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On the measurement of comparative advantage

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Abstract This paper shows that the standard measure of revealed comparative advantage (RCA), ranging from 0 to ∞, has problematic properties. Due to its multiplicative specification, it has a moving mean larger than its expected value of 1, while its distribution strongly depends on the number of countries and industries. These properties make its outcomes incomparable across time and place and its economic interpretation problematic. We propose an alternative measure, the additive RCA, ranging from −1 to +1, with a symmetric distribution that centers on a stable mean of zero, independent of the classifications used. Statistical tests show the distribution of the additive index to be more stable. Besides, we propose an aggregate RCA, a regional specialization index, ranging from 0 for pure intra-industry trade to 1 for pure inter-industry trade. The same conclusions and proposals hold for the multiplicative location quotient (LQ), which is used as a measure for the revealed locational attractiveness of certain regions or countries for certain types of industry.

JEL Classification F14 · R12 · C43

1 Introduction

In both trade theory and location theory comparative advantage is defined in simplified theoretical terms within their own contexts. Thus, depending on the model used different answers will be provided for such questions as "which regions and countries have what types of comparative advantages" (Ten Raa and Mohnen

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2001), while correspondingly different answers will be given to the question of the most desirable policy response.

In trade theory this is most evident since comparative advantage there is mostly defined as the difference in relative prices in a non-existent, autarkic world. Balassa (1965, p. 116) summarized the problem as follows: “Comparative advantages appear to be the outcome of a number of factors, some measurable, others not, some easily pinned down, others less so. One wonders, therefore, whether more could not be gained if, instead of enunciating general principles and trying to apply these to explain actual trade flows, one took the observed pattern of trade as a point of departure.” He therefore proposed to measure the ‘revealed’ comparative advantage of certain countries for certain exporting commodities by means of what has become known as the Balassa Index or the index of Revealed Comparative Advantage (RCA).

In spatial economics, exactly the same mathematical measure, there known as the Location Quotient (LQ), is used to measure the ‘revealed’ locational advantages of certain regions to attract and develop certain industries (Isard et al. 1960). The two concepts are closely related, not only mathematically, but also from an economic point of view. A regional or national specialization in the production of certain goods measured by the LQ will inevitably lead to export specialization, measured by the RCA, and vice versa.[1]

In international trade research the measurement of revealed comparative advantage has led to considerable debate, concentrating on the issue of “which index has the best theoretical properties” (see Vollrath 1991, for an overview). Kunimoto (1977) provided a cornerstone to that debate by proposing only the use of indices that could be interpreted as measures of ‘actual-to-expected’ trade, where ‘expected’ needs to be defined in the absence of the type of comparative advantage being studied. Citing difficulties in interpreting and comparing RCAs from different studies, Hinloopen and Van Marrewijk (2001) attempt to derive its distribution and properties empirically. They barely succeed, because among other things, “the distribution of the RCA differs considerably over countries” (op. cit. p. 3).

Knowing the formal statistical distribution of the RCA would be helpful for interpreting and comparing RCA outcomes. Therefore, the search for its distribution should not be abandoned easily. Our research, however, leads to the conclusion that deriving the distribution of the RCA—and mutatis mutandis that of the LQ—is an impossible task.

The main problem concerns the sensitivity of the distribution of the RCA and the LQ with regard to changes that should have none or only little effect on its distribution. For example, the distribution is shown to depend on the number and size of the industries and countries used in the analysis, while the mean of the RCA is unstable and cannot be given an economic interpretation, thus making it futile to try to derive the statistical distribution of the RCA. To obtain an index with more attractive theoretical and numerical properties, we propose an alternative, *additive* RCA, with a

[1] In fact, if domestic demand specialization and import specialization are added to export and domestic output specialization, a handy choice of formula applied to the appropriate accounting identity results in a precise relationship between the RCA and the LQ (see van der Linden and Oosterhaven 2001, for an empirical account). Bowen (1983, 1985, 1986) uses this relationship to derive his alternative, net trade definition of the RCA. Combined with the assumption of identical homothetic preferences, this leads to an RCA that equals the production LQ minus 1. Balance et al. 1985, 1986) and Volrath (1991) however, challenged Bowen’s RCA on several grounds.

stable mean, which is better suited for further use, since it appears to have a more stable distribution than that of the standard, multiplicative index.

In Section 2 we will discuss the properties of the traditional, *multiplicative* RCA and LQ, and in Section 3 we present the alternative, *additive* RCA and LQ, and a regional export specialization coefficient, the *aggregate* RCA, which is derived from it and may serve as an alternative measure of intra-industry trade. In our conclusion we suggest the use of the related spatial concentration coefficient when inter-sectoral comparisons of export or production specialization are at issue. Throughout the article we refer to the standard multiplicative RCA as the MRCA, and we use ARCA to indicate our additive alternative.

2 On the properties of the multiplicative RCA

The general index of the revealed comparative advantage of sector j in country A is defined as:

$$MRCA_j^A = \left(X_j^A / X^A\right) / \left(X_j^{REF} / X^{REF}\right) \tag{1}$$

where

X_j^A	equals the export of sector j in country A;
X^A	the total export of country A;
X_j^{REF}	the export of sector j of the reference countries;
and X^{REF}	the total export of the reference countries.

The MRCA compares the actual export share of sector j in country A with a measure of the expected export share. The latter is based on the assumption that sector j in REF does not have a comparative (dis)advantage. Consequently, an MRCA larger than 1 is interpreted as a ‘revealed comparative advantage’ or as the degree of ‘export specialization’ of country A in sector j, whereas an MRCA smaller than 1 is interpreted as a ‘revealed comparative disadvantage.’ This measure has several peculiar properties which we outline below.

2.1 Distribution of the multiplicative RCA

First, Hinloopen and Van Marrewijk (2001) empirically observe that the mean of the sectoral MRCAs is well above 1. This seems strange as it suggests that each country has a comparative advantage in its ‘average sector’, whereas one would expect the ‘average sector’ to be neutral in terms of its MRCA. This result, however, directly follows from choosing specification (1).

To understand this, let us assume that there are only two countries, A and B. Then, if the export share of sector j in A is x times as large as its export share in B, its MRCA equals x if B is taken as its reference country, while the MRCA of B will equal $1/x$, if A is taken as its reference country, meaning that the counterpart of an MRCA of x is an MRCA of $1/x$. Of course, the distribution of the xs, and hence that of the $1/x$s, is not known a priori. Nevertheless, the average of each x and its corresponding $1/x$ is always larger than 1, which therefore explains the result for the mean.

Second, the distribution of the MRCAs around this mean turns out to be asymmetric (Hinloopen and Van Marrewijk 2001); this empirical outcome can also be explained theoretically. Note that a pure interindustry trade world only has zero and infinitely large MRCAs, whereas a pure intra-industry world only has MRCAs equal to 1. If one combines the two pure cases, a (three-peaked) asymmetric distribution would result. In reality, pure cases do not exist, if only because of imperfect sector classifications. Hence, reality will show a less peaked but still asymmetric distribution.

In the two-country case, its shape will equal the distribution of xs and $1/x$s. With equal class sizes, this implies that the distribution of the MRCAs will partly be determined by the distribution of $1/x$, which starts with high frequencies close to zero and then slowly but continuously declines. Both arguments imply that the distribution of the MRCAs, if it could be determined, minimally follows a composed function and certainly cannot be described by a single function over its entire domain from 0 to ∞.

The distribution of $1/x$ is in fact the type of empirical density found in Fig. 4 in Hinloopen and Van Marrewijk (2001). When three-digit Standard Industrial Trade Classification (SITC-3) data, with hundreds of goods, are used for the Netherlands and Poland, a similar distribution is found (see Fig. 1).[2]

However, this smooth $1/x$-type distribution is only found if the size of the classes is chosen carefully. With the Dutch-Polish data, this shape only appears if the size of the classes is large enough. For smaller class sizes, the first column remains large, which indicates that relatively many MRCAs have values close to and equal to zero. The other columns, however, become more equally sized and show several local extremes. As an illustration, Fig. 2 displays the same MRCAs as those of Fig. 1, but with a class size of 0.04 instead of 0.20.[3] This reveals that the distribution of the MRCAs is not as regular or as smooth as expected or hoped for.

2.2 The number of countries

Third, deriving the distribution of the standard MRCA is further complicated by its dependence on the number of countries in the analysis. To start, again suppose that there are only two countries, A and B. If country B is taken as the reference country, the MRCA of sector j in country A is larger than 1, if and only if:

$$\left[X_j^A \middle/ X^A\right] > \left[X_j^B \middle/ X^B\right] \tag{2}$$

[2] These data were collected for a study into the consequences of the EU-enlargement for the bilateral trade between The Netherlands and Poland (Hoen and de Mooij 2001). The reference group consists of the EU-countries Austria, Belgium/Luxembourg, Denmark, Germany, Spain, Finland, France, United Kingdom, Greece, Ireland, Italy, Portugal, and Sweden. The reference group excludes the Netherlands and Poland for reasons to be given in the next section.

[3] Figures 1 and 2 only display the first 50 classes. The last classes have MRCAs that are all larger than, respectively, 10 and 2. The omitted classes contain, respectively, 10 and 107 MRCAs. The total number of MRCAs in this study is 528.

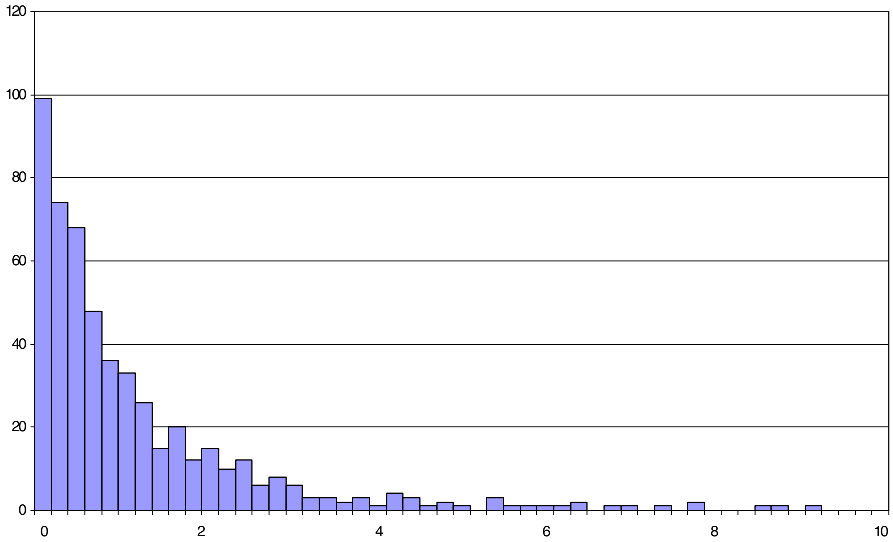

Fig. 1 Frequency of standard MRCAs for Poland and The Netherlands, with class size 0.20

If instead both countries are taken as reference countries, the MRCA of sector j in country A is larger than 1, if and only if:

$$\left[X_j^A \middle/ X^A\right] > \left[\left(X_j^A + X_j^B\right) \middle/ \left(X^A + X^B\right)\right] \tag{3}$$

which is equivalent to (2). Hence, in the two-country case, if one country has an MRCA larger than 1 in a certain sector, the second country has an MRCA smaller

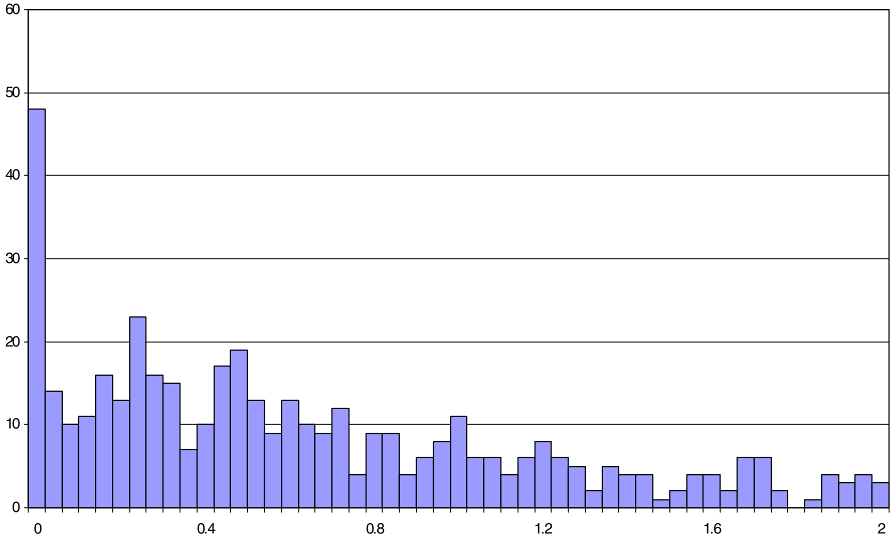

Fig. 2 Frequency of standard MRCAs for Poland and the Netherlands, with class size 0.04

than 1 in the same sector. If both countries are pooled, the number of sectors with an MRCA smaller than 1 will be 50%, irrespective of the choice of reference countries.

This symmetry, however, disappears when more than two countries are considered. Hinloopen and Van Marrewijk (2001) compare MRCAs for 12 EU-countries. They find that only about one-third of all MRCAs are larger than 1, which implies that the median of the MRCAs is well below 1. This clearly differs from 50%, which shows that the distribution of the MRCA depends on the number of countries in the analysis.

2.3 The number of sectors

Fourth, the number of sectors also influences the size and distribution of the MRCAs. Suppose that an arbitrary sector a is divided into two subsectors, i and j. Only by pure coincidence does one then obtain precisely: $MRCA_i = MRCA_a = MRCA_j$. In all other cases one obtains either $MRCA_i > MRCA_a > MRCA_j$ or $MRCA_j > MRCA_a > MRCA_i$. With a more detailed sector classification the maximum of the MRCAs will therefore become larger and the minimum will become smaller. This minimum, however, is bounded from below; as soon as one single sector has zero exports, the minimum MRCA will not decrease further, but the maximum will.

More generally, at higher levels of sectoral detail the export shares of each sector become smaller and smaller, and then the denominator in (1) becomes smaller, which works as a multiplier on the numerator. Hence, the MRCAs from a more detailed sector classification will contain more extreme values than those from an aggregated sector classification. As mentioned earlier, the larger the x, the larger the average of x and $1/x$. A more detailed sector classification is thus likely to lead to both a larger mean and a larger maximum.

This theoretical dependence of the MRCAs on the number of sectors may be illustrated empirically by the MRCAs for the Netherlands and Poland. When the classification goes from SITC-1 to SITC-3, the results in Table 1 confirm the above

Table 1 Statistics for standard MRCAs for different sector classifications for 1997

	SITC-1	SITC-2	SITC-3	SITC-4	SITC-5
The Netherlands					
Minimum MRCA	0.1	0.0	0.0	0.0	0.0
Median MRCA	1.5	0.9	0.7	0.6	0.5
Average MRCA	1.4	1.5	3.1	2.2	2.1
Maximum MRCA	2.8	11.9	314.6	309.4	180.8
Average, except max.	−10.4%	−10.5%	−38.0%	−13.1%	−3.0%
Standard deviation	0.8	1.9	21.2	12.8	7.8
Poland					
Minimum MRCA	0.0	0.0	0.0	0.0	0.0
Median MRCA	1.0	0.9	0.6	0.4	0.2
Average MRCA	1.0	2.7	2.5	2.0	1.7
Maximum MRCA	2.3	99.1	200.4	241.1	327.8
Average, except max.	−13.0%	−54.0%	−29.9%	−11.8%	−6.8%
Standard deviation	0.8	12.0	13.4	8.9	9.5

prediction. Beyond SITC-3, however, the mean and the maximum do not increase further, but this deviation is a statistical artefact, as 3.5% of all exports is not classified in SITC-4, and 25.0% is not classified in SITC-5. The outcome leads to empty commodity categories and to a lower total amount of exports. Since the non-classified exports relate to small categories with, on average, extreme MRCAs, the average of the MRCAs (and for the Netherlands also the maximum MRCA) decreases from SITC-3 to SITC-4 and SITC-5.

The sensitivity of the standard MRCA for the classification used also follows from the exclusion of the single largest MRCA and from the values for the standard deviation, as shown in the last two rows for both countries in Table 1.[4]

2.4 Conclusion

To theoretically derive the distribution of the standard MRCA appears to be impossible, because it depends on the number of countries and sectors, while its mean is unstable and larger than the theoretically expected value of 1. Thus, its mean cannot be given an economic interpretation, while empirical values of sectoral MRCAs cannot easily be compared across time and space. Hence, it is worthwhile to develop an index that has fewer or none of these problems. The ideal index preferably should have the following properties:

1. The expected value, when a sector has neither a comparative advantage nor a comparative disadvantage, should be identical across time and space (a stable mean or median).
2. Equally large comparative advantages and comparative disadvantages should have a numerically equal deviation from this expected value (symmetry around the mean or median).
3. The distribution of the index should be independent of the number and classification of the commodities or sectors used (independence of classifications).
4. The distribution of the index should be stable, such that the individual sectoral values may be compared across time and space (stable distribution).

3 Proposal for an alternative, additive RCA

In our view the root cause of the problems with the standard MRCA lies in its multiplicative character. We therefore propose instead the use of an additive RCA and LQ. In this section we analyze the properties of this alternative and argue that the country or region under consideration has to be excluded from the group of reference countries or regions. Moreover, we show how a specific aggregation of the additive RCA and LQ results in an index of export specialization or an index of output or employment specialization.

[4] Hinloopen and Van Marrewijk (2001) compute the average of 814 MRCAs, with and without the largest observation and observe that including the largest observation increases the average by 20%. Table 1 shows that this specific result is strongly dependent on the sector classification.

3.1 The sectoral and the aggregate additive RCA

To construct an Additive RCA we take the difference between the export shares, instead of the quotient as in the standard MRCA. Consequently, the additive revealed comparative advantage of sector j in country A is defined as:

$$ARCA_j^A = \left(X_j^A / X^A\right) - \left(X_j^{REF} / X^{REF}\right) \tag{4}$$

This index is zero if the export share of sector j in country A is equal to that of the reference countries. It is larger than zero if country A has a 'revealed comparative advantage' in sector j, and it is smaller if country A has a 'revealed comparative *dis*advantage'. Since (4) is additive in shares, the mean of the ARCAs has a value of zero, independent of the number and classification of the sectors or countries, as can easily be proven by summing (4) over j. The economic interpretation is also clear: the 'average' sector does not have a comparative (dis)advantage. The ARCA index thus satisfies criterion 1. As a consequence, the mean of the ARCAs secures a stable anchor for the distribution of the ARCAs around it, but by itself does not provide useful information.

The interesting question is not whether the 'average' sector has a comparative (dis)advantage, which it should not have, but whether or not a country 'as a whole' has a relatively specialized export package. This can be measured by the *regional specialization coefficient* (Oosterhaven 1995). In the context of international trade research this coefficient may best be labeled as the *aggregate* ARCA of country A, since it takes the sum of the absolute values of (4):

$$ARCA^A = \frac{1}{2}\sum_j \left| \left(X_j^A / X^A\right) - \left(X_j^{REF} / X^{REF}\right) \right| \tag{5}$$

The division by 1/2 secures that the aggregate ARCA results in an index ranging from 0 to 1; it will be zero if a country has an export package precisely equal to that of the reference countries, which will occur when all trade is of the intra-industry type. It will be 1 if a country has a unique export package consisting only of commodities that are absent in the package of the reference countries, which will occur when all trade is of the inter-industry type. Thus, 1 minus (5) also offers an alternative Intra-Industry Trade index.[5]

3.2 Choice of reference countries

Choosing the set of reference countries is not an easy matter. There are various considerations, all related to the purpose of the analysis (Hinloopen and Van

[5] Husted and Melvin (2000, p. 137) aggregate the absolute differences between export and import shares, and Krugman and Obstfeld (2000, p. 138) use the difference between exports and imports divided by the sum of both, all per sector. Our specification has the advantage of only using export data, which are mutually more comparable (van der Linden 1998, p. 82–89). The standard deviation of (4) also represents a measure of aggregate export specialization. However, with squared differences extreme deviations are weighted more heavily. We prefer (5) as it weighs all differences equally, be they small or large.

Marrewijk 2001). There is one technical issue that has not yet been discussed, namely whether or not to exclude the country at hand from the group of reference countries. When more countries are compared it seems handy to include all of them, because in that case, each country will be compared with the same reference group instead of with a changing one. The implication here is that including country *A* in the reference group is to be preferred when international or interregional comparisons are made.

Unfortunately, in that case the ARCA index becomes biased; if one considers the case in which country *A* is fully specialized, this can easily be seen. Without loss of generality, assume that country *A* is the only exporter of the last product *n*. Since country *A* is fully specialized, it does not export any other product, and no other country exports product *n*. Without loss of generality, further assume *m* countries with country *A* as the *m*th country. The total export of the reference countries then equals:

$$X^{REF} = \sum_{r=1}^{m} \sum_{i=1}^{n} X_j^r = \sum_{r=1}^{m=1} \sum_{i=1}^{n=1} X_j^r + X_n^A \tag{6}$$

and, the aggregate ARCA for country *A* then equals:

$$ARCA^A = \frac{1}{2} \sum_{i=1}^{n} \left| \left(X_i^A / X^A\right) - \left(X_i^{REF} / X^{REF}\right) \right| = 1 - \left(X_n^A / X^{REF}\right) \tag{7}$$

This index is smaller than 1, whereas it should be equal to 1, as country *A* is fully specialized. If we use all countries excluding country *A* as reference countries, the aggregate index does become 1 as required (Hoen 2002, p. 196–198).

3.3 Distribution of the additive RCA

The ARCA for an individual sector, with country *A* excluded from the group of reference countries, ranges from exactly −1 to exactly +1. In the theoretical two-country case each ARCA value of $+x$ no longer has $1/x$ as its counterpart but rather has $-x$. Moreover, the absolute sum of the negative values equals the sum of the positive values, irrespective of the number of countries and sectors, as can be easily verified. Hence, we expect the distribution of the ARCAs to be centered symmetrically around its stable mean, as required by criterion 2.

The empirical distribution of the ARCAs for the STIC-3 classification for the Netherlands and Poland (Hoen and de Mooij 2001) is shown for two different class sizes in Figs. 3 and 4.[6] They show that the Additive RCAs are indeed centered on zero and that the distribution resembles a bell shape irrespective of the class size chosen. Despite the bell shape, however, the data do not fit into a normal distribution, as the kurtosis of 27 is far too high; the distribution of the ARCAs is more peaked than that of a normal distribution with a kurtosis of 3. This indicates a

[6] In order to be comparable with the Figs. 1 and 2, Figs. 3 and 4 display the (central) 50 classes around zero. Figure 3 omits the ten most extreme values, and Fig. 4 omits the 108 most extreme values from a total of 528 Additive RCAs.

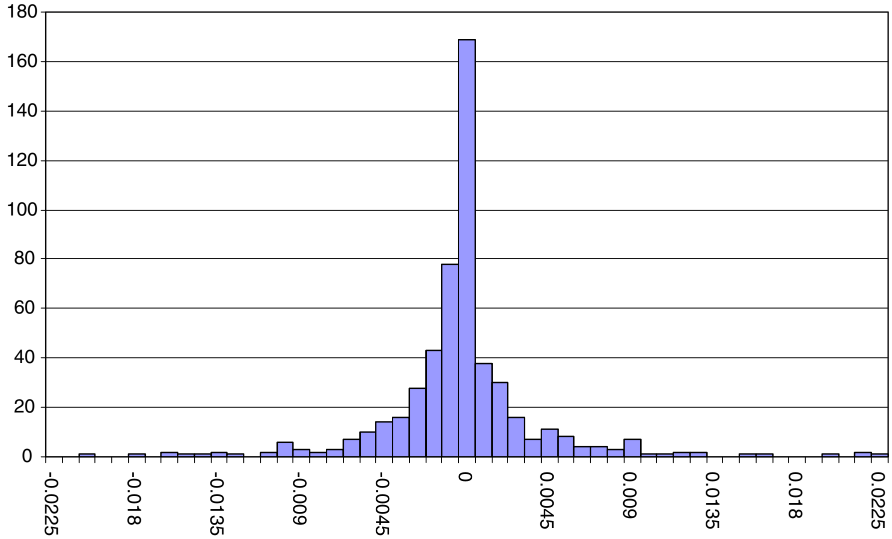

Fig. 3 Frequency of Additive RCAs for the Netherlands and Poland, with class size 0.0009

dominance of intra-industry exports, with only a few Dutch and Polish sectors having a strong comparative advantage or disadvantage compared to the exports of the reference EU-countries.

The normal distribution is widely used, and thus it appears attractive to have a distribution resembling it. There is, however, no explanation as to why a normal or even a bell-shaped distribution is better by definition. Many statistical distributions exist that do not have a bell shape and are perfectly suitable for statistical analysis.

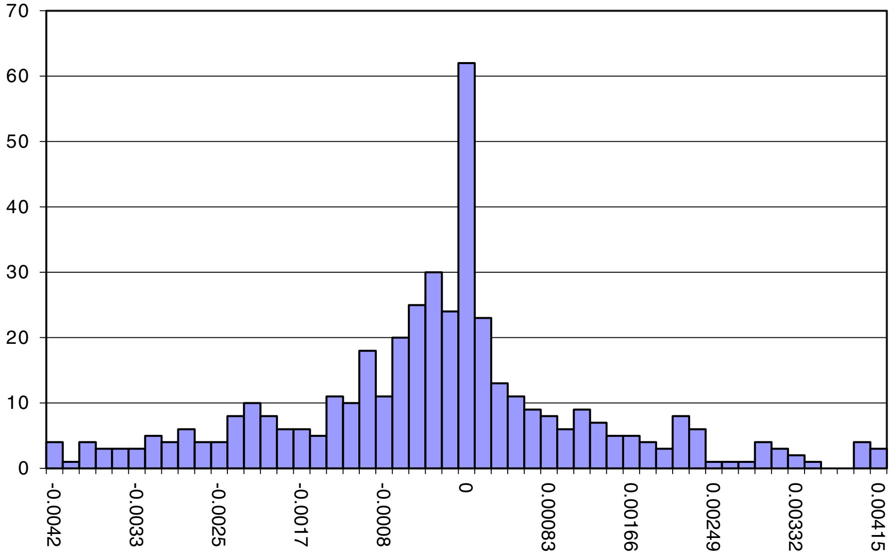

Fig. 4 Frequency of Additive RCAs for the Netherlands and Poland, with class size 0.000166

Therefore, criterion 3 and 4 did not refer to the shape of the distribution, but rather to its stability.

The shape of the distribution of the standard MRCA as discussed in Section 2 is influenced by factors that should have no influence, such as the number of countries in the reference group. The shape of the distribution of the MRCA moreover is highly sensitive to its extreme values. The core question therefore is whether or not the distribution of the ARCA is more stable. We begin by analyzing the effect of the number and classification of sectors on the distribution of the ARCA.

3.4 Number of sectors and the additive RCA

Unfortunately, the ARCA is also dependent of the size and the number of sectors, as follows from Table 2. As opposed to the standard MRCA, however, the minimum and maximum of the ARCA do not per definition decrease and increase with a finer sector classification. Nevertheless, Table 2 shows that a finer sector classification empirically leads to a gradually increased peaked distribution, as follows from the standard deviation that decreases continuously with the increasing number of sectors from SITC-1 to SITC-5. The statistics for the ARCA, however, do not appear as sensitive to the lacking export categories as do the statistics of the standard MRCA in Table 1. Furthermore, the median empirically soon becomes equal to the mean.[7] In all, these features give the ARCA a much more stable and more regular distribution than the standard MRCA if different sector classifications are used, as required by criterion 3.

The last rows of Table 2 show the empirical results of the Aggregate ARCA for the Netherlands and Poland for different sector classifications. Obviously, a finer sector classification captures a larger degree of export specialization, which makes this aggregate measure dependent on the sector classification. The important order difference in export specialization between the Netherlands (smaller) and Poland (larger), however, does appear to be independent of the sector classification.

3.5 Stability of the entire distribution

Finally, we test whether the distribution of the ARCA as a whole is more stable than that of the standard MRCA. The export data of Poland and the Netherlands are used to derive the empirical distributions of the additive and multiplicative RCAs for different years and different levels, and the χ^2-test is used to test whether these differences are significant. The distributions of the two RCAs are derived from the bilateral and total export data of the Netherlands for the years 1988, 1992 and 1997, and of Poland for the years 1992 and 1997, using the SITC-3 classification, which is the most detailed classification without empty commodity categories. Thus, we test the stability of the entire distribution of both RCAs with regard to time, space and type of export data. The results for the Additive RCA are displayed in Table 3 and those for the Multiplicative RCA can be seen in Table 4.

[7] Note that the SITC-1 classification only contains ten very aggregate commodity groups, which in general is too aggregate for a meaningful empirical analysis of comparative advantage.

Table 2 Statistics for additive RCAs for different sector classifications for 1997

	SITC-1	SITC-2	SITC-3	SITC-4	SITC-5
The Netherlands					
Minimum ARCA	−0.097	−0.074	−0.051	−0.053	−0.016
Median ARCA	0.007	0.000	0.000	0.000	0.000
Maximum ARCA	0.061	0.066	0.040	0.023	0.026
Standard deviation	0.049	0.017	0.007	0.003	0.001
Aggregate ARCA	0.182	0.333	0.399	0.453	0.464
Poland					
Minimum ARCA	−0.197	−0.056	−0.037	−0.038	−0.015
Median ARCA	0.003	0.000	0.000	0.000	0.000
Maximum ARCA	0.096	0.060	0.057	0.044	0.035
Standard deviation	0.084	0.018	0.007	0.003	0.002
Aggregate ARCA	0.284	0.356	0.452	0.526	0.585

Because 101 frequency classes are used, the outcomes are tested against an χ^2 distribution with 100 degrees of freedom. For the significance levels of 1 and 5% the critical values are 136 and 124, respectively (Kanji 1999, p. 75). Outcomes above these values indicate that the distributions are significantly different. The results in Table 3 show no significant differences between the distributions of the Additive RCA. Thus the distribution of the ARCA seems to be stable with regard to time, space and type of export data used, as required by criterion 4.

A comparison of Tables 3 and 4 shows that 40 of the 45 χ^2-values for the Multiplicative RCA are larger than the comparable values for the Additive RCA, indicating a lesser general degree of stability of the standard MRCA. The individual results in Table 4 show in greater detail that most of the distributions of the standard MRCA are unstable with regard to the type of data used, as 18 out of the 25 χ^2-values comparing bilateral exports with total exports are above the critical value of 124.

Although the data in Table 3 do not show significant differences between the distributions of the Additive RCA, this does not mean that the distributions are the same; different tests may lead to different outcomes. If the median test is used with a significance level of 5% (Kanji 1999, p. 83), results show that the additive distributions do differ with the type of export data used in 15 out of 25 cases. With the same export data they differ significantly in time and space in 3 out of 20 cases.

When applied to the standard MRCA, however, the median test shows larger differences than for the ARCA, in 42 out of 45 comparisons. By examining the MRCA separately, 21 out of 25 comparisons with different export data show significant differences. Moreover, with the same export data, significant differences exist with regard to space and time in 9 out of 20 cases. Thus, also with the median test, the distribution of the Additive RCA is significantly more stable than the distribution of the Multiplicative RCA, as required by criteria 1 and 4.

3.6 Relevance for policy makers

A final difference between the standard MRCA and the Additive RCA concerns the type of sector that each measure emphasizes. This difference is important for policy

Table 3 Outcomes of the χ^2-test for the Additive RCA distribution

		Total export data				
		The Netherlands			Poland	
		1988	1992	1997	1992	1997
Total export data						
The Netherlands	1988	–	–	–	–	–
	1992	52	–	–	–	–
	1997	59	57	–	–	–
Poland	1992	82	83	83	–	–
	1997	62	76	64	74	–
Bilateral export data						
The Netherlands	1988	95	100	98	82	84
	1992	76	79	74	72	73
	1997	74	75	76	88	76
Poland	1992	103	94	98	75	88
	1997	88	106	100	93	92
		Bilateral export data				
		The Netherlands			Poland	
		1988	1992	1997	1992	1997
Bilateral export data						
The Netherlands	1988	–	–	–	–	–
	1992	71	–	–	–	–
	1997	73	79	–	–	–
Poland	1992	74	69	83	–	–
	1997	74	78	76	73	–

makers, since the choice of which sectors to promote is influenced by the choice of index used. As we have already mentioned, the Multiplicative RCA is likely to have the most extreme values for the smaller sectors, due to the denominator effect. The Additive RCA will generally have larger values for the larger sectors, since these sectors tend to have larger export shares and thus potentially larger differences in export shares. Hence, the standard MRCA emphasizes the comparative advantage of the smaller sectors, whereas the Additive RCA emphasizes the (percentage-wise smaller) comparative advantage of the larger sectors. A policy maker who wants to identify and promote sectors that have large impacts on the economic system is therefore likely to prefer the ARCA, whereas a policy maker who wants to identify comparative advantage sectors without considering their economic impacts will prefer the standard MRCA.

4 Conclusion

This paper shows that the well known standard (multiplicative) index of revealed comparative advantage (MRCA) suggests that the ‘average sector’ has a (net) comparative advantage. Moreover, the mean of the MRCA becomes larger when a more detailed sector classification is used, while the distribution around the moving

Table 4 Outcomes of the χ^2-test for the standard MRCA distribution

		Total export data				
		The Netherlands			Poland	
		1988	1992	1997	1992	1997
Total export data						
The Netherlands	1988	–	–	–	–	–
	1992	72	–	–	–	–
	1997	78	76	–	–	–
Poland	1992	113	112	83	–	–
	1997	100	88	101	96	–
Bilateral export data						
The Netherlands	1988	185	174	171	128	126
	1992	119	127	110	73	84
	1997	132	125	120	83	100
Poland	1992	205	205	189	128	137
	1997	185	178	173	130	141
		Bilateral export data				
		The Netherlands			Poland	
		1988	1992	1997	1992	1997
Bilateral export data						
The Netherlands	1988	–	–	–	–	–
	1992	67	–	–	–	–
	1997	111	81	–	–	–
Poland	1992	66	98	113	–	–
	1997	91	87	113	60	–

mean of the MRCA is dependent on the number of countries analyzed. The same conclusions hold for the well known location quotient (LQ), which is used to measure the 'revealed attractiveness' of a certain region or country for the location of a certain industry. Most of these problems stem from the multiplicative specification of the MRCA and the LQ.

We therefore propose an Additive RCA (ARCA) and an Additive LQ with symmetric, bell shaped distributions between −1 and +1, and with a mean of zero which, by definition, is independent of the number and classification of the countries and sectors distinguished. Moreover, for a country as a whole, we propose an aggregate ARCA that runs from 0 to 1, respectively, indicating pure intra-industry trade and pure inter-industry trade. Finally, we show that to obtain a non-biased ARCA or Additive LQ, the country or region under consideration should be excluded from the group of reference countries or regions.

An empirical evaluation of the multiplicative and additive RCAs shows that the theoretically expected greater stability of the ARCA also shows up empirically. The distribution of the standard MRCA depends on the type of export data used (total or bilateral) and on space and time. Although the distribution of the additive index also depends on these factors, the magnitude of the dependence is significantly less than that of the multiplicative index.

For policy makers, the standard MRCA will still be of importance if they want to identify sectors with a comparative advantage without considering their economic impacts. If the size of the impact is important, policy makers should use the additive index, as it highlights the comparative advantage of the larger sectors.

Finally, this paper has only dealt with inter-country and interregional comparisons. However, comparable conclusions and suggestions may be made when, for inter-sectoral comparisons, one has to select a sectoral or an aggregate ‘spatial concentration index’ (Oosterhaven 1995). Such an index would, for example, compare world export patterns or world production patterns between industries, and would also run from zero (no spatial concentration at all) to 1 (complete spatial concentration in one single country).[8]

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[8] This Additive Spatial Concentration Index has much better properties than the widely used Herfindahl index, which aggregates squared shares (Herfindahl 1950). A major disadvantage of the Herfindahl index is that it has an unstable lower bound (perfect spreading) that depends on the number of countries used in the analysis, but this is a topic for another article.