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THE DYNAMICS OF HUNGARIAN AGRI-FOOD TRADE PATTERNS IN THE EU

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The evolving pattern of Hungary's agri-food trade is analysed using recently developed empirical procedures based on the classic Balassa index and its symmetric transformation. The extent of trade specialisation exhibits a declining trend; Hungary has lost comparative advantage for a number of product groups over time. The indices of specialisation have also tended to converge. For particular product groups, the indices display a less persistent pattern. They are stable for product groups with comparative disadvantage, but product groups with weak to strong comparative advantage show significant variation. The results reinforce the finding of a general decrease in specialisation, but do not support the idea of self-reinforcing mechanisms, emphasised strongly in much of the endogenous growth and trade literature.

Keywords: international trade, revealed comparative advantage, agri-food trade, Hungary

JEL classification index: F12, Q17

1. INTRODUCTION

The analysis of agricultural trade between Eastern and Western Europe has recently became a frequently discussed topic again (e.g. Eiteljörge and Hartmann 1999; Bojnec 2001; Fertő and Hubbard 2003). However, discussions rarely deal with the evolution of trade patterns, even though theoretical literature on growth and trade stresses that comparative advantage is dynamic and develops endogenously over time. In particular, one strand of literature (Lucas 1988; Young 1991; Grossman and Helpman 1991) has demonstrated that the growth rate of a country may be permanently reduced by a "wrong" specialisation. Another strand emphasises the role of factor accumulation in determining the evolution of international trade (Findlay 1970, 1995; Deardorff 1974).

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In this paper we apply recently developed empirical methods in a preliminary analysis of the dynamics of Hungarian agri-food trade patterns.[1] The paper is organised as follows: section 2 briefly reviews some of the theoretical literature concerning the dynamics of trade patterns. Section 3 outlines the measurement of trade specialisation, while section 4 describes the empirical models and procedures applied. Our results are reported and discussed in section 5, with a summary and some conclusions presented in section 6.

2. TRADE DYNAMICS

The standard Heckscher–Ohlin model implies that the pattern of trade specialisation changes only if trading partners experience a change in their relative factor endowments. This suggests that the existence of persistent trade patterns is perfectly consistent with the model, if relative factor endowments of countries and factor price ratios do not change significantly with respect to their main trading partners. New trade theory emphasises the importance of increasing returns to scale, which complicates prediction because of the specific assumptions needed about the nature of scale economies. If economies of scale are internal to the firm, then the main implications of the factor proportions theorem do not change (Helpman and Krugman 1985; Krugman 1987). This may also be the case if economies are external to the firm but negligible with respect to factor intensity (Kemp 1969; Markusen 1981). However, in some models economies of scale can have a significant impact on trade outcomes (Wong 1995).

Grossman and Helpman (1990; 1991), under the assumption that knowledge spillovers are international in scope, have shown that the history of the production structure of a country does not affect its long-run trade pattern, which depends only on the relative factor endowments. But other models show that dynamic scale economies arising from "learning by doing" are country-specific, which suggests a lock-in effect for the pattern of specialisation. Krugman (1987) and Lucas (1988) demonstrate that in the presence of dynamic scale effects, the long-run trade pattern is determined by initial comparative advantage. Although varied in nature and outcome, one of the main implications of the new trade models is that the pattern of trade tends to become more specialised. Yet Proudman and Redding (2000) focus on international trade and endogenous technical change, and illustrate that a precisely specified model yields ambiguous conclusions as

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to whether trade patterns display persistence or mobility over time; they conclude that it is ultimately an empirical question.

3. MEASURING TRADE SPECIALISATION

The most widely used indicator of a country's trade specialisation is the Revealed Comparative Advantage (RCA) index first proposed by Balassa (1965):

$$B = (x_{ij} / x_{it}) / (x_{nj} / x_{nt}) \tag{1}$$

where x represents exports, i is a country, j is a commodity, t is a set of commodities and n is a set of countries.[2] B is based on observed trade patterns; it measures a country's exports of a commodity relative to its total exports and to the corresponding export performance of a set of countries. If $B > 1$, then a comparative advantage is revealed, that is, a sector in which the country is relatively more specialised.

Many researchers have attempted to refine an index of revealed comparative advantage (e.g. Donges and Riedel 1977; Kunimoto 1977; Bowen 1983; and Vollrath 1987, 1989 and 1991). Iaparde (2001) provides a critical overview on the most common devices for measuring international specialisation. In the present paper only the B index is used.

A problem with the Balassa index is that its value is asymmetric; it varies from one to infinity for products in which a country has a revealed comparative advantage, but only from zero to one for commodities with a comparative disadvantage. This asymmetry creates at least two problems. First, if the mean of the B index is higher than its median, then the distribution of B will be skewed to the right. This means that the relative weight of sectors with $B > 1$ will be overestimated compared to sectors with $B < 1$ (De Benedictis and Tamberi 2001). This issue has a bearing on econometric work focusing on revealed comparative advantage patterns, as Dalum *et al.* (1998: 427) point out: "A skewed distribution violates the assumption of normality of the error term in regression analysis, thus not producing reliable t-statistics. In addition, the use of the B in regression analysis gives much more weight to values above one, when compared to observations below one".

Second, a methodological problem arises when one applies the logarithmic transformation of the Balassa index, because a change in B from 0.01 to 0.02 has the same impact as a change from 50 to 100. (This criticism also applies to other

[2] In this study i is Hungary, j is an agri-food product, t is total trade, n is the EU.

RCA indices.) Dalum *et al.* (1998) propose a revealed symmetric comparative advantage (RSCA) index to alleviate the skewness problem:

$$\text{RSCA} = (B - 1) / (B + 1). \qquad (2)$$

The RSCA ranges from minus one to plus one and avoids the problem of zero values, which arises in the logarithmic transformation. The main advantage of this approach is that changes below unity have the same weight as changes above unity. But the disadvantage is that forced symmetry does not necessarily imply normality in the error terms and may hide some of the *B* dynamics (De Benedictis and Tamberi 2001).

Proudman and Redding (2000) note that the arithmetic mean of the *B* index across sectors is not necessarily equal to one. They argue that the numerator in equation (1) is unweighted by the share of total exports accounted for by a particular product group, while the denominator is a weighted sum of export shares of all commodities. Hence, if a country's trade pattern is described by high export shares in a few sectors, which account for a small share of exports to the reference market, this implies high values for the numerator and low values for the denominator. This yields a mean value of *B* above one in a given country. Moreover, average values of *B* may change over time, hence a country may misleadingly display changes in its average extent of specialisation as measured by the *B* index. The authors propose an alternative measure of revealed comparative advantage in which a country's export share in a given product group is divided by its mean export share in all commodity groups:

$$\overline{B}_{ij} = \frac{B_{ij}}{\frac{1}{n}\sum_j B_{ij}} \qquad (3)$$

The mean value of the normalised *B* in (3) is constant and equal to one. The interpretation of this index is that one normalises the *B* measure by its cross-section mean in order to abstract from changes in the average extent of specialisation. However, De Benedictis and Tamberi (2001) point out that this procedure is not satisfactory. They argue that the normalised *B* index loses its consistency with respect to the original *B*, because it may display the opposite status where the *B* value falls in the range between one and its mean.

Earlier, Hillman (1980) investigated the relationship between the *B* index and comparative advantage as indicated by pre-trade relative prices, abstracting from considerations caused by the possibility of government intervention on exports. He showed that the *B* index is not appropriate for cross-commodity comparison of comparative advantage, because in this case the value of *B* is independent of comparative advantage in the Ricardian sense of pre-trade relative prices. Yeats (1985) provided empirical evidence that the *B* index in the country-industry approach fails to serve as an appropriate cardinal or ordinal measure of a country's RCA. But he also noted that the quantitative evidence developed by the RCA approach is fully consistent with the prediction of factor proportion theory.

Hillman (1980) developed a condition that has to be fulfilled to obtain a correspondence between the *B* index and pre-trade relative prices in cross-country comparisons for a given product. He showed that comparative advantage according to pre-trade relative prices for country *i* in commodity *j* requires the following necessary and sufficient condition:

$$1-\frac{X_{ij}}{W_i} > \frac{X_{ij}}{X_j}\left(1-\frac{X_j}{W}\right), \tag{4}$$

where X_{ij} is exports of commodity *i* by country *j*, X_j is total exports of country *j*, W_i is world exports of commodity *i*, and *W* is the world's total exports. Assuming identical homothetic preferences across countries, the condition in equation (4) is necessary and sufficient to guarantee that changes in the *B* index are consistent with changes in countries relative factor endowments. This condition guarantees that growth in the level of a country's exports of a commodity results in an increase in the *B* index. For an empirical test, Marchese and de Simone (1989) transformed Hillman's condition into the following form:

$$HI = \left(1-\frac{X_{ij}}{W_i}\right) / \frac{X_{ij}}{X_j}\left(1-\frac{X_j}{W}\right). \tag{5}$$

If *HI* is larger than unity, the *B* index used in cross-country comparison will be a good indicator of comparative advantage. The authors argue that Hillman's index should be calculated in any empirical research attempting to identify the long-term implications of trade liberalisation using the *B* index. However, only two studies appear to have applied Hillman's index. Marchese and de Simone (1989) show that Hillman's condition is violated in 9.5% of exports of 118 developing countries in 1985. In the data set used by Hinloopen and Van Marrewijk (2001), Hillman's condition was not valid for 7% of export values and for 0.5% of the number of observations. These results suggest that Hillman's condition is less restrictive than might have been expected.

The problem with using *B* and similar indices is that, in reality, observed trade patterns can be distorted by government policies and interventions and may therefore misrepresent underlying comparative advantage. Government interference in agriculture is commonplace, a point noted by Balassa *(op. cit.)*. The extent to which import restrictions, export subsidies and other protectionist policies might distort indices of revealed comparative advantage is therefore a concern. Although concerns over the trade-distorting effects of government interference cannot be totally allayed, various RCA indices, when used judiciously, still provide a useful guide to underlying comparative advantage in the Hungarian agri-food sectors (Fertő and Hubbard 2003).

4. EMPIRICAL MODEL AND PROCEDURES

We use an approach following Brasili *et al.* (2000), Proudman and Redding (2000) and Hinloopen and van Marrewijk (2001). Whereas these studies concentrate exclusively on manufacturing sectors, we focus on agri-food sectors and investigate the stability in the pattern of the B indices for Hungary.

Some specifications aim to measure RCA at the global level (e.g. Vollrath 1991), others at a regional or sub-global level (as in Balassa's original specification), whilst some restrict the analysis to bilateral trade between just two countries or trading partners (e.g. Dimelis and Gatsios 1995; Gual and Martin 1995). Given that we are interested in the dynamics of the agri-food trade pattern of Hungary, the B index is calculated in the EU context.

Following Marchese and de Simone (1989), we have tested the validity of the Hillman condition for our data set. Our results show that our calculations of the B index are fully consistent with Hillman's condition.

Our investigations are focused mainly on the stability of the B index over time. One can distinguish at least two types of stability: (1) stability of the distribution of the B indices from one period to the next; and (2) stability of the value of the B indices for particular product groups from one period to the next (Hinloopen and Van Marrewijk 2001).

The first type of stability is investigated in several ways. First, applying the procedure of Hinloopen and Van Marrewijk (2001) we focus on the cumulative distribution and the probability density function. Second, after Dalum *et al.* (1998) we use regression analysis to test whether the degree of B changes. To alleviate the skewness issue relating to the B index, Dalum *et al*. used RSCA (equation 2) and estimated:

$$RSCA_{ij}^{t2} = \alpha_i + \beta_i RSCA_{ij}^{t1} + \varepsilon_{ij}\,, \tag{6}$$

where superscripts $t1$ and $t2$ describe the start year and end year, respectively. The dependent variable, RSCA at time $t2$ for sector i in country j, is tested against the independent variable which is the value of RSCA in year $t1$; α and β are standard linear regression parameters and ε is a residual term. If $\beta = 1$, then this suggests an unchanged pattern of RSCA between periods $t1$ and $t2$. If $\beta > 1$, the country tends to be more specialised in product groups in which it is already specialised, and less specialised where initial specialisation is low. In other words, the existing specialisation of the country is strengthened. If $0 < \beta < 1$, then commodity groups with low (negative) initial RSCA indices grow over time, while product groups with high (positive) initial RSCA indices decline. The special case where $\beta < 0$ indicates a change in the sign of the index. However, Dalum *et al.* (1998) point out that $\beta > 1$ is not a necessary condition for growth in the overall specialisation pattern. Thus, following Cantwell (1989), they argue that it can be shown that:

$$\sigma_i^{2t2} / \sigma_i^{2t1} = \beta_i^2 / R_i^2, \tag{7a}$$

and hence,

$$\sigma_i^{t2} / \sigma_i^{t1} = |\beta_1| / |R_i|, \tag{7b}$$

where R is the correlation coefficient from the regression and σ^2 is variance of the dependent variable. It follows that the pattern of a given distribution is unchanged when $\beta = R$. If $\beta > R$ the degree of specialisation has grown, while if $\beta < R$ the degree of specialisation has fallen.

The second type of stability, that of the value of the B indices for particular product groups, is analysed in two ways. First, following a recent empirical method pioneered by Proudman and Redding (2000) and applied by Brasili *et al.* (2000) and Hinloopen and Van Marrewijk (2001), we employ transition probability matrices to identify the persistence and mobility of revealed comparative advantage as measured by the B index. Following Hinloopen and Van Marrewijk (2001), we divide the B index into four classes:

Class a: $0 < B \leq 1$;
Class b: $1 < B \leq 2$;
Class c: $2 < B \leq 4$;
Class d: $4 < B$.

Class a refers to all those product groups without a revealed comparative advantage. The other three classes, b, c, and d, describe the sectors with a revealed comparative advantage, roughly classified into weak revealed comparative advantage (class b), medium comparative advantage (class c) and strong revealed comparative advantage (class d).

Second, the degree of mobility in patterns of specialisation can be summarised using indices of mobility. These formally evaluate the degree of mobility throughout the entire distribution of B indices and facilitate direct cross-country comparisons of mobility. The first of these indices (M_1, following Shorrocks 1978) evaluates the trace (tr) of the transition probability matrix. This index thus directly captures the relative magnitude of diagonal and off-diagonal terms, and can be shown to equal the inverse of the harmonic mean of expected duration of remaining in a given cell.

$$M_1 = \frac{K - tr(P)}{K - 1}, \tag{8a}$$

where K is the number of cells, and P is transition probability matrix.

The second index (M_2, after Shorrocks 1978 and Geweke *et al.* 1986) evaluates the determinant (det) of the transition probability matrix.

$$M_2 = 1 - \left|\det(P)\right|. \tag{8b}$$

5. DYNAMICS OF HUNGARIAN AGRI-FOOD TRADE

We focus on Hungary's agri-food trade patterns in aggregate imports (EU 15) over the period 1992–2000. The data are supplied by the OECD at the three-digit level of the SITC and contain 64 product groups. Contrary to most empirical studies, we measure the B index with respect to total merchandise exports. Hungary's exports of agricultural commodities and food, although with a declining share of total trade, make a significant contribution to reducing a negative trade balance. The Association Agreement signed between Hungary and the EU in 1991 has led to partial trade liberalisation and increased competitive pressures on both partners.

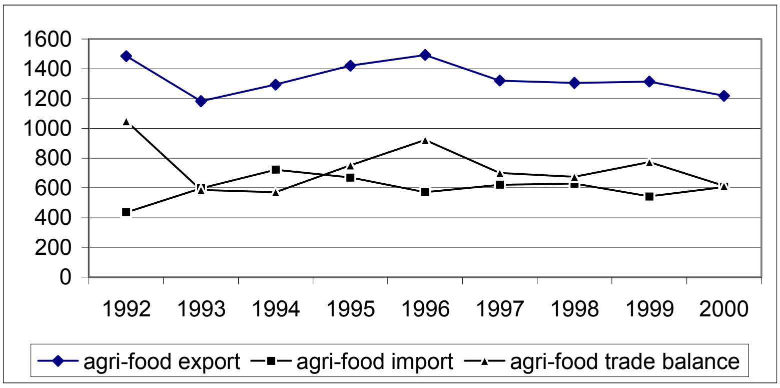

Figure 1. Hungarian agri-food trade with the EU (USD 1000)

Figure 1 shows that Hungarian agri-food exports to the EU15 varied between USD 1.2 and 1.6 billion, whilst agri-food imports fluctuated between USD 400 and 700 million during the analysed period. The balance of agricultural trade with the European Union fluctuated very much. It reached its highest value, over USD 1 billion, in 1992, while the lowest value was USD 571 million in 1994. It should be noted that Hungary was the only country in the region that achieved a positive balance in agricultural trade with the European Union continuously after the Association Agreement.

5.1. The shape of the distribution

Table 1 provides three types of information on the distribution of the *B* index. First, percentile points "P–z" are reported, where *z* ranges from 5 to 95. This shows information on the cumulative distribution of the *B* index. For example, in 1992 the P–25 point is 0.11, which means that 25% of the observations in 1992 had a *B* index below 0.11. Second, some summary statistics on the distribution are presented – the mean, the maximum and the standard deviation.

Table 1

Empirical distribution of the *B* index

	1992	1993	1994	1995	1996	1997	1998	1999	2000
P–5	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
P–10	0.00	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00
P–25	0.11	0.08	0.06	0.05	0.02	0.01	0.03	0.03	0.02
P–50	0.53	0.53	0.50	0.40	0.36	0.25	0.26	0.20	0.19
P–75	1.58	1.44	1.62	1.15	1.10	0.98	0.91	0.85	0.81
P–90	6.71	5.38	4.79	3.77	3.75	3.03	2.24	1.93	1.86
P–95	8.58	8.33	6.61	4.79	5.65	4.27	2.98	3.68	3.05
Mean	2.30	1.89	1.55	1.18	1.15	0.93	0.79	0.75	0.73
Maximum	30.92	24.75	17.83	12.13	11.17	8.98	8.36	7.74	9.58
Standard deviation	4.84	3.76	2.83	2.03	2.01	1.62	1.42	1.38	1.45

Source: Based on OECD SITC code data at three-digit level.

Table 1 shows that the P–z values have declined over time. While 50% of the observations in 1992 had a *B* index below 0.53, this value was only 0.19 in 2000. That is, the distribution has shifted to the left. Moreover, the mean of the *B* index fell continuously during the analysed period. The evidence indicates that the revealed comparative advantage in Hungarian agriculture has worsened in the EU markets.

A more complete picture can be obtained by examining the sectoral distribution of the RSCA indices at the beginning and end of the period. This is shown in *Figure 2*, where the graphs illustrate, for Hungary, estimates of the kernel density function in the start and end years.

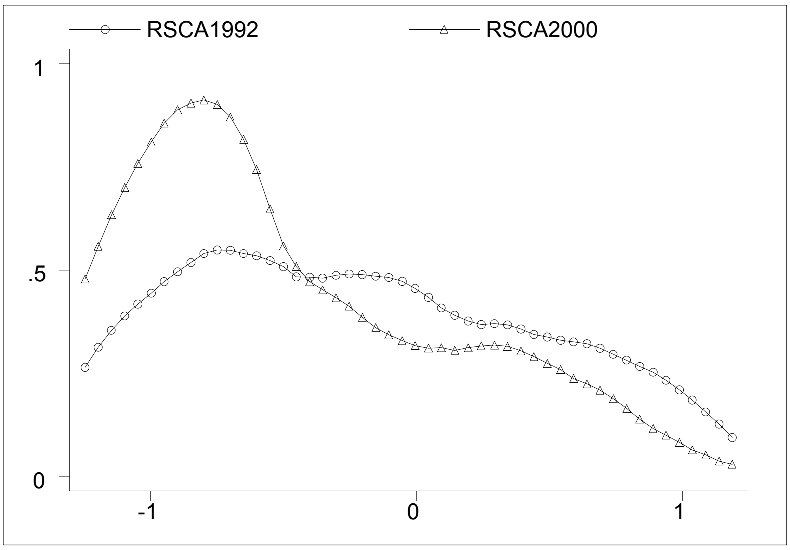

Figure 2. Probability density functions

Figure 2 shows that the shape of RSCA indices is asymmetric and right-skewed for both starting and ending years. Note that contrary to the expectation of Hinloopen and Marrewijk (2001), the distribution of the indices is not monotonically decreasing for each of the countries. The curve of the kernel distribution function shifted up between 1992 and 2000. This suggests an increase in the number of below-zero sectors. In other words, Hungary lost some of its revealed comparative advantage in agri-food sectors during the period. However, the curve of the kernel distribution did not move to the right, indicating no increase of international specialisation.

In order to evaluate the statistical significance of these changes, a two-tailed Wilcoxon signed rank test was performed. This test was chosen instead of the more traditional *t*-test because it does not require the assumption of normality in the distribution of the data. The null hypothesis was the absence of any difference in the RSCA indices between the start and end years. Results show that, at a level of significance of 5%, the null hypothesis was rejected.

The relatively high β values in *Table 2* reveal that trade patterns have not altered considerably from one year to the next. The β/R ratios show that the pattern of revealed comparative advantage has converged. Furthermore, they suggest that the dispersion in the distribution of the *B* index has been stable. Contrary to the intention of the normalisation approach proposed by Dalum *et al.* (1998) and Laursen (1998), the Jarque-Bera tests report non-normality in the error terms for 6 out of the 8 regressions.

Table 2

Stability of the *B* index between 1992 and 2000

	α	β	*P*	β/R	*J–B**
1992	–0.33	0.75	0.82	0.91	2.15
1993	–0.30	0.76	0.83	0.91	2.94
1994	–0.27	0.77	0.83	0.92	19.91
1995	–0.21	0.81	0.85	0.92	36.43
1996	–0.18	0.84	0.90	0.95	64.19
1997	–0.12	0.86	0.90	0.95	25.70
1998	–0.07	0.92	0.91	0.95	146.73
1999	–0.02	0.96	0.97	0.98	193.65

* Jarque-Bera test $\chi^2_{2.5\%} = 5.99$.

Source: Based on OECD SITC code data at three-digit level.

5.2. Intra-distribution dynamics

Further information on the dynamics of the *B* index can be obtained by analysis of Markovian transition matrices. Our estimated transition matrix is based on a seven-year period, and shows the probability of passing from one state to another between the starting year (1992) and the ending year (2000).

Table 3

Transition probabilities of *B* index

B	*a*	*b*	*c*	*d*
a	0.98	0.02	0.00	0.00
b	0.78	0.22	0.00	0.00
c	0.50	0.00	0.00	0.50
d	0.08	0.50	0.33	0.08
initial distribution	0.64	0.14	0.03	0.19
final distribution	0.77	0.14	0.06	0.03
limit distribution	0.97	0.02	0.01	0.00

Source: Based on OECD SITC code data at three-digit level.

The transition matrix suggests that values of the *B* index are fairly persistent from 1992 to 2000 for observations with a revealed comparative *dis*advantage (class *a*) (*Table 3*). The diagonal element of 0.92 indicates the probability of a product with a revealed comparative *dis*advantage in 1992 having that same status at the end of the period. However, indices in classes *b*, *c* and *d* display a considerable variation in their pattern. The probability of a loss of revealed comparative advantage for those observations starting with a weak revealed comparative advantage (class *b*) are high (0.78), whilst the probability of a move from class *c* (medium revealed comparative advantage) to class *a* is 0.50. There is a 0% chance of moving from class *a* and *b* to class *d* (high revealed comparative advantage) and the probability of an observation remaining in class *d* is only 0.08. The limit distribution suggests a "worse case scenario" should these trends continue. Both indices (M_1 = 0.907 and M_2 = 0.967) indicate a high degree of mobility in *B* indices for Hungary.

6. SUMMARY AND CONCLUSIONS

The changing pattern of Hungarian agri-food trade was analysed in this paper. The classic Balassa index and its symmetric transformation was employed as a measure of trade specialisation. The main findings of the empirical analysis can be summarised as follows.

Despite significant changes in Hungarian agriculture during transition, the distribution of the *B* indices did not alter radically over the period from 1992 to 2000. Moreover, the extent of specialisation in Hungarian agri-food trade exhibits a declining trend. In other words, Hungary has lost revealed comparative advantage for some product groups over time. Another feature of the *B* indices is that their pattern has converged over the period. The stability of the *B* indices for particular product groups displays a less persistent pattern. Results suggest that the *B* indices are stable for observations with revealed comparative *dis*advantage, in all cases. But product groups with weak to strong revealed comparative advantage show a significant variation over the period.

How may these stylised measurements be linked to findings of other empirical studies and the predictions of theory? Our study of Hungary's agri-food trade fits well with the overall picture emerging from other empirical studies (Balassa 1977; Amendola *et al.* 1992; Laursen 2000; Proudman and Redding 2000, and Brasili *et al.* 2000), which reveal a general tendency of decrease in specialisation, with a few exceptions. From a theoretical point of view, the tendency towards a more symmetric and less polarised distribution of the *B* index is in accordance with the Heckscher–Ohlin model. Furthermore, our results do not support the idea that self-reinforcing mechanisms, emphasised strongly in much of the endogenous growth and trade literature, are evident. However, our results should be interpreted with care, because they are based on a partial (EU) context. This sheds light on the need for further research in a more general framework (world level).

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