is described as UV_i^{Im}. The authors assumed that horizontal trade occurs when the difference between UV_i^{Ex} and UV_i^{Im} is small enough – in their study, the difference did not exceed +/- 15%. So, the following condition, called the similarity criterion, should be satisfied:

$$1 - \alpha \leq \frac{UV_i^{EX}}{UV_i^{IM}} \leq 1 + \alpha \tag{2}$$

Vertical intra-industry trade thus takes place when:

$$1 - \alpha > \frac{UV_i^{EX}}{UV_i^{IM}} \tag{3a}$$

and

$$\frac{UV_i^{EX}}{UV_i^{IM}} > 1 + \alpha \tag{3b}.$$

The Greenaway *et al.* (1994a, 1995) approach has a weakness in condition (2), because of the only illusory symmetry. Some products classified for trade purposes as vertically integrated products from the viewpoint of a reporting country may appear to be horizontally integrated products from the viewpoint of a partner country, and inversely. The modification proposed by Fontagné and Freudenberg (1997, p. 29) targets this deficiency. The formula (2) is replaced by the following one:

$$\frac{1}{1+\alpha} \leq \frac{UV_i^{EX}}{UV_i^{IM}} \leq 1 + \alpha \tag{4}$$

and consequently – formula (3a) with:

$$\frac{1}{1+\alpha} > \frac{UV_i^{EX}}{UV_i^{IM}} \tag{5a}.$$

In this paper, the formulas 4, 5a and 3b were applied and the threshold α was chosen at the level of 15%. It is the most common threshold level in the literature, while the second is 25% - to address the exchange rate fluctuations (Fukao *et al.*,

[1]It also occurs that in some cases information on the supplementary unit lacks. Such cases, however, do not represent more than 2% of trade, and their magnitude depends on the applied statistical classification. There are two methods of overcoming this deficiency: one assumes the removal of the flawed data from the dataset, and the second keeps them in the dataset but classifies the intra-industry trade type as "unallocated" (neither horizontal nor vertical).

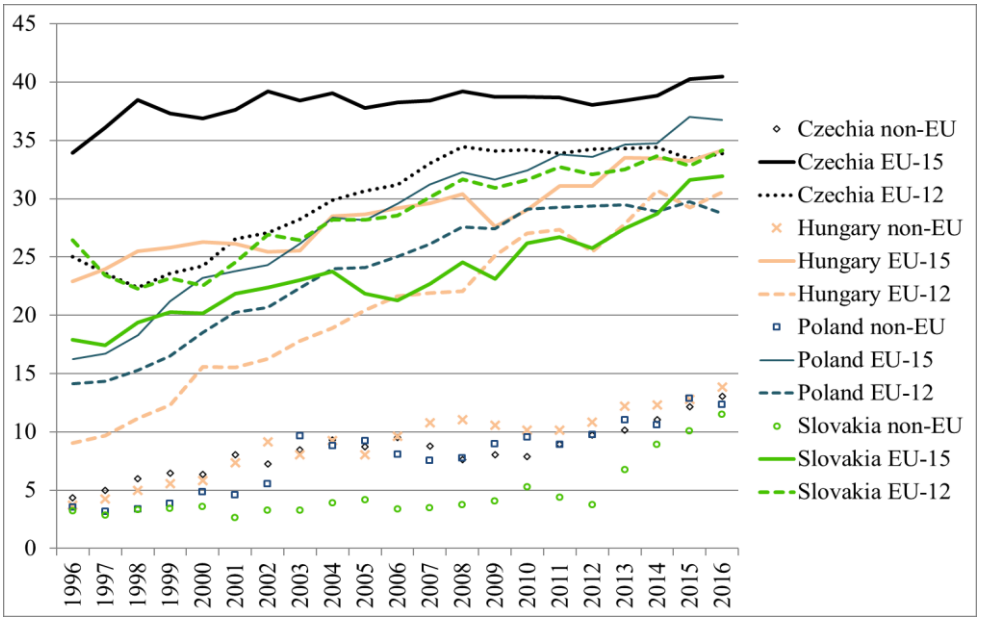
2003, p. 6). In fact, there are no technical reasons or theoretical foundations to use this specific (or any other) threshold value (Ito and Okubo, 2012, p. 7). Ito and Okubo (2012, pp. 8-9) made a sensitivity analysis of the threshold level, pointing to the dependence of the results on a certain threshold. Toporowski (2012, pp. 174-175) performed an analogous sensitivity analysis of such a threshold and stated that while the values of horizontal and vertical intra-industry trade differ depending on the threshold value, the trends in horizontal and vertical trade remained stable regardless of the threshold value. Hallak and Schott (2010, p. 2) pointed to the fact that the price (and thus the unit value) does not necessarily reflect the quality of the traded product, but rather the cost structure. Yet, their proposed alternative to the Greenaway *et al.* (1994a) approach is not feasible in empirics due to the lack of necessary accessible data.

2. Changes in intra-industry specialisation

Since the beginning of the research period, there has been a remarkable difference in intra-industry specialisation between EU (15 members and 12 pre-members) and non-EU trading partners (see Figure 1). While in 1996, extra-EU trading partners noted less than 5% intra industry trade with Visegrad countries, the EU-15 states' intra industry trade ranged from 16.2 (Poland) to 33.9% (Czech Republic) and pre-member states ranged from 9% (Hungary) to 26.4% (Slovakia). All V4 states noted a growth in intra-industry specialisation in 2016 r. compared to 1996, independently to the group of trading partners. Yet, both EU-15 and EU-12 were partner groups with which V4 countries enjoyed higher IIT growth rates than in trading with extra-EU group. This empirical evidence pointed to the effect of tightening links between Visegrad countries and the EU member states.

When looking at the average annual changes in GL index (see Table 1), integration within the EU improved the shares of IIT, which is seen in the relatively smaller increases of the index in the case of extra-EU partners and in relatively bigger increases in the case of trade with pre-members and EU-15 during the research period. With the exception of Slovakia, the IIT growth rate with EU-15 was the highest before accession and the highest among the partner groups. This means a fast pace in re-profiling their economies to increase coherence with the demand of consumers from the EU which, after this sharp adjustment, did not need to be strongly re-oriented further.

Figure 1. Intra-industry trade (% of total trade) between the Visegrad countries and EU-15, EU-12 and the 26 biggest non-EU partners



Source: own calculations based on UN COMTRADE

In the first post-accession years (2004-2009), the growth pace slowed, or reversed, independently of the partner group (except for the Czech Republic's and Slovakia's trade with the EU-12). During the global financial crisis, which in Europe manifested as the Eurozone crisis[2], once again the increase of intra industry specialisation remained weak, yet it somewhat ameliorated regarding the trade with EU-15. This points to the continuing convergence process between both trading groups, despite (or – paradoxically – thanks to) the economic crisis. It pointed to the strengthening position of the Visegrad group in GVCs.

As for horizontal intra-industry trade, the highest shares were noted in trade with pre-member states, which may point to remarkable similarities in their production profile, concentrated in heavy industry (see: Figure 2). Again, the horizontal trade with the extra-EU states was the lowest compared to both other groups. In 2016, the growth of indexes was also observed in all cases and the increases were the highest in the case of EU-15 (with the exception of Hungary noting the highest rises in trading with EU-12). The rises were the lowest in the case

[2] For this study, it is defined as the 2009-2014 period because, since 2014, the GDP of the Eurozone started to recover at a significant pace compared to the previous years.

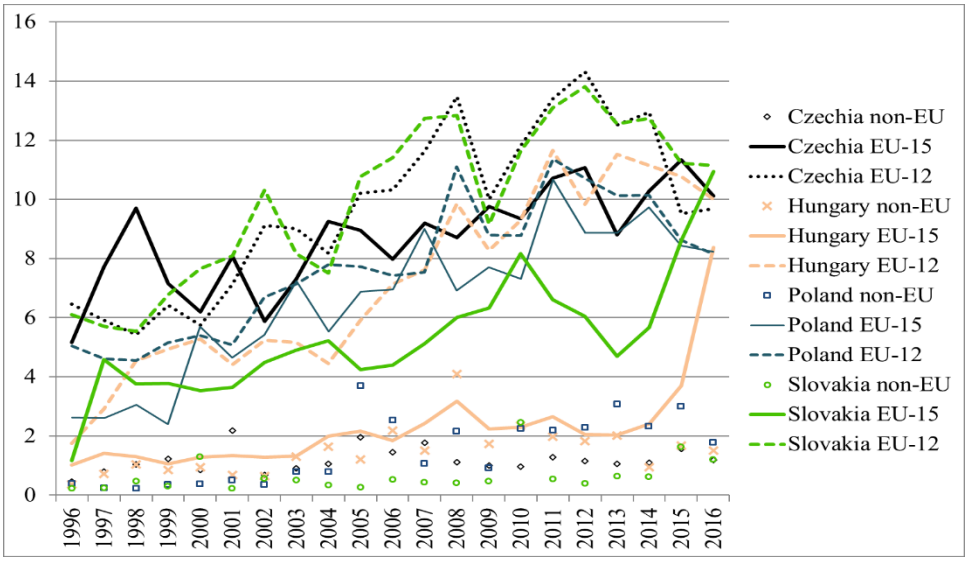
of extra-EU states. These results, in line with the theoretic foundations, pointed to the convergence of demands of the EU-15 and Visegrad countries' consumers.

Table 1. Average annual change in share of intra-industry specialisation in trade

Country	Partner group	1996-2004	2004-2009	2009-2014	2014-2016	1996-2016
Czech Republic	non-EU	0.62	-0.25	0.61	0.66	0.41
	EU-15	0.64	-0.07	0.02	0.55	0.31
	EU-12	0.61	0.85	0.06	-0.18	0.42
Hungary	non-EU	0.69	0.27	0.35	0.50	0.48
	EU-15	0.70	-0.18	1.17	0.23	0.54
	EU-12	1.23	1.25	1.12	-0.05	1.03
Poland	non-EU	0.66	0.03	0.32	0.58	0.42
	EU-15	1.52	0.66	0.62	0.67	0.98
	EU-12	1.23	0.68	0.30	-0.06	0.69
Slovakia	non-EU	0.09	0.03	0.96	0.88	0.40
	EU-15	0.73	-0.13	1.11	1.08	0.67
	EU-12	0.22	0.54	0.55	0.16	0.37

Source: own calculations based on UN COMTRADE

Figure 2. Horizontal intra-industry trade (% of total trade) between the Visegrad countries and EU-15, EU-12 and the 26 biggest non-EU partners



Source: own calculations based on UN COMTRADE

The partner group with which the Visegrad States (see: Table 2) noted the highest increases of horizontal intra industry specialisation during the research period was the EU-15 (or the EU-12 in the case of Hungarian trade). The lowest increases in horizontal intra-industry specialisation occurred in trade with non-EU partners, which means that the consumption (but also the production) profiles between these trading groups did not converge much over time. These results also witnessed the effects of integration on two-way trade (which was increasing seriously in the case of EU partners, but not much with the other partners).This type of two-way trade had been increasing particularly fast before EU membership in the case of trade with EU-15, and after EU accession in the case of trade with EU-12. These results suggested that, thanks to the single market, the Visegrad countries consumers first started to converge their demand structure to the EU-15 consumers, and in consequence, the consumption patterns within the group of the Visegrad countries consumers became increasingly similar. The crisis did not change (or even enhance) the pattern of the Visegrad states' trade with the EU-12: their horizontal intra industry specialisation grew faster than during the entire research period.

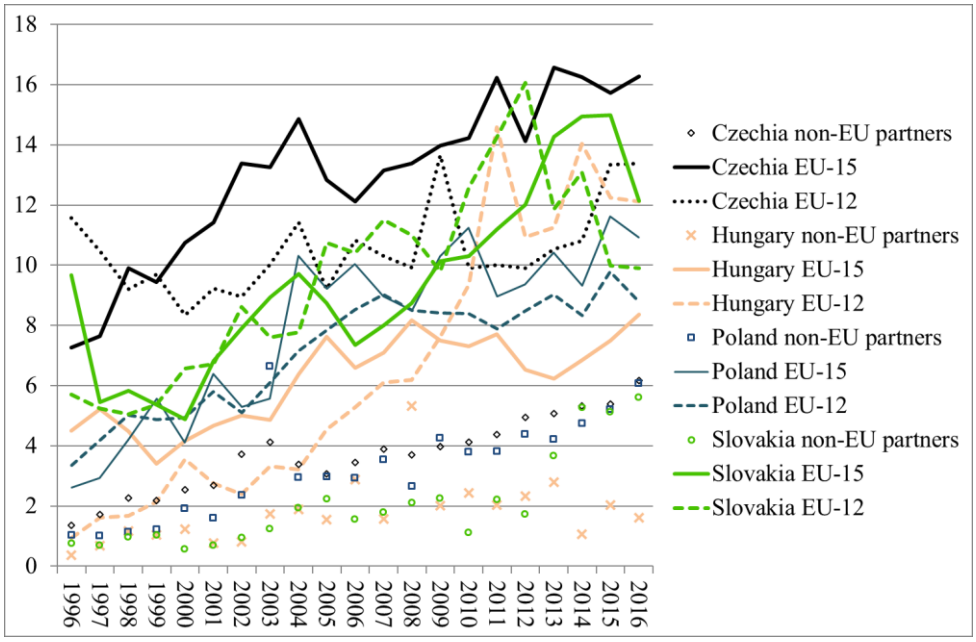
Table 2. Average annual change in share of horizontal intra-industry specialisation in trade

Country	Partner group	1996-2004	2004-2009	2009-2014	2014-2016	1996-2016
Czech Republic	non-EU	0.07	-0.01	0.02	0.03	0.04
	EU-15	0.51	0.10	0.11	-0.06	0.24
	EU-12	0.22	0.36	0.59	-1.09	0.15
Hungary	non-EU	0.16	0.02	-0.16	0.19	0.05
	EU-15	0.12	0.05	0.03	1.99	0.35
	EU-12	0.34	0.77	0.57	-0.38	0.39
Poland	non-EU	0.05	0.03	0.28	-0.18	0.07
	EU-15	0.36	0.43	0.41	-0.50	0.27
	EU-12	0.35	0.20	0.27	-0.66	0.15
Slovakia	non-EU	0.01	0.03	0.03	0.19	0.05
	EU-15	0.51	0.22	-0.13	1.76	0.47
	EU-12	0.18	0.33	0.72	-0.53	0.24

Source: own calculations based on UN COMTRADE

The vertical high quality intra industry trade share showed a rising trend, and this referred not only to the EU-15 and the EU-12 (or pre-members) partner groups but, in the case of Poland and Slovakia, also to the extra-EU group (See: Figure 3). The extra-EU states represented a group with which V4 countries noted the lowest indices in 1996. The quality of commodities traded was rising across the research period, as the vertical high quality trade shares were substantially growing, regardless of the group.

Figure 3. Vertical high quality intra-industry trade (% of total trade) between the Visegrad countries and EU-15, EU-12 and the 26 biggest non-EU partners



Source: own calculations based on UN COMTRADE

The vertical high quality intra industry specialisation which reflects the share of exported high quality commodities of the Visegrad States was also growing during the entire researched period. The group was not, however, coherent (See: Table 3). While the Czech Republic's, Poland's and Slovakia's specialisation developed the most in trade with EU-15, Hungarian specialisation improved the most in trade with EU-12.

While before the crisis, the patterns did not drastically change downward, the occurrence of the economic uncertainty related to the crisis impeded the further growth of the high quality two-way trade in most of the analysed countries and diversified these patterns among them (with Slovakia being the only country which maintained a growing trend, regardless of a trading partner group).

Table 3. Average annual changes in share of vertical high quality intra-industry specialisation in trade

Country	Partner group	1996-2004	2004-2009	2009-2014	2014-2016	1996-2016
Czech Republic	non-EU	0.26	0.12	0.27	0.28	0.23
	EU-15	0.95	-0.18	0.46	0.01	0.43
	EU-12	-0.02	0.45	-0.57	0.86	0.09
Hungary	non-EU	0.19	0.02	-0.19	0.18	0.06
	EU-15	0.23	0.22	-0.13	0.51	0.18
	EU-12	0.28	0.88	1.28	-0.64	0.53
Poland	non-EU	0.24	0.26	0.09	0.44	0.24
	EU-15	0.96	0.00	-0.19	0.53	0.40
	EU-12	0.47	0.25	-0.01	0.15	0.26
Slovakia	non-EU	0.15	0.06	0.60	0.11	0.23
	EU-15	0.01	0.08	0.96	-0.94	0.12
	EU-12	0.26	0.40	0.66	-1.06	0.20

Source: own calculations based on UN COMTRADE

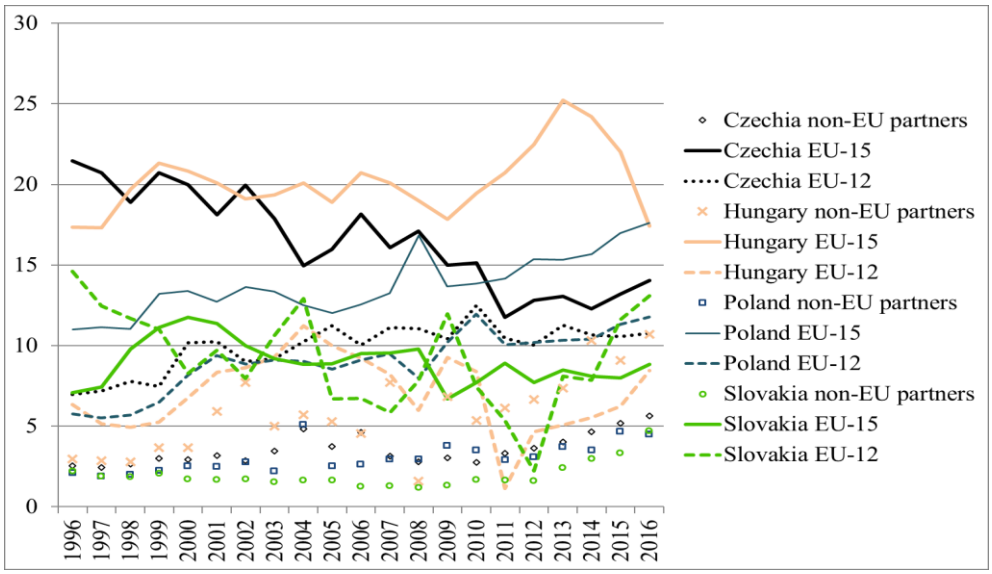
Regarding vertical low quality intra industry trade, except for Slovakia, it was a dominant component of trade for the EU-15 in 1996 (see Figure 4). During the research period, the shares of this trade grew only slightly, compared to the other parts of IIT, which may point to an improvement of a relative quality of produced commodities in Visegrad countries. In 2016, the highest indices, with the exception of Slovakia, were noted in the case of trade with EU-15. A group with which the V4 countries noted lower shares of this type of trade was EU-12, which may point that – vis-à-vis the other UE-12 – the Visegrad countries have advanced much more in the GVC ladder.

Regarding intra-industry specialisation in exports of low quality (or simply, semi-products), the average annual growth rates during the entire research periods were not as high as in the case of other specialisations (see Table 4). These moderate growths or even decreases – compared with overall changes in overall and horizontal and vertical high quality IIIT – point to the gradual advance of Visegrad countries in GVCs.

Before the EU 2004, the low quality intra-industry trade was rising relatively fast, regardless of the group of trading partners. Since then, the pace of growth was in most cases either stopped or reversed (especially towards non-EU partners). This points to the advance in the production ladder since that period. During the crisis, the vertical low quality intra-industry specialisation of Visegrad countries (with the exception of Poland) was rising faster in the case of trade with non-EU member states, than during the entire period researched. This may reflect the fact that during the crisis the price competition among the suppliers located in the lower parts of GVCs (mostly

non-EU countries) was strengthened. But this is also partly a currency depreciation effect.

Figure 4. Vertical low quality intra-industry trade (% of total trade) between the Visegrad countries and EU-15, EU-12 andthe26 biggest non-EU partners



Source: own calculations based on UN COMTRADE

Table 4. Average annual changes in share of vertical low quality intra-industry specialisation in trade

Country	Partner group	1996-2004	2004-2009	2009-2014	2014-2016	1996-2016
Czech Republic	non-EU	0.29	-0.36	0.32	0.34	0.15
	EU-15	-0.82	0.01	-0.54	0.60	-0.35
	EU-12	0.41	0.04	0.04	0.04	0.18
Hungary	non-EU	0.34	0.23	0.69	0.13	0.37
	EU-15	0.34	-0.46	1.27	-2.26	0.00
	EU-12	0.61	-0.39	-0.74	0.97	0.10
Poland	non-EU	0.37	-0.26	-0.05	0.33	0.11
	EU-15	0.19	0.23	0.40	0.64	0.32
	EU-12	0.41	0.23	0.04	0.45	0.29
Slovakia	non-EU	-0.07	-0.06	0.33	0.57	0.12
	EU-15	0.22	-0.43	0.28	0.25	0.08
	EU-12	-0.21	-0.19	-0.82	1.75	-0.07

Source: own calculations based on UN COMTRADE

3. Model

To estimate the possible effects of the European integration and of the crisis, the dynamic panel Arellano-Bover (1995) / Blundell-Bond (1998) two-step method of estimation (the system General Method of Moments) was chosen. This estimator has many advantages regarding common problems arising from estimating models with panel data. This method of estimation allows independent variables to be not strictly exogenous, and they may be correlated with the errors. But this method can also be used when the fixed effects as well as heteroscedasticity and autocorrelation occur within individuals but not across them. It can be used when the panels are "short T" and "long N", that is, a low number of periods and a high number of groups. It is designed for linear functional relationship. It enables the usage of instruments that improve the efficiency of the model. The instruments can be "internal"—based on the lag of the instrumented variables. Still, Roodman (2006, p. 14) states that the estimators do allow "external" instruments. Roodman (2006, pp. 13-14) defined some conditions that the GMM system should meet. First, the first-difference residuals should have an autocorrelation of the first order negative and significant, but no second order autocorrelation. Second, over-identified instruments should not be correlated with the error term.

The collected data ranges from 1996 to 2016 and includes 4566 observations in 218 groups (unbalanced panel), representing the intra-industry trade shares of each Visegrad country's bilateral trade with each trading partner (all EU partners as of 2016 and the 26 biggest non-EU trading partners as of 2016). The author estimated several models, each for a specific, explained variable: total intra-industry trade (IIT), horizontal intra-industry trade (HIIT), vertical high quality intra-industry trade (VHIGH) and vertical low quality intra-industry trade (VLOW).

The literature shows a broad scope of the determinants of intra-industry specialisation in trade. For instance, the level of development of the trading countries has a huge impact on intra-industry trade. The higher it is, the higher the share of two-way trade. The literature explains it by stating that if the consumers are richer, they can afford consuming different varieties of one good (since they are prone to have more varieties (Krugman, 1980; Lancaster, 1979). Also, a higher level of development means a relative abundance in capital, which, in theoretic models, is necessary to produce differenced commodities (Czarny, 2002, p. 174). The explaining variable used in the literature that instruments this determinant is the average GDP per capita of the trading partners (in this study, the variable is named AGPC). The development level of a country may imply a higher technological level, since the differentiated commodities are usually of relatively high technological intensity.

A difference in development (or alternatively, the economic distance) between the trading countries is also an important determinant of two-way trade. Yet, depending on the type of two-way trade, it may increase (vertical) or decrease

(horizontal) it. On the total intra-industry trade, it is expected to lower it, as Greenaway *et al*. (1994a) pointed to the similarities of the trading countries (and thus the structure of demand). The empiric studies (Durkin and Krygier, 2000) point to the positive correlation between this determinant and the vertical intra-industry trade, which is coherent with the theoretic models that include the differences in factor endowment. The explaining variable used in the literature that represents this determinant is the difference in the GDP per capita of the trading partners and, in this study, it is named DGPC.

The size of the markets also plays a significant role in the research on two-way trade. Some researchers say that big market entails a demand for differentiated goods, but it is also linked with the growing economies of scale (Amiti, 1998).The size of the market may be approximated with GDP (i.e. Lortscher and Wolter, 1980) (the same as in this study) or with GNP (Balassa, 1986). Kandogan (2003, p. 7) and Hummels and Levinsohn (1995, p. 812) used a GDP variable in estimating the gravity model explaining two-way trade, and they both received contradictory results.

The geographic distance is well founded in both theoretic models as well as in empirical studies and it is useful in gravity models. In practice, a variable distance is measured with geographic distance (as a crow flies) between the capitals of the trading partners. Some researchers additionally choose the common border of the trading countries (as a dummy variable). This determinant may be broadened and include the cost of transport/trade (Grubel and Lloyd, 1975). In general, the increasing cost of trade (including the increasing distance) lowers the trade in substitutes which are the object of two-way trade (Bergstrand and Egger, 2006).

The level of economic integration between the trading partners is linked with the cost of trade. Bergstrand (1990) says that a level of tariffs affects the size of two-way trade. Yet, in the case of the economic integration between the EU and the Visegrad countries, the issue of trade tariffs is not the case, and the higher levels of integration should be assessed. The height and structure of trade barriers do not provide comprehensive information about the integration, thus some proxies of economic integration have been emerging in the literature. Dixon and Menon (1997) applied the dummy variables representing the binding FTA, preferential trade agreements or regional trade agreements as the explaining variables. Gullstrand (2002) or Crespo and Fontoura (2004) introduced EU dummy variable and interestingly, in their study, the EU is either not significant or decreasing the intra industry specialisation). As a proxy of economic integration, Ben-David (1996) used a volume of trade. For the purposes of this paper, the EU dummy variable is introduced, but, to measure the adjustments prior to the EU membership of the Visegrad countries, the PRE-EU dummy variable (the period in which the countries conducted accession negotiations) was also introduced to the model.

FDI is also an interesting determinant of IIT, as it represents the other economic links between the trading partners and I may shape the trade structure of

the host country. Interestingly, the impact of FDI on two-way trade is opaque. Though Grubel and Lloyd (1975) or Greenaway and Milner (1986) stated that it increased the IIT, Markusen (1995) pointed that there are different types and motivations of investment and thus some of FDI may generate the opposite effect. Kandogan (2003, p. 8) obtained a negative effect of FDI on horizontal intra-industry specialisation. In this study, the FDI inward stock variable was introduced as the Visegrad states, which are the subject of this research, are predominantly the host countries for FDI, and their outward investment are extremely low compared to the inward FDI.

The economic crisis may have a detrimental effect on intra-industry trade as it may break global supply chains (Yong *et al.,* 2015). For the purpose of this study, the "CRIS" dummy representing the occurrence of the global financial crisis, evolving into the euro area crisis (which solely for the purpose of this paper equals 1 in 2009-2014 years, otherwise being 0) was introduced.

The results (rounded to 3 decimal places or more if the rounded estimate is 0) of the estimation are the following (see Table 5):

Table 5. Results of the econometric modelling

	Model 1	**Model 2**	**Model 3**	**Model 4**
Explained Variable	IIT	HIIT	VHIGH	VLOW
Explained Variable $_{t-1}$	0.388*** 0.009	-0.002*** 0.0003	0.15*** 0.0004	0.183*** 0.001
Explained Variable$_{t-2}$	0.087*** 0.001	0.006*** 0.0003	0.056*** 0.001	-0.013*** 0.001
Explained Variable $_{t-3}$	-0.022*** 0.001	0.057*** 0.0004	0.059*** 0.003	0.172*** 0.001
DIST	-0.0004*** 0.00002	0.0006*** 0.00002	-0.006*** 0.0001	-0.0006*** 0.000004
FDI	0.0002*** 0.00001	0.00004*** 0.000001	0.0001*** 0.000001	0.00005*** 0.000001
GDP	0.001*** 0.00001	-0.00008*** 0.023	0.001*** 0.00003	0.001*** 0.00003
AGPC	0.00013*** 0.00001	0.0001*** 0.000004	0.0002*** 0.000005	0.00006*** 0.000005
DGPC	-0.00005*** 0.0000004	0.000001*** 0.0000003	-0.00001*** 0.000001	-0.0002*** 0.00003
EU	1.29*** 0.31	1.113*** 0.009	0.082*** 0.042	-0.136*** 0.022
PREEU	1.46*** 0.03	0.54*** 0.008	-0.593*** 0.025	1.386*** 0.024
CRIS	-0.058*** 0.016	0.202*** 0.0008	0.135*** 0.022	-0.413*** 0.003
CONST	0.282*** 0.007	-0.71*** 0.007	4.04*** 0.035	4.212*** 0.03

Number of instruments	400	400	400	400
Wald test	$Chi^2(12)=3.97e+6$ $Prob>chi^2 = 0$	$Chi^2(12) = 6.88e+6$ $Prob>chi^2 = 0$	$Chi^2(12) = 3.19e+7$ $Prob>chi^2 = 0$	$Chi^2(13) = 1.08e+7$ $Prob>chi^2 = 0$
Sargan test	$Chi^2(176)=201.1$ $Prob> chi^2=1$	$Chi^2(387)=212.15$ $Prob> chi^2=1$	$Chi^2(176)=213.1$ $Prob> chi^2=1$	$Chi^2(176)=214.75$ $Prob> chi^2=1$
Arellano-Bond test for zero autocorrelation	Order 1: -2.004 Prob>z = 0.001 Order 2: 0.2731 Prob>z = 0.426	Order 1: -2.5024 Prob>z = 0.012 Order 2: -2.027 Prob>z = 0.042	Order 1: -2.204 Prob>z = 0.028 Order 2: 1.124 Prob>z = 0.261	Order 1:-3.778 Prob>z = 0.0002 Order 2: 0.801 Prob>z = 0.423

Source: own calculations
*** - 99% confidence interval

For such a dynamic panel data estimation technique, which includes instruments, there might appear to be a problem with the validity of the used instrumental variables. These instruments may be correlated with some sets of residuals and thus the variables are overidentified. The Sargan test enables an assessment of whether the overidentifying restrictions are valid or not. The null hypothesis states that the overidentifying restrictions are valid, which means that the model is mis-specified. Rejecting this hypothesis means that the instruments are appropriate. The other problem that may arise is with the endogeneity of the unobserved time-invariant component, as it may be correlated with the second lag of the dependent variable. The Arellano-Bond test assesses whether serial correlation occurs (null hypothesis). While first-order serial correlation may occur, the model still may be well specified. But when second-order serial correlation occurs, the model is mis-specified, and it should be redesigned.

In Model 1, in which the explained variable is the total IIT share, the null hypothesis in Sargan test is rejected, which means that the instruments used in the model are valid. The Arellano-Bond test results rejected the hypothesis on the serial correlation of order 2, which means that the model is correctly specified. The Wald test indicated that the explanatory variables are jointly significant. The FDI, AGPC, DGPC coefficients are positive, which means that IIT changes are in the same direction as the changes in total bilateral trade, joint GDP and differences in GDP per capita. EU and PREEU positive coefficients prove the fact that the European integration (statistically) enhanced the share of IIT, which means that the integration contributed to the changing patterns of Visegrad groups' trade, making this group increasingly alike and connected to the Western Europe. The geographic distance coefficient is negative, pointing to the detrimental role of transportation costs to the intra-industry trade and it is coherent with the theoretic models. The CRIS negative coefficient points to the weakening of the intra industry specialisation during the crisis, and a possible channel of this weakening is the certain damage done to the GVCs.

In Model 2, in which the explained variable is the horizontal IIT share, the null hypothesis in Sargan test is rejected. The Wald test indicated that the explanatory variables are jointly significant. Yet, the Arellano-Bond test results pointed to the serial correlation of order 2, which is a weakness of this model decreasing its reliability in explaining the variability of the horizontal two-way trade. This requires further research with either different timeframe, different set of explanatory variables or different estimation method. Additionally, the coefficients of the differences in GDP per capita and geographic distance are positive, while the theoretic models show a negative impact of economic and geographic distance on horizontal intra-industry trade.

In Model 3, in which the explained variable is vertical high quality intra-industry specialisation in trade, the null hypothesis in Sargan test is rejected. The Arellano-Bond test results rejected the hypothesis on the serial correlation of order 2, which means that the model is properly specified. The Wald test indicated that the explanatory variables are jointly significant. The FDI, GDP, AGPC coefficients are positive and statistically significant, which means that VHIGH changes in the same direction as the changes in total FDI inward stock, joint GDP and GDP per capita. This result may be explained by the theory, since the number of varieties is high when the market is large and the trading partners are well developed. The negative geographic distance coefficient was coherent with the theory. Surprisingly, the DGPC coefficient turned out to be negative while the empiric studies as well as the theoretic models pointed to the positive effect. The EU variable has a positive coefficient and the PREEU coefficient is negative, which points to the different patterns in changes in production profile before and after the Visegrad countries' EU membership. While before the EU accession, the multinational corporations focused on investment in facilities producing semi-products (or less expensive, low quality commodities), after the enlargement, there was a gradual change towards final and more sophisticated products. Also, interestingly, the CRIS coefficient was positive, which pointed to the strengthening position of the Visegrad countries within the GVCs during the crisis. This also may mean that, paradoxically, the crisis was an opportunity for the Visegrad countries to improve their economic position both regionally and globally regarding production chains.

In Model 4, in which the explained variable is vertical low quality intra-industry specialisation in trade, the null hypothesis in Sargan test is rejected. The Arellano-Bond test results rejected the hypothesis on the serial correlation of order 2. The Wald test indicates that the explanatory variables are jointly significant. The FDI, GDP, AGPC coefficients are positive and DIST coefficients are negative, which is coherent to the theory and empirical studies. Surprisingly, in Model 3, the DPGC coefficient is positive. PREEU has a positive coefficient, while the EU dummy has a negative coefficient, which pointed to the gradual advance of the Visegrad countries in the GVCs (from the lower stage of production to the higher

stage of production). The negative sign of CRIS coefficient pointed to the possible Visegrad countries' advance on the GVCs production ladder during the crisis.

Conclusions

This paper offers empirical evidence on the major trends in the changing patterns of Visegrad countries' trade and on the determinants of those changes. This analysis consists of four parts: a short literature review, the methodology of intra-industry trade measurement, the description of changes in intra-industry specialisation (including its structure) of the Czech Republic, Hungary, Poland and Slovakia with their trading partners gathered in three groups: EU-15, EU-12 and the non-EU partners. The last part is an assessment of the influence of European integration and of the crisis on intra-industry trade and its structure.

This paper finds that intra-industry specialisation was growing regardless of the trading partner group, yet the slowest average annual increases may be mostly observed in trade with non-EU partners during the entire research period. Simultaneously, depending on the specific Visegrad country, the highest intra-industry specialisation increases were noted in trade with either the EU-15 or the EU-12. Also, the lowest increase in horizontal intra-industry specialisation was noted in trade with non-EU partners, which pointed to the possible convergence between the Visegrad countries and the other EU member states and the effect of the European integration. In the case of vertical intra-industry trade, the results were not coherent across the Visegrad countries, yet overall, the results suggested the gradual improvement of the V4 countries position in the GVC.

The estimation with dynamic panel data techniques, like the system GMM, has been rather rarely used in estimating intra-industry specialisation. The GMM system estimation proved that EU membership, as well as the pre-accession period, enhanced intra-industry trade, as well as the horizontal intra-industry specialisation of the Visegrad countries. The mis-specification of the model explaining the variability of horizontal IIT however weakened the conclusions drawn on the factors determining this type of trade. Regarding high-quality intra-industry trade, EU membership implied higher shares of this trade, while the pre-accession period implied a decrease in this specialisation (in the case of low quality IIT – the opposite). This pointed to the evolving production profile of the Visegrad countries through FDI: from a focus on less-sophisticated goods or semi-products before accession towards better quality and final goods. This also showed the increasing inclusion of these countries in GVCs in the pre-accession period and their advancement in these chains after EU enlargement in 2004. The crisis, however, weakened the growth of intra-industry specialisation in the Visegrad countries' trade.

These results have important implications for policymakers in the EU. They may encourage them to aim towards enlargement or at least other forms of

integration with the EU's neighbourhood, as this may entail some economic convergence in neighbouring countries.

Acknowledgment: This project is financed by the National Science Centre in Poland, based on decision no. DEC-2011/01/N/HS4/03247

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