Article

On Empirical Distribution of RCA Indices

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Abstract

Revealed comparative advantage (RCA) indices form an integral part of the application of trade theory. The indices help in identifying the comparative advantage or disadvantages of countries in various products and thus aid the policy makers in formulation of policies oriented towards export expansion. However, given the application of such indices as a cardinal or ordinal measure over time, an important question that arises is how reliable such indices are for the said purposes. In this regard, the stability of index distributions has important implications for applicability of the indices as a cardinal or ordinal measure over time. This article, therefore, makes an important contribution to the literature by trying to analyze the stability of empirical distributions of RCA indices and identify the index that would be most reliable as a cardinal or ordinal measure, among alternative RCA indices suggested in the literature.

Keywords

Revealed comparative advantage index, exports, imports, distribution, cardinal, ordinal, non-parametric tests.

Introduction

The revealed comparative advantage (RCA) index, originally proposed by Balassa (1965), is extensively used in the literature towards understanding the possibilities of gainful exchange of products amongst trading nations (Batra & Khan, 2005; Ekram, Huang and Tran, 2013; Hassan, 2013; Hiley, 1999; Karaalp, 2011; Kijboonchoo & Kalayanakupt, 2003; Smyth, 2005; Wignaraja, 2011). According to Ballance, Forstner and Murray (1987), the index should serve: (a) as a dichotomous measure to understand whether a country has a comparative advantage or disadvantage in a sector; (b) as a cardinal measure to compare the extent of a comparative advantage of countries (sectors) with respect to a sector (country); (c) as an ordinal measure to rank sectors (countries) with respect to a country (sector). However, application of the index for the latter two purposes necessitates the stability of the index distribution (through stable mean) over sectors or countries. Additionally, the stability of the distribution over time is also crucial for temporal comparison of the index values. Some of the existing literatures are however wary about the stability of distribution of Balassa index (Hoen & Oosterhaven, 2006; Yeats, 1985; Yu, Cai, & Leung, 2009). In fact, evidences of fluctuations in the arithmetic mean value for the distribution of Balassa index have been documented by Hoen and Oosterhaven (2006) and Hinloopen and Marrewijk (2001) in their respective studies.[1] Benedictis and Tamberi (2001, 2004) noticed the distribution of the Balassa index to be stable from 1986 to 1996 for France, but unstable for Italy, Germany and Japan. These evidences cast doubt on the findings of studies which applied Balassa's index for comparing sectors or countries or for temporal comparisons.

It is important to understand the implications of changing mean value over the usage of the index as a cardinal or ordinal measure or for over time comparison. With a symmetrical index distribution (about the value zero), if a country gains a comparative advantage in a sector, some other country must lose a comparative advantage in the

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same sector so that the country average for that sector remains constant at zero. Similar observations could be made about a country distribution across sectors. Such distributional feature facilitates the usage of the index as a cardinal measure. It follows, variable mean value is not suitable for using the index as a cardinal measure. Further, an unstable distribution produced by an unstable mean might imply that the same value for the Balassa index may have different meaning for different countries (while comparing index distributions for two countries across identical sectors) or different meaning for different sectors (while comparing index distributions for two sectors across identical countries). Thus, application of the index as an ordinal measure becomes unreliable. Additionally, if the distribution of index values across sectors for a country differs from year to year, then problem may arise in interpreting the index values over time. The comparative advantage theory is essentially ex-ante in nature, as inferences about post-trade scenario are drawn on the basis of pre-trade prices. In this respect, RCA indices must be fairly sticky over time for them to reflect the true comparative advantage of countries (Leromain & Orefice, 2014). According to Yu, Cai, & Leung (2009), stable mean value is essential for a meaningful time series analysis.

Recognizing the deficiencies with the Balassa index distribution, the literature suggested many modifications of the original index. The details on the distributions of such alternative indices are provided in Table A.1 in the Appendix. It is to be noted, some of the indices are based only on exports, while some are based on both exports and imports.

The skewness in the distribution of Balassa index will be evident from Table A.1. The alternatives to Balassa index were suggested to address the problems of asymmetry, non-normality and unstable mean, associated with the Balassa index. If the calculated index values exceed/fall short of unity (for Balassa index) or zero (for all other indices), the comparative advantage/disadvantage of a country in a sector will be revealed. As also evident from Table A.1, the stability in the calculated mean (equal to comparative advantage neutral point) across sectors (for a country in a year) or across countries (for a sector in a year) is noticeable for Normalized Revealed Comparative Advantage (NRCA) index only. Thus, the NRCA index is theoretically acceptable both as a cardinal/ordinal measure with respect to a country/sector. The Additive Revealed Comparative Advantage (ARCA) index, however, is theoretically more appropriate for usage as a cardinal measure, only with respect to a country, and as an ordinal measure, only with respect to a sector. This is because the index distribution has a stable mean only across sectors for a country in a year, but not across countries for a sector in a year. From the structure of the remaining five indices, it will be apparent that none of them feature stable distributions with stable sectoral (country) means over different countries (sectors) over time.

The contribution of the present article is to evaluate the empirical distribution of all seven indices presented in Table A.1 and determine the stability in their distributions over sectors, over countries and over time. An index with the most stable distribution over time, sectors and countries can reliably be used as a cardinal or ordinal measure, or for temporal comparison. We proceed in two ways. First, cumulative distribution plots and kernel density plots of various RCA indices have been compared over time. Similar analyses have been carried out by Benedictis and Tamberi (2001, 2004) and Hinloopen and Marrewijk (2001). They, however, restrict themselves to the distribution of the Balassa index only.

Graphical analysis of the index distributions has its own limitation. As a result, several non-parametric methods, for example, Wilcoxon's signed rank (SR) test, Wilcoxon's rank sum (RS) test and Kolmogorov–Smirnov (KS) test have been used to test the statistical shifts of the distributions over different dimensions. Although Benedictis and Tamberi (2004) in their article make use of the SR test, they restrict themselves to the examination of the stability in distribution of Balassa index over time for separate countries only. We perform the test for separate sectors as well. Analyzing the stability of the sectoral/country index distributions over countries/sectors for a particular year, using Wilcoxon's RS test and KS test, has not been performed in the past.

We consider the non-parametric methodology to be essential as many of the indices are non-normally distributed.

To the best of our knowledge, such a comprehensive study on the empirical distributions of RCA indices is lacking in the literature. The existing studies on empirical distributions of Balassa's RCA index have a limited coverage. By making a detailed analysis of the indices, the major contribution of the article is to seek for an 'ideal' index which will be stable over time and will have desirable cardinal and ordinal properties. Such an index should be preferable for a comparative analysis and policy makers must, therefore, refrain from ad hoc usage of Balassa index. Given the data set, a careful analysis shows that, among all indices, the NRCA index possesses such desirable properties.

The article is divided into the following sections. The data and methodology are described in the next section, followed by the results section. The final section concludes the article.

Methodology and Data

Before analyzing the stability of the empirical distributions of each RCA index, a preliminary analysis on the yearly cumulative distributions and summary statistics on each index are presented. Three years—1998, 1999 and 2000—have been selected due to the largest set of common country observations on sectoral exports. The sample for each year consists of all countries and sectors.

The distribution of the indices are, next, graphically analyzed using cumulative distribution plots and the corresponding probability density functions represented by kernel density plots, for a number of countries for each particular year. Graphical analysis provides a preliminary guide to the stability of index distributions over years. As already discussed, the stability of index distributions over time is required to provide valid interpretations to the index values. The methodology of graphically illustrating the stability of index distributions through cumulative distribution plots or kernel density plots is based on Hinloopen and Marrewijk (2001) and Benedictis and Tamberi (2001, 2004). Hinloopen and Marrewijk (2001) plotted the cumulative distributions for the index of Balassa for 12-member nations of European Union grouped together. Benedictis and Tamberi (2001, 2004) plotted the kernel density distributions for the index of Balassa for France, Germany, Italy and Japan. The current study, in order to provide a more intensive evaluation of the distribution plots, will make use of country-specific samples. Consideration of a group of countries, as done by Hinloopen and Marrewijk, fails to reveal the variations in distribution plots due to country heterogeneity. Thus, the country sample of Benedictis and Tamberi will be considered in this article. Apart from the mentioned set of developed countries, two other emerging developing economies—China and India—will be considered in this article. Selection of these two specific developing countries is driven by their significant shares in the world population and GDP growth rates. It must also be noted that China, France, Germany, Italy and Japan were placed among the top 10 countries with the largest shares in the world exports of manufactures, according to the data for 1998, 1999 and 2000 from Trade, Production and Protection (TPP) database, 1976–2004 by Nicita and Olarreaga (2007). India, although not among the top ten, is often considered to be a competitor of China in exports of many labour-intensive manufactures (Dimaranan, Ianchovichina, & Martin, 2007). Nevertheless, our intention is to keep the sample of countries as heterogeneous as possible, even if it implies including a country which is not a big player in merchandise trade.[2]

The cumulative distributions plotted for three separate years for each country and each index helps to study the shifts in the empirical distributions of the indices. Kernel density plots, apart from exhibiting the shifts in distributions over time, throw an additional light towards the degree of asymmetry in data. While a graphical analysis of the data through cumulative distribution and kernel density plots helps in determining the changes in distributions of the considered RCA indices over time, the data must further be analyzed to understand the statistical significance of those changes. A two-tailed Wilcoxon's SR test is used for the purpose. Wilcoxon's (1945) SR test is a nonparametric test which tests for differences in distributions between two paired samples. The null hypothesis for the test consists of equal distributions through equal means or medians, while the alternative hypothesis relates to unequal distributions through unequal means or medians.

The stability analysis can also be performed with respect to countries and sectors of any particular year to determine the usefulness of the RCA indices as a cardinal or ordinal measure. Since comparisons of country distributions over different sectors or sectoral distributions over different countries involve non-paired data, Wilcoxon's (1945) RS test rather than SR test would be appropriate for determining the statistical significance of shift in distributions over sectors or over countries. The RS test tests for the hypothesis that the two independent samples are drawn from two populations which share similar distributions. Acceptance of the null hypothesis of similar distributions over sectors or countries, therefore, would provide evidence in favour of the usage of the index as a cardinal or ordinal measure.

Departures from null hypothesis that the RS test tries to test are the location shifts of the distributions, which under the assumption of identically-shaped distributions imply testing for differences in means or medians.

To perform a robustness check on the performance of RCA index distributions over sectors or over countries, another non-parametric test, the KS test is considered. This test pertains to unpaired samples and hence is not suitable for analyzing the empirical distributions over time. The *KS* test examines the null hypothesis of equal distributions against the alternative hypothesis of unequal distributions, by considering the maximum difference between two cumulative distributions. As pointed out by Lehmann (2006), although the test is based on actual observations, it is similar to an analysis of ranks as ranking all the observations will not change the maximum difference between the cumulative distributions.

The Wilcoxon's RS test, as previously discussed, detects shifts in distributions due to changes in mean or median. The KS test detects shifts in distributions due to changes in mean or median, standard deviation, presence of outliers, differences in skewness or kurtosis, number of modes, etc.

Hence, if the KS test reports statistically significant changes in distributions, it could be due to any one or more factors noted.

While discussing the methodology, one needs to note the problems associated with the structure of the Balassa index. Due to the asymmetric distribution of the Balassa index, using the arithmetic mean to identify the performance of the average sector or average country can be doubtful. For distributions skewed to the right, arithmetic mean tends to assign more weight to the sectors with index value exceeding unity than to sectors with index value less than unity (Bendictis & Tamberi, 2001). As a result, a country can be interpreted to have a comparative advantage in the average sector (on computing the mean across sectors for a country in a year) or an average country will have a comparative advantage in any sector (on computing mean across countries for a sector in a year). According to Benedictis and Tamberi (2001), such interpretations are of little significance. In fact, under such circumstances median will be a better indicator, as it is less than mean for a rightly skewed distribution, and further unlike mean, it is not influenced by extreme values. However, such problems may not arise with other indices whose theoretical distributions are symmetric. Nevertheless, while analyzing the stability of index distributions in this article, we not only resort to non-parametric methods but also graphical analysis. As described, non-parametric methods consider the stability of means as well as medians. Graphical analysis such as cumulative distribution plots rely on many parameters rather than on mean alone.

The necessary data from 60 countries on exports and imports of 28 manufacturing sectors, classified on the basis of 3-digit International Standard Industrial Classification of All Economic Activities (ISIC) (revision 2) for the years 1998, 1999 and 2000, are collected from the TPP database, 1976–2004 by Nicita and Olarreaga (2007).

Discussion of Results

The results of the analysis are discussed in this section.

Discussions on the Summary Statistics and Graphical Analysis

Summary Statistics

Table A.2 in the Appendix presents the cumulative distributions and the summary statistics for each of the years 1998, 1999 and 2000, for the Balassa, Revealed Symmetric Comparative Advantage (RSCA) and Additive Revealed Comparative Advantage (ARCA) indices. Table A.3 in the Appendix reports the similar statistics for the same three years for the NRCA, Log-of-Balassa, Relative Trade Advantage (RTA) and Revealed Competitiveness (RC) indices. The sample for each index in each year includes 60 countries and each country has 28 sectoral observations.[3]

In Tables A.2 and A.3, p-1 to p-99 are the percentile points and they give detailed information on cumulative distributions of the RCA indices. A value of 0.252 corresponding to the p-25 point for the index of Balassa, in the year 1998, signifies that 25 per cent of the observations have index values below 0.252 and 75 per cent of the observations have index values above 0.252. The differences in percentiles between the years for Balassa index in Table A.2 do not seem to be very significant. Thus, the cumulative distributions can be regarded as stable over time for the Balassa index. Similar observations can be made about the cumulative distributions of the other indices reported in Tables A.2 and A.3.

Considering the summary statistics for the index of Balassa in Table A.2, the computed arithmetic mean is above the comparative advantage neutral point of unity with minor fluctuations over time. The levels of skewness and kurtosis for all the three years are well beyond the demarcated values of 0 and 3 for a symmetrical normal distribution. The mean value of 1.287 greater than the median value of 0.659, for the year 1998, implies the distribution is skewed to the right and this holds true for the other years also. The median also does not seem to fluctuate to a significant extent. In case of RSCA index in Table A.2, the arithmetic means are different from the comparative advantage neutral point of zero, but they seem to be quite stable over the years. The extent of asymmetry in the distribution and the degree of ‘peakedness’ are also not high. In fact, they are closer to the prescribed value of 0 and 3 for a normal distribution. The means and the medians, although not equal to each other, do not seem to differ to a significant extent. Thus, the empirical distribution of the RSCA index is almost at par with its theoretical distribution. For the ARCA index in Table A.2, the mean does not significantly differ from the comparative advantage neutral point of zero for each year. The median is also observed to be quite stable over the years. The measures on skewness and kurtosis, though not as large as that of Balassa index, are certainly greater than that of RSCA index and are quite different from the prescribed values of 0 and 3 for a normal distribution. Almost similar conclusions emerge while analyzing the summary statistics of the NRCA index in Table A.3, although it seems to be more symmetrically distributed compared to the ARCA index. Greater asymmetry in the empirical distribution of the

ARCA index is probably due to its theoretical structure which ensures that its distribution across sectors will be symmetric. But the same need not follow in case of its distribution across countries. Both Log-of-Balassa and RC indices in Table A.3 report minor fluctuations in arithmetic mean and median values over time. The computed means are also different from the comparative advantage neutral point of zero to some extent. Taking into consideration the levels of skewness and kurtosis and also minor differences between the means and medians for each of the two indices, the empirical distributions of both Log-of-Balassa and RC indices can be conceived to be a little close to a normal distribution. However, their performance in this respect is still short of the RSCA index. Like most indices, the RTA index in Table A.3 records minor fluctuations in the mean and median values over time, which implies the overall stability in its distributions. The levels of skewness and kurtosis recorded by the RTA index are higher than all, but the index of Balassa. Additionally, the mean values for each year being greater than the median confirms the fact that in general the distributions are skewed to the right. Thus, in contrast to its theoretical distribution, the empirical distribution of the RTA index is not symmetrically distributed.

Therefore, an analysis of Tables A.2 and A.3 suggests that over time the empirical distributions are quite stable for the RCA indices. The empirical distribution of the RSCA index seems to be most well behaved, for not only it is stable over time but also approximately normal. The Log-of-Balassa index and RC index also presumably fit into the category of normal distribution, but certainly not as well as the RSCA index. The NRCA index, although characterized by a stable symmetrical empirical distribution, cannot be considered to be normally distributed. Among the indices analyzed, only the ARCA index and the NRCA index report means substantially close to their comparative advantage neutral points, thus providing easier interpretation to the average sector or country.

Graphical Analysis

The findings corresponding to each index in Tables A.2 and A.3 relate to all countries and all sectors for each particular year. The cumulative distribution plots and the kernel density plots across 28 sectors, to be considered subsequently, are specific to a single country and represent the shifts in distributions over 1998, 1999 and 2000 in case of each index. The countries sampled for analysis include China, France, Germany, India, Italy and Japan. The cumulative distribution plots for China are presented in the figures in Figure A.1 in the Appendix. The plots for other countries can be provided on request. We, however, here discuss the findings corresponding to all countries in details.

Contrary to the findings in Table A.2, and as also claimed by Hinloopen and Marrewijk (2001), variability in cumulative distributions of Balassa index to a certain extent are observed for the considered sample. Only for France, the cumulative distributions for the Balassa index are similar to the extent that they are almost indistinguishable for each year. The RSCA index has quite noticeable variations in the distributions over the years for India. For other countries, the distributions seem to vary over time, but the differences do not appear to be as large as is noticed in the case of India. The ARCA index exhibits a noticeable stability of distributions over the years, particularly for Germany, France and Japan. Similar observations could be made about the NRCA index. For other countries, both the indices report very insignificant variations in distributions over time. The Log-of-Balassa index does not seem to perform well in generating stable distributions over the years, as observed in the case of China, Germany, India and Japan. For Italy and France, the index, however, exhibits better performance. The distributions for RTA index can also be distinguished from year to year, except for France. A similarity in distributions of RC index over three years is only observed for Italy, and over 1998 and 1999 for France. Thus, based on the findings, among all the seven indices analyzed, the cumulative distribution plots reveal reliability of comparing the ARCA and NRCA index values for a country over time. The cumulative distributions presented in Tables A.2 and A.3, however, represent all of the indices to be largely stable over time.

The kernel density plots for China are illustrated in the figures in Figure A.2 in the Appendix. As in the case of cumulative distribution plots, we do not present the kernel density plots for other countries. We do, however, provide here a detailed analysis on the generated plots of all countries.[4] The Epanechnikov kernel function, which is the default function in Stata is used for the estimation of densities and is the most efficient in minimizing the mean integrated squared error (StataCorp, 2013).[5] Since the kernel density plots are not compared across countries for any particular index, need is not felt for keeping the bandwidth same for every country for each index, as done by Benedictis and Tamberi (2004).

For each index, the comparative advantage neutral point is considered to depict a fixed demarcation value and shifts in density functions with reference to that demarcation point is noted to determine the stability of the density functions. For all the countries, excepting Germany and Japan, the density plot for the Balassa index is skewed to the right. The shifts in density plots to the right of the demarcation point of 1 over the years, though not so explicit but to a certain extent, are observed for Germany, India and Italy. In the case of India and Italy, the shifts are particularly apparent for the year 2000 and for Germany for the year 1999, although there is some amount of ambiguity in the shifts of the plots. Tests of significance which are to be considered in the next section will be able to determine statistical significance of the shifts. The shift of the plots to the right indicates an increase in the number of sectors with index value greater than 1. The plots for RSCA index are largely symmetric in the case of France. Shifts in the density functions for RSCA index over the years to the right of the demarcation point of zero are most visible for India, and to some extent for Germany. The ARCA and NRCA indices do not exhibit any significant shifts in the density plots. They also seem to be largely symmetric around the demarcation point of zero with exceptions in the case of Japan and Italy. The Log-of-Balassa index generates an apparently symmetrical probability density function only in the case of France, for in other cases some amount of skewness towards the left is observed. Shifts in the density functions to the right of the demarcation point of zero are apparent for India. However, the shape of the function for 1998 differs to some extent from that of the years 1999 or 2000 for India. The RTA index features some amount of asymmetry in its density plots, particularly for China, Japan and Germany. Such observed asymmetry in the empirical distribution of the RTA index was also noted in Table A.3, although theoretically the index is supposed to be symmetrically distributed about the value zero. Shifts in density plots towards left and towards right are observed for Germany and for Japan, respectively. The RC index is characterized by asymmetry in its density functions and the shifts do not seem to be significant over time.

Thus, the graphical analysis produces some contradictory results as compared to the results emerging from Tables A.2 and A.3. The differences are expected as the Tables A.2 and A.3 relate to all countries and all sectors together, while the graphical analysis relates to a particular country and, hence, are more relevant for case-by-case policy analysis. In this respect, both NRCA and ARCA indices being generally characterized by stable symmetrical empirical distributions across sectors is no anomaly. Both the kernel density plots and summary statistics in Tables A.2 and A.3, however, agree to the fact that the distributions of both the indices are far from being normal. Nevertheless, for cross-country, cross sector or cross time comparisons, distributions of RCA indices need not be normal. Asymmetrical empirical distributions of RSCA index, Log-of-Balassa index and RC index in case of some kernel density plots, although not apparent from Tables A.2 and A.3, are a noteworthy fact and could be attributed to country-specific behaviour of data.

Discussion of Results for the Tests of Significance

Results for Wilcoxon's SR Test

The results of graphical analysis are reinforced by Wilcoxon's SR test in this subsection. The same six countries selected for graphical analysis—China, France, Germany, India, Italy and Japan—and the three years—1998, 1999 and 2000—are considered. Since the Wilcoxon's SR test permits comparison of only two samples at a time, the three years are considered in a group of two, in order to run the test. For each country in each year, the number of sectors is 28. Table A.4 in the Appendix reports the standardized normal approximation of the test statistics and the corresponding p values for each country and index. The numbers of accepted cases for null hypothesis for each country, as well as for all countries together for each index, are also reported. Based on the combination of years, for each index and country, the number of cases analyzed is three. The reported numbers of cases where the null hypothesis gets accepted for each country in Table A.4 are out of those three cases. Based on the combination of years and number of countries, the total number of cases analyzed is 18 for each index. The reported number of cases where the null hypothesis gets accepted for all countries together is out of those 18 cases.

As evident from Table A.4, null hypothesis gets rejected mostly for India and then for Italy. But for all other countries, the test reports stable distributions over time for each of the indices considered. The results, therefore, differ to some extent from the drawn inferences from cumulative distribution plots and kernel density plots. The SR test seems to project that many of the differences noticed with cumulative distribution plots and kernel density plots are not, in fact, statistically significant. Particularly, in case of cumulative distribution functions, shifts in distributions are observed for RTA and RC indices for most countries, but the SR test posit such shifts to be statistically insignificant. Shifts in cumulative distribution functions are also noted with Log-of-Balassa index for China, Germany and Japan and to no extent for Italy. But the SR test reveals the shifts to be statistically insignificant for China, Germany and Japan, but significant for Italy. On the basis of kernel density plots for Balassa index, shifts in distributions are noted for Germany, India and Italy. The SR test, however, reports the shifts to be statistically insignificant for Germany, but significant for India and Italy. Shifts in kernel density plots were also noted in case of Germany for RSCA index and in case of Germany and Japan for RTA index. But the SR test does not show the shifts to be statistically significant. For India however, there seems to be some parity in the graphical analysis and the test of significance. Both graphical analysis and SR test agree to the fact that ARCA index and NRCA index are the most stable over time. The RC index is also found to be as stable as the ARCA index or NRCA index on the basis of SR test, but the same is not supported by cumulative distribution plots, although to some extent by kernel density plots. This could be attributed to the fact that the shifts in kernel density plots are more in line with the shifts in the means of two distributions. Since the SR test studies the shifts in the means of two distributions, the results of kernel density plots and SR test could be expected to coincide. Hence, although Yu, Cai, & Leung (2009) argued the distribution of the NRCA index to be time invariant, based on the analysis in this subsection, the ARCA index and RC index are found to be equally good substitutes for the NRCA index. However, the comparison of Balassa index values over time must be done with care.

Next, we repeat the above exercise for separate sectors. To test the stability of the country index distributions over years for separate sectors using the SR test, seven sectors are selected. The selected seven sectors have the following ISIC codes—321 (textiles products), 322 (wearing apparel except footwear), 323 (leather products, leather substitutes and furs), 324 (footwear), 351 (industrial chemicals), 352 (other chemical products) and 385 (professional, scientific and measuring equipments). For each sector in each year the number of countries is 60. Table A.5 in the Appendix reports the standardized normal approximations of the test statistics and the corresponding *p* values for each sector and index. The numbers of accepted cases for null hypothesis for each sector as well as for all sectors together are also reported. Based on the combination of years and number of sectors, the total number of cases analyzed is 21 for each index. The reported number of cases where the null hypothesis gets accepted for all sectors together is out of those 21 cases.

The findings of Table A.5 are to some extent different from that of Table A.4. The NRCA index is clearly found to be superior to any other index. Thus, it features the most stable distribution over time for different sectors. Although ARCA and RC indices are found to be as good as the NRCA in Table A.4, the same does not hold in Table A.5.

Results for Wilcoxon's RS Test

To evaluate the stability of index distributions over sectors and over countries, the Wilcoxon's RS test is used. Tables A.6 and A.7 in the Appendix report the numbers of cases where the null hypotheses of equality of distributions over sectors and over countries, respectively for each index are accepted. Since, the RS test permits testing the distributions of only two samples at a time, the test is performed by considering two sectors or two countries at a time. As considered in Table A.5, results corresponding to only seven sectors are presented in Table A.6. The sectors being considered in a group of two for the test and the numbers of reported cases for acceptance of null hypothesis are out of a total of 21 cases for each index. For each sector, the number of countries is 60. In Table A.7, results corresponding to the previously considered six countries are presented. The countries being considered in a group of two for the test and the numbers of reported cases for acceptance of null hypothesis are out of a total of 15 cases for each index. For each country the number of sectors is 28. The results are reported in Tables A.6 and A.7 for the year 2000 only.

In Table A.6, the NRCA index is found to be the most stable over sectors. In fact, the results presented in Table A.6 are consistent with the observation that the arithmetic mean of the country index values is stable over sectors (with a fixed value of zero), only for the NRCA index. Hence, the stability of the mean implies that the NRCA index can reliably determine the extent of comparative advantage of one country over another in a sector and also rank different sectors for a country reliably.

As per the results reported in Table A.7, the ARCA index is found to be most stable over countries. In confirmation with its theoretical structure, the results corresponding to the ARCA index is as expected. The NRCA index marginally falls short of the ARCA index, in terms of the stability of empirical distributions. Thus, taking into consideration the results presented in Table A.7, the ARCA index is reliable as a cardinal measure with respect to a country and as an ordinal measure with respect to a sector. The NRCA index may feature a theoretically stable mean of zero across sectors. But, it might not be as reliable as the ARCA index as a cardinal measure with respect to a country or as an ordinal measure with respect to a sector. As observed in Table A.7, the larger cases of rejection of the null hypothesis are noted for the other indices and this directly follows from the fact that the arithmetic mean of these remaining indices vary from country to country.

Robustness Check Using KS Test

The Wilcoxon's RS test results corresponding to Tables A.6 and A.7 are compared with the KS test results reported in Tables A.8 and A.9 in the Appendix.

Compared to Table A.6, fewer cases for acceptance of the null hypothesis are reported in Table A.8 for all indices. However, the NRCA index still continues to be featured by the most stable empirical distribution over sectors. Hence, both the RS and KS tests agree to the fact that the NRCA index is the most reliable as a cardinal measure with respect to a sector and as an ordinal measure with respect to a country. It would be possible to note from the tables that the values of the test statistics are same for the Balassa index, RSCA index and Log-of-Balassa index for each group of sectors, for both tests. Since, both the RS and KS tests are based on the ranks of the observations, the test results are unaffected by changes in the scale of the variables. The RSCA and Log-of-Balassa indices being quasi logarithmic and logarithmic transformations of the Balassa index, respectively, involve changes in the scale of the variables and that would not alter the RS or the maximum difference between the cumulative distributions of the indices. Upon analyzing Tables A.6 and A.8, one cannot ignore a few cases where the test statistic for the KS test is statistically insignificant, but is significant in the case of Wilcoxon's RS test.[6] This could be attributed to the fact that compared to the RS test, the KS test is based on many parameters that contribute to deviations from the null hypothesis. Therefore, the KS test has less power to detect a change in distribution exclusively due to a shift in the mean or median, but has more power to detect changes in the shape of the distribution (Lehman, 2006). Following this argument, the cases where the null hypothesis of equality of distribution gets rejected in case of both, the KS and Wilcoxon's RS tests, are probably those cases for which changes in population distributions are not only due to shifts in location but also due to the shape. The cases where the null hypothesis is rejected by the Wilcoxon's test but accepted by the KS test are those where the population distributions have almost similar shapes but differ with respect to their location, which implies differing means or medians. And finally, the cases where the null hypothesis is accepted by the Wilcoxon's test but rejected by the KS test are probably those where population distributions have differing shapes but similar means or medians.

In Table A.9, the numbers of accepted cases for null hypothesis of equality of distributions are same as in Table A.7 for all, but the indices of the NRCA and RC. The ARCA index continues to remain the most stable index over countries as in Table A.7. Thus, the stability of its distribution ensures the index could be used as a cardinal measure with respect to a country and as an ordinal measure with respect to a sector. It would be possible to note that the null hypothesis is rejected by the Wilcoxon's test, but accepted by the KS test while analyzing the equality of population distributions in case of China and Japan for the indices of Balasssa, RSCA, Log-of-Balassa and RTA. Similar observations are also noted for the country combinations—Germany and Italy (for the indices of Balassa, RSCA and Log-of-Balassa), India and Japan (for RTA index), and Italy and Japan (for the indices of RTA and RC). As previously argued, this could be attributed to the potentiality of the KS test to identify more changes in the shape of the distributions rather than their locations.

Although the conclusions that emerge from both the RS and KS tests do not differ, it seems that changes in the distributions of indices, due to changes in the mean, will be more relevant for the study under consideration. Changes in the mean value for a particular index have important implications for the usage of the index as a cardinal or as an ordinal measure. In this respect, the shifts in distributions exclusively due to the changes in the arithmetic mean must be considered more important than the shifts in distributions which can be due to the changes in the mean or standard deviation or skewness or kurtosis. Hence, preference can be assigned to results corresponding to the Wilcoxon's RS test, which reports the NRCA index to be most stable over sectors and the ARCA index to be the most stable over countries. However, since the NRCA index only marginally falls short of the ARCA index while analyzing the stability of the index distributions over countries using Wilcoxon's RS test, one can consider the NRCA index as good as the ARCA index.

Conclusion

The empirical distributions of the RCA indices are analyzed in this article with the primary objective of identifying an 'ideal' index. The country- and sector-specific results, which are more relevant for policy analysis, uphold the superiority of the NRCA index over all other indices taken up for examination in this article. Thus, the index could be used as an ordinal measure for ranking sectors with respect to a country or for ranking countries with respect to a sector. The index could also be used as a cardinal measure for comparing countries with respect to a sector or for comparing sectors with respect to a country. Further, its empirical distribution is time stable, which ensures the usage of the index for time series analysis. The original RCA index of Balassa and all other subsequently suggested modifications of the Balassa index could not compete with the NRCA index in these respects. However, one major drawback of the NRCA index is its non-normal distribution which, although not required for usage of the index as a cardinal or ordinal measure, is definitely essential in case of parametric tests necessitating normally distributed errors.

Our data analysis, therefore, throws light on the fact that widespread use of the Balassa index for comparative analysis is a matter of concern. The results generated through the usage of the Balassa index as a cardinal or ordinal measure should be cautiously interpreted. The index, however, is as reliable as any other index in the identification of sectors, in which countries have comparative advantage or disadvantage, as every other index is an additive or ratio transformation of the Balassa index. Perhaps that is the reason behind widespread usage of the Balassa index despite the problems associated with its distribution. Nevertheless, future researchers attempting to determine relative position of sectors or countries through the use of Balassa index should recognize the feasibility of such studies.

The conclusions drawn in this article are dependent upon the data set used. An extension of data set both in terms of time and, sectors and countries will enable a more detailed analysis on the empirical distributions of the RCA indices.

Appendix

Table A.1. RCA Index Specifications[7]

Index	Proposed By	Formula	CA Neutral Point	Limit	Proposed Improvement in Distribution
Balassa	Balassa (1965)	$\frac{X_a^i/X_t^i}{X_a^w/X_t^w}$	1 (approx)	$[0, +\infty]$	Asymmetric, non-normal
Revealed Symmetric Comparative Advantage (RSCA)	Dalum, Laursen and Villumsen (1998) and Laursen (1998)	$\frac{\frac{X_a^i/X_t^i}{X_a^w/X_t^w}-1}{\frac{X_a^i/X_t^i}{X_a^w/X_t^w}+1}$	0 (approx)	$[-1, +1]$	Symmetric–induces normality
Additive Revealed Comparative Advantage (ARCA)	Hoen and Oosterhaven (2006)	$\frac{X_a^i}{X_t^i}-\frac{X_a^w}{X_t^w}$	0 (approx)	$(-1, +1)$	Symmetric, stable arithmetic mean across sectors
Normalized Revealed Comparative Advantage (NRCA)	Yu et al. (2009)	$\frac{X_a^i}{X_t^w}-\frac{X_t^i}{X_t^w}\frac{X_a^w}{X_t^w}$	0	$\left[-\frac{1}{4}, +\frac{1}{4}\right]$	Symmetric, stable arithmetic mean across sectors and countries
Log-of-Balassa	Vollrath (1991)	$ln\frac{X_a^i/X_t^i}{X_a^w/X_t^w}$	0 (approx)	$[-\infty, +\infty]$	Symmetric–induces normality
Relative Trade Advantage (RTA)	Vollrath (1991)	$\frac{X_a^i/X_t^i}{X_a^w/X_t^w}-\frac{M_a^i/M_t^i}{M_a^w/M_t^w}$	0	$(-\infty, +\infty)$	Incorporates both demand and supply aspects; symmetric
Revealed Competitiveness (RC)	Vollrath (1991)	$ln\frac{X_a^i/X_t^i}{X_a^w/X_t^w}-\frac{M_a^i/M_t^i}{M_a^w/M_t^w}$	0	$(-\infty, +\infty)$	Incorporates both demand and supply aspects; symmetric–induces normality

Notes: The approximate values for the comparative advantage neutral points for the indices of Balassa, RSCA, ARCA and Log-of-Balassa arise due to the inclusion of all countries and all commodities in the reference group. If the reference group is the rest of the world, the comparative advantage neutral points will be exactly equal to 1 or 0. The calculation of the limits will be available on request.

Table A.2. Balassa/RSCA/ARCA Index: Entire Sample Analysis

Summary Statistics/Year	Balassa			RSCA			ARCA		
	1998	1999	2000	1998	1999	2000	1998	1999	2000
p-1	0.0004	0.001	0.001	**–0.999**	**–0.997**	**–0.998**	–0.161	–0.163	–0.169
p-5	0.022	0.028	0.024	**–0.957**	**–0.946**	**–0.953**	–0.119	–0.118	–0.110
p-10	0.067	0.069	0.068	**–0.874**	**–0.870**	**–0.873**	–0.033	–0.034	–0.034
p-25	0.252	0.253	0.250	**–0.598**	**–0.596**	**–0.600**	–0.013	–0.013	–0.014
p-50	0.659	0.647	0.652	**–0.205**	**–0.215**	**–0.211**	–0.003	–0.003	–0.003
p-75	1.335	1.349	1.363	**0.143**	**0.148**	**0.154**	0.005	0.005	0.005
p-90	2.889	2.910	2.819	**0.486**	**0.489**	**0.476**	0.035	0.034	0.035
p-95	4.228	4.346	4.486	**0.617**	**0.626**	**0.635**	0.076	0.078	0.079
p-99	10.040	10.312	11.941	**0.819**	**0.823**	**0.845**	0.307	0.307	0.315
Maximum Value	104.720	113.179	112.484	**0.981**	**0.982**	**0.982**	0.705	0.789	0.729
Mean	1.287	1.320	1.367	**–0.207**	**–0.203**	**–0.202**	0.00001	0.00001	0.00001
Standard Deviation	3.270	3.486	3.773	**0.484**	**0.484**	**0.488**	0.070	0.070	0.069
Skewness	20.314	21.092	18.121	**0.178**	**0.198**	**0.170**	3.590	3.545	3.362
Kurtosis	605.506	640.876	476.159	**2.133**	**2.148**	**2.128**	30.182	31.381	29.350
No. of Observations	1677	1677	1677	**1677**	**1677**	**1677**	1677	1677	1677

Source: Authors' calculations.

Table A.3. NRCA/Log-of-Balassa/RTA/RC Index: Entire Sample Analysis

Summary Statistics/Year	NRCA			Log-of-Balassa			RTA			RC		
	1998	1999	2000	1998	1999	2000	1998	1999	2000	1998	1999	2000
p-1	–0.002	–0.002	–0.002	**–6.527**	**–5.904**	**–6.132**	–4.404	–4.027	–4.736	**–6.362**	**–5.881**	**–5.798**
p-5	–0.001	–0.001	–0.001	**–3.671**	**–3.520**	**–3.631**	–1.351	–1.504	–1.401	**–3.420**	**–3.274**	**–3.414**
p-10	–0.0003	–0.0003	–0.0003	**–2.648**	**–2.627**	**–2.662**	–0.987	–1.014	–1.040	**–2.358**	**–2.254**	**–2.351**
p-25	–0.0001	–0.0001	–0.0001	**–1.364**	**–1.367**	**–1.383**	–0.601	–0.608	–0.610	**–1.096**	**–1.148**	**–1.140**
p-50	–0.00001	–0.00001	–0.00001	**–0.413**	**–0.434**	**–0.425**	–0.201	–0.200	–0.197	**–0.313**	**–0.304**	**–0.322**
p-75	0.00001	0.00001	0.00001	**0.295**	**0.301**	**0.319**	0.381	0.371	0.349	**0.416**	**0.396**	**0.385**
p-90	0.0002	0.0002	0.0002	**1.061**	**1.068**	**1.036**	1.720	1.745	1.692	**1.398**	**1.384**	**1.360**
p-95	0.0008	0.0008	0.0008	**1.442**	**1.469**	**1.501**	3.373	3.420	3.471	**2.092**	**2.103**	**2.009**
p-99	0.003	0.003	0.003	**2.307**	**2.333**	**2.480**	9.035	9.412	10.440	**4.140**	**3.858**	**3.917**
Maximum Value	0.008	0.009	0.008	**4.651**	**4.729**	**4.723**	61.144	69.308	66.721	**6.949**	**6.877**	**7.035**
Mean	< 0.00001	< 0.00001	< 0.00001	**–0.674**	**–0.652**	**–0.672**	0.227	0.249	0.268	**–0.423**	**–0.418**	**–0.446**
Standard Deviation	0.001	0.001	0.001	**1.610**	**1.569**	**1.642**	2.673	2.835	3.154	**1.722**	**1.656**	**1.691**
Skewness	2.262	2.322	2.252	**–1.275**	**–1.127**	**–1.324**	9.552	11.065	10.339	**–0.608**	**–0.503**	**–0.760**
Kurtosis	36.507	40.212	40.405	**6.433**	**6.034**	**7.307**	180.080	228.632	173.340	**6.283**	**6.081**	**6.921**
No. of Observations	1677	1677	1677	**1668**	**1673**	**1672**	1677	1677	1677	**1668**	**1673**	**1672**

Source: Authors' calculations.

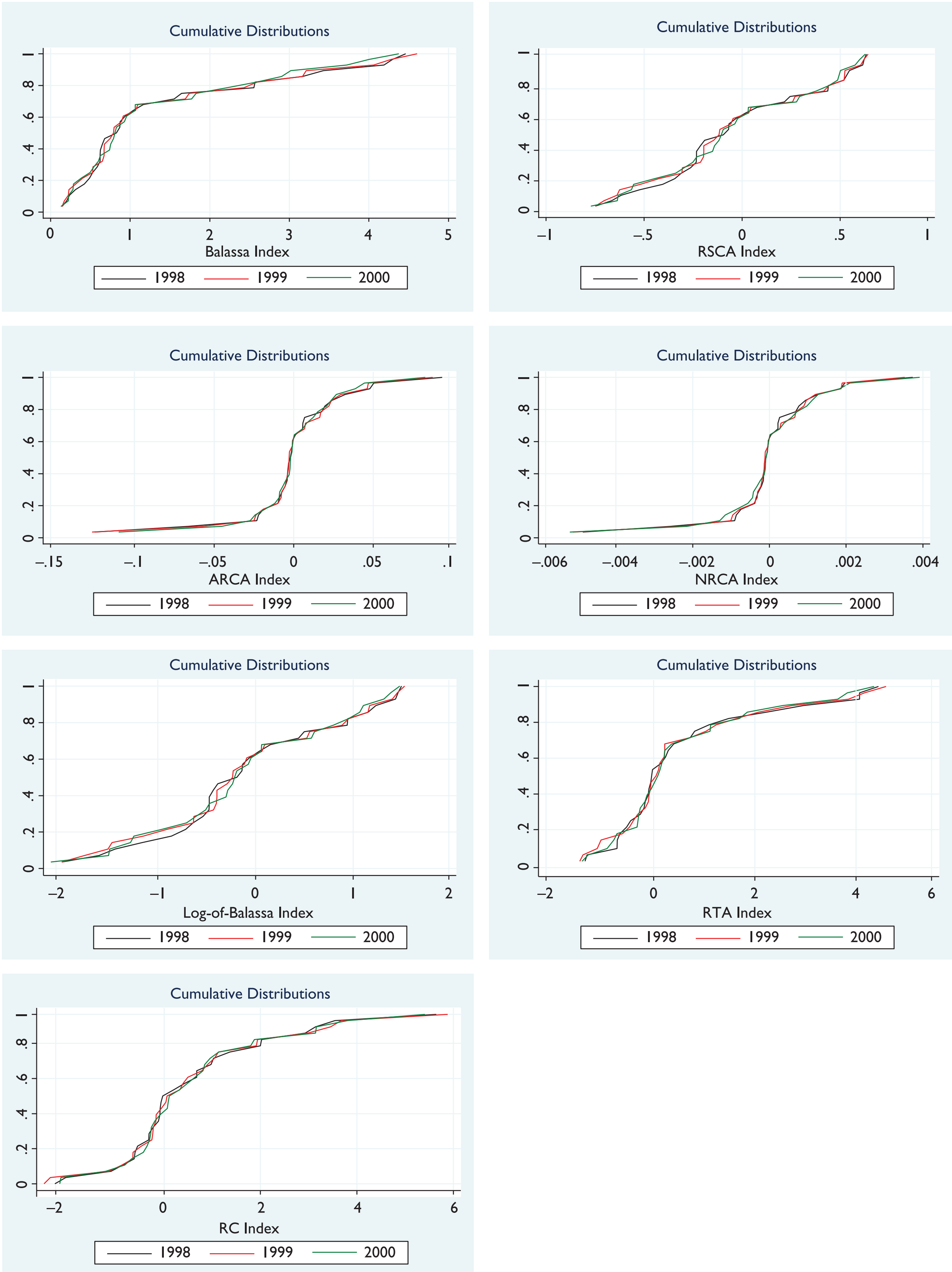

Figure A.1. Cumulative Distribution Plots for China

Source: Authors' calculations.

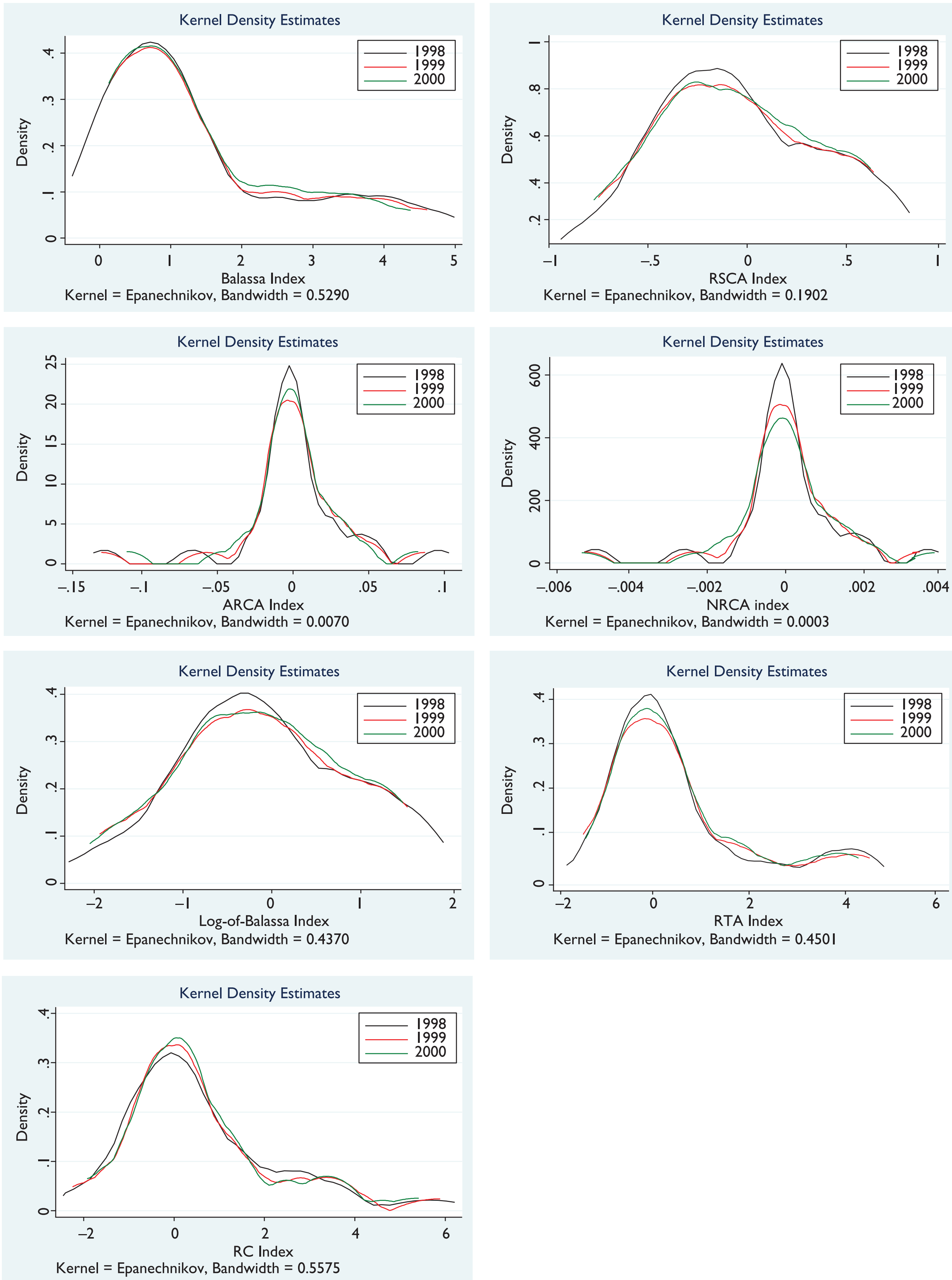

Figure A.2. Kernel Density Plots for China

Source: Authors' calculations.
Note: All cumulative distribution and kernel density plots using Stata 11.

Table A.4. Wilcoxon's SR Test for Countries

Country	Year Combinations	Balassa	RSCA	ARCA	NRCA	Log-of-Balassa	RTA	RC
	1998–1999	–0.250 (0.802)	–0.137 (0.891)	1.093 (0.274)	0.729 (0.466)	0.046 (0.964)	0.410 (0.682)	–0.091 (0.927)
	1999–2000	0.911 (0.362)	0.296 (0.767)	0.888 (0.375)	0.182 (0.855)	0.524 (0.601)	0.091 (0.927)	–0.638 (0.524)
	1998–2000	0.911 (0.362)	0.159 (0.873)	0.478 (0.633)	0.091 (0.927)	0.25 (0.802)	0.797 (0.426)	–0.433 (0.665)
China	Accepted Cases for Null	3	3	3	3	3	3	3
	1998–1999	–1.412 (0.158)	–1.002 (0.316)	–0.615 (0.539)	–0.729 (0.466)	–1.025 (0.306)	–1.435 (0.151)	–1.435 (0.151)
	1999–2000	0.25 (0.802)	0.683 (0.495)	0.182 (0.855)	–0.137 (0.891)	0.729 (0.466)	–1.753 (0.080)	–0.751 (0.452)
	1998–2000	0.046 (0.964)	0.273 (0.785)	0.319 (0.750)	–0.342 (0.733)	0.342 (0.733)	–1.89 (0.059)	–0.956 (0.339)
Germany	Accepted Cases for Null	3	3	3	3	3	3	3
	1998–1999	–1.594 (0.111)	–1.594 (0.111)	–0.865 (0.387)	–1.184 (0.236)	–1.662 (0.096)	–0.455 (0.649)	–1.047 (0.295)
	1999–2000	–0.592 (0.554)	–0.455 (0.649)	–0.228 (0.820)	–0.228 (0.820)	–0.41 (0.682)	0.524 (0.601)	0.615 (0.539)
	1998–2000	–1.23 (0.219)	–1.002 (0.316)	–0.41 (0.682)	–0.455 (0.649)	–1.047 (0.295)	0.25 (0.802)	0.433 (0.665)
France	Accepted Cases for Null	3	3	3	3	3	3	3
	1998–1999	–1.594 (0.111)	–1.594 (0.111)	–0.41 (0.682)	–0.068 (0.946)	–1.457 (0.145)	–2.095* (0.036)	–1.776 (0.076)
	1999–2000	–2.254* (0.024)	–2.71** (0.007)	–1.503 (0.133)	–0.25 (0.802)	–2.733** (0.006)	0.888 (0.375)	1.526 (0.127)
	1998–2000	–2.163* (0.031)	–2.846** (0.004)	–0.888 (0.375)	–0.296 (0.767)	–2.824** (0.005)	0.159 (0.873)	–0.023 (0.982)
India	Accepted Cases for Null	1	1	3	3	1	2	3
	1998–1999	–1.571 (0.116)	–1.571 (0.116)	–0.387 (0.699)	0.114 (0.909)	–1.708 (0.088)	–0.364 (0.716)	–0.228 (0.820)
	1999–2000	–2.004* (0.045)	–1.708 (0.088)	–0.820 (0.412)	–0.182 (0.855)	–1.958 (0.050)	–0.114 (0.909)	0.114 (0.909)
	1998–2000	–2.049* (0.040)	–2.141* (0.032)	–1.025 (0.306)	–0.159 (0.873)	–2.300* (0.022)	–0.25 (0.802)	–0.387 (0.699)
Italy	Accepted Cases for Null	1	2	3	3	2	3	3
	1998–1999	–1.366 (0.172)	–1.64 (0.101)	–0.911 (0.362)	–0.023 (0.982)	–1.344 (0.179)	–0.319 (0.750)	–1.776 (0.076)
	1999–2000	0.205 (0.838)	–0.068 (0.946)	–1.207 (0.228)	0.182 (0.855)	–0.273 (0.785)	0.228 (0.820)	< 0.001 (1.000)
	1998–2000	–0.137 (0.891)	–0.843 (0.400)	–1.184 (0.236)	0.342 (0.733)	–0.865 (0.387)	< 0.001 (1.000)	–1.298 (0.194)
Japan	Accepted Cases for Null	3	3	3	3	3	3	3
Total No. of Accepted Cases for Null Hypothesis		14	15	18	18	15	17	18

Source: Authors' calculations.

Notes: * denotes significance at 5 per cent level. ** denotes significance at 1 per cent level. Reported numbers of cases for each index are out of 3 for each country and out of 18 for all the countries together. For each country in each year, there are observations on 28 sectors.

Table A.5. Wilcoxon's SR Test for Sectors

ISIC Codes	Year Combinations	Balassa	RSCA	ARCA	NRCA	Log-of-Balassa	RTA	RC
321	1998–1999	0.994	1.458	1.163	1.244	1.428	1.494	2.319*
		(0.320)	(0.145)	(0.245)	(0.214)	(0.153)	(0.135)	(0.020)
	1999–2000	1.347	1.796	1.737	1.141	1.561	2.407*	2.194*
		(0.178)	(0.073)	(0.082)	(0.254)	(0.119)	(0.016)	(0.028)
	1998–2000	1.759	2.746**	2.047*	1.708	2.466*	1.936	3.489**
		(0.079)	(0.006)	(0.041)	(0.088)	(0.014)	(0.053)	(0.001)
	Accepted Cases for Null	3	2	2	3	2	2	0
322	1998–1999	0.493	1.038	0.486	0.037	0.913	0.530	2.15*
		(0.622)	(0.299)	(0.627)	(0.971)	(0.361)	(0.596)	(0.032)
	1999–2000	0.648	1.907	1.178	0.361	1.62	1.053	3.062**
		(0.517)	(0.057)	(0.239	(0.718)	(0.105)	(0.293)	(0.002)
	1998–2000	0.670	1.708	1.112	0.773	1.340	0.751	3.254**
		(0.503)	(0.088)	(0.266)	(0.440)	(0.180)	(0.453)	(0.001)
	Accepted Cases for Null	3	3	3	3	3	3	0
323	1998–1999	1.310	2.002**	1.259	1.185	1.737	1.259	1.575
		(0.190)	(0.045)	(0.208)	(0.236)	(0.082)	(0.208)	(0.115)
	1999–2000	0.913	1.090	1.045	0.317	0.891	0.905	1.178
		(0.361)	(0.276)	(0.296)	(0.752)	(0.373)	(0.365)	(0.239)
	1998–2000	1.053	1.929	1.148	1.296	1.656	0.751	2.238*
		(0.293)	(0.054)	(0.251)	(0.195)	(0.098)	(0.453)	(0.025)
	Accepted Cases for Null	3	2	3	3	3	3	2
324	1998–1999	–0.420	0.213	–0.802	–0.434	0.309	0.088	0.770
		(0.675)	(0.831)	(0.422)	(0.664)	(0.757)	(0.930)	(0.441)
	1999–2000	2.746**	3.467**	0.604	–0.346	3.335**	3.026**	5.109**
		(0.006)	(0.001)	(0.546)	(0.729)	(0.001)	(0.003)	(< 0.001)
	1998–2000	2.694**	3.107**	0.427	–0.604	2.830**	2.967**	4.061**
		(0.007)	(0.002)	(0.669)	(0.546)	(0.005)	(0.003)	(< 0.001)
	Accepted Cases for Null	1	1	3	3	1	1	1
351	1998–1999	0.015	–0.346	–0.420	–0.928	–0.317	1.274	–0.353
		(0.988)	(0.729)	(0.675)	(0.354)	(0.752)	(0.203)	(0.724)
	1999–2000	–0.059	–0.066	0.199	–0.839	< 0.001	0.125	–0.037
		(0.953)	(0.947)	(0.842)	(0.401)	(1.000)	(0.900)	(0.971)
	1998–2000	–0.515	–0.655	–0.707	–0.810	–0.508	1.119	–0.110
		(0.606)	(0.512)	(0.480)	(0.418)	(0.612)	(0.263)	(0.912)
	Accepted Cases for Null	3	3	3	3	3	3	3
352	1998–1999	0.361	0.817	1.141	1.207	0.802	0.361	1.06
		(0.718)	(0.414)	(0.254)	(0.227)	(0.422)	(0.718)	(0.289)
	1999–2000	–2.039*	–2.128*	–2.878**	–1.031	–2.231**	–0.081	–1.200
		(0.041)	(0.033)	(0.004)	(0.303)	(0.026)	(0.936)	(0.230)
	1998–2000	–0.368	–0.236	–1.310	0.640	–0.169	0.633	1.097
		(0.713)	(0.814)	(0.190)	(0.522)	(0.866)	(0.527)	(0.273)
	Accepted Cases for Null	2	2	2	3	2	3	3
385	1998–1999	0.670	0.449	3.291**	1.561	0.536	–0.854	–0.762
		(0.503)	(0.653)	(0.001)	(0.119)	(0.592)	(0.393)	(0.446)
	1999–2000	0.876	0.824	3.136**	1.325	0.707	–1.789	–1.038
		(0.381)	(0.410)	(0.002)	(0.185)	(0.480)	(0.074)	(0.299)
	1998–2000	1.583	1.458	3.401**	3.320**	1.298	–1.575	–1.034
		(0.114)	(0.145)	(0.001)	(0.001)	(0.194)	(0.115)	(0.301)
	Accepted Cases for Null	3	3	0	2	3	3	3
Total No. of Accepted Cases for Null Hypothesis		18	16	16	20	17	18	12

Source: Authors' calculations.

Notes: * denotes significance at 5 per cent level. ** denotes significance at 1 per cent level. Reported numbers of cases for each index are out of 3 for each sector and out of 21 for all the sectors together. For each sector in each year there are observations on 60 countries.

Table A.6. Wilcoxon's RS Test for Sectors

Sector Combinations	Balassa	RSCA	ARCA	NRCA	Log-of-Balassa	RTA	RC
321–322	–0.698	–0.698	–0.724	–0.835	–0.698	–3.506**	–3.769**
	(0.485)	(0.485)	(0.469)	(0.404)	(0.485)	(0.001)	(0.0002)
321–323	0.388	0.388	–0.772	–0.304	0.388	–2.341*	–2.131*
	(0.698)	(0.698)	(0.440)	(0.761)	(0.698)	(0.019)	(0.033)
321–324	2.813**	2.813**	–0.289	0.168	2.813**	–0.966	–0.310
	(0.005)	(0.005)	(0.773)	(0.867)	(0.005)	(0.334)	(0.757)
321–351	2.283*	2.283*	3.826**	0.630	2.283*	1.386	1.554
	(0.022)	(0.022)	(0.0001)	(0.529)	(0.022)	(0.166)	(0.120)
321–352	2.141*	2.141*	2.771**	0.446	2.141*	1.622	1.832
	(0.032)	(0.032)	(0.006)	(0.656)	(0.032)	(0.105)	(0.067)
321–385	5.144**	5.144**	5.983**	2.215*	5.144**	1.275	2.981**
	(< 0.001)	(< 0.001)	(< 0.001)	(0.027)	(< 0.001)	(0.202)	(0.003)
322–323	1.107	1.107	0.525	0.877	1.107	1.538	2.173*
	(0.268)	(0.268)	(0.600)	(0.381)	(0.268)	(0.124)	(0.030)
322–324	3.181**	3.181**	0.924	1.081	3.181**	2.519*	2.462**
	(0.002)	(0.002)	(0.356)	(0.280)	(0.002)	(0.012)	(0.014)
322–351	2.677**	2.677**	4.351**	1.386	2.677**	4.928**	4.745**
	(0.007)	(0.007)	(< 0.001)	(0.166)	(0.007)	(< 0.001)	(< 0.001)
322–352	2.383*	2.383*	3.349**	1.081	2.383*	5.044**	4.970**
	(0.017)	(0.017)	(0.001)	(0.280)	(0.017)	(< 0.001)	(< 0.001)
322–385	4.934**	4.934**	6.083**	2.467*	4.934**	4.740**	5.543**
	(< 0.001)	(< 0.001)	(< 0.001)	(0.014)	(< 0.001)	(< 0.001)	(< 0.001)
323–324	2.294*	2.294*	1.139	0.709	2.294*	1.491	1.139
	(0.022)	(0.022)	(0.255)	(0.479)	(0.022)	(0.136)	(0.255)
323–351	1.774	1.774	3.559**	1.391	1.774	4.225**	3.511**
	(0.076)	(0.076)	(0.0004)	(0.164)	(0.076)	(< 0.001)	(0.0004)
323–352	1.359	1.359	2.467*	0.919	1.359	4.314**	3.921**
	(0.174)	(0.174)	(0.014)	(0.358)	(0.174)	(< 0.001)	(0.0001)
323–385	4.267**	4.267**	6.876**	3.706**	4.267**	4.430**	4.792**
	(< 0.001)	(< 0.001)	(< 0.001)	(0.0002)	(< 0.001)	(< 0.001)	(< 0.001)
324–351	–1.197	–1.197	3.023**	1.029	–1.197	2.414*	1.097
	(0.231)	(0.231)	(0.003)	(0.304)	(0.231)	(0.016)	(0.273)
324–352	–1.296	–1.296	1.979*	0.504	–1.296	2.698**	1.380
	(0.195)	(0.195)	(0.048)	(0.614)	(0.195)	(0.007)	(0.168)
324–385	1.317	1.317	6.598**	3.338**	1.317	1.806	2.194*
	(0.188)	(0.188)	(< 0.001)	(0.001)	(0.188)	(0.071)	(0.028)
351–352	–0.189	–0.189	–1.811	–0.226	–0.189	0.493	0.441
	(0.850)	(0.850)	(0.070)	(0.821)	(0.850)	(0.622)	(0.659)
351–385	3.517**	3.517**	0.793	1.375	3.517**	–0.436	1.753
	(0.0004)	(0.0004)	(0.428)	(0.170)	(0.0004)	(0.663)	(0.080)
352–385	3.307**	3.307**	3.223**	1.664	3.307**	–1.485	1.244
	(0.001)	(0.001)	(0.001)	(0.096)	(0.001)	(0.137)	(0.214)
No. of Accepted Cases for Null Hypothesis	9	9	8	17	9	10	9

Source: Authors' calculations.

Notes: * denotes significance at 5 per cent level. ** denotes significance at 1 per cent level. Reported numbers of cases are out of a total of 21 cases for each index. For each sector in the year 2000, there are observations on 60 countries.

Table A.7. Wilcoxon's RS Test for Countries

Country Combinations	Balassa	RSCA	ARCA	NRCA	Log-of-Balassa	RTA	RC
China–Germany	–0.115 (0.909)	–0.115 (0.909)	–0.164 (0.870)	0.033 (0.974)	–0.115 (0.909)	1.376 (0.169)	1.737 (0.082)
China–France	–0.164 (0.870)	–0.164 (0.870)	0.049 (0.961)	0.098 (0.922)	–0.164 (0.870)	1.295 (0.196)	1.524 (0.128)
India–China	0.688 (0.491)	0.688 (0.491)	–0.115 (0.909)	–0.606 (0.544)	0.688 (0.491)	–0.229 (0.819)	< 0.001 (1.000)
China–Italy	–1.180 (0.238)	–1.180 (0.238)	–0.770 (0.441)	–0.754 (0.451)	–1.180 (0.238)	–0.016 (0.987)	0.557 (0.577)
China–Japan	2.392* (0.017)	2.392* (0.017)	1.180 (0.238)	1.737 (0.082)	2.392* (0.017)	2.704** (0.007)	3.097** (0.002)
Germany–France	–0.147 (0.883)	–0.147 (0.883)	0.311 (0.756)	0.213 (0.831)	–0.147 (0.883)	–0.098 (0.922)	–0.098 (0.922)
India–Germany	0.279 (0.781)	0.279 (0.781)	–0.262 (0.793)	–0.295 (0.768)	0.279 (0.781)	–1.737 (0.082)	–2.016* (0.044)
Germany–Italy	–2.114* (0.035)	–2.114* (0.035)	–1.311 (0.190)	–1.131 (0.258)	–2.114* (0.035)	–1.737 (0.082)	–1.999* (0.046)
Germany–Japan	2.016* (0.044)	2.016* (0.044)	1.671 (0.095)	1.671 (0.095)	2.016* (0.044)	1.835 (0.067)	1.852 (0.064)
India–France	0.541 (0.589)	0.541 (0.589)	–0.262 (0.793)	–1.032 (0.302)	0.541 (0.589)	–1.639 (0.101)	–1.999* (0.046)
France–Italy	–1.753 (0.080)	–1.753 (0.080)	–1.196 (0.232)	–1.180 (0.238)	–1.753 (0.080)	–1.442 (0.149)	–1.622 (0.105)
France–Japan	2.622** (0.009)	2.622** (0.009)	1.475 (0.140)	1.917 (0.055)	2.622** (0.009)	1.917 (0.055)	2.147* (0.032)
India–Italy	–1.376 (0.169)	–1.376 (0.169)	–0.541 (0.589)	–1.098 (0.272)	–1.376 (0.169)	0.049 (0.961)	0.328 (0.743)
India–Japan	1.721 (0.085)	1.721 (0.085)	1.344 (0.179)	2.376* (0.018)	1.721 (0.085)	2.72** (0.007)	3.179** (0.002)
Italy–Japan	3.490** (0.001)	3.490** (0.001)	2.130* (0.033)	2.524* (0.012)	3.490** (0.001)	2.720** (0.007)	2.819** (0.005)
No. of Accepted Cases for Null Hypothesis	10	10	14	13	10	12	8

Source: Authors' calculations.

Notes: * denotes significance at 5 per cent level. ** denotes significance at 1 per cent level. Reported numbers of cases are out of a total of 15 cases for each index. For each country in the year 2000, there are observations on 28 sectors.

Table A.8. KS Test for Sectors

Sector Combinations	Balassa	RSCA	ARCA	NRCA	Log-of-Balassa	RTA	RC
321–322	0.1500 (0.509)	0.1500 (0.509)	0.1500 (0.509)	0.2167 (0.120)	0.1500 (0.509)	0.3667** (0.001)	0.4500** (< 0.001)
321–323	0.1167 (0.809)	0.1167 (0.809)	0.4000** (< 0.001)	0.1500 (0.509)	0.1167 (0.809)	0.2333 (0.076)	0.2500* (0.047)
321–324	0.3500** (0.001)	0.3500** (0.001)	0.4167** (< 0.001)	0.1833 (0.266)	0.3500** (0.001)	0.1667 (0.375)	0.2500* (0.047)
321–351	0.2500* (0.047)	0.2500* (0.047)	0.4333** (< 0.001)	0.1500 (0.509)	0.2500* (0.047)	0.2000 (0.181)	0.1833 (0.266)
321–352	0.2333 (0.076)	0.2333 (0.076)	0.3500** (0.001)	0.100 (0.925)	0.2333 (0.076)	0.2500* (0.047)	0.1833 (0.266)

Sector Combinations	Balassa	RSCA	ARCA	NRCA	Log-of-Balassa	RTA	RC
321–385	0.4000**	0.4000**	0.5167**	0.3667**	0.4000**	0.2167	0.2500*
	(< 0.001)	(< 0.001)	(< 0.001)	(0.001)	(< 0.001)	(0.120)	(0.047)
322–323	0.1500	0.1500	0.3500**	0.2500*	0.1500	0.2000	0.3000**
	(0.509)	(0.509)	(0.001)	(0.047)	(0.509)	(0.181)	(0.009)
322–324	0.2833*	0.2833*	0.3667**	0.2833*	0.2833*	0.2500*	0.2333
	(0.016)	(0.016)	(0.001)	(0.016)	(0.016)	(0.047)	(0.076)
322–351	0.3833**	0.3833**	0.4000**	0.2333	0.3833**	0.5000**	0.5667**
	(< 0.001)	(< 0.001)	(< 0.001)	(0.076)	(< 0.001)	(< 0.001)	(< 0.001)
322–352	0.2667*	0.2667*	0.3000**	0.2333	0.2667*	0.4167**	0.5500**
	(0.028)	(0.028)	(0.009)	(0.076)	(0.028)	(< 0.001)	(< 0.001)
322–385	0.4333**	0.4333**	0.5167**	0.4500**	0.4333**	0.5333**	0.5833**
	(< 0.001)	(< 0.001)	(< 0.001)	(< 0.001)	(< 0.001)	(< 0.001)	(< 0.001)
323–324	0.2667*	0.2667*	0.2167	0.1667	0.2667*	0.3167**	0.3500**
	(0.028)	(0.028)	(0.120)	(0.375)	(0.028)	(0.005)	(0.001)
323–351	0.2833*	0.2833*	0.5833**	0.2333	0.2833*	0.3667**	0.3167**
	(0.016)	(0.016)	(< 0.001)	(0.076)	(0.016)	(0.001)	(0.005)
323–352	0.1667	0.1667	0.5500**	0.2333	0.1667	0.4500**	0.3333**
	(0.375)	(0.375)	(< 0.001)	(0.076)	(0.375)	(< 0.001)	(0.003)
323–385	0.4000**	0.4000**	0.7833**	0.4500**	0.4000**	0.3833**	0.3833**
	(< 0.001)	(< 0.001)	(< 0.001)	(< 0.001)	(< 0.001)	(< 0.001)	(< 0.001)
324–351	0.2667*	0.2667*	0.5833**	0.1833	0.2667*	0.2667*	0.3667**
	(0.028)	(0.028)	(< 0.001)	(0.266)	(0.028)	(0.028)	(0.001)
324–352	0.2667*	0.2667*	0.5500**	0.1667	0.2667*	0.2333	0.3500**
	(0.028)	(0.028)	(< 0.001)	(0.375)	(0.028)	(0.076)	(0.001)
324–385	0.2500*	0.2500*	0.8000**	0.3667**	0.2500*	0.3500**	0.3833**
	(0.047)	(0.047)	(< 0.001)	(0.001)	(0.047)	(0.001)	(< 0.001)
351–352	0.1833	0.1833	0.2667*	0.0833	0.1833	0.1667	0.1167
	(0.266)	(0.266)	(0.028)	(0.985)	(0.266)	(0.375)	(0.809)
351–385	0.3500**	0.3500**	0.2667*	0.2333	0.3500**	0.2167	0.1667
	(0.001)	(0.001)	(0.028)	(0.076)	(0.001)	(0.120)	(0.375)
352–385	0.2833*	0.2833*	0.2833*	0.2833*	0.2833*	0.3000**	0.1333
	(0.016)	(0.016)	(0.016)	(0.016)	(0.016)	(0.009)	(0.660)
No. of Accepted Cases For null Hypothesis	6	6	2	14	6	8	6

Source: Authors' calculations.

Notes: For each index, the test statistics and the asymptotic p values are reported. The exact p values are also reported by Stata, but they do not differ significantly from the asymptotic p values in the sense that the number of cases for acceptance of null hypothesis remains the same. * denotes significance at 5 per cent level. ** denotes significance at 1 per cent level. Reported number of cases are out of a total of 21 cases for each index. For each sector in the year 2000, there are observations on 60 countries.

Table A.9. KS for Countries

Country Combinations	Balassa	RSCA	ARCA	NRCA	Log-of-Balassa	RTA	RC
China–Germany	0.2857	0.2857	0.1786	0.1429	0.2857	0.2857	0.3929*
	(0.203)	(0.203)	(0.763)	(0.938)	(0.203)	(0.203)	(0.027)
China–France	0.2500	0.2500	0.1786	0.1429	0.2500	0.2857	0.3929*
	(0.346)	(0.346)	(0.763)	(0.938)	(0.346)	(0.203)	(0.027)
China–India	0.2500	0.2500	0.1429	0.2857	0.2500	0.1429	0.1429
	(0.346)	(0.346)	(0.938)	(0.203)	(0.346)	(0.938)	(0.938)
China–Italy	0.2857	0.2857	0.2857	0.2857	0.2857	0.1786	0.1786
	(0.203)	(0.203)	(0.203)	(0.203)	(0.203)	(0.763)	(0.763)

(Table A9 continued)

(Table A9 continued)

Country Combinations	Balassa	RSCA	ARCA	NRCA	Log-of-Balassa	RTA	RC
China–Japan	0.3214 (0.111)	0.3214 (0.111)	0.2857 (0.203)	0.3571 (0.056)	0.3214 (0.111)	0.3571 (0.056)	0.3929* (0.027)
Germany–France	0.2500 (0.346)	0.2500 (0.346)	0.2143 (0.541)	0.1786 (0.763)	0.2500 (0.346)	0.1786 (0.763)	0.1786 (0.763)
Germany–India	0.2857 (0.203)	0.2857 (0.203)	0.2500 (0.346)	0.2500 (0.346)	0.2857 (0.203)	0.3214 (0.111)	0.4286* (0.012)
Germany–Italy	0.3571 (0.056)	0.3571 (0.056)	0.2500 (0.346)	0.2143 (0.541)	0.3571 (0.056)	0.3929* (0.027)	0.4286* (0.012)
Germany–Japan	0.3929* (0.027)	0.3929* (0.027)	0.3214 (0.111)	0.3214 (0.111)	0.3929* (0.027)	0.3571 (0.056)	0.3571 (0.056)
France–India	0.3929* (0.027)	0.3929* (0.027)	0.2143 (0.541)	0.2500 (0.346)	0.3929* (0.027)	0.3214 (0.111)	0.4286* (0.012)
France–Italy	0.3571 (0.056)	0.3571 (0.056)	0.3214 (0.111)	0.3214 (0.111)	0.3571 (0.056)	0.3929* (0.027)	0.3929* (0.027)
France–Japan	0.4643** (0.005)	0.4643** (0.005)	0.3571 (0.056)	0.4286* (0.012)	0.4643** (0.005)	0.4286* (0.012)	0.4643** (0.005)
India–Italy	0.3929* (0.027)	0.3929* (0.027)	0.1786 (0.763)	0.2857 (0.203)	0.3929* (0.027)	0.1429 (0.938)	0.1429 (0.938)
India–Japan	0.3214 (0.111)	0.3214 (0.111)	0.2857 (0.203)	0.5714** (< 0.001)	0.3214 (0.111)	0.3571 (0.056)	0.4286* (0.012)
Italy–Japan	0.4643** (0.005)	0.4643** (0.005)	0.3929* (0.027)	0.4643** (0.005)	0.4643** (0.005)	0.3571 (0.056)	0.3571 (0.056)
No. of Accepted Cases for Null Hypothesis	10	10	14	12	10	12	6

Source: Authors' calculations.

Notes: For each index, the test statistics and the corresponding asymptotic p values are reported. * denotes significance at 5 per cent level. ** denotes significance at 1 per cent level. Reported number of cases are out of a total of 15 cases for each index. For each country in the year 2000, there are observations on 28 sectors.

Notes

1. Hinloopen and Marrewijk (2001) studied a group of European Union member countries over the period 1992 to 1996. Hoen and Oosterhaven (2006) analyzed the cases for the Netherlands and Poland for the year 1997.
2. Hinloopen and Marrewijk were in the favour of usage of a homogenous set of countries exporting to a single market, in order to ensure comparison of countries with similar level of development and similar transport costs. But here, we consider a heterogeneous group of countries, each exporting to the world as a whole. It is always better to have countries with different structures. Having only Eurozone or OECD countries may give statistically significant results, but application of RCA index outside that specific group of countries remains questionable. On the other hand, if an index or a set of indices show consistent performance across countries which are structurally dissimilar, such indices should find higher applicability in empirical studies. Further, when the reference group comprises the world, the effect of transport cost may not be significantly relevant as every country is exporting to its immediate neighbours as well as to its distant trading partners.
3. Nepal reports missing observations on sectors with ISIC codes 332, 354 and 361 for all the 3 years considered.
4. The plots can be provided on request.
5. In the present analysis, the density estimates were also obtained by using the Gaussian kernel functions and default bandwidth. The generated density plots were found to be very similar to those obtained by using Epanechnikov kernel functions.
6. For example, in the cases of Balassa index (321–352), RSCA index (321–352), Log-of-Balassa index (321–352), RTA index (321–323 and 324–352) and RC index (322–324).
7. The variables can be described as follows: *i*–any country; *a*–any sector; *t*–sum of all sectors; *w*–world total (for calculating the index values in this paper, *t* and *w* will include the sum of all sectors and sum of all countries, respectively on which data would be available); X^i_a–exports of product *a* by country *i*; X^i_t–exports of all products by country *i*; X^w_a–exports of product *a* by all countries; X^w_t–exports of all products by all countries. M^i_a, M^i_t, M^w_a and M^w_t can be similarly defined for imports.

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