On the Empirical Distribution of the Balassa Index

By

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I. Introduction

The concept of "revealed comparative advantage" as defined by Bela Balassa is widely used in practice to determine a country's weak and strong sectors. Michael Porter, for example, uses a Balassa index exceeding 1, in some cases strengthened to a Balassa index exceeding 2, to identify a country's strong sectors in his influential book *The Competitive Advantage of Nations.*[1] Other empirical examples are Ariovich (1979), Reza (1983), Yeats (1985), Peterson (1988), Crafts (1989), and Amiti (1999). Despite detailed discussions on the Balassa index – see Kunimoto (1977), Hillman (1980), Bowen (1983, 1985, 1986), Ballance et al. (1985, 1986, 1987), Vollrath (1991), and Bowen et al. (1998) – the distribution of the Balassa index cannot be derived theoretically. In addition, the distribution has not been systematically analyzed empirically (see also Yeats; 1985: 61).[2] Specific values of the

Remark: We would like to thank, without implicating, Leendert Punt for excellent assistance. An earlier version of this paper was presented at CEPR's 1998 European Research Workshop on International Trade. We are grateful to an anonymous referee for detailed and constructive comments, and to Harry Bowen, Stephen Martin, Stephen Redding, Teun Schmidt and workshop participants at the University of Copenhagen and the CPB (Netherlands Bureau for Economic Policy Analysis) for useful comments. Thanks are also due to the Dutch-Japanese Trade Association (Dujat) for making available the data. Any errors are, of course, our responsibility.

[1] Additional selection criteria were also used by Porter. See Porter (1990: 739–740) for details.

[2] Hillman (1980), for example, develops a necessary and sufficient monotonicity condition under identical homothetic preferences for the correspondence between the Balassa index and pre-trade relative prices for a particular industry in two different countries. In our data set the Hillman condition was violated for 7.0 percent of the export value (somewhat smaller than the 9.5 percent found by Marchese and Nadal de Simone 1989), and for less than 0.5 percent of the number of observations. Since the distributions of the Balassa index reported below are based on the number of observations, we conjecture that our findings are not affected by the Hillman critique.

Balassa index are therefore difficult to interpret. Moreover, it is a priori not clear that a particular value for the Balassa index implies the same extent of comparative advantage for different countries.

We provide a systematic analysis of the *empirical distribution* of the Balassa index. To determine this distribution we could, in principle, proceed in two alternative directions. First, we could take the world as a whole as the group of reference countries and consider all exports of all countries. Second, we could select a group of similar countries for reference purposes and investigate export flows for these countries only. There are several disadvantages to the first approach. Not only could it be that countries at very different levels of (economic) development are being compared, disturbing influences in the export flows are also not being controlled for. Consider, for example, the export of flowers to Germany, either from the Netherlands or from Kenya. Since, like Germany, the Netherlands are a member of the European Union, access to the German market is easier for the Dutch than for the Kenyans.[3] Moreover, as a neighbor the Dutch incur much lower transport costs to reach the German market than do the Kenyans.

To circumvent these difficulties we take the second approach mentioned above. That is, we analyze the export performance of similar countries to a third market. For that we have selected the member states of the European Union as the reference countries and consider export flows to Japan. Apart from concentrating on countries with a comparable level of economic development which all incur similar transport cost, there are two additional reasons for this selection; access to the relatively homogenous Japanese market is, in principle, the same for all member states of the European Union, and the Japanese market is large enough to generate substantial export flows for a representative array of products. Accordingly, the results presented in this paper provide "clean" insights as to the statistical properties of the Balassa index.[4]

To analyze in detail the empirical distribution of the Balassa index we proceed as follows. In Section II we briefly discuss the Balassa index and describe the data. In Section III, we consider the Balassa index for the EU-12 as a whole, that is, we group all observations for the different countries together. Both the effect of aggregation of export flows

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[3] On the restrictions imposed on the import of flowers into the European Union, see European Commission (1995: Chapter 6).

[4] Ignoring exports to other countries outside the European Union could yield biased results. However, since the export flows to Japan are the second-largest of total extra-EU exports (the flow to the U.S. is the largest) we conjecture that this possible bias is modest if at all present.

over time on the EU-wide distribution of the Balassa index is considered, and its stability over time. Observe that there are (at least) two types of stability: (*i*) stability of the *distribution* of the Balassa index from one period to the next, and (*ii*) stability of the *value* of the Balassa index for a particular industry and country from one period to the next. The first type of stability is analyzed in section III. The second type of stability is analyzed in Section IV. The persistence issues addressed in Section IV, for which we analyze Markovian transition probability matrices, give insights into the behavior of a particular industry's comparative advantage over time. Section V investigates the empirical distribution of the Balassa index for the member states separately. Although these distributions also appear to be stable over time (type *i* stability), they differ markedly between nations. This indicates that a particular value of the Balassa index has a different meaning for different countries.

Our main conclusions, see also Section VI, can be summarized as follows. In all cases the distribution of the Balassa index is very skewed with a median well below one, a mean well above one, and a monotonically declining density function. The process is apparently well defined in the sense that the distribution changes very little from one period to the next. Moreover, aggregation over time of export flows, that is analyzing annual rather than monthly trade flows, or pooling values of the Balassa index, either based on monthly or annual flows, has only a mild influence on the distribution. The observations for individual industries are, however, more persistent over time for annual than for monthly trade flows. The widely used criterium "Balassa index > 1" to identify sectors with a comparative advantage selects about one third of the exporting industries. Finally, we note that the distribution of the Balassa index differs considerably across countries, making comparisons of the index between countries problematic. This certainly holds for the dynamic properties of the process. Although different mobility indices based on our estimated transition probability matrices do not always lead to the same ranking, within our sample of countries Germany appears to have the most persistent and Greece the most mobile pattern of comparative advantage over time.

II. The Balassa Index

Although Liesner (1958) was the first to utilize an index of revealed comparative advantage, the most frequently used measure in this respect is called the "Balassa index", after the refinement and popularization by Balassa (1965, 1989). Given a group of reference countries the Balassa index basically measures normalized export shares, where the normalization is with respect to the exports of the same industry in the group of reference countries. In particular, if X_j^A is country A's export value of industry j, X_j^{ref} is industry j's export value for the group of reference countries, and we define $X^i = \sum_j X_j^i$ for $i = A, ref$, then country A's Balassa index of revealed comparative advantage for industry j, BI_j^A, equals:

$$BI_j^A = \frac{X_j^A / X^A}{X_j^{ref} / X^{ref}}. \tag{1}$$

If BI_j^A exceeds 1, country A is said to have a comparative advantage in industry j, since this industry is more important for country A's exports than for the exports of the reference countries.

For our empirical investigation we use a comprehensive data set provided by Eurostat. The data used concern export flows (in value) from 12 member states of the European Union (Germany, France, the Netherlands, Belgium, Luxembourg, the United Kingdom, Denmark, Ireland, Spain, Portugal, Italy and Greece; henceforth referred to as "EU-12") to Japan from 1992 through 1996. The export figures are monthly data and cover all 2-digit Combined Nomenclature industries as distinguished by Eurostat. This includes the "secret uses" category "00" (weapons, coming from the United Kingdom, Germany and the Netherlands) and the "special uses" category "99" (with only a few observations), but it excludes category "77" ("reserved for future use," with no observations). The total number of different industries therefore equals 99 (Table A1 in the Appendix provides a brief description of all the industries). Since Luxembourg is combined with Belgium in the observations we have 5 (years) × 12 (months) × 11 (countries) × 99 (industries) = 65,340 non-negative observations. The actual number of positive observations equals 47,339 (which is 72.5 percent of all possible observations).

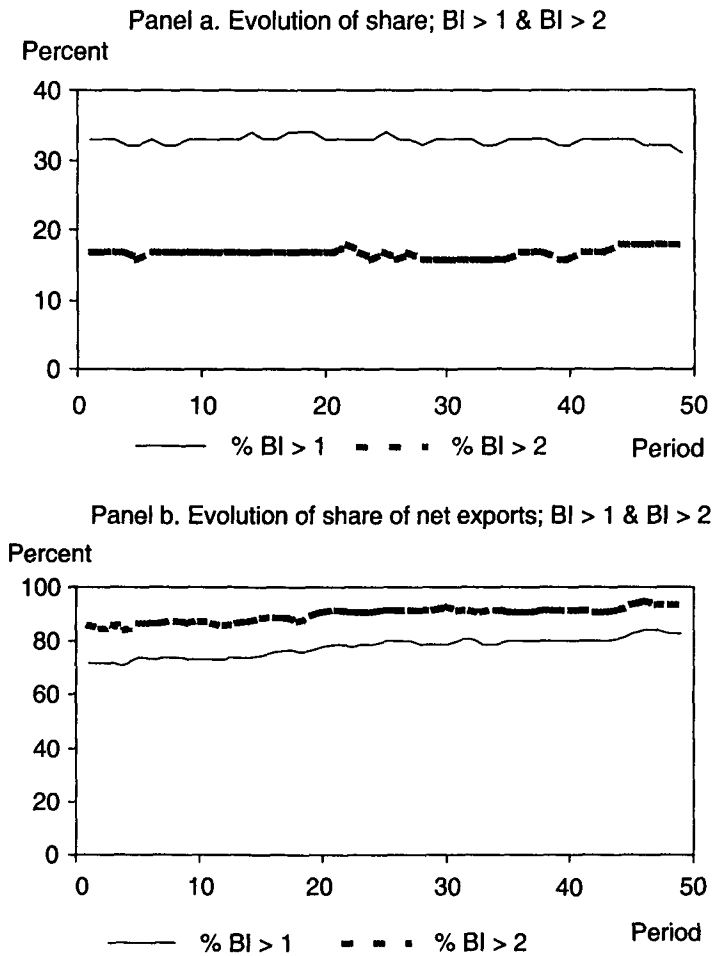
The exports from the EU-12 countries to Japan (20,566 million euro in 1992, rising to 31,957 million euro in 1996) are much lower than the exports from Japan to the EU-12 countries (51,530 million euro in 1992, falling to 49,136 million euro in 1996), although the gap is narrowing slowly. To illustrate the use of the Balassa index to identify sectors with a comparative advantage, and to characterize the data set we performed some calculations presented in Table 1 and Figure 1. First, Table 1 shows the three sectors for each country with the highest Balassa index in 1994, the year in the middle of our sample period, as

Table 1: *Top Three Industries According to the Balassa Index, 1994*

Industry			Value exp.[a]	Share exp.[b]	BI	Value imp.[a]	Share imp.[b]	Trade balance[c]
					France			
1	88	Aircraft	467,665	11.85	6.16	65,395	1.29	402,270
2	28	Chemicals	171,089	4.33	3.74	27,456	0.54	143,633
3	95	Toys	139,625	3.54	3.73	99,970	1.97	39,655
					Belgium and Luxembourg			
1	57	Carpets	38,478	2.49	9.83	88	0.00	38,390
2	71	Jewelry	519,449	33.66	8.64	63,614	2.21	455,835
3	79	Zinc	2,072	0.13	6.37	173	0.01	1,899
					Netherlands			
1	6	Flowers	126,415	9.26	18.37	2,073	0.04	124,342
2	17	Sugars	21,654	1.59	8.69	128	0.00	21,526
3	18	Cocoa	20,096	1.47	6.98	89	0.00	20,007
					Germany			
1	98	Ind. Plants	213	0.00	2.85	*	*	*
2	10	Cereals	30,472	0.33	2.82	18	0.00	30,454
3	87	Cars	3,492,975	37.48	2.12	3,133,060	20.48	359,915
					Italy			
1	50	Silk	59,019	1.73	6.63	2,775	0.08	56,244
2	53	Paper yarn	27,172	0.80	5.08	364	0.01	26,808
3	51	Wool	217,479	6.38	4.90	1,228	0.04	216,251
					United Kingdom			
1	75	Nickel	49,087	1.28	5.41	8,229	0.07	40,858
2	78	Lead	318	0.01	4.86	29	0.00	289
3	1	Live an.	29,907	0.78	4.32	2,531	0.02	27,376
					Ireland			
1	29	Org. chem.	256,485	28.69	4.21	10,780	1.20	245,705
2	21	Edible	8,442	0.94	3.39	24	0.00	8,418
3	30	Pharma	160,574	17.96	3.18	9,055	1.01	151,519
					Denmark			
1	2	Meat	626,190	46.78	17.98	*	*	*
2	16	Prep. meat	17,619	1.32	11.27	2,090	0.23	15,529
3	43	Fur	7,726	0.58	6.59	*	*	*
					Greece			
1	24	Tobacco	24,699	31.18	142.7	*	*	*
2	20	Fruit	18,269	23.06	47.64	*	*	*
3	5	Other an.	836	1.06	16.11	29	0.00	807
					Portugal			
1	45	Cork	17,201	15.53	187.1	118	0.02	17,083
2	47	Pulp	8,757	7.90	111.5	*	*	*
3	26	Ores	16,482	14.88	64.93	*	*	*
					Spain			
1	26	Ores	27,116	3.65	18.46	*	*	*
2	3	Fish	89,157	12.01	11.76	3,145	0.15	86,012
3	47	Pulp	3,663	0.49	8.06	*	*	*

[a] In 1,000 euro – [b] As percentage – [c] Exports – Imports, in 1,000 euro. * = data not available (in almost all cases this means imports are effectively zero).

Figure 1: *Evolution of Share of Industries (percent) with Balassa Index Exceeding 1 or 2, and Share of Those Industries with Positive Net Exports*[a]



[a]Monthly moving annual observations, EU-12 countries grouped together; January 1992 – December 1996.

well as the export value for these sectors, and the share of the sector in the total exports of the country.

The sector with the highest comparative advantage in France, for example, is the aircraft industry ($BI = 6.16$). With almost 500 million euro in export value it represents a sizable share of French exports (almost 12 percent). Clearly, this sector benefits from intermediate deliveries, mainly from Spain, Germany and the United Kingdom, to the Airbus industry in Toulouse. A quick look at the top three industries in Table 1 shows that many sectors are fairly traditional, for example carpets and jewelry (diamonds) in Belgium, flowers in Holland, cars in Germany, silk and wool in Italy, (pork) meat in Denmark, and cork in Portugal. In many cases the top ranking industries represent a substantial share of a country's exports; from high to low: Danish meat (46.78 percent), German cars (37.48 percent), Belgian jewelry (33.66 percent), Greek tobacco (31.18 percent), Irish chemicals (28.69 percent), and Portuguese cork (15.53 percent). To illustrate that a top ranking industry in terms of the Balassa index, which after all is a relative measure, does not have to be an important sector for a nation, we can look at the exports of German complete industrial plants (0.00 percent), English lead (0.01 percent), or Belgian zinc (0.13 percent).

When the Balassa index exceeds one, the sector is identified as a sector with comparative advantage and one would generally expect net exports to be positive. In this respect, however, we have to be cautious since the comparative advantage is calculated with respect to a set of reference countries which excludes Japan and, as mentioned above, the EU-12 countries have a substantial trade deficit with Japan. Thus, to verify if net exports are indeed positive Table 1 also gives the value of the imports from Japan, the share in total imports, and the trade balance for each of the top three ranking industries. In all cases in Table 1 net trade is indeed positive.[5] This topic is analyzed further in Figure 1. First, panel a illustrates the evolution over time of the share of industries with a Balassa index higher than 1 and higher than 2 for the EU-12 countries grouped together (monthly moving annual observations, see Section III). As panel a shows, the share of industries with a Balassa index higher than 1, which are thus identified as industries with a comparative advantage, is stable at 33 percent (± 1 percent). Similarly, the share of industries with a Balassa index higher than 2, which could be characterized as industries with medium and strong comparative advantage (see Section IV), is stable at 17 percent (± 1 percent). Second, panel b of Figure 1 shows for the industries with a Balassa index exceeding 1 and exceeding 2, the share of those industries with positive net exports. The share of industries with a Balassa index higher than 1 with positive net

[5] Table 1 shows a fair number of *s, indicating that import data are not available. Since this almost always implies that those flows are effectively zero, we put them equal to zero in Figure 1.

exports is slowly rising from 72 to 83 percent. Similarly, the share of industries with a Balassa index higher than 2 with positive net exports is slowly rising from 86 to 94 percent. This largely reflects the declining trade deficit of the EU-12 vis-à-vis Japan.

III. Shape, Stability and Aggregation over Time

This section analyzes three issues. First, we investigate the *shape* of the distribution of the Balassa index, focusing on the cumulative distribution, some summary statistics, and the probability density function. Second, we investigate the *stability* of the distribution of the Balassa index over time, that is whether this distribution is the same, for example, in 1992 and in 1994 or drastically different. Recall that in this section we will identify the first type of stability mentioned in the introduction, tracking the evolution of individual sectors over time in Section IV below. Third, we analyze the impact of aggregation of export flows over time, that is grouping 12 observations on monthly export flows together in one observation for an annual export flow, both for the shape and the stability of the distribution of the Balassa index. Subsection III.1 below considers monthly export flows, while Subsection III.2 considers annual export flows.

1. Monthly Observations

Panel a of Table 2 gives information on the distribution of the Balassa index for the months of 1996. See Hinloopen and Van Marrewijk (2000)[6] for the years 1992 through 1995. The results in this table are pooled per annum as well as for the whole period in panel b of Table 2. In both panels of Table 2 three types of information are listed.

First, the percentile points "*p*-*z*" are listed, where *z* varies from 1 to 99. This gives detailed information on the cumulative distribution of the Balassa index. For example, in January 1996 the *p*-25 point is at 0.20 (panel a), which indicates that 25 percent of the observations in January 1996 had a Balassa index below 0.20 and 75 percent of the observations in January 1996 had a Balassa index above 0.20. Similarly, the *p*-90 point in that month was 4.24, indicating that 90 percent of the observations had a Balassa index below 4.24, and 10 percent above 4.24.

[6] This refers to a companion paper for our analysis, which contains more details and is downloadable as pdf file and word 97 file from our personal web pages (see references).

Table 2: *Empirical Distribution of the Balassa Index Based on Monthly Export Flows (EU-12 countries grouped together)*[a]

Panel a. Monthly Export Flows — *Panel b. Monthly Export Flows (pooled per annum)*

1996	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	1992	1993	1994	1995	1996	1992–96
p-1	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
p-2.5	0.00	0.01	0.01	0.01	0.00	0.01	0.01	0.01	0.01	0.01	0.01	0.00	0.01	0.01	0.01	0.01	0.01	0.01
p-5	0.02	0.02	0.02	0.02	0.01	0.02	0.02	0.02	0.02	0.02	0.02	0.01	0.02	0.02	0.02	0.01	0.02	0.02
p-10	0.04	0.04	0.04	0.04	0.03	0.04	0.04	0.04	0.05	0.04	0.04	0.03	0.04	0.05	0.04	0.04	0.04	0.04
p-25	0.20	0.18	0.19	0.17	0.18	0.15	0.19	0.19	0.20	0.20	0.19	0.18	0.17	0.19	0.18	0.17	0.18	0.18
p-50	0.67	0.62	0.62	0.66	0.59	0.59	0.62	0.66	0.58	0.65	0.62	0.60	0.62	0.63	0.62	0.62	0.62	0.62
p-75	1.66	1.53	1.49	1.61	1.62	1.43	1.55	1.63	1.58	1.52	1.48	1.42	1.56	1.58	1.54	1.51	1.55	1.55
p-90	4.24	3.89	3.83	3.95	3.58	3.73	3.62	4.04	4.08	3.92	4.22	3.76	4.06	4.10	3.89	3.66	3.92	3.92
p-95	7.22	6.17	6.13	7.10	6.04	6.43	6.41	7.92	6.21	6.74	6.90	5.97	6.52	6.75	6.17	5.90	6.64	6.38
p-97.5	13.1	12.5	13.1	11.7	10.1	13.4	14.8	17.1	14.0	12.4	12.0	10.3	11.42	13.00	10.75	11.11	12.96	11.87
p-99	24.2	29.4	27.7	36.9	22.7	21.1	35.5	26.2	23.3	22.9	22.8	19.1	28.16	30.07	24.79	26.68	24.95	27.37
max	303	351	183	321	192	208	159	199	210	235	288	202	325.10	299.43	347.10	346.87	350.75	350.75
mean	2.83	2.53	2.20	2.80	2.05	2.19	2.21	2.43	2.28	2.19	2.40	2.09	2.46	2.59	2.40	2.27	2.35	2.41
std	16.4	15.9	9.0	16.9	8.7	10.6	8.3	9.9	10.3	9.8	12.6	10.1	12.18	13.18	13.12	11.72	11.87	12.42
obs	762	814	809	791	816	813	825	807	814	824	808	813	9,197	9,340	9,477	9,629	9,696	47,339
BI-1	0.61	0.64	0.64	0.63	0.64	0.65	0.65	0.63	0.64	0.63	0.64	0.66	0.63	0.63	0.64	0.64	0.64	0.64
BI-2	0.79	0.80	0.81	0.79	0.80	0.81	0.79	0.79	0.80	0.80	0.80	0.81	0.80	0.80	0.80	0.81	0.80	0.80
BI-4	0.89	0.91	0.90	0.90	0.91	0.91	0.91	0.90	0.89	0.90	0.89	0.91	0.90	0.90	0.90	0.91	0.90	0.90
BI-8	0.96	0.96	0.96	0.96	0.96	0.96	0.96	0.95	0.96	0.96	0.96	0.96	0.96	0.96	0.96	0.96	0.96	0.96

[a] p-z reports the Balassa index for the z-th percentile, for z = 1, 2.5, 5, 10, 25, 50,75, 90, 95, 97.5, and 99; max = maximum; std = standard deviation; obs = number of observations; BI-γ reports the share of industries with a Balassa index lower than γ, for γ = 1, 2, 4, 8.

Second, some summary statistics on the distribution are given, in particular the maximum, the mean, the standard deviation, and the number of observations. In January 1996 these were 303, 2.83, 16.4, and 762, respectively (see panel a).

Third, the Balassa index points "*BI-z*" are given, where *z* ranges from 1 to 8. This readily identifies the share of industries below certain Balassa index cut-off points. For example, in January 1996 the *BI*-1 point was 0.61 (panel a), indicating that 61 percent of the observations in January 1996 had a Balassa index below 1, and thus 39 percent had a Balassa index above 1. Similarly, the *BI*-4 point in January 1996 is 0.89, indicating that 89 percent of the observations had a Balassa index below 4, and 11 percent of the observations had a Balassa index above 4.

The last column of panel b shows that the mean Balassa index for the period as a whole for monthly observations equals 2.41, almost 4 times the median Balassa index of 0.62. This indicates that the distribution is skewed to the right. Indeed, skewness for all observations for the period as a whole equals 15.30, while the kurtosis is 282.81 (these values are not listed in Table 2).[7] The distribution is therefore not only skewed, but also "fat tailed" (a relatively large share of the observations is in the tails of the distribution). The median Balassa index of 0.62 also indicates that the "Balassa index > 1" criterion used to identify industries with a comparative advantage selects less than half of the industries when applied to monthly observations. More precisely, 64 percent of the observations have a Balassa index below 1, 80 percent have an index value below 2, 90 percent have an index value below 4, and 96 percent have an index value below 8. Put differently, the "Balassa index > 1" criterion applies to about 36 percent of the industries with positive (monthly) exports.

Panel b of Table 2 shows also that the distribution of the Balassa index is remarkably stable over time if the values of the Balassa index based on monthly export flows are pooled per annum: the maximum (rounded) percentage point deviation of the cumulative distribution for

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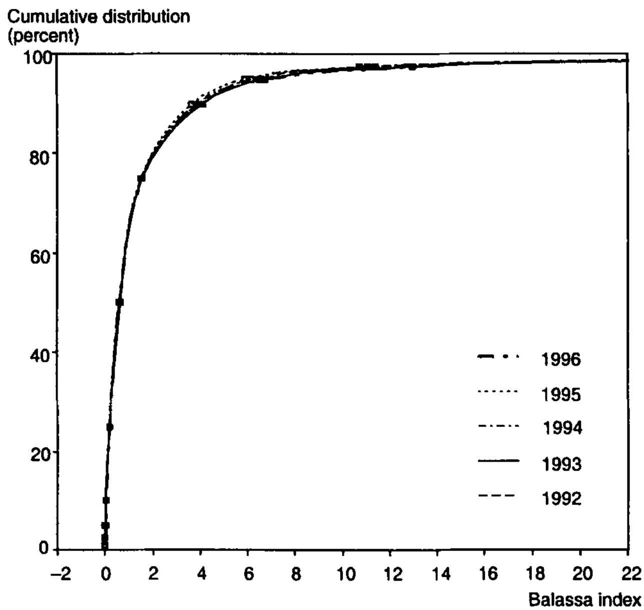
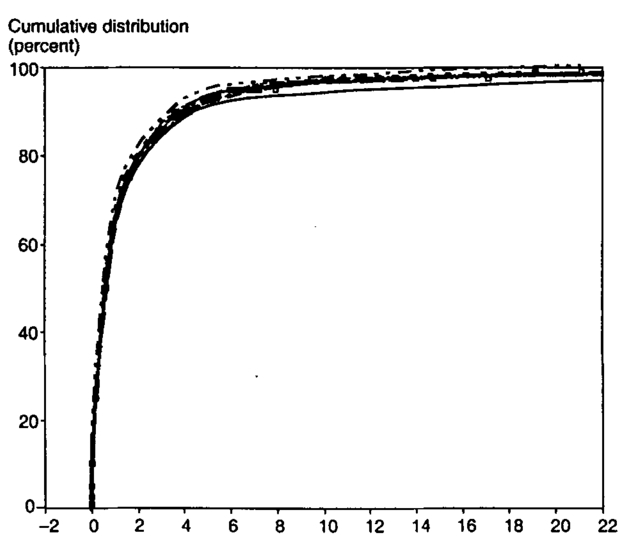
[7] μ_z is the *z*-th moment of a distribution, for $z = 1, 2, 3 \ldots$ and σ is the standard deviation, then skewness is defined as μ_3/σ^3 and kurtosis as μ_4/σ^4. Note that these measures are dimensionless. For all symmetric distributions skewness equals 0, while skewness is positive (negative) for long tails to the right (left). Kurtosis is always positive, so that this measure is usually interpreted relative to the normal distribution which has a kurtosis of 3. Kurtosis values larger than 3 indicate fat tails (with respect to the normal distribution), while values smaller than 3 are indicative for relatively thin tails.

Figure 2: *The Cumulative Distribution of the Balassa Index over Time*

Panel a. Monthly export flows, pooled per annum; EU-12 countries grouped together



Panel b. Monthly export flows, for the months of 1996; EU-12 countries grouped together



any single year from the (pooled total of the) period as a whole is 1, 1, 1 and 0 percent for "Balassa index = 1, 2, 4, 8", respectively. Panel a of Table 2 shows that this even holds for each individual month: the maximum (rounded) percentage point deviation of the cumulative distribution for any single month in 1996 from (the pooled total of) the period as a whole is 3, 1, 1 and 1 percent for "Balassa index = 1, 2, 4, 8" respectively. Also note that in all cases, that is, whether a particular month or a particular (pooled) year is considered, at most 5 percent of the industries have a Balassa index exceeding 8.

The mean Balassa index fluctuates more substantially over time. This comes as no surprise in view of the very high skewness and kurtosis, which suggests the presence of outlying observations. This also implies that the mean is a poor indicator. Consider for example the export flows in February 1996 with 814 observations and a mean Balassa index of 2.53, which accommodates the maximum value of 351 for that month. Without that single maximum observation there would be 813 observations with a mean Balassa index of 2.10. Indeed, due to one observation the mean increases from 2.10 to 2.53, or by more than 20 percent.

The findings of this subsection as summarized in Table 2 are illustrated in Figure 2. Panel 2a shows the cumulative distribution per year (monthly observations, pooled per annum), while panel 2b shows the cumulative distribution for the months of 1996. The distribution looks very similar from month to month and from year to year, both in Table 2 and Figure 2. In fact, the distribution is so stable over time that it is almost impossible to distinguish between the different years (Figure 2, panel a), or between the different months (Figure 2, panel b).

2. Annual Observations

In this subsection we consider annual export flows. Observe that due to aggregation of the monthly export flows the number of observations diminishes dramatically. However, since we have data available on a monthly basis we would not make complete use of the information in our dataset if we considered annual observations only from January to December. Indeed, we also have observations for years starting in, say, April and ending in March. Combining then the best of both worlds leads us to consider monthly moving annual observations, which gives us 46,280 observations.

Hinloopen and Van Marrewijk (2000) give the distribution of the Balassa index for monthly moving annual observations for each period for which data are available. In Table 3 this information on annual ob-

Table 3: *The Cumulative Distribution of the Balassa Index and Aggregation of Export Flows Over Time (EU-12 countries grouped together)*[a]

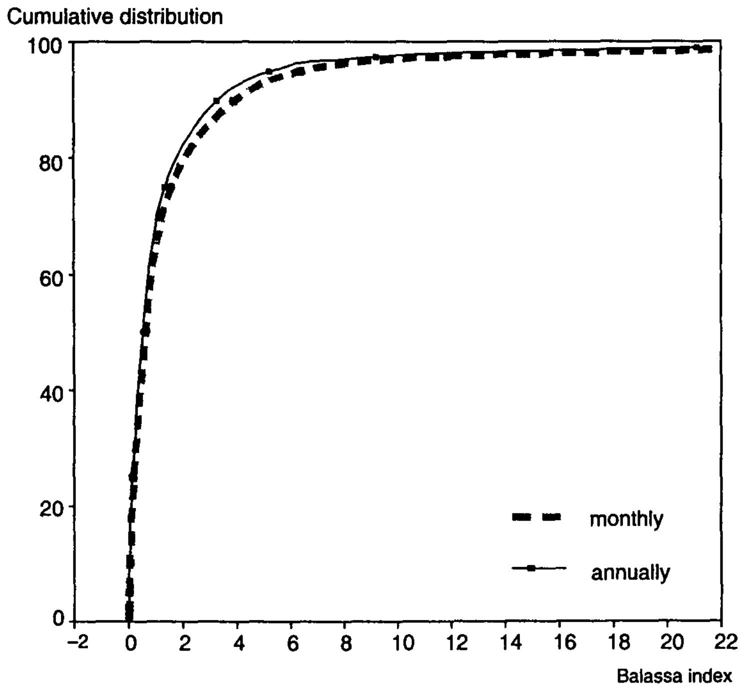
	Monthly	Annually
p-1	0.00	0.00
p-2.5	0.01	0.00
p-5	0.02	0.01
p-10	0.04	0.03
p-25	0.18	0.13
p-50	0.62	0.53
p-75	1.55	1.34
p-90	3.92	3.34
p-95	6.38	5.56
p-97.5	11.87	9.63
p-99	27.37	22.12
max	350.75	249.76
mean	2.41	2.08
std	12.42	11.17
obs	47,339	46,280
BI-1	0.64	0.67
BI-2	0.80	0.83
BI-4	0.90	0.92
BI-8	0.96	0.97

[a] The table is based on monthly export flows (middle column) and monthly moving annual export flows (right column) for January 1992 through December 1996; p-z reports the Balassa index for the z-th percentile, for z = 1, 2.5, 5, 10, 25, 50, 75, 90, 95, 97.5, and 99; max = maximum; std = standard deviation; obs = number of observations; BI-γ reports the share of industries with a Balassa index lower than γ, for γ = 1, 2, 4, 8.

servations is summarized and compared with monthly observations (see also the last column of Table 2, panel b). As is to be expected, the distribution of the Balassa index based on annual rather than monthly observations has less extreme outliers, causing the distribution to be more compact. The maximum falls by 29 percent from 351 to 250, the mean falls by 14 percent from 2.41 to 2.08, the standard deviation falls by 10 percent from 12.42 to 11.17, and the kurtosis drops by 7 percent from 282.81 to 262.05. These measures are, however, dominated by relatively few observations: as is evident from Table 3 less than 20 percent of the monthly observations and less than 17 percent of the annual observations of the Balassa index is above the mean.

On the other hand, the *shape* of the cumulative distribution, which depends on the majority of the observations, is much less affected by

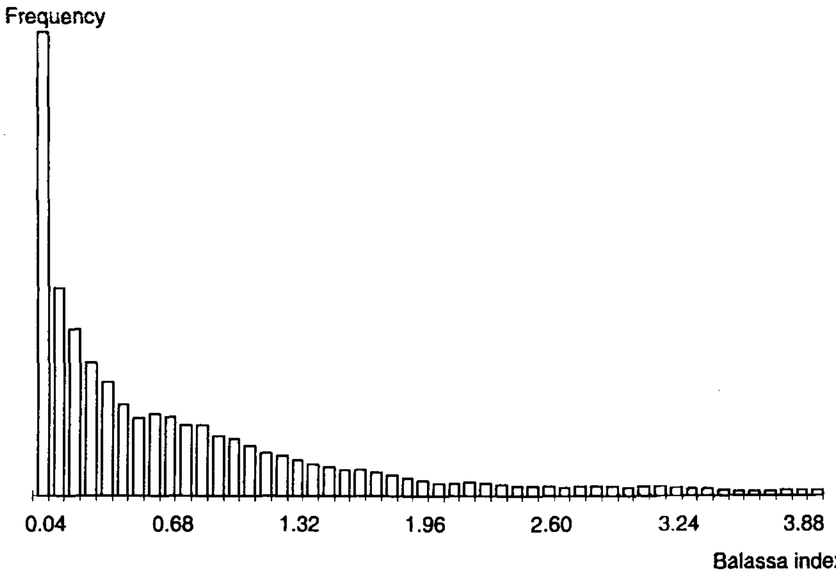
Figure 3: *The Effect of Aggregation over Time of Export Flows on the Cumulative Distribution of the Balassa Index*



aggregation of export flows over time. Indeed, when compared to Balassa indices based on monthly export flows, the share of industries with a Balassa index below 1, 2, 4 or 8 rises by only 3, 3, 2 and 1 percentage point(s), respectively. Also the kurtosis changes little, from 15.30 to 15.14. This relatively mild influence of aggregation over time on the shape of the cumulative distribution of the Balassa index is illustrated in Figure 3.

Note that the distribution itself, based on monthly moving annual export flows, is also stable over time (see also Section III.1). This is perhaps most clearly illustrated by a comparison of the results per annum for the period as a whole (see Table 3) with any distribution based on monthly moving annual export flows (see Hinloopen and Van Marrewijk 2000). This shows that the maximum deviation for the Balassa index at 1, 2, 4, or 8 is only 1 percentage point for all but one "moving" year.

Figure 4: *The Probability Density Function of the Balassa Index Based on Monthly Moving Annual Observations (restricted to* $0 \leq BI \leq 4$*)*

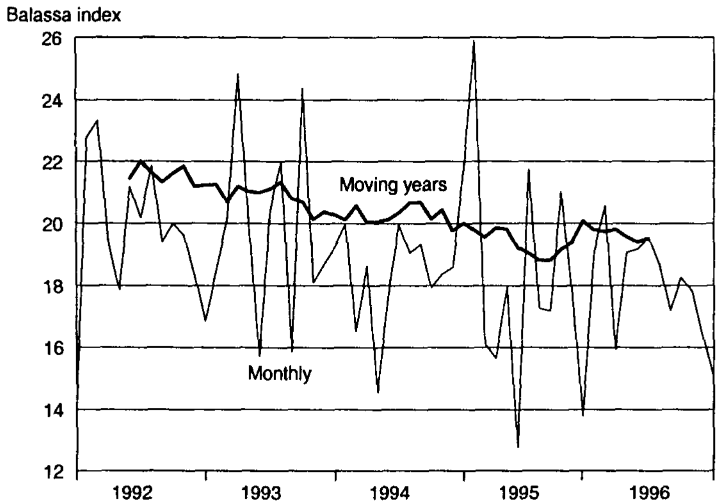


The final issue addressed in this subsection is the shape of the density function, rather than the cumulative distribution. At various universities and seminars we asked our colleagues to sketch their expected shape of this density function (before showing the cumulative distribution!). Sometimes we gave them additional information, like the median and the mean. Invariably, they sketched a bell-shaped function with a fat right tail, where the top could be either above or below "Balassa index = 1" (usually depending on whether or not we informed them that the median was below 1). This, admittedly, unscientific method indicates that many economists have a poor intuitive grasp of the shape of the density function of the Balassa index. Our empirical results show that the density function of the Balassa index is not bell-shaped at all, but monotonically declining, as shown in Figure 4.

IV. Persistence

Section III investigates the shape of the cumulative distribution of the Balassa index and the stability of this distribution over time, both for

Figure 5: *The Balassa Index Based on Monthly and Annul Export Flows for the Netherlands, Industry 6 (Live trees and other plants; bulbs, roots and the like; cut flowers and ornamental foliage)*



monthly and for annual observations. Since we found this distribution to be rather stable over time, we can formulate statements such as "the probability that the Balassa index exceeds 2 in the period April 1994 – March 1995 is about 17 percent". However, this type of stability does not imply that the observations for the Balassa index for a particular industry and country are persistent over time.

As an illustration of this point consider Figure 5. It depicts the value of the Balassa index for industry 6 (live trees and other plants; bulbs, roots and the like; cut flowers and ornamental foliage) for the Netherlands, both based on monthly observations and on monthly moving annual observations. Clearly the value of the Balassa index fluctuates over time, be it much less if it is based on monthly moving annual export flows than on monthly export flows. Indeed, there may be seasonal fluctuations in the exports of a particular industry. To the extent that these fluctuations do not occur simultaneously in the country under investigation and the group of reference countries these seasonal fluctuations lead to fluctuations in the Balassa index which are hard to interpret. Annual observations eliminate such difficulties of interpretation.

On the other hand, although the values of the Balassa index in Figure 5 vary considerably, they are always above one, both for monthly and annual data (in fact, CN-category 6 has the highest Balassa index for the Netherlands throughout the sample period). This suggests that information on the value of the Balassa index for a particular industry in a particular period is also indicative for the value of the Balassa index in the next period for that same industry. This section investigates such persistence over time using transition probability matrices based on monthly moving annual export flows.

Empirical research into the persistence and mobility of revealed comparative advantage over time using transition probability matrices is pioneered by Proudman and Redding (1998a, 1998b). Although we use a similar procedure, there are also several differences. First, Proudman and Redding (1998a) investigate 2 countries (the U.K. and Germany), extended to 5 countries (adding France, Japan and the U.S.A.) in Proudman and Redding (1998b), whereas we investigate 12 member states of the European Union. Second, they analyze 22 manufacturing industries, whereas we analyze all (that is, 99) 2-digit CN industries. Third, they analyze annual OECD data for 1970–1993, whereas we analyze monthly Eurostat data for 1992–1996. Fourth, for their selected group of 5 countries they consider the world as a whole (approximated by the OECD data) as a reference, without corrections in the trade data. As explained in the introduction, we take the EU-12 countries as a reference and analyze exports to a third market (Japan) to correct for trade biases (market access, distance, heterogeneous tastes) to get a clean measure of comparative advantage. Fifth, they normalize the Balassa index such that the mean is equal to one for all countries. Since this normalization is not standard practice in applied research we did not follow that procedure. Sixth, and finally, they endogenously divide the Balassa index into four classes to ensure that the number of observations is roughly equal for each class. Although attractive for estimation purposes there are two main disadvantages to that approach. Not only are the boundaries between the classes hard to interpret (what does it mean in Proudman and Redding (1998a: 22) for the U.K. to have a normalized Balassa index in the third class between 0.941 and 1.165?), but they also differ from one country to another (the third class for Germany in Proudman and Redding (1998a: 22) ranges from 1.006 to 1.258). The latter makes comparisons between countries, particularly of differences in persistence, difficult. For these reasons we divide the Balassa index into 4 classes which can be readily interpreted:

Class *a*: $0 <$ Balassa index ≤ 1;
Class *b*: $1 <$ Balassa index ≤ 2;
Class *c*: $2 <$ Balassa index ≤ 4; and
Class *d*: $4 <$ Balassa index.

Class *a* captures all those industries without a comparative advantage. The other three classes, *b*, *c*, and *d*, relate to sectors with a comparative advantage, roughly divided into "weak comparative advantage" (class *b*), "medium comparative advantage" (class *c*), and "strong comparative advantage" (class *d*). The characteristics of these classes, and their differences across countries, will become clear as we progress.

1. Transition Probability Matrices

Let p_{ab}^{m} denote a one-step transition probability, that is the probability that for *m*onthly observations next period's Balassa index of a particular sector and country fall in class *b*, given that this period's Balassa index for that same sector and country falls in class *a*. Similarly, p_{da}^{y} denotes the probability that for *y*early observations next period's Balassa index of a particular sector and country falls in class *a*, given that this period's Balassa index for that same sector and country falls in class *d*, et cetera. Panel a of Table 4 gives the pooled results of the one-step empirical transition probabilities for all member states considered for the period as a whole, both monthly and annually, on the assumption that this probability is the same for all sectors and countries. For example, panel a indicates that, given that an industry has a weak comparative advantage in 1994 (is in class *b* for annual observations), the probability that it also has a weak comparative advantage in 1995 is 64 percent, while the probability that it shows no comparative advantage in 1995 is 23 percent, etc. Hinloopen and Van Marrewijk (2000) give all empirical, one-step, 4×4 transition probability matrices for all classes and all months, both for monthly observations and for monthly-moving annual observations. These 59 monthly and 37 annual transition probability matrices were used to calculate the average transition probabilities with a concomitant 95 percent reliability interval in Panel b of Table 4.

There is a close correspondence between the pooled and average transition probabilities: there is a 1 percent deviation for only 4 estimated transition probabilities for monthly flows, while there is a 0 percent deviation for the other 12 monthly observations and for all annual observations. The estimated reliability intervals are small and, with one exception, smaller for annual than for monthly flows.

Table 4: *Transition Probabilities and Concomitant Ergodic Distributions (EU-12 countries grouped together)*[a]

Panel a. Transition Probabilities

Monthly export flows						Annual export flows					
		to						to			
40,365		a	b	c	d	33,783		a	b	c	d
from	a	0.88	0.09	0.02	0.01	from	a	0.93	0.06	0.01	0.00
	b	0.34	0.50	0.13	0.03		b	0.23	0.64	0.12	0.01
	c	0.13	0.22	0.47	0.18		c	0.06	0.20	0.62	0.12
	d	0.05	0.05	0.19	0.71		d	0.02	0.02	0.14	0.82
Ergodic distribution						Ergodic distribution					
		π_a	π_b	π_c	π_d			π_a	π_b	π_c	π_d
Empirical		0.64	0.16	0.10	0.10	Empirical		0.67	0.16	0.09	0.08
Implied		0.63	0.17	0.10	0.10	Implied		0.65	0.17	0.10	0.08

Panel b. Average Transition Probabilities

Monthly export flows						Annual export flows					
		to						to			
40,365		a	b	c	d	33,783		a	b	c	d
	a	0.87	0.10	0.02	0.01		a	0.93	0.06	0.01	0.00
		±0.004	±0.003	±0.002	±0.001			±0.003	±0.002	±0.001	±0.001
	b	0.34	0.50	0.13	0.03		b	0.23	0.64	0.12	0.01
from		±0.013	±0.012	±0.008	±0.004	from		±0.011	±0.012	±0.008	±0.002
	c	0.14	0.22	0.46	0.18		c	0.06	0.20	0.62	0.12
		±0.012	±0.012	±0.017	±0.013			±0.008	±0.013	±0.016	±0.009
	d	0.05	0.05	0.19	0.71		d	0.02	0.02	0.14	0.82
		±0.007	±0.007	±0.012	±0.014			±0.004	±0.005	±0.008	±0.010

[a] The first number (top-left) in each matrix is the number of transitions the matrix is based upon. Cell entries are rounded such that the rows of each matrix add up to one. Below the entries of average transition probabilities are the reliability intervals ($\pm 2s^z_{ij}/\sqrt{N_z}$ for $i,j = a,b,c,d$ and $z = m,y$; where s^z_{ij} is the estimated standard deviation, $N_m = 59$ and $N_y = 37$). See Hinloopen and Van Marrewijk (2000).

The diagonal elements of the matrices in Table 4 suggest that the observations on the Balassa index are more persistent from period to period for both low (class *a*) and high (class *d*) observations than for the apparently more transient intermediate classes (*b* and *c*). Moreover, as argued above and illustrated in Figure 3, the classes appear to be more persistent for annual than for monthly observations; all the diagonal entries, for example, are higher for annual than for monthly observations, indicating that it is more likely to stay in the same class. Alternatively, there is a 1 percent chance of moving from class *a* to class *d* for monthly observations, compared to a 0 percent probability for annual observations. The estimates on the reverse movements are 5 and 2 percent, respectively.

2. Ergodic Distributions

To assess whether or not the Markov transition matrices capture the underlying data-generating process, we compute the implied limiting distribution and compare these with their empirical counterpart. As we will see, the fit is quite good.

Assume that the transition probabilities in Table 4 are time stationary, and let P_z, for $z = m, a$, be the Markov transition matrix, with p^z_{ij} the probability of moving from class i to class j for z type observations, $i, j = a, b, c, d$. In the terminology of Markov chains these are irreducible, aperiodic, recurrent Markov chains with partially reflecting barriers. Further, let $p^{z(n)}_{ij}$ be the n-step transition probability, i.e. the probability of going from class i to class j in n steps. If the transition probability is stationary the matrix $P^{(n)}_z$, the n-step probability matrix, is simply given by matrix multiplication: $P^{(n)}_z = P^n_z$. Under these conditions (see Theorems 1.2 and 1.3 in Karlin and Taylor 1975: 83–85) the share of Balassa indices in each class a, b, c, d evolves to a stationary probability distribution π^z_a, π^z_b, π^z_c, and π^z_d, the "ergodic" distribution, characterized by:

$$\lim_{n\to\infty} p^{z(n)}_{ji} = \lim_{n\to\infty} p^{z(n)}_{ii} = \pi^z_i, \text{ for } i, j = a,b,c,d \text{ and } z = m,y$$
$$\pi^z_i \geq 0, \ \sum_i \pi^z_i = 1, \text{ and } \pi^z_j = \sum_i \pi^z_i \, p^z_{ij} \tag{2}$$

The top line of (2) indicates that the probability of evolving over time to any particular class is independent of the initial class and equal to the stationary probability distribution. The bottom line of (2) uniquely determines the π^z_i. It can be used to determine the stationary probability distribution. Alternatively, one can simply calculate P^n_z for large n, which is the procedure we used, to obtain the implied stationary probability distribution (see Table 4). This result is then compared with the empirical distribution in Table 4. These appear to be very similar, specifically for monthly observations, suggesting that the transition probability matrices accurately characterize the data-generating process underlying the distributions of the Balassa index.

3. Sectoral Mobility

The literature has developed a number of "mobility indices", which collapse into one number the mobility information of a transition probability matrix (see Proudman and Redding 1998b: 24). Let P be the transition probability matrix, let n be the number of classes, let π_i be its ergodic distribution, where i indicates the class, and let λ_m be the eigenvalues of P for $m = 1, \ldots, n$. Number the eigenvalues in declining modulus. We consider the following mobility indices, labeled $M_1 - M_4$:[8]

Shorrocks (1978)	$M_1 = (n - tr(P))/(n - 1)$
Bartholomew (1973)	$M_2 = \sum_k \pi_k \sum_l p_{kl} \lvert k - l \rvert$
Shorrocks (1978)	$M_3 = 1 - \det(P)$
Sommers and Conlisk (1979)	$M_4 = 1 - \lvert \lambda_2 \rvert$

Since the diagonal elements of P give the probability of staying in the same class, 1 minus these elements give an indication of mobility, which explains M_1. Since P is a transition probability matrix there is always one eigenvalue equal to 1 and the modulus of the other eigenvalues is bounded from above by 1. Convergence to the ergodic distribution occurs at a geometric rate given by powers of the eigenvalues. The smaller the modulus of an eigenvalue, the faster its corresponding component converges. Moreover, the dominant, that is the slowest, convergence term is given by the second largest eigenvalue. Emphasizing that aspect explains M_4. Alternatively, the product of the eigenvalues is equal to the determinant of the matrix. This gives a rationale for M_3. As explained above, the size of each class evolves to the ergodic distribution. Mobility index M_2, finally, uses these as weights to calculate an extended version of M_1 while simultaneously 'penalizing' large movements.

Table 5 reports the mobility indices for both monthly and annual observations. All indices indicate lower annual mobility than monthly mo-

[8] Proudman and Redding (1998b) also consider $M_5 = (n - \sum_m \lvert \lambda_m \rvert)/(n - 1)$. Since all eigenvalues are real for our matrices, M_5 equals M_1.

Table 5: *Mobility Indices Based on the Transition Matrices (EU-12 countries grouped together)*

	Monthly export flows	Annual export flows
M_1	0.49	0.33
M_2	0.31	0.18
M_3	0.90	0.73
M_4	0.21	0.12

bility. On the face of it this seems to violate Shorrocks's (1978) period consistency criterion, as also discussed in Geweke et al. (1986), arguing that over a longer period of observation for the same process mobility should increase. Observe, however, that the process leading to the distribution of the Balassa index based on annual observations is not the same as the monthly process iterated 12 times. In the latter case the index is based on a flow of exports over a one-month period and transitions are based on comparing changes from one month to the next. For annual observations the index is based on a flow of exports over a twelve month period and transitions are based on comparing changes from one year to the next. Apparently, Shorrock's notion does not apply when different types of export flows are considered.

As indicated, the Balassa indices based on annual export flows are more persistent (in the sense of lower mobility) than those based on monthly export flows. A particular value of the Balassa index based on annual export flows is therefore more likely to reflect the 'true' comparative advantage. Accordingly, for the remainder of the analysis, which is concerned with regional differences, we use (monthly moving) annual export flows.

V. Regional Differences

Sections III and IV focus on the shape of the distribution of the Balassa index and its stability over time. To that end the individual observations of different EU-12 member states are grouped together. That, however, bypasses a range of interesting questions to be addressed on differences in degree of specialization and mobility between countries (see also Proudman and Redding 1998a, 1998b). Indeed, in most cases practitioners calculating Balassa indices are interested in comparing the out-

Table 6: *Empirical Distribution of the Balassa Index Based on Annual Export Flows (EU-12 countries separately)*[a, b]

	FRA	BLX	NET	GER	IT	UK	IRE	DEN	GRE	POR	SPA
p-1	0.02	0.00	0.00	0.00	0.00	0.01	0.00	0.00	0.00	0.00	0.00
p-2.5	0.04	0.00	0.01	0.02	0.00	0.02	0.00	0.00	0.00	0.00	0.00
p-5	0.08	0.01	0.03	0.04	0.00	0.06	0.00	0.00	0.01	0.00	0.01
p-10	0.18	0.05	0.06	0.07	0.03	0.15	0.00	0.01	0.02	0.01	0.04
p-25	0.49	0.15	0.31	0.22	0.16	0.34	0.03	0.03	0.05	0.05	0.20
p-50	0.88	0.44	0.82	0.54	0.59	0.78	0.10	0.18	0.24	0.38	0.64
p-75	1.60	1.04	1.58	1.03	1.94	1.43	0.41	0.55	2.36	2.24	2.12
p-90	2.71	2.73	4.09	1.58	4.22	2.37	1.74	2.87	10.81	14.90	5.16
p-95	3.49	5.09	6.77	1.92	4.59	3.13	2.75	6.42	21.10	39.53	8.43
p-97.5	4.08	7.91	7.98	2.36	4.92	4.03	3.77	9.99	65.57	119.3	11.75
p-99	5.70	10.98	19.20	2.78	6.29	4.87	4.87	19.46	191.1	210.7	18.19
max	6.87	12.40	22.00	3.03	7.37	5.93	15.69	23.30	249.8	239.9	33.47
mean	1.20	1.12	1.62	0.71	1.31	1.06	0.56	1.16	6.87	8.94	1.96
std	1.09	1.97	2.70	0.62	1.58	1.00	1.25	3.08	27.49	31.57	3.52
obs	4,749	4,503	4,501	4,785	4,654	4,708	3,843	4,189	2,713	3,309	4,326
BI-1	0.58	0.74	0.59	0.74	0.61	0.61	0.82	0.81	0.67	0.66	0.60
BI-2	0.84	0.87	0.79	0.95	0.76	0.87	0.92	0.88	0.73	0.74	0.74
BI-4	0.97	0.93	0.90	1.00	0.89	0.97	0.98	0.91	0.79	0.82	0.86
BI-8	1.00	0.97	0.98	1.00	1.00	1.00	1.00	0.96	0.87	0.87	0.95

[a] The table is based on monthly moving annual export flows for January 1992 through December 1996; p-z reports the Balassa index for the z-th percentile, for z = 1, 2.5, 5, 10, 25, 50,75, 90, 95, 97.5, and 99; max = maximum; av = average; std = standard deviation; med = median; obs = number of observations; BI-γ reports the share of industries with a Balassa index lower than γ, for γ = 1, 2, 4, 8. – [b] FRA = France; BLX = Belgium/Luxembourg; NET = the Netherlands; GER = Germany; IT = Italy; IRE = Ireland; DEN = Denmark; GRE = Greece; POR = Portugal; SPA = Spain.

come for different countries. This section investigates these spatial differences and finds them to be quite large. At this point we stress, however, that although the distribution and the transition probabilities may vary from one country to another, the stability of the distribution itself and of the transition matrices is comparable to the results found and discussed for the EU-12 as a whole in Sections III and IV.

1. Different Distributions

Table 6 summarizes the results on the distribution of the Balassa index for individual countries based on monthly moving annual export flows. There appears to be considerable country to country variation. For example, on average 33 percent of the EU-12 industries has a Balassa index above 1 (see Table 3), but this ranges from a low of 18 percent for Ireland to a high of 42 percent for France. Similarly, on average 8 percent of the EU-12 industries has a Balassa index above 4, where the country observations vary from 21 percent for Greece to 0 percent for Germany.

If anything, the results presented in Table 6 show that the same value for the Balassa index has a different meaning for different countries. Accordingly, using the Balassa index to identify a country's weak and strong sectors in comparison to other countries should be done with care. On the other hand, using the Balassa index to rank a country's exporting industries is not disputed by the results presented in Table 6.

2. Different Transition Probabilities

Table 7 reports the estimated pooled transition probability matrices for each EU-12 country for the classes *a-d* as defined in Section IV (see our website for the estimated average transition probability matrices).[9] Again, there appears to be considerable variation, this time in transition probabilities between the EU-12 countries. For example, the probability that an industry which portrays no comparative advantage in a particular year remains in the same class (that is, does not portray a comparative advantage the next year either) varies from 86 percent for the Netherlands to 97 percent for Denmark. Similar variation can be identified for the other three classes.

Below each estimated transition matrix the implied ergodic distribution is reported as well as the empirical counterpart. In most cases the implied and empirical distribution are similar, indicating that the transition probability matrices adequately capture the underlying distribution. Accordingly, the transition probability matrices can be used to investigate differences in mobility between the EU-12 member states. Table 8 reports the four mobility indices defined in Section IV for each country, where the ordering of countries is roughly from persistent to mobile. Proudman and Redding (1998b) estimate similar mobility indices for France, the U.K. and Germany. For these countries they find a consistent ranking, being that France has the most mobile trade specialization pattern while that of Germany is the most persistent. We find the same ranking for each mobility index for these three countries. It is unclear at this point whether a high or low mobility index is beneficial for the macro-economic development of a nation. As the European soc-

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[9] Since Germany has no industries with a Balassa index exceeding 8, its estimated transition probability matrix is confined to the classes *a* – *c* only.

Table 7: *Transition Probabilities and Ergodic Distributions (EU-12 countries separately)*[a]

France

3,582		to a	to b	to c	to d
from	a	0.87	0.13	0.00	0.00
	b	0.21	0.61	0.18	0.00
	c	0.05	0.22	0.65	0.08
	d	0.00	0.02	0.33	0.65
Ergodic distribution		π_a	π_b	π_c	π_d
Empirical		0.58	0.26	0.13	0.03
Implied		0.50	0.27	0.19	0.04

Belgium/Luxembourg

3,319		to a	to b	to c	to d
from	a	0.94	0.05	0.01	0.00
	b	0.29	0.59	0.10	0.02
	c	0.05	0.16	0.62	0.16
	d	0.07	0.04	0.13	0.76
Ergodic distribution		π_a	π_b	π_c	π_d
Empirical		0.74	0.13	0.06	0.07
Implied		0.72	0.13	0.08	0.07

Netherlands

3,304		to a	to b	to c	to d
from	a	0.86	0.12	0.01	0.01
	b	0.27	0.61	0.12	0.00
	c	0.05	0.14	0.70	0.11
	d	0.02	0.03	0.12	0.83
Ergodic distribution		π_a	π_b	π_c	π_d
Empirical		0.59	0.20	0.11	0.09
Implied		0.51	0.22	0.15	0.12

Germany

3,646		to a	to b	to c	to d
from	a	0.96	0.04	0.00	0.00
	b	0.15	0.80	0.05	0.00
	c	0.00	0.14	0.86	0.00
	d	0.00	0.00	0.00	1.00
Ergodic distribution		π_a	π_b	π_c	π_d
Empirical		0.74	0.21	0.05	0
Implied		0.74	0.19	0.07	0

(Table continued on next page)

cer player of the last century, Johan Cruyff, has taught us: every disadvantage has its advantage. In fact, this point is part of our ongoing research program.

A formal confirmation that the dynamics of the Balassa index is different for each country is given in Table 9, which summarizes the findings on country-by-country testing for equal transition probability ma-

Table 7: *Continued*

Italy

3,479		to a	b	c	d
	a	0.93	0.06	0.01	0.00
from	b	0.17	0.70	0.13	0.00
	c	0.03	0.12	0.78	0.07
	d	0.00	0.01	0.11	0.88
Ergodic distribution					
		π_a	π_b	π_c	π_d
Empirical		0.61	0.15	0.13	0.11
Implied		0.54	0.18	0.17	0.10

United Kingdom

3,544		to a	b	c	d
	a	0.95	0.04	0.01	0.00
from	b	0.17	0.78	0.05	0.00
	c	0.09	0.24	0.62	0.05
	d	0.00	0.01	0.22	0.77
Ergodic distribution					
		π_a	π_b	π_c	π_d
Empirical		0.61	0.26	0.10	0.03
Implied		0.74	0.19	0.06	0.02

Ireland

2,732		to a	b	c	d
	a	0.96	0.03	0.01	0.00
from	b	0.18	0.59	0.23	0.00
	c	0.08	0.36	0.44	0.12
	d	0.06	0.00	0.58	0.36
Ergodic distribution					
		π_a	π_b	π_c	π_d
Empirical		0.82	0.10	0.06	0.02
Implied		0.75	0.14	0.09	0.02

Denmark

3,049		to a	b	c	d
	a	0.97	0.03	0.00	0.00
from	b	0.26	0.60	0.14	0.00
	c	0.06	0.28	0.51	0.15
	d	0.03	0.01	0.02	0.94
Ergodic distribution					
		π_a	π_b	π_c	π_d
Empirical		0.81	0.07	0.06	0.09
Implied		0.82	0.09	0.03	0.07

(Table continued on next page)

trices.[10] Under the null hypothesis $p_{ij}=\tilde{p}_{ij}$ for each state i

$$\sum_j^m n_i^* \frac{(p_{ij}-\tilde{p}_{ij})^2}{\tilde{p}_{ij}} \sim \chi^2(m-1), \quad n_i^* \equiv \sum_{t=0}^{T-1} n_i(t), \tag{3}$$

[10] Obviously, Germany is not part of Table 8 as it is the only country that has no observations in class *d*.

Table 7: *Continued*

Greece

1,730		a	b	c	d
		to			
from	a	0.91	0.04	0.03	0.02
	b	0.37	0.27	0.26	0.10
	c	0.05	0.23	0.34	0.38
	d	0.03	0.04	0.06	0.87
Ergodic distribution					
		π_a	π_b	π_c	π_d
Empirical		0.67	0.06	0.06	0.21
Implied		0.46	0.07	0.08	0.38

Portugal

2,250		a	b	c	d
		to			
from	a	0.90	0.07	0.03	0.00
	b	0.43	0.25	0.29	0.03
	c	0.13	0.21	0.38	0.28
	d	0.00	0.01	0.06	0.93
Ergodic distribution					
		π_a	π_b	π_c	π_d
Empirical		0.66	0.08	0.08	0.18
Implied		0.40	0.07	0.09	0.44

Spain

3,148		a	b	c	d
		to			
from	a	0.94	0.05	0.01	0.00
	b	0.38	0.49	0.12	0.01
	c	0.06	0.21	0.53	0.20
	d	0.04	0.02	0.28	0.66
Ergodic distribution					
		π_a	π_b	π_c	π_d
Empirical		0.60	0.14	0.12	0.14
Implied		0.73	0.12	0.09	0.06

[a] The table is based on monthly moving annual export flows for January 1992 through December 1996. Cell entries are rounded such that the rows of each matrix add up to one. The first number (top-left) in each transition matrix is the number of Balassa indices the matrix is based upon.

where p_{ij} are the estimated transition probabilities, $\tilde{p}_{ij}$ are the probabilities under the null, m is the number of states, and $n_i(t)$ denotes the number of sectors in cell i at time t. The null hypothesis is that the data-generating process is given by the estimated transition probability matrix of the country in each row of Table 9, that is for all states $i = 1,\dots,m$. The resulting test statistic determines if the estimated transition probability matrix for each country in the column of Table 9 is equal to the null. It is asymptotically distributed $\chi^2(m(m-1))$, see

Table 8: *Mobility Indices Transition Matrices (EU-12 countries separately)*[a,b]

	M_1	M_2	M_3	M_4
GER	0.19	0.08	0.36	0.10
IT	0.23	0.15	0.57	0.08
DEN	0.33	0.09	0.76	0.06
UK	0.29	0.12	0.67	0.17
BLX	0.36	0.17	0.76	0.15
NET	0.33	0.25	0.73	0.13
SPA	0.46	0.21	0.89	0.17
POR	0.51	0.21	0.98	0.07
FRA	0.40	0.26	0.82	0.18
IRE	0.55	0.17	0.98	0.17
GRE	0.54	0.28	0.98	0.13
EU-12	0.33	0.18	0.73	0.12

[a] The ordering of countries in the table from persistent to mobile is based on the ranking of the four mobility indices, where first the median ranking and then the mean ranking was decisive. – [b] FRA = France; BLX = Belgium/Luxembourg; NET = the Netherlands; IT = Italy; IRE = Ireland; DEN = Denmark; GRE = Greece; POR = Portugal; SPA = Spain.

Proudman and Redding (1998a) for further details.[11] Despite the relatively short observation period, since we obviously cannot use overlapping (that is monthly moving) observations, the null hypothesis of equal transition probabilities is soundly rejected in 85 out of 90 country-by-country comparisons. Indeed, mobility patterns differ between countries. The 5 asymmetric exceptions may well be part of standard statistical fluctuations.

VI. Conclusions

We describe the empirical distribution of the Balassa index by analyzing the export performance of similar countries to a third market using European Union – Japan trade data. We investigate individual countries and the EU-12 as a whole.

In all cases the distribution of the Balassa index is very skewed with a median well below one, a mean well above one, and a monotonical-

[11] Observe that the distribution of the test-statistic is *independent* of the way the transition matrices are constructed.

Table 9: *Test Statistic Value for the Hypothesis of Equal Transition Matrices*[a, b]

	FRA	BLX	NET	IT	UK	IRE	DEN	GRE	POR	SPA
FRA	–	34.53**	26.87**	40.96**	52.38**	43.66**	50.39**	122.10**	117.45**	42.21**
BLX	71.22**	–	31.63**	19.56	29.11**	47.66**	15.10	48.16**	46.29**	24.72*
NET	30.26**	24.09*	–	21.35*	43.50**	72.24**	38.55**	98.46**	45.81**	43.34**
IT	59.95**	32.07**	57.23**	–	24.45*	60.02**	14.90	282.66**	75.32**	75.40**
UK	116.32**	23.86*	79.35**	23.40*	–	45.12**	23.10**	114.17**	90.19**	48.86**
IRE	110.63**	52.48**	148.32**	130.88**	51.96**	–	71.07**	145.73**	143.15**	62.25**
DEN	299.23**	41.76**	125.13**	57.79**	87.24**	272.39**	–	124.89**	127.11**	316.52**
GRE	220.53**	58.15**	127.94**	113.22**	215.70**	122.94**	42.33**	–	14.38	115.10**
POR	183.61**	59.15**	103.17**	106.77**	224.50**	124.78**	42.53**	24.66*	–	113.46**
SPA	57.27**	10.28	40.83**	44.50**	50.96**	22.94*	27.82**	52.91**	42.97**	–
EU	46.85**	7.34	21.19*	8.63	18.83	41.73**	14.58	75.23**	40.41**	28.47**

[a] Each row concerns the test statistic where the 'true' transition matrix is that of the country in that row. – [b] FRA = France; BLX = Belgium/Luxembourg; NET = the Netherlands; IT = Italy; IRE = Ireland; DEN = Denmark; GRE = Greece; POR = Portugal; SPA = Spain; EU = EU-12.

* H_0 rejected at the 5 percent significance level; ** H_0 rejected at the 1 percent significance level.

ly declining density function. The process is apparently well defined in the sense that the distribution changes very little from one period to the next. Moreover, aggregation over time, that is analyzing annual rather than monthly trade flows, or pooling values of the Balassa index, has only a mild influence on the distribution. The observations for individual industries are, however, more persistent over time for annual than for monthly trade flows. The widely used criterium "Balassa index > 1" to identify sectors with a comparative advantage selects about one-third of the exporting industries.

The distribution of the Balassa index differs considerably across countries, making comparisons of the index between countries problematic. This certainly holds for the dynamic properties of the process. Although different mobility indices based on our estimated transition probability matrices do not always lead to the same ranking, Germany appears to have the most persistent and Greece the most mobile pattern of comparative advantage over time.

Several avenues for further research are worth investigating and preliminary work in some directions is under way. It may be worthwhile to extend the database, both in time and geographical sense, to see if the patterns of dynamic comparative advantage observed in this study are structural. In addition, an investigation into country-specific characteristics (such as country size and breadth of export flows) that lead to different distributions of the Balassa index is needed. This could lead to corrections of the Balassa index that make comparisons between countries useful. Finally, an investigation into the desirability of mobility as defined in this paper is needed, for example by analyzing to what extent the mobility indicators are correlated with macro-economic performance indicators.

Appendix

Table A1: *Overview of Industries (2-digit Combined Nomenclature Industry Code (Eurostat))*[a]

CN	Description
00	Secret uses, official confidentiality
01	Live animals
02	Meat and edible meat offal
03	Fish and crustaceans, molluscs and other aquatic invertebrates
04	Dairy produce; birds' eggs; natural honey; edible products of animal origin, not elsewhere specified or included
05	Products of animal origin, not elsewhere specified or included
06	Live trees and other plants; bulbs, roots and the like; cut flowers and ornamental foliage
07	Edible vegetables and certain roots and tubers
08	Edible fruit and nuts; peel of citrus fruit or melons
09	Coffee, tea, maté and spices
10	Cereals
11	Products of the milling industry; malt; starches; inulin; wheat gluten
12	Oil seeds and oleaginous fruits; miscellaneous grains, seeds and fruit; industrial or medicinal plants; straw and fodder
13	Lac; gums, resins and other vegetable saps and extracts
14	Vegetable plaiting materials; vegetable products not elsewhere specified or included
15	Animal or vegetable fats and oils and their cleavage products; prepared edible fats; animal or vegetable waxes
16	Preparation of meat, of fish or of crustaceans, molluscs or other aquatic invertebrates
17	Sugars and sugar confectionery
18	Cocoa and cocoa preparations
19	Preparations of cereals, flour, starch or milk; pastrycooks' products
20	Preparations of vegetables, fruit, nuts or other parts of plants
21	Miscellaneous edible preparations
22	Beverages, spirits and vinegar
23	Residues and waste from the food industrys; prepared animal fodder
24	Tobacco and manufactured tobacco substitutes
25	Salt; sulphur; earths and stone; plastering materials, lime and cement
26	Ores, slag and ash
27	Mineral fuels, mineral oils and products of their distillation; bituminous substances; mineral waxes
28	Inorganic chemicals; organic or inorganic compounds of precious metal, of rare-earth metals, of radioactive elements or of isotopes
29	Organic chemicals
30	Pharmaceutical products
31	Fertilizers
32	Tanning or dyeing extracts; tannins and their derivatives; dyes, pigments and other colouring matter; paints and varnishes; putty and other mastics; inks

[a] CN = Combined Nomenclature; No observations on categories 77 and 98.

Table A1: *Continued*

CN	Description
33	Essential oils and resinoids; perfumery, cosmetic or toilet preparations
34	Soap, organic surface-active agents, washing preparations, lubricating preparations, artificial waxes, prepared waxes, polishing or scouring preparations, candles and similar articles, modelling pastes, 'dental waxes' and dental preparations with a basis of plaster
35	Albuminoidal substances; modified starches; glues; enzymes
36	Explosives; pyrotechnic products; matches; pyrophoric alloys; certain combustible preparations
37	Photographic or cinematographic goods
38	Miscellaneous chemical products
39	Plastics and articles thereof
40	Rubber and articles thereof
41	Raw hides and skins (other than furskins) and leather
42	Articles of leather; saddlery and harness; travel goods, handbags and similar containers; articles of animal gut (other than silkworm gut)
43	Furskins and artificial fur; manufactures thereof
44	Wood and articles of wood; wood charcoal
45	Cork and articles of cork
46	Manufactures of straw, of esparto or of other plaiting materials; basketware and wickerwork
47	Pulp of wood or of other fibrous cellulosic material; waste and scrap of paper or of paperboard
48	Paper and other paperboard; articles of paper pulp, of paper or of paperboard
49	Printed books, newspapers, pictures and other products of the printing industry; manuscripts, typescripts and plans
50	Silk
51	Wool, fine or coarse animal hair; horsehair yarn and woven fabric
52	Cotton
53	Other vegetable textile fibres; paper yarn and woven fabrics of paper yarn
54	Man-made filaments
55	Man-made staple fibres
56	Wadding, felt and nonwovens; special yarns; twine, cordage, ropes and cables and articles thereof
57	Carpets and other textile floor coverings
58	Special woven fabrics; tufted textile fabrics; lace; tapestries; trimmings; embroidery
59	Impregnated, coated, covered or laminated textile fabrics; textile articles of a kind suitable for industrial use
60	Knitted or crocheted fabrics
61	Articles of apparel and clothing accessories, knitted or crocheted
62	Articles of apparel and clothing accessories, not knitted or crocheted
63	Other made-up textile articles; sets; worn clothing and worn textile articles; rags
64	Footwear, gaiters and the like; parts of such articles
65	Headgear and parts thereof
66	Umbrellas, sun umbrellas, walking-sticks, seat-sticks, whips, riding crops and parts thereof

Table A1: *Continued*

CN	Description
67	Prepared feathers and down and articles made of feathers or of down; artificial flowers; articles of human hair
68	Articles of stone, plaster, cement, asbestos, mica or similar materials
69	Ceramic products
70	Glass and glassware
71	Natural or cultured pearls, precious or semi-precious stones, precious metals, metals clad with precious metal, and articles thereof; imitation jewellery; coins
72	Iron and steel
73	Articles of iron or steel
74	Copper and articles thereof
75	Nickel and articles thereof
76	Aluminium and articles thereof
77	(reserved for possible future use in the harmonized system)
78	Lead and articles thereof
79	Zinc and articles thereof
80	Tin and articles thereof
81	Other base metals; cermets; articles thereof
82	Tools, implements, cutlery, spoons and forks of base metal; parts thereof of base metal
83	Miscellaneous articles of base metal
84	Nuclear reactors, boilers, machinery and mechanical appliances; parts thereof
85	Electrical machinery and equipment and parts thereof; sound recorders and reproducers, television image and sound recorders and reproducers, and parts and accessories of such articles
86	Railway or tramway locomotives, rolling-stock and parts thereof; railway or tramway track fixtures and fittings and parts thereof; mechanical (including electromechanical) travel signalling equipment of all kinds
87	Vehicles other than railway or tramway rolling-stock, and parts and accessories thereof
88	Aircraft, spacecraft, and parts thereof
89	Ships, boats and floating structures
90	Optical, photographic, cinematographic, measuring, checking, precision, medical or surgical instruments and apparatus; parts and accessories thereof
91	Clocks and watches and parts thereof
92	Musical instruments; parts and accessories of such articles
93	Arms and ammunition; parts and accessories thereof
94	Furniture; bedding, mattresses, mattress supports, cushions and similar stuffed furnishings; lamps and lighting fittings not elsewhere specified or included; illuminated signs, illuminated name-plates and the like; prefabricated buildings
95	Toys, games, and sports requisites; parts and accessories thereof
96	Miscellaneous manufactured articles
97	Works of art, collectors' pieces and antiques
98	Complete industrial plant exported in accordance with Commission Regulation (EEC) No. 518/79
99	(reserved for special uses determined by the competent Community authorities)

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Abstract: On the Empirical Distribution of the Balassa Index. – The concept of revealed comparative advantage as measured by the Balassa index is widely used in practice to determine a country's weak and strong sectors. Interpreting the Balassa index is difficult, however, in view of the limited knowledge to date on the distribution of this index. We analyze the *empirical* distribution of the Balassa index and its stability and properties over time, using Japan- European Union trade data. It appears that the distribution is relatively stable over time and that the widely used rule that "a Balassa index above one" identifies a strong sector, selects about one-third of all industries. On the other hand, the distribution appears to differ markedly across countries. JEL no. C14, F01