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Covergence And Divergence In The European Union

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Convergence and Divergence in the European Union

Paper presented at the 40th European Congress of the European Regional Science Association, August 29 – September 1, 2000, Barcelona, Spain.

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Abstract:

Theoretically, European integration leads to convergence as well as divergence between the countries included in the integration process. For example, increased technological spillovers lead to convergence of the production processes used in the EU-countries, whereas specialisation leads to divergence of the commodities produced in each country (the sectoral distribution). The patterns of convergence and divergence found empirically, however, differ from the patterns that are expected theoretically. This paper uses intercountry input-output tables of six European countries (Germany, France, Italy, the Netherlands, Belgium and Denmark) of the years 1970, 1975, 1980 and 1985 to analyse the empirical patterns of convergence and divergence. The analyses include, among others, technological convergence, convergence of the sectoral distributions, and changing patterns of specialisation and intra-industry trade. By comparing the empirical patterns with the theoretical expectations, the outcomes shed new light on the theories of international trade.

1. Introduction

One of the most important economic events of the twentieth century in Europe has been the process of European economic integration. This integration has had a large impact on all European economies involved in the process. Free trade and free mobility of production factors resulted in, among other things, more intensive economic relations between European countries. The effects of integration are ubiquitous in real life: shops throughout the European Union sell products from all over Europe. Economic theory, however, is unclear with respect to the effects of economic integration. There are many theories on economic integration, but the conclusions of these theories differ widely.

Next to investigating the effects of integration from a theoretical point of view, it is also important to assess these effects empirically. This paper performs such an empirical analysis. It uses the unique example of the European Union to analyse whether convergence or divergence occurred between the economic systems of the European Union. Of course, convergence and divergence may occur in numerous ways. Hence, Section 2 describes which economic aspects are expected to show convergence or divergence according to the trade theories. Section 3 analyses whether this expected convergence and divergence also appeared empirically. In section 4 the results are evaluated. Finally, Section 5 contains the conclusions of the analysis.

All results of this paper stem from Hoen (1999). For a further description and explanation of the methods and data used as well as for more results and a more thorough theoretical background, the reader is referred to this publication.

2. Theoretical Expectations

Most trade theories argue that integration influences economic growth due to specialisation and technological spillovers. Technological spillovers also lead to convergence of production technologies. After integration, countries that lag behind in production technologies are in a good position to copy more advanced technologies of other countries, which leads to an increase in their productivity. Thus, technological spillovers provide relatively less developed countries an opportunity to catch up with relatively more developed countries (see e.g. Romer, 1990).

In general, countries that lag behind have the best opportunities to increase growth. Since higher productivity allows for generating more value added, GDP growth will be faster in the case of integration than in the case without integration. It is expected

that relatively less developed countries show higher GDP growth rates than relatively more developed countries. These conclusions are not only expected theoretically, they are found empirically as well. For example, Ben-David (1994) and Barro and Sala-i-Martin (1995) conclude that relatively poor countries experience faster GDP growth than countries that are relatively rich. However, this conclusion only holds for certain groups of countries. Ben-David finds that it holds for the group of richest countries in the world; Barro and Sala-i-Martin find a relationship among European countries. Mankiw, Romer, and Weil (1992) also notice that convergence does not hold for all countries together. However, they show that if GDP growth is corrected for population growth and for the rates of saving, convergence does hold. They even find a rate of convergence close to the convergence predicted by the Solow model.

Hence, theoretical analyses and earlier empirical analyses suggest that economic integration leads to convergence of the levels of welfare in the countries involved in the process of integration. Further, these countries are expected to experience specialisation and convergence of technologies. The next sections analyse whether these general expectations hold true in the specific example of the European Union.

3. Empirical Findings

Section 2 discussed the theoretical expectations concerning convergence and divergence in case of international economic integration. This section analyses whether these expectations also hold empirically. Section 3.1 tests whether the levels of per capita GDP show convergence among the EU-countries. Then, sections 3.2, 3.3 and 3.4 test whether specialisation occurs in three ways, respectively whether the production patterns show divergence, whether export specialisation occurs among the countries of the EU, and whether intra-industry trade has increased or decreased between the EU countries. Finally, Section 3.5 analyses whether technological convergence took place between the EU countries.

All analyses are based on intercountry EU input-output tables. These tables are available for the years 1970, 1975, 1980 and 1985 in current prices (see Van der Linden, 1998) and in constant prices (Hoen, 1999). The analyses in the next sections are all based on the tables in constant prices. The countries included in the tables are Germany, France, Italy, The Netherlands, Belgium and Denmark. I will refer to these six countries

as the 'included EU countries'. Since no data are available for the other countries, only the included EU countries are analysed.

3.1 Convergence of Per Capita GDP

Many analyses about convergence use the concepts of β -convergence and σ -convergence. These concepts respectively refer to whether a negative relation exists between levels of GDP per capita (or per worker) and growth rates of this variable, and to whether the dispersion in the levels of GDP per capita (or per worker) decreases. Most analyses about the European Union find convergence according to both concepts (see Dluhosch, 2000).

The results of total value added (as measure for GDP) in constant prices as included in the intercountry input-output tables is in accordance with these results. The first columns of table 1 show the level of GDP per capita in the six EU countries included in the intercountry EU input-output tables in constant prices. The countries are ordered according to their level of per capita GDP. Interestingly, the order of the countries did not change between 1970 and 1985.

The growth rates of the countries with larger per capita GDP tend to be smaller than the growth rates of the countries with smaller per capita GDP. The correlation coefficient of GDP-level in 1970 and GDP growth between 1970 and 1985 is negative, and a regression of these two variables leads to a significantly negative coefficient. Hence, the data show β -convergence. The dispersion also declines, which is shown by the variation coefficient. Clearly, the data also show σ -convergence. It seems, therefore, that the data are in accordance with the theoretical expectations: the levels of per capita GDP in the EU are converging.

Table 1: GDP per capita in millions of ECUs and GDP growth in percentages

	GDP level		GDP growth			
	1970	1985	1970-1975	1975-1980	1980-1985	overall
Denmark	9.4*	13.0	1.9%	2.2%	2.4%	2.2%
France	9.0	11.4	1.0%	2.3%	1.4%	1.6%
The Netherlands	7.8	10.6	3.0%	1.9%	1.2%	2.1%
Germany	7.3	9.8	1.3%	3.2%	1.4%	2.0%
Belgium	6.6	9.4	3.7%	2.7%	0.8%	2.4%
Italy	5.6	9.3	3.4%	3.6%	3.4%	3.5%
EU	7.3	10.2	1.9%	2.9%	1.8%	2.2%
Variation coefficient	0.17	0.12				
Correlation coefficient			-0.67	-0.75	-0.26	-0.77
Regression coefficient			-84	-171	-39	-173
t-value			-2.0	-2.6	-0.6	-2.7

* estimate

3.2 Convergence of Sectoral Distribution

The analysis in Section 3.1 can be repeated for value added per sector. The pattern of value added figures of a country shows which sectors are relatively large in this country and which sectors are relatively small. This pattern of value added figures is called the 'sectoral distribution' of a country. The EU sectoral distribution is a weighted average of the sectoral distributions of the included EU countries. Hence, the difference between the sectoral distribution of a country and the EU sectoral distribution shows which sectors are large or small in this country relative to the average size of this sector in the EU.

Similarly, the growth of value added of the sectors can be compared with the average growth of these sectors in the EU. For total value added, it was expected that countries with the smallest GDP per capita would show most growth. For sectoral value added, however, a different expectation applies. Since international integration is assumed to lead to specialisation, it is expected that a country which is relatively strong in a particular sector develops this sector even further. Likewise, a country that is not specialised in a particular sector will concentrate on other sectors and will import the products of this sector from a country that does have a comparative advantage in this

sector. Hence, a relatively large sector is expected to grow even further and a relatively small sector is expected to decline even further. Table 2 shows the correlation coefficients between the differences of the sectoral distributions of the EU countries and the EU average and the differences between the sectoral growth rates and the EU average.

Table 2: Correlation between differences in sectoral size and differences in sectoral growth

	Correlation coefficient	t-value	Rank correlation coefficient*	t-value
Italy	-0.61	-3.74	-0.63	-3.91
The Netherlands	-0.01	-0.06	-0.18	-0.87
Belgium	-0.46	-2.50	-0.66	-4.23
Denmark	-0.56	-3.23	-0.35	-1.79
France	-0.37	-1.92	-0.58	-3.42
Germany	-0.30	-1.53	-0.29	-1.47
EU	-0.38	-4.94	-0.41	-5.50

* Spearman's (non-parametric) rank correlation coefficient

Surprisingly, all correlation coefficients are negative, and most coefficients are significantly smaller than zero. Hence, the sectoral distributions show convergence. This means that the sectoral distributions of the included EU countries move towards their average, which is not in accordance with the expectation of specialisation. The next section will analyse the pattern of specialisation directly.

3.3 Specialisation

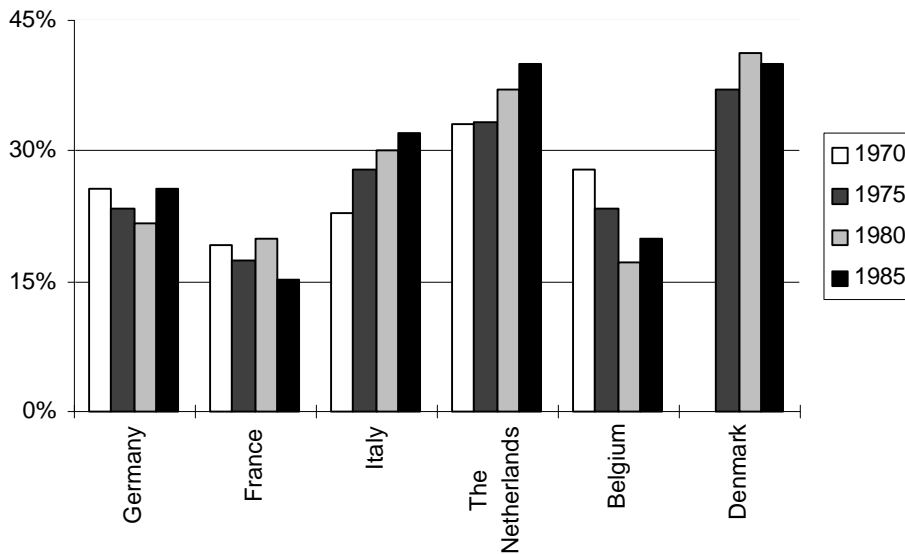
According to most trade theories, economic integration goes together with increased specialisation of the countries involved in the integration process. The countries that have a comparative advantage in a particular product, will increase their production of this product. Then, they exchange this product for products in which other countries have a comparative advantage. Therefore, specialisation leads to increased trade in different products and hence it can be tested by looking at the pattern of exports. For the

case of the EU, the developments of specialisation are tested by means of the export specialisation index. This index computes how similar the exports of a country are relative to the exports of a group of reference countries. Let the exports of product i from country r be denoted by z_i^r and the exports of the other EU countries of the same product by z_i^{EU} . Then, the degree of export specialisation of country r is computed as (see Oosterhaven, 1995):

$$s^r = \sum_{i=1}^n \left| \frac{z_i^r}{z^r} - \frac{z_i^{EU}}{z^{EU}} \right| * \frac{1}{2} * 100\% . \quad (1)$$

If the index i is omitted, the specialisation index refers to total exports of the country or group of countries¹. The results per country are displayed in Figure 1.

Figure 1: Export specialisation of the six EU countries



The figure shows mixed results. The Netherlands and Italy experience continuously increasing specialisation. In France and Belgium the mixed patterns result in a decrease between 1970 and 1985; in Denmark and Germany the result is an overall increase between the first year (which, for Denmark, is 1975) and 1985. For Germany, however, the difference between 1970 and 1985 is very small.

Since Figure 1 shows increases as well as decreases in specialisation, the results are not totally in accordance with the results of Section 3.2. Section 3.2 concluded that

the sectoral distribution of the included EU countries become more similar over time, which may indicate that specialisation has decreased. Still, in at least 3 of the six included EU countries, specialisation increases whereas only 2 countries show a clear decrease between 1970 and 1985. These results can only hold if the countries specialise but still exchange or produce similar products. Hence, the paradox between the outcomes of this section and Section 3.2 can only be explained if intra-industry trade increased in spite of the increase in specialisation.

3.4 Intra-Industry Trade

The traditional trade theories conclude that economic integration leads to a situation in which the countries specialise in different products and trade these products against each other. Although this would imply a situation of increased specialisation and no intra-industry trade, Grubel and Lloyd (1971, 1975) found that empirically much trade exists of intra-industry trade, regardless of the level of detail of the commodity classification used. Even in countries that experience increasing economic integration, intra-industry trade exists and may increase. Hence, several authors, such as Aquino (1978), have argued that the traditional view that international trade results from specialisation is not an accurate description of the real world.

Contributions in Grossman (1992) show how consumer preferences and differentiated products may lead to intra-industry trade in case of economic integration. However, most theories that explain the increase of intra-industry trade after economic integration, conclude that integration leads to intra-industry specialisation, which means that countries specialise in different varieties of the same product. Intra-industry specialisation will lead to a decrease of the specialisation index used in Section 3.4, since trade will consist of similar goods instead of different goods. Hence, according to the traditional trade theories as well as to most new trade theories, specialisation and intra-industry trade have a negative relation: if one increases, the other must decrease, and vice versa.

Table 3 summarises the empirical results of intra-industry trade based on the intercountry EU input-output tables. To compute the Grubel-Lloyd indexes, domestic deliveries are ignored, since only exports are to be considered. Further, it is assumed that every cell concerns transactions of a unique product. Hence, deliveries from the German agricultural sector to the German chemical sector consist of different goods than

deliveries from the German agricultural sector to the German food sector. Similarly, deliveries from the German agricultural sector to the French chemical sector consist of different goods than deliveries from the German agricultural sector to the Dutch chemical sector, both of which are different from deliveries from the Italian agricultural sector to the French chemical sector, and so on. For the overall index per country, the weighted averages of all bilateral indexes are used. In equations, a bilateral Grubel-Lloyd index is computed as

$$gl_{ij}^{rs} = 1 - \frac{|z_{ij}^{rs} - z_{ij}^{sr}|}{(z_{ij}^{rs} + z_{ij}^{sr})} \quad (2)$$

in which z_{ij}^{rs} denotes the deliveries² of sector i from country r to sector j in country s .

The overall index for country r is computed as

$$\overline{gl}^r = \sum_{i,j,s \neq r} w_{ij}^{rs} gl_{ij}^{rs} \quad (3)$$

in which

$$w_{ij}^{rs} = \frac{z_{ij}^{rs} + z_{ij}^{sr}}{\sum_{i,j,s \neq r} z_{ij}^{rs} + \sum_{i,j,s \neq r} z_{ij}^{sr}} \quad (4)$$

Table 3: Weighted averages of the Grubel-Lloyd indexes

Country	1970	1975	1980	1985
Germany	0.49	0.51	0.54	0.54
France	0.55	0.55	0.57	0.57
Italy	0.50	0.48	0.45	0.48
Netherlands	0.45	0.44	0.45	0.44
Belgium	0.50	0.53	0.56	0.55
Denmark	n.a.	0.35	0.37	0.38

The results in Table 3 show that intra-industry trade increased over time in four of the six countries. Only Italy and The Netherlands show a decrease in intra-industry trade. Since most countries show an increase in intra-industry trade, it may be concluded that generally within the EU intra-industry has increased. Although this conclusion is in line with the conclusions of most empirical analyses, it is not in accordance with the results of Section 3.3. Hence, the combined results of intra-industry trade and export specialisation lead to a paradox in the theories of economic integration. This paradox, however, is in line with the empirically found convergence of the sectoral distributions found in Section 3.2. It seems as if the processes that take place in reality in a situation of economic integration are still not accurately described by the trade theories.

3.6 Structural Convergence

Most international trade theories expect international trade and economic integration to lead to faster technological changes, as countries that lag behind in technology will easily catch up with the relatively advanced technologies of other countries. These so-called ‘technological spillovers’ between countries lead to technological convergence between the countries.

The relation between technological convergence and trade is also found empirically. Dowrick (1992) uses a regression analysis to examine whether convergence can be explained by technological catch up. He points to an earlier study of Dowrick and Nguyen (1989) that showed a “strong and consistent tendency (...) for technological catch up to occur” within OECD countries since 1950 (Dowrick, 1992, p. 603). A similar conclusion is drawn by Evenson (1997) and by Sakurai, Papaconstantinou, and Ioannidis (1997). Helliwell (1992) estimates to what extent the convergence in the growth rate of technological progress depends upon international trade flows. He concludes that trade intensity level as well as trade intensity growth have led to more rapid technological progress.

In the intercountry EU input-output tables it is possible to analyse technological convergence by examining the production (or input) structures. Although the production structure of a sector is not the same as its technology, the concepts are related. Elements in a column of an input-output table denote the inputs used in the production process, the so-called ‘technological coefficients’. If technology changes, the production process may require a different mix of inputs and the production structure changes. Therefore,

even without knowing the underlying production technology, a changing technology may be observed by changes in the production structure. However, since the convergence the input structures does not directly measure technological convergence, this type of convergence will be referred to as ‘structural convergence’.

In the analysis of structural convergence, the concepts of β -convergence and σ -convergence cannot be used directly. Still, the convergence index used in this chapter is comparable to the index based on σ -convergence, since it uses dispersion among the EU member countries. It is different in the sense that it uses technological coefficients (the elements of the input structures) rather than GDP per capita. The structural convergence index used in this chapter is based on differences between technological coefficients of each EU country separately and average technological coefficients of the EU as a whole. Hence, the analysis uses:

$$\tilde{a}_{ij}^r = \tilde{a}_{ij}^{EU} + u_{ij}^{rEU}, \quad (5)$$

in which \tilde{a}_{ij}^{EU} is a weighted average of the input coefficients of the six EU countries, with the figures of total production of sector j in country r used as weights. Thus, coefficients \tilde{a}_{ij}^{EU} reflect the average production structure used in the EU to produce product j .

If the production process of sector j in country r equals the average production structure of sector j in the EU, u_{ij}^{rEU} equals zero for every i . The further the production structures are apart, the larger the (absolute) differences are. Therefore, the variance of u_{ij}^{rEU} can be used as a measure of convergence.³ If the variance of the differences in a production structure decreases over time, this production structure converges to the EU average. An F-test is used to test whether the variance decreases or increases significantly. Tables 4 and 5 show the sectors with significant convergence and divergence based on a significance level of 1%^{4 5}.

Table 4: Sectors with significant convergence of the production structures

	1970-1975	1975-1980	1980-1985	1970-1985
Germany	18	2		
France	18		22,23	8,19,22,23
Italy		2,23		6,12,14
Netherlands	8		9	9,24
Belgium		3		
Denmark	n.a.	12,23		n.a.
Total	3	6	3	9

Table 5: Sectors with significant divergence of the production structures

	1970-1975	1975-1980	1980-1985	1970-1985
Germany	2,3,20,23		25	3,20
France	3		2,18	2,3
Italy	2,23		25	
Netherlands	5	2		5
Belgium				
Denmark	n.a.		20	n.a.
Total	8	1	5	5

Tables 4 and 5 show that in the first period, from 1970 to 1975, the number of sectors that experienced divergence exceeds the number of sectors that experienced convergence by 8 over 3. In the second period, between 1975 and 1980, the relation was reverse. Overall, between 1970 and 1985 the number of sectors that converged to the EU average exceeds the number of sectors that diverged. Although the period from 1980 to 1985 shows a little more divergence than convergence, the general picture that emerges from Tables 4 and 5 is that divergence dominated in the first five years, and convergence dominated in the second period. The last period shows about as much convergence as divergence. Over the entire period the number of sectors with significant convergence exceeds the number of sectors with significant divergence. Hence, there is slightly more evidence of structural convergence than of structural divergence.

4. Evaluation of the Results

The empirical analyses presented in this paper are in line with most theoretical expectations. Section 3.2 shows a negative relation between the level of *GDP per capita* and its growth, which is in line with the theoretically expected convergence of GDP per capita. The *sectoral value added shares* of the countries, analysed in Section 3.3, also show convergence, which indicates that the relative sizes of the sectors in the EU countries become more equal over time. If each country specialises in the production of particular commodities, a sector in a country becomes larger if the country specialises in the production of its commodities and smaller if the country substitutes the production of its commodities by imports. Since most trade theories predict specialisation, the sectoral distributions of value added should show a divergence among the EU countries. Hence, the empirical observations of the changes in the sectoral distributions of value added contradict the theoretical expectations of the traditional trade theories.

The convergence of the sectoral distributions implies that the countries may have experienced a decrease in specialisation. Evidence of *export specialisation*, however, is found in the intercountry EU input-output tables. This increased specialisation together with the convergence in the sectoral distributions seems to be a paradox. It can be resolved if intra-industry trade has increased. Furthermore, the theoretically expected increase in specialisation only applies in general; specific countries or sectors sometimes show decreases in specialisation. This indicates that the trade theories are a simplification of the processes that take place in reality.

The intercountry EU input-output tables show a general increase in *intra-industry trade* in most countries. This roughly confirms the increase in intra-industry trade expected by the new trade theories. The empirical situation is, however, more complex than the theories suggest: the overall level of intra-industry trade increases whereas specific countries and sectors experience decreases in intra-industry trade.

The last indication of convergence occurs in the input structures of the included EU countries. The outcomes of the analysis of *structural convergence* suggest that it is more likely that technological convergence occurred than technological divergence. The evidence, however, is weak.

In summary, the analyses show three cases of convergence and one case of divergence between the included EU countries. The levels of per capita GDP, the sectoral distributions, and the input structures show signs of convergence. Divergence is only found as an increase of specialisation for some countries. Since this increase in specialisation goes together with an increase in intra-industry trade and with convergence in the sectoral distribution, the analyses show a paradox that cannot (yet) be explained by the existing trade theories. It is therefore concluded that the trade theories remain a simplification of the processes at work in reality.

Finally, some remarks about the paradox between specialisation and intra-industry trade need to be made. According to the trade theories, there should be an inverse relation between export specialisation and intra-industry trade. Figure 1 and Table 3 show that countries with relatively much specialisation have relatively little intra-industry trade and vice versa. Hence, empirically, this relation holds for the *levels* of export specialisation and intra-industry trade. *Changes* in intra-industry trade and specialisation, however, do not always confirm the theoretical expectations: Figure 1 and Table 3 show many cases of a simultaneous increase or decrease of specialisation and intra-industry trade. Hence the paradox mainly only applies to the changes in specialisation and intra-industry trade; the levels of specialisation and intra-industry trade are in line with the theoretical expectations.

It is not clear whether the paradox stems from theoretical causes or from empirical causes. Most theories from which a relation between intra-industry trade and specialisation can be derived distinguish only two countries and two commodities. In a situation of more than two countries and more than two commodities the conclusions about a relation between intra-industry trade and specialisation may change. On the other hand, if intra-industry trade and export specialisation are conceptually the same, a single measure would be sufficient. In such case, different outcomes for the two indexes implies that at least one of these does not measure what it ought to. Further research is necessary to solve these problems.

5. Conclusions

One of the most interesting results of the analyses in the paper is the indication of a process of convergence between the included EU countries. Convergence is found in

three ways. First, relatively poor countries tend to have relatively large welfare growth, whereas the growth rates of GDP per capita in relatively rich countries are often relatively small. Second, the sectoral distributions of value added showed convergence among the EU countries. Smaller than average sectors tend to have growth rates that are larger than average and vice versa. Third, there is an indication of technological convergence: although the number of sectors with significant structural convergence is very small, it exceeds the number of sectors with significant structural divergence.

Although the evidence is not very strong, the empirical analyses are in line with most theoretical expectations. It holds for most general empirical outcomes and general theoretical expectations; detailed outcomes often show a different picture. On the country level the outcomes sometimes contradict the theoretical expectations. Furthermore, the general increase in specialisation together with the general increase in intra-industry trade is a paradox, since theoretically there should be a negative relation between changes in specialisation and intra-industry trade. Therefore, based on the analyses in this dissertation, the trade theories seem to offer a reasonable but rough explanation of economic changes of countries in a process of economic integration. They are a simplification of the detailed developments. The empirical analyses indicate that actual processes are much more complex than the processes described by the trade theories.

Notes

¹ I only consider exports of country r to the other included EU countries, hence total exports means total exports to the five other included EU countries. The reference group consists of all included EU countries except for country r . Including country r may bias the results, see Hoen, (1999).

² In order not to complicate the equation, final demand is also included in the variable z . Hence, the index applies to intermediate demand as well as final demand.

³ The variance is computed for each sector j in each country r .

⁴ The null hypothesis of this test is that the variances of the errors in two years are the same. The alternative hypothesis is that the variances are unequal. Since both variances are based on 25 observations, the critical F-value is $F_{0.01,24,24}$ which equals 2.66. Hence, convergence is significant if the ratio of the variances exceed 2.66; divergence is significant if the ratio is smaller than $\frac{1}{2.66}$.

⁵ The sectors are classified according to NACE-CLIO 25. Appendix A contains an overview of the sectors and their corresponding numbers.

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Appendix: sector classification

- 1 Agriculture, forestry and fishery products
- 2 Fuel and power products
- 3 Ferrous and non-ferrous ores and metals
- 4 Non-metallic mineral products
- 5 Chemical products
- 6 Metal products except machinery and transport equipment
- 7 Agricultural and industrial machinery
- 8 Office and data processing machines
- 9 Electrical goods
- 10 Transport equipment
- 11 Food, beverages, tobacco
- 12 Textiles and clothing, leather, footwear
- 13 Paper and printing products
- 14 Rubber and plastic products
- 15 Other manufacturing products
- 16 Building and constructing
- 17 Recovery, repair services, wholesale and retail trade
- 18 Lodging and catering services
- 19 Inland transport services
- 20 Maritime and air transport services
- 21 Auxiliary transport services
- 22 Communication services
- 23 Credit and insurance
- 24 Other market services
- 25 Non-market services