On Empirical Distribution of RCA Indices

Deb, Kaveri and Sengupta, Bodhisattva

Indian Institute of Information Technnology Guwahati, Indian Institute of Technology Guwahati

May 2016

Analyzing the Empirical Distributions of RCA Indices

Kaveri Deb[¥] & Bodhisattva Sengupta[§]

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 cardinal or ordinal measures over time, an important question that arises is how reliable such indices are for the said purposes. In this regard, stability of index distributions has important implications for applicability of the indices as cardinal or ordinal measures over time. This paper 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.

JEL classification: F14, C12

¥ Department of Humanities and Social Sciences, Indian Institute of Information Technology Guwahati, Guwahati 781001, Assam, India.
E-mail: kaveri@iitg.ernet.in

§ Department of Humanities and Social Sciences, Indian Institute of Technology Guwahati, Guwahati 781039, Assam, India.
E-mail: bsengupta@iitg.ernet.in

1 Introduction

The Revealed Comparative Advantage (RCA) index originally proposed by Balassa (1965) finds its application towards understanding the possibilities of gainful exchange of products amongst trading nations. The index has however been a subject of discourse and potential improvements of the index have been consequently suggested in the literature, to address many deficiencies that the index suffers from.

Ballance *et al.* (1987) recognized that the usefulness of any RCA index can be divided into three categories. First, the index helps in identifying those countries which reveal comparative advantage in a particular sector and those countries which do not. Second, based on the values of the index, it is possible to generate cross country ranking with respect to a particular sector, or cross sector ranking with respect to a particular country. Third, it facilitates quantification of the extent of comparative advantage of a country in a sector compared to some other country or the extent of comparative advantage of a country in a sector compared to any other sector. The second application hints towards the usage of the index as an ordinal measure while the third application implies usage of the index as a cardinal measure.

Yeats (1985) claimed that the Balassa's index characterized by an asymmetrical distribution with a comparative advantage neutral point of unity, is not suitable either as a cardinal or as an ordinal measure. Despite this fact, the original index of Balassa found its application in various studies to infer the presence of strong or the weak sectors of a country in comparison to other countries, or to identify the comparative advantage or disadvantage of a country in a commodity compared to other commodities (Batra and Khan 2005, Smyth 2005, Wignaraja 2011, Karaalp 2011, Ekram *et al.* 2013, Hassan 2013). Further, the index also found its application in determining the changes in pattern of comparative advantage of countries over time (Hiley 1999, Kijboonchoo and Kalayanakupt 2003). These applications seem to ignore the arguments of Yeats and rely on the assumption that the underlying distribution is stable either over countries or over products or over time, as the case may be.

However, concerns have been raised in the existing literature about the stability of the index distributions across countries or across products. For instance, Hoen and Oosterhaven (2006) and Yu *et al.* (2009) argue that Balassa's RCA index is characterized by an unstable mean due to its variable upper bound but fixed lower bound. The variability in the upper bound could be attributed to the sensitivity of the index to size of the sector or the size of a country, so that smaller countries (sectors) tend to have more asymmetric distributions across sectors (countries). If the upper bound keeps on changing from country to country or from sector to sector, the average or the mean value would also keep on changing. The phenomenon of changing mean value would be evident from the computation of arithmetic mean of index values across countries for a particular commodity or across commodities for a particular country. Evidently, the arithmetic mean will fluctuate from sector to sector or country to country, and evidences of such fluctuating mean value (above 1) have been documented by Hoen and Oosterhaven (2006) and Hinloopen and Marrewijk (2001) in their respective studies. Thus, skewness or asymmetry in the distribution of the index brought about by varying upper bound is certainly responsible for an average index value above unity or above the comparative advantage neutral point. If the underlying distribution is always symmetrically distributed about the value zero, usage of the index as a cardinal measure becomes feasible. For in that case, if a country gains comparative advantage in a sector, some other country must lose comparative advantage in that particular sector to retain an average value of zero. Under such circumstances, it is possible to identify the comparative advantage or disadvantage of one country compared other countries in exporting a particular product. However, if the computed average is not stable and not equal to zero, then if one country gains comparative advantage in a product, it would not be possible to say for certain that it has gained comparative advantage compared to other countries, as it does not necessarily follow that some other country has lost comparative advantage in that same product. Hence, comparing countries for a particular product becomes quite unfeasible. Similar observations could be made while comparing sectors for a country.

A closer look at the phenomenon of unstable mean reveals another issue. An unstable mean would imply an unstable distribution. If the distribution of index values across countries for a particular commodity differs from the distribution of index values across the same group of countries for another commodity, then the same value for the index of Balassa may have different meaning for different commodities. Accordingly, using Balassa's index to identify comparative advantage or disadvantage of a country in a commodity in comparison to the other commodity must be done with care. This implies, ranking of sectors with respect to a country could be problematic. Thus, the index may not be suitable as an ordinal measure. If on the other hand, the distribution of index values across sectors for a particular country differs from the distribution of index values across the same group of sectors for another country, then again the same value for Balassa's index may have different meaning for different countries. Therefore, using Balassa's index to identify a country's weak and strong sectors in comparison to other countries is not an easy task. Hence, ranking of countries with respect to a sector is difficult. These arguments relate to the observations by Yeats (1985) who takes note of the fact that different sectors may have different country distributions which adds to the infeasibility of direct comparison of index values for a country across sectors. Similar difficulties in case of cross country comparison for a sector were noted by him.

Thus, not only the index fails to act as a cardinal measure, its use as an ordinal measure is also questionable.

On similar grounds, 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. As observed by Leromain and Orefice (2014) the concept of comparative advantage is ex-ante in nature as it is based on pre-trade relative prices. Using pre-trade prices, inferences are drawn about post-trade scenario. In this regard if RCA indices are used as a proxy for comparative advantage, they must be expected to be sticky over time. Benedictis and Tamberi (2001, 2004), Hinloopen and Marrewijk (2001) have analyzed the stability of Balassa's distribution over time. Benedictis and Tamberi noticed the distribution to be stable over time for France but unstable for Italy, Germany and Japan. Hinloopen and Marrewijk by grouping the individual observations on 12 members of European Union found the distributions to be considerably stable both over months and years. Stability of index distribution over time through stability of the mean also ensures reliable applicability of the index for time series analysis, as recognized by Yu *et al.* (2009).

Due to the asymmetric distribution of Balassa index, using its arithmetic mean to identify the performance of the average sector or the average country can be doubtful. For distributions skewed to the right, the arithmetic mean tends to assign more weight to the sectors with index value exceeding unity than to sectors with index value less than unity (Benedictis and Tamberi 2001). As a result, a possible interpretation of the mean value will be - a country has comparative advantage in the average sector (on computing the mean across sectors for a country) or an average country has comparative advantage in any sector (on computing the mean across countries for a sector). Hence, such interpretations are of little significance (Benedictis and Tamberi 2001).[1]

Several alternative trade indices of RCA were suggested in the literature after Balassa's index was diagnosed with deficiencies. For instance, Dalum *et al.* (1998) and Laursen (1998) suggested the Revealed Symmetric Comparative Advantage (RSCA) index to address the possibility of non-normally distributed residuals associated with the asymmetric distribution of the Balassa index. Hoen and Oosterhaven (2006) with the objective of making the mean of the distribution of Balassa index stable across sectors, formulated the Additive Revealed Comparative Advantage (ARCA) index. Yu *et al.* (2009) suggested the Normalized Revealed Comparative Advantage (NRCA) index, which not only has a stable mean across sectors but also across countries. The index is also characterized by stable distributions over time. Vollrath (1991) suggested an index by taking the logarithm of Balassa index. The index by inducing symmetry in distribution could generate normally distributed residuals in parametric regression analysis. With due recognition to the fact that RCA indices based on both demand and supply effects are more consistent with the theoretical concept of comparative advantage, Vollrath (1991) recommended the Relative Trade Advantage (RTA) index and Revealed Competitiveness (RC) index. All of the RCA indices mentioned so far will be taken up for analysis in this paper. [2] The formulae for each of the RCA index mentioned can be expressed as follows:

---

[1] For rightly skewed distributions, the mean would be greater than the median or the middle most value. In fact median would be a better indicator of the average sector or country. Unlike arithmetic mean, the median is not influenced by extreme values. A low median (less than unity) in case of a country would imply that the country has large share of sectors with comparative disadvantage, and a high median (greater than unity) would imply large share of sectors with comparative advantage for the country (Benedictis and Tamberi 2004).

[2] Proudman and Redding (1998) also suggested a trade based index by normalizing the original index with its cross-sectoral mean. The suggestion was meant to fix the mean of the Balassa index distribution across sectors for a country. This would help to establish the comparability of the index values across sectors within an individual country (Yu *et al.* 2009). But as recognized by Deb and Basu (2011), in their proposed index, they do not address one of the chief concerns of the present research – the symmetry of the distribution of the index, and hence do not seem to be a substantial improvement over the Balassa's index. For that reason the RCA index by Proudman and Redding has not been separately considered for analysis in this paper. Apart from trade based indices, some other RCA indices were suggested by Bowen (1983) and Lafay (1992) that take into account other macroeconomic

1) $Balassa's\ RCA\ Index = \frac{X_a^i/X_t^i}{X_a^w/X_t^w}$

2) $RSCA\ Index = \frac{\frac{X_a^i/X_t^i}{X_a^w/X_t^w} - 1}{\frac{X_a^i/X_t^i}{X_a^w/X_t^w} + 1}$

3) $ARCA\ Index = \frac{X_a^i}{X_t^i} - \frac{X_a^w}{X_t^w}$

4) $NRCA\ Index = \frac{X_a^i}{X_t^w} - \frac{X_t^i}{X_t^w}\frac{X_a^w}{X_t^w}$

5) $Log\ of\ Balassa\ Index = ln\frac{X_a^i/X_t^i}{X_a^w/X_t^w}$

6) $RTA\ Index = \frac{X_a^i/X_t^i}{X_a^w/X_t^w} - \frac{M_a^i/M_t^i}{M_a^w/M_t^w}$

7) $RC\ Index = ln\frac{X_a^i/X_t^i}{X_a^w/X_t^w} - ln\frac{M_a^i/M_t^i}{M_a^w/M_t^w}$

In all the above index specifications, *i* denotes any particular country and *a* denotes any particular sector. *t* is the sum of all sectors and *w* is the world total. However, while 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. Therefore ${X^i}_a$ is the exports of product *a* by country *i*, ${X^i}_t$ is the exports all products by country *i*, ${X^w}_a$ is the exports of product *a* by all countries and ${X^w}_t$ is the 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. In case of the indices with numbers 2 to 7, if the calculated value is greater (less) than zero then country *i* will reveal comparative advantage (disadvantage) in product *a*. An approximate value of zero denotes comparative advantage neutral point for RSCA index, ARCA index and Log of Balassa index.[3] For NRCA index, RTA index and RC index, the comparative advantage neutral points are equal to zero. The limits of the distributions for RSCA index and ARCA index will tend towards ± 1. The limits of the distributions for NRCA index are $\pm\frac{1}{4}$. The limits of the distributions for Log of Balassa index, RTA index and RC index will tend towards $\pm\infty$.

---

variables apart from exports and imports. However, given the extensive usage of trade based indices in the literature, the discussion in this paper would be restricted to those indices only.

[3] The approximate value for the comparative advantage neutral point arises due to the inclusion of all countries and all commodities in the reference group.

As evident from the structures of the above specified indices, the computed arithmetic mean across sectors or across countries will be stable and equal to the comparative advantage neutral point of zero, only in case of the NRCA index. Thus, as per the structure, the NRCA index is reliable for comparing countries or sectors. The ARCA index generates a stable arithmetic mean equal to the value of zero, only across sectors, but not across countries (Yu *et al.* 2009). As a result, while it is seems possible to compare a country's comparative advantages in different commodities, application of the index for cross country comparison with respect to a sector is doubtful. Application of rest of the indices is doubtful not only for cross country comparison but also for cross sector comparison.

The objective in this paper is to evaluate the empirical distribution of all 7 indices to determine the stability in their distributions over sectors, over countries and over time. An index with most stable distribution over time, sectors and countries can reliably be used as a cardinal or ordinal measure over time. While criticisms about the application of Balassa's index as a cardinal or ordinal measure have been voiced in the literature, this paper makes an attempt to discover the truth in the claim through empirical analysis. At the same time, the empirical distributions of other RCA indices are analyzed in order to examine the differences in performance of these RCA indices with that of Balassa index. Such a comprehensive study on the empirical distributions of RCA indices is lacking in the existing literature. Previously Benedictis and Tamberi (2001, 2004) and Hinloopen and Marrewijk (2001) have attempted to analyze the empirical distributions of Balassa's RCA index only. However, their studies do not provide an intensive account of the statistical significance on stability of index distributions over time, over sectors and over countries, in the manner as presented in this paper.

The paper is henceforth divided into 3 sections. The data and methods of analyses are described in section 2. The results are discussed in section 3. Section 4 concludes the paper by citing the superiority of NRCA index over all other indices in terms of stable distributions over sectors, countries and time.

2 Methodology and Data

Before analyzing the stability of the empirical distributions of each RCA index, a preliminary analysis on the cumulative distributions and summary statistics on each index are presented for each of the years – 1998, 1999 and 2000.[4] For each year the sectoral observations on the considered countries are grouped together. Similar analysis has been carried out by Hinloopen and Marrewijk (2001), although they made use of monthly data for the years 1992 to 1996 for 12 member states of European Union while exporting to Japan. In their paper, they thus report the cumulative distributions and summary statistics for the index of Balassa only, for each month, each year, as well as for the whole period. The analysis in this paper differs from their study in a few respects. First, the countries considered are heterogeneous group of countries and they are exporting to the world (or the group of countries on whom data are available) as a whole, instead of any specific country. As noted by Hinloopen and Marrewijk, this approach pertains to comparing countries at different levels of development with each facing differing transport costs. However, consideration of all countries permits a more comprehensive analysis on the export performance of any country with respect to many countries. Consideration of similar countries exporting to a single country tends to provide limited insights into the relative export potential of any country. Further when the reference group comprises of 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 distant trading partners. The second difference between the studies is, only yearly data could be accessed for analysis in this paper and relevant results are reported for each considered year only. Third, the analysis in this paper includes not only Balassa's index but also several other indices proposed to overcome one or more deficiencies of Balassa's index.

The distribution of the indices are 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 therefore provides a preliminary guide to the stability of index distributions over years. As already discussed, 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

[4] Selections of these 3 years are based on the largest set of country observations on sectoral exports, common to each year, from the Trade Production and Protection database.

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 paper. Apart from the mentioned set of developed countries, two other emerging developing economies will also be considered in this paper. These two countries are China and India. The selection of these two developing countries rather than any other developing country is driven by their significant shares in the world population and GDP growth rates.[5] It must also be noted that China, France, Germany, Italy and Japan were placed among the top ten countries with largest shares in the world exports of manufactures, according to the data for 1998, 1999 and 2000.[6] India although does not figure among the top ten, being a labor abundant economy as China, it is often considered to be a competitor of China in exports of many labor intensive manufactures (Dimaranan *et al.*, 2007). Further, there are speculations on the part of Chinese media that with slowing Chinese economy, India might emerge as the next "factory of the world" (PTI, 2015, August 18).

The cumulative distributions plotted for 3 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 additional light towards the degree of asymmetry in data. Kernel density estimation is a non-parametric method of estimating the probability density function of a continuous random variable. The basic objective for the plot is to make inferences about the population distribution based on the finite sample data. It is a non-

[5] The two countries' competitive population size and GDP growth rates have been noted in the literature. The shares of two countries' in the world population have been estimated to be the largest. As per the World Development Indicators of World Bank, the respective shares of China and India are 18.9% and 17.6% for the year 2014. According to the World Economic Outlook April 2015, released by International Monetary Fund (IMF), India would be the fastest growing economy in the world by recording faster growth rates than China in 2015, as well as in 2016. India's GDP growth rates for 2015 and 2016 have been projected to be 7.5% against China's 6.8% (2015) and 6.3% (2016). In 2014 however China was the fastest growing economy with its growth rate pegged at 7.4% against 7.2% by India.

[6] The shares are calculated on the basis of Trade Production and Protection database. However, the measure could be influenced by size of country.

parametric approach because it does not assume anything about the underlying distribution of the variable.

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. For that purpose, a two tailed Wilcoxon's signed rank test on the data is performed. The Wilcoxon (1945)'s signed rank test is a non-parametric test and tests for any difference in distributions between two samples, provided that these two samples are not independent, but matched or paired or they constitute repeated measurements on a single sample. Thus the signed rank test tests for the null hypothesis of equal distributions through equal means against the alternative hypothesis of unequal distributions through unequal means. Benedictis and Tamberi (2004) make use of the signed rank test for determining the statistical significance of changes in the probability density functions for the index of Balassa between the years 1986 and 1996 in case of Italy, France, Germany and Japan. By considering the distribution of Balassa's index for a particular country at two different points in time, they essentially restrict themselves to matched pairs of observations. This paper also makes use of the Wicoxon's signed rank test to study the statistical significance of the shifts in country distributions over time, but the analysis offered in this paper differs from that of Benedictis and Tamberi in two respects. First, Wilcoxon's signed rank test statistics is computed not only for France, Germany, Italy, Japan, but also for China and India. Second, the statistical significance of shifts in distributions for each country over three years is evaluated not only for the index of Balassa but also for other RCA indices suggested in the literature.

Apart from analyzing the stability of index distributions over years for separate countries, Wilcoxon's signed rank test is also applied to examine the stability of the index distributions over years for separate sectors. Benedictis and Tamberi did not inspect this with Balassa's index.

The stability analysis is not only restricted to time but can also be extended to countries and sectors, to determine the usefulness of the RCA indices as cardinal or ordinal measures. Since comparison over sectors or over countries involve unmatched or non-paired data, Wilcoxon's signed rank test would not be suitable. In this respect Wilcoxon (1945)'s rank sum test is quite helpful in determining the statistical significance of shift in distributions across countries over sectors or shifts in distributions across sectors over countries. Wilcoxon' rank sum test also known as the Wilcoxon-Mann-Whitney test is thus used for the purpose of determining any change in the distribution of RCA indices between any two sectors or between any two countries. Wilcoxon's rank sum test is a non-parametric alternative to 2 sample t test on unmatched or non-paired data, i.e., when the samples drawn are independent. While t test assumes that the underlying population should be normally distributed, Wilcoxon's test assumes away any such requirement on the form of the distributions and it is entirely based on the order of the observations in the samples. This characteristic will particularly be helpful given the fact that not many of the RCA indices are normally distributed. Hence, the statistical inferences will not be biased. The test however assumes that the data are drawn from a continuous distribution. The same assumption also holds for the non-parametric signed rank test previously mentioned. The rank sum test thus tests for the hypothesis that the two independent samples are drawn from two populations which share similar distributions. However, it is to be noted, there could be differences in distributions in the two populations from which the samples come due to differences in standard deviations or medians or skewness and kurtosis. But the rank sum test might accept the null hypothesis as it only compares the rank sum of the two groups. Thus, in order to validate the null hypothesis, one needs to assume that the two distributions share the same shape. For in that case, changes in distributions will be reflected by shifts in location which permits a comparison of the actual rank sums with their expected or mean value. Effectively, then the test will also permit analysis of the differences in means or medians (Hart 2001, Campbell 2006). Thus, departures from the null hypothesis that the Wilcoxon's rank sum test tries to test are the location shifts of the distributions, which under the assumption of identically shaped distributions implies testing for differences in means or medians.

Considering RCA index values across countries for any two sectors, acceptance of the null hypothesis will imply that the distributions across countries for the two sectors are stable. Similarly, while comparing the two countries, acceptance of the null hypothesis will imply the distributions across sectors for two countries are stable. These findings will provide evidence in support of the point that the index could reliably be used as an ordinal measure or for ranking of sectors (countries) with respect to a country (sector). Further, since the rank sum test analyses changes in distributions through changes in means or medians, stability of the index distribution would imply stability of mean across sectors or across countries. Hence, the index can be used as a cardinal measure. Similar attempts to analyze sectoral mean or country mean have not been made in the existing literature.

To perform a robustness check on the performance of RCA index distributions over sectors or over countries, the Kolmogorov Smirnov test is considered. This test pertains to unpaired samples and hence is not suitable for analyzing the empirical distributions over time. Smirnov (1939) devised a non-parametric test to determine whether distribution functions associated with two different populations from which two samples are drawn, are identical (Conover 1999). This test is also known as the Kolmogorov Smirnov two sample test, as it is similar in spirit to the one sample Kolmogorov test for comparing an empirical distribution function with the corresponding hypothesized distribution function. For both tests, the statistics are a function of the vertical distance between two distribution functions. The Kolmogorov Smirnov test computes the test statistics by considering the maximum difference between two cumulative distributions. The test therefore tests for the null hypothesis of equal distributions against the alternative hypothesis of unequal distributions. As pointed out by Lehmann (2006) although the test is based on actual observations, it is similar to an analysis of ranks. This is so because, ranking all the observations will not change the maximum difference between the cumulative distributions.

The Wilcoxon's rank sum test as previously discussed, detects location shifts in distributions, which with the assumption of identically shaped distributions signify changes in mean or median. The Kolmogorov Smirnov test detects shifts in distributions due to changes in mean, standard deviation, presence of outliers, differences in skewness or kurtosis, number of modes etc. Hence, if the Kolmogorov Smirnov test reports statistically significant changes in distributions, it could be due to any one or more factors noted.

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 Trade, Production and Protection (TPP) Database, 1976-2004 by Nicita and Olarreaga (2007).

3 Discussion of Results

The results of the analysis are discussed in this section.

3.1 Discussions on the Summary Statistics and Graphical Analysis

For each of the 7 indices, Tables 1.A to 1.G give detailed information on the cumulative distributions and the summary statistics for each of the years 1998, 1999 and 2000. The sample for each index in each year includes 60 countries and each country has 28 sectoral observations.[7]

Table 1.A

Empirical Distribution of Balassa Index for Each Year: Entire Sample Analysis

Summary Statistics/ Year	1998	1999	2000
p-1	0.0004	0.001	0.001
p-5	0.022	0.028	0.024
p-10	0.067	0.069	0.068
p-25	0.252	0.253	0.250
p-50	0.659	0.647	0.652
p-75	1.335	1.349	1.363
p-90	2.889	2.910	2.819
p-95	4.228	4.346	4.486
p-99	10.040	10.312	11.941
Maximum Value	104.720	113.179	112.484
Mean	1.287	1.320	1.367
Standard Deviation	3.270	3.486	3.773
Skewness	20.314	21.092	18.121
Kurtosis	605.506	640.876	476.159
No. of observations	1677	1677	1677

Table 1.B

Empirical Distribution of RSCA Index for Each Year: Entire Sample Analysis

Summary Statistics/ Year	1998	1999	2000
p-1	-0.999	-0.997	-0.998
p-5	-0.957	-0.946	-0.953
p-10	-0.874	-0.870	-0.873
p-25	-0.598	-0.596	-0.600
p-50	-0.205	-0.215	-0.211
p-75	0.143	0.148	0.154
p-90	0.486	0.489	0.476

[7] Nepal reports missing observations on sectors with ISIC codes 332, 354 and 361 for all 3 years considered.

p-95	0.617	0.626	0.635
p-99	0.819	0.823	0.845
Maximum Value	0.981	0.982	0.982
Mean	-0.207	-0.203	-0.202
Standard Deviation	0.484	0.484	0.488
Skewness	0.178	0.198	0.170
Kurtosis	2.133	2.148	2.128
No. of observations	1677	1677	1677

Table 1.C

Empirical Distribution of ARCA Index for Each Year: Entire Sample Analysis

Summary Statistics/ Year	1998	1999	2000
p-1	-0.161	-0.163	-0.169
p-5	-0.119	-0.118	-0.110
p-10	-0.033	-0.034	-0.034
p-25	-0.013	-0.013	-0.014
p-50	-0.003	-0.003	-0.003
p-75	0.005	0.005	0.005
p-90	0.035	0.034	0.035
p-95	0.076	0.078	0.079
p-99	0.307	0.307	0.315
Maximum Value	0.705	0.789	0.729
Mean	0.00001	0.00001	0.00001
Standard Deviation	0.070	0.070	0.069
Skewness	3.590	3.545	3.362
Kurtosis	30.182	31.381	29.350
No. of observations	1677	1677	1677

Table 1.D

Empirical Distribution of NRCA Index for Each Year: Entire Sample Analysis

Summary Statistics/ Year	1998	1999	2000
p-1	-0.002	-0.002	-0.002
p-5	-0.001	-0.001	-0.001
p-10	-0.0003	-0.0003	-0.0003
p-25	-0.0001	-0.0001	-0.0001
p-50	-0.00001	-0.00001	-0.00001
p-75	0.00001	0.00001	0.00001
p-90	0.0002	0.0002	0.0002

p-95	0.0008	0.0008	0.0008
p-99	0.003	0.003	0.003
Maximum Value	0.008	0.009	0.008
Mean	<0.00001	<0.00001	<0.00001
Standard Deviation	0.001	0.001	0.001
Skewness	2.262	2.322	2.252
Kurtosis	36.507	40.212	40.405
No. of observations	1677	1677	1677

Table 1.E

Empirical Distribution of Log of Balassa Index for Each Year: Entire Sample Analysis

Summary Statistics/ Year	**1998**	**1999**	**2000**
p-1	-6.527	-5.904	-6.132
p-5	-3.671	-3.520	-3.631
p-10	-2.648	-2.627	-2.662
p-25	-1.364	-1.367	-1.383
p-50	-0.413	-0.434	-0.425
p-75	0.295	0.301	0.319
p-90	1.061	1.068	1.036
p-95	1.442	1.469	1.501
p-99	2.307	2.333	2.480
Maximum Value	4.651	4.729	4.723
Mean	-0.674	-0.652	-0.672
Standard Deviation	1.610	1.569	1.642
Skewness	-1.275	-1.127	-1.324
Kurtosis	6.433	6.034	7.307
No. of observations	1668	1673	1672

Table 1.F

Empirical Distribution of RTA Index for Each Year: Entire Sample Analysis

Summary Statistics/ Year	**1998**	**1999**	**2000**
p-1	-4.404	-4.027	-4.736
p-5	-1.351	-1.504	-1.401
p-10	-0.987	-1.014	-1.040
p-25	-0.601	-0.608	-0.610
p-50	-0.201	-0.200	-0.197
p-75	0.381	0.371	0.349
p-90	1.720	1.745	1.692

p-95	3.373	3.420	3.471
p-99	9.035	9.412	10.440
Maximum Value	61.144	69.308	66.721
Mean	0.227	0.249	0.268
Standard Deviation	2.673	2.835	3.154
Skewness	9.552	11.065	10.339
Kurtosis	180.080	228.632	173.340
No. of observations	1677	1677	1677

Table 1.G

Empirical Distribution of RC Index for Each Year: Entire Sample Analysis

Summary Statistics/ Year	1998	1999	2000
p-1	-6.362	-5.881	-5.798
p-5	-3.420	-3.274	-3.414
p-10	-2.358	-2.254	-2.351
p-25	-1.096	-1.148	-1.140
p-50	-0.313	-0.304	-0.322
p-75	0.416	0.396	0.385
p-90	1.398	1.384	1.360
p-95	2.092	2.103	2.009
p-99	4.140	3.858	3.917
Maximum Value	6.949	6.877	7.035
Mean	-0.423	-0.418	-0.446
Standard Deviation	1.722	1.656	1.691
Skewness	-0.608	-0.503	-0.760
Kurtosis	6.283	6.081	6.921
No. of observations	1668	1673	1672

p-1 to 99 in Tables 1.A to 1.G are the percentile points and they give detailed information of the 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% of the observations have index values below 0.252 and 75% of the observations have index values above 0.252. Although the percentiles appear to vary between the years, particularly towards the upper ends of the distributions, the differences 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.

Considering the summary statistics for the index of Balassa in Table 1.A, the computed arithmetic mean is above the comparative advantage neutral point of unity (approximately) and is seen to fluctuate over time.[8] However, the differences in its magnitudes are quite small. The levels of skewness and kurtosis are well beyond the demarcated values of 0 and 3 for a symmetrical normal distribution in case of all the three years. In fact, apart from being skewed, a large kurtosis implies that a sizeable portion of the observations for the index is towards the end of the distribution. A mean value of 1.287 greater than 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 1.B, the arithmetic means are different from the comparative advantage neutral point of zero (approximately), but they seem to be quite stable over the years.[9] 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 1.C, the mean does not significantly differ from the comparative advantage neutral point of zero (approximately) for each year. The median is also observed to be quite stable over the years. The measures on skewness and kurtosis, though not so 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 1.D, 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 the clubbing of countries and sectors in a particular year. The theoretical structure of the ARCA index ensures that its empirical distribution across sectors will be symmetric, but the same need not follow in case of its empirical distribution across countries. Both Log of Balassa and RC indices in Tables 1.E and Tables 1.G respectively report minor fluctuations in arithmetic mean and median values over time. The computed means are also

[8] A little deviation of the calculated arithmetic mean from the value of unity is expected as the reference group in the index calculation includes all countries and all commodities.

[9] Deviations to some extent from the value of zero are expected as the reference group includes all countries and all commodities.

different from the comparative advantage neutral point of zero to some extent.[10] However, the numbers of observations differ between the years for the two indices. 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 1.F records minor fluctuations in the mean and median values over time, which implies overall stability in its distributions. The levels of skewness and kurtosis recorded by the index are higher than any other index, excepting 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 the empirical distribution of the RTA index is not symmetrically distributed. Therefore an analysis of Tables 1.A to 1.G suggests that over time the empirical distributions are quite stable for the RCA indices. The empirical distribution of RSCA index seems to be most well behaved, for not only it is stable over time, but 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 NRCA index report means substantially close their comparative advantage neutral points of zero as expected theoretically.

The findings corresponding to each index in Tables 1.A to 1.G 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 each country are presented in the Figures A.1 to A.6 in the Appendix.

Contrary to findings in Table 1.A and as also claimed by Hinloopen and Marrewijk (2001) variability in cumulative distributions of Balassa index to certain extent are observed for the considered sample. Only for France, the cumulative distributions for the Balassa index are

[10] The comparative advantage neutral point is approximately zero in case of Log of Balassa index. But equal to zero in case of RC index.

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 noticed in case of India. The ARCA index exhibits 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. Log of Balassa index do not seem to perform well in generating stable distributions over the years, as observed in 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. Similarity in distributions of RC index over 3 years is only observed for Italy, and over 1998 and 1999 for France. Thus among all the 7 indices analyzed, the cumulative distribution plots hint towards the fact that only the ARCA and NRCA index values for a country could reliably be compared over time, as they feature stable distributions across countries analyzed. The cumulative distributions presented in Tables 1.A to 1.G however represent all of the indices to be largely stable over time.

The Kernel density plots are illustrated in the Figures A.7 to A.12 in the Appendix for the same set of countries over the same set of years. The Epanechnikov Kernel function, which is the default function in Stata is used for the estimation of densities and is most efficient in minimizing the mean integrated squared error (StataCorp 2013). Along with the default Kernel function, default bandwidth calculated by Stata is used.[11] 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 in the Figures A.7 to A.12 of Appendix, the comparative advantage neutral point could be considered to depict a fixed demarcation value and shifts in density functions with reference to that demarcation point could be noted to determine the stability of the density

[11] The choice of the Kernel function is not integral to the estimation of Kernel density function as the choice of the bandwidth (StataCorp 2013). Epanechnikov (1969) compared the efficiency of various Kernels with respect to his Kernel function and found that there is not much variance in the results (as quoted in Ullah 1988). In the present analysis, the density estimates were also obtained by using Gaussian Kernel functions and default bandwidth. The generated density plots were found to be very similar to those obtained by using Epanechnikov Kernel function.

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 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 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 is indicator of an increase in the number of sectors with index value greater than 1. The plots for RSCA index are largely symmetric in 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 case of Japan and Italy. The Log of Balassa index generates an apparently symmetrical probability density function only in 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 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 6, 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 1.A to 1.G. The differences are expected as the Tables 1.A to 1.G 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 1.C and 1.D 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 1.B, 1.E and 1.G, is a noteworthy fact and could be attributed to country specific behavior of data.

3.2 Discussion of Results for the Tests of Significance

The results of graphical analysis are reinforced by Wilcoxon's signed rank test in this subsection. Since the Wilcoxon's signed rank test permits comparison of only two samples at a time, the 3 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. Shifts of the country distributions across sectors over time are analyzed using the signed rank test. Table 2 reports the standardized normal approximation of the test statistics for each country, the corresponding p values, and the numbers of accepted cases for null hypothesis for each country as well as for all countries together. Based on the combination of years, for each country, number of cases analyzed are 3. The reported numbers of cases where the null hypothesis gets accepted for each country in Table 2 are out of those 3 cases. Based on the combination of years and number of countries, the total numbers of cases analyzed are 18. The reported numbers of cases where the null hypothesis gets accepted for all countries together are out of those 18 cases.

[Insert Table 2 here]

As evident from Table 2, maximum cases of rejection of the null hypothesis are observed for India followed by 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 inference from cumulative distribution plots and Kernel density plots. The signed rank 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 signed rank 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 signed rank 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 signed rank test however reports the shift 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 Germany and Japan for RTA index. But the signed rank test does not show the shifts to be statistical significant. For India however, there seems to be some parity in the graphical analysis and the test of significance. Both graphical analysis and signed rank test agree to the fact that ARCA index and NRCA index are the most stable over time. RC index is also found to be as stable as the ARCA index or NRCA index on the basis of signed rank 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 means of two distributions. Since the signed rank tests studies the shifts in means of two distributions, the results of Kernel density plots and signed rank test could be expected to coincide. The shifts in the cumulative distribution plots are however not exclusive to changes in means and therefore cumulative distribution plots may not be at par with the signed rank test. According to Table 2 RTA index emerge to be the second most stable index over time. The RSCA index and Log of Balassa index do not perform as good as the previously mentioned indices. Balassa index seem to be generating the largest number of cases where the null hypothesis gets rejected. Hence, although Yu *et al.* (2009) argue the distribution of the NRCA index to be time invariant, based on the analysis in this paper, 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.

To test the stability of the index distributions over years for separate sectors using the signed rank test, 7 sectors are selected. For each of the selected sectors the index distributions over the years are analyzed. The selected 7 sectors have the following ISIC codes - 321 (manufacture of textiles), 322 (manufacture of wearing apparel except footwear), 323 (manufacture of leather products, leather substitutes and furs), 324 (manufacture of footwear), 351 (manufacture of industrial chemicals), 352 (manufacture of other chemical products) and 385 (manufacture of professional, scientific and measuring equipments). For each sector in each year the numbers of countries are 60. Table 3 reports the standardized normal approximations of the test statistics, the corresponding p values, and the numbers of accepted cases for null hypothesis for each sector as well as for all sectors together. Based on the combination of years, for each sector, number of cases analyzed are 3. The reported numbers of cases where the null hypothesis gets accepted for each sector in Table 3 are out of those 3 cases. Based on the combination of years and number of sectors, the total numbers of cases analyzed are 21. The reported numbers of cases where the null hypothesis gets accepted for all sectors together are out of those 21 cases.

[Insert Table 3 here]

The findings of Table 3 are to some extent different from that of Table 2. NRCA index is clearly found to be superior to any other index. Thus, it features the most stable distribution over time for different sectors. Balassa and RTA indices have the second most stable distributions over time. Although ARCA and RC indices are found to be as good as the NRCA in Table 2, the same does not hold in Table 3.

To evaluate the stability of index distributions over sectors and over countries the Wilcoxon's rank sum test is used. Tables 4 and 5 report the number of cases where the null hypotheses of equality of distributions over sectors and over countries respectively for each index are accepted. Since, the Wilcoxon's rank sum 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 3, in Table 4, results corresponding to only 7 sectors - 321 (manufacture of textiles), 322 (manufacture of wearing apparel except footwear), 323 (manufacture of leather products, leather substitutes and furs), 324 (manufacture of footwear), 351 (manufacture of industrial chemicals), 352 (manufacture of other chemical products) and 385 (manufacture of professional, scientific and measuring equipments) are presented. The sectors being considered in a group of two for the test, the number of reported cases for acceptance of null hypothesis, are out of a total of 21 cases for each index. For each sector, the numbers of countries are 60. In Table 5, results corresponding to 6 countries – China, Germany, France, India, Italy and Japan are presented. The countries being considered in a group of two for the test, 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 numbers of sectors are 28. Results are reported in Tables 4 and 5 for the year 2000 only.

[Insert Table 4 here]

In Table 4, the NRCA index is found to be most stable over sectors. Since the Wilcoxon's rank sum test studies the shifts in the distributions due to shifts in the mean or the median (assuming the distributions are of identical shapes), the results corresponding to NRCA index in Table 4 is consistent with the observation that the arithmetic mean of the index values across countries is stable between sectors, with the value being fixed at zero. Hence, stability of the mean serves dual purpose – as a cardinal measure and as an ordinal measure. It is not only possible to reliably determine the extent of comparative advantage of one country over another in a sector, it is also possible to rank different sectors for a country reliably. The other indices report larger cases for rejection of the null hypothesis for equality of distributions. Since it has been previously claimed that none of the indices other than the NRCA index, generate stable mean across countries with respect to a sector, larger cases of rejection of null hypothesis for those indices must not be surprising.

[Insert Table 5 here]

As per the results reported in Table 5, the ARCA index is found to be most stable over countries. Since, theoretically the arithmetic mean of the ARCA index values across sectors for a particular country is zero and stable over countries, the results corresponding to ARCA index is as per expectations. NRCA index marginally falls short of the ARCA index in terms of stability of empirical distributions. Thus, taking into consideration the results presented in Table 5, the ARCA index is reliable for comparing index values across sectors within a country, i.e., the index serves as a cardinal measure with respect to a country. Also, a country's weak and strong sectors in comparison to other countries can be determined with ARCA index. This implies reliability of the index towards ranking of countries in a particular sector. Thus, the ARCA index may serve the purpose of an ordinal measure with respect to a sector. NRCA index may feature a stable mean of zero across sectors, but 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 5, 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.

3.2.1 Robustness Check using Kolmogorov Smirnov Test

The Wilcoxon's rank sum test results corresponding to Tables 4 and 5 are compared with the Kolmogorov Smirnov test results reported in Tables 6 and 7. Table 6 reports the test statistics for each sector and each index, the corresponding p values, and the numbers of cases for acceptance of the null hypothesis. Table 7 reports the test statistics for each country and each index, the corresponding p values, and the number of cases for acceptance of the null hypothesis. Hence, the results reported in Tables 6 and 7 can be compared with those reported in Tables 4 and 5 respectively. As in Tables 4 and 5, the number of reported cases for acceptance of null hypotheses in Tables 6 and 7 are out of total of 21 and 15 cases respectively, for each index.

[Insert Table 6 here]

Compared to Table 4, fewer cases for acceptance of the null hypothesis are reported in Table 6 for all indices. However, the NRCA index still continues to be featured by the most stable empirical distribution over sectors. Hence, both the Wilcoxon's rank sum test and Kolmogorov Smirnov test agree to the fact that NRCA index is most reliable 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 the Log of Balassa index for each group of sectors for both tests. Since, both the rank sum test and Kolmogorov Smirnov tests are based on the ranks of the observations, the test results are unaffected by changes in 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 scale of the variable and that would not alter the rank sum or the maximum difference between the cumulative distributions of the indices. Although in general, compared to Table 4, an increase in the number of cases where it is possible to reject the null hypothesis is observed in Table 6, one cannot ignore a few cases where the test statistic for Kolmogorov Smirnov test is statistically insignificant but significant in case of Wilcoxon's rank sum test.[12] This could be attributed to the fact that compared to Wilcoxon's rank sum test, the Kolmogorov Smirnov test is based on many parameters that contribute to deviations from the null hypothesis. Therefore, Kolmogorov Smirnov test has less power to detect a change in distribution exclusively due to a shift in the mean or median but 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 Kolmogorov Smirnov and Wilcoxon's rank sum tests are probably

[12] 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), RC index (322-324).

those cases for which, changes in population distributions are not only due to shifts in location but also the shape. The cases where the null hypothesis is rejected by Wilcoxon's test but accepted by Kolmogorov Smirnov's 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 Wilcoxon's test but rejected by Kolmogorov Smirnov's test are probably those where population distributions have differing shapes but similar means or medians.

[Insert Table 7 here]

In Table 7, the numbers of accepted cases for null hypothesis of equality of distributions are same as in Table 5 for all but the indices of NRCA and RC. The ARCA index continues to remain the most stable index over countries as in Table 5. Thus, the stability of its distribution ensures the index could be used 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 Kolmogorov Smirnov's 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 indices. 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 argued in the previous paragraph, this could be attributed to the potentiality of Kolmogorov Smirnov test to identify more changes in shape of the distributions rather than their locations.

Although the conclusions that emerge from both the Wilcoxon's rank sum test and Kolmogorov Smirnov's test do not differ, it seems changes in the distributions of indices due to changes in the mean will be more relevant for the study under consideration. Changes in 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 shifts in distributions exclusively due to changes in arithmetic mean must be considered more important than shifts in distributions which can be due to changes in mean or standard deviation or skewness or kurtosis. Hence, preference can be assigned to results corresponding to the Wilcoxon's rank sum test which reports NRCA index to be most stable over sectors and ARCA index to be 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 rank sum test, one can consider NRCA index as good as the ARCA index.

4 Conclusion

The empirical distributions of RCA indices are analyzed in this paper with the primary objective of identifying an index which could reliably be used as a cardinal and ordinal measure over time. The country and sector specific results, which are more relevant for policy analysis, uphold the superiority of NRCA index over all other indices taken up for examination in this paper. 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 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 variables.

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

Appendix

Figure A.1
Cumulative Distribution Plots for China

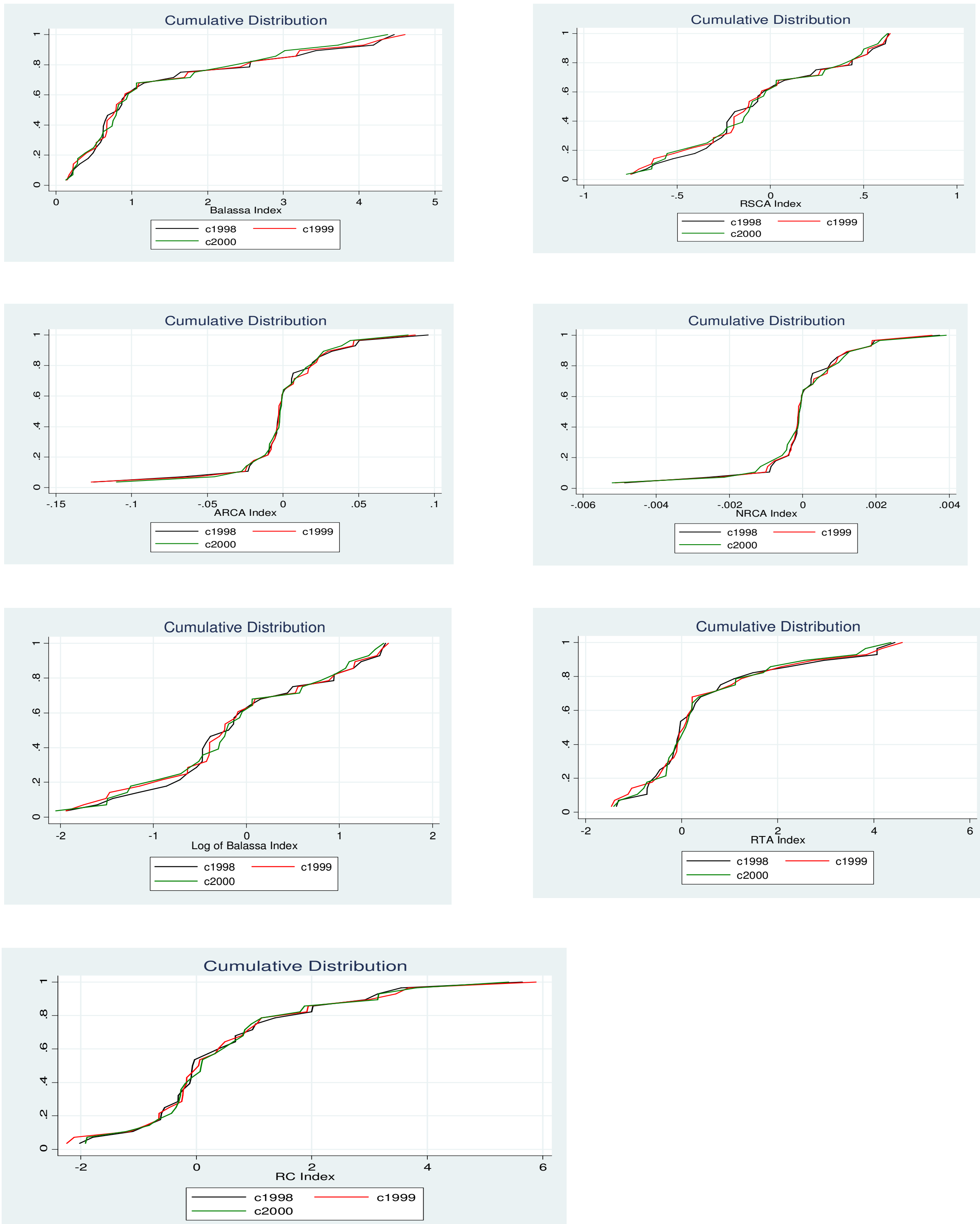
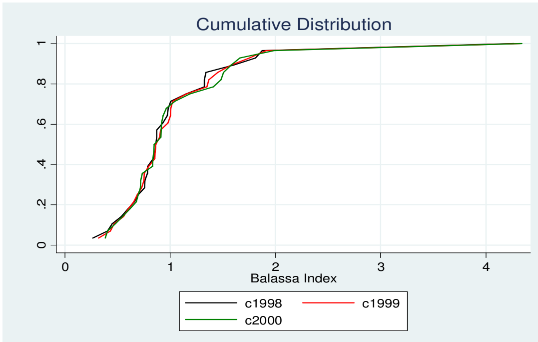
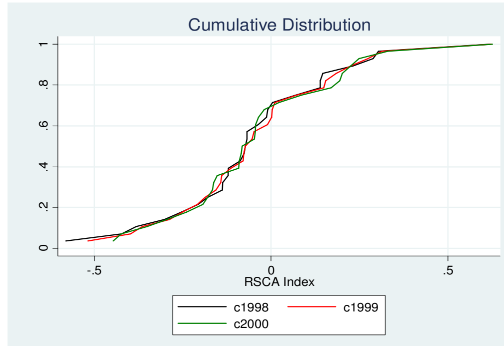
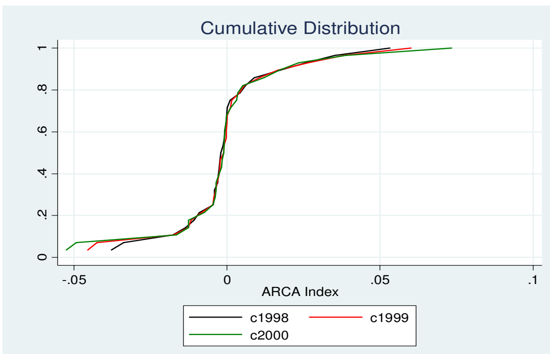
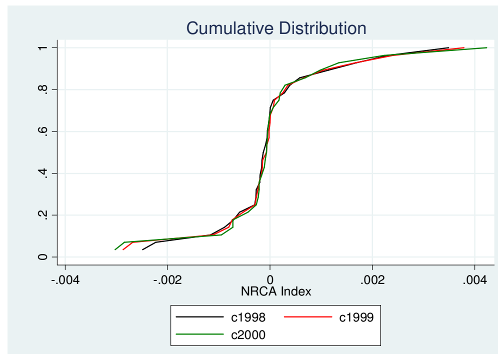


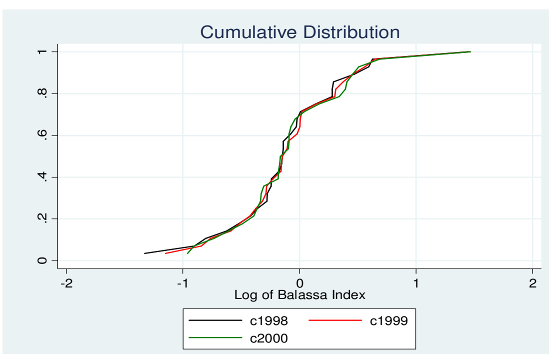
Figure A.2
Cumulative Distribution Plots for France

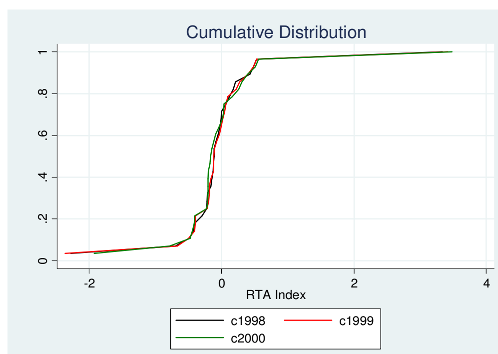












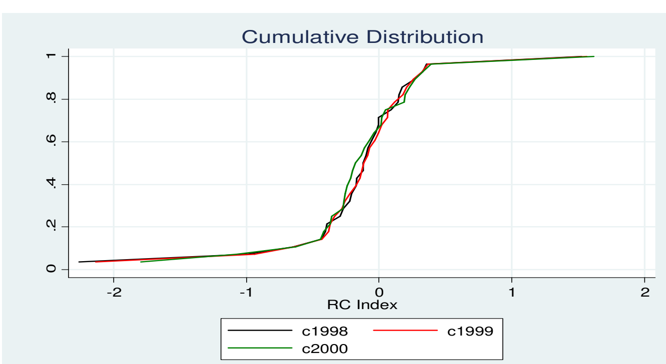
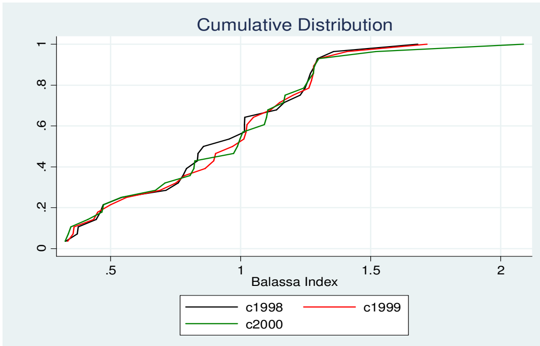
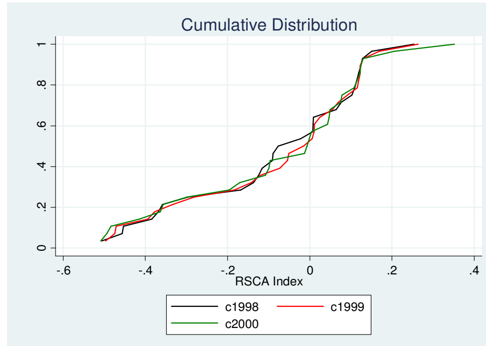
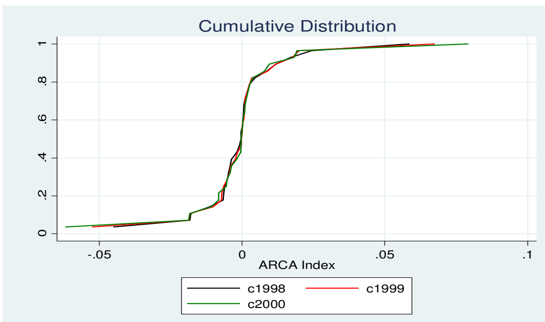
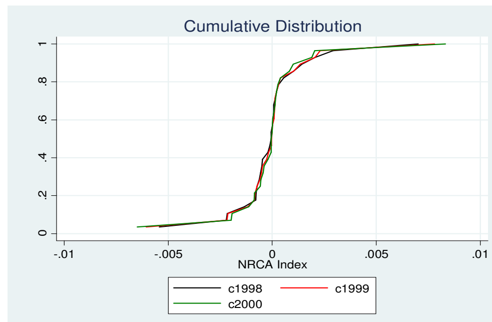


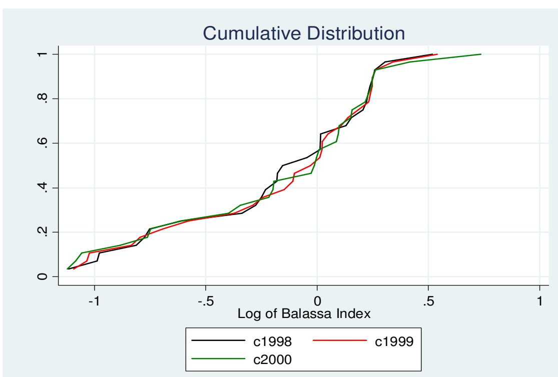
Figure A.3
Cumulative Distribution Plots for Germany

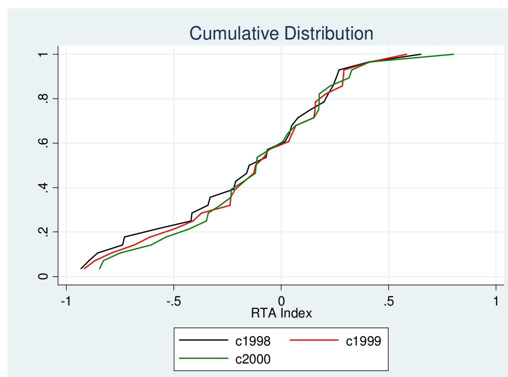












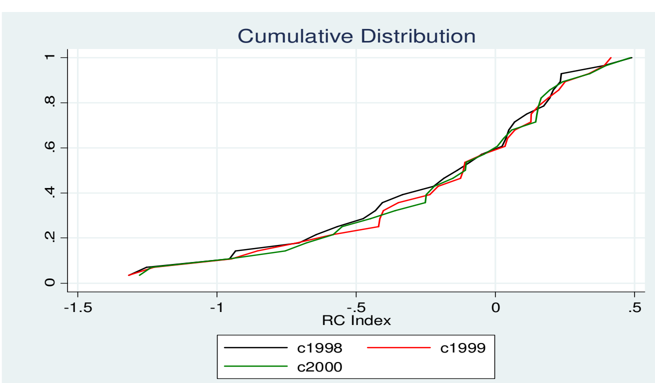
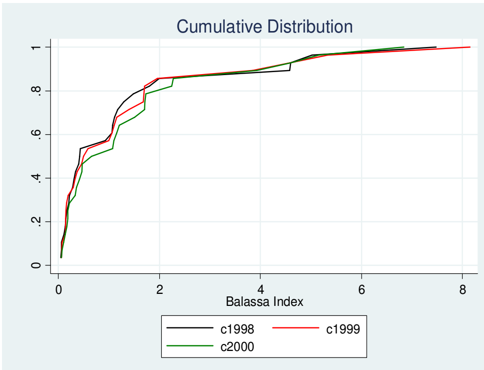
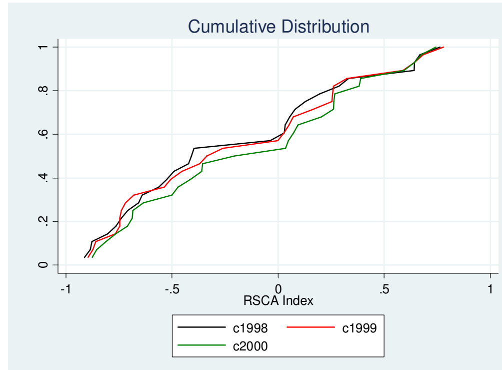
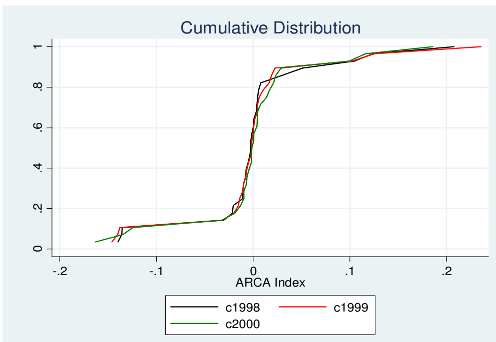
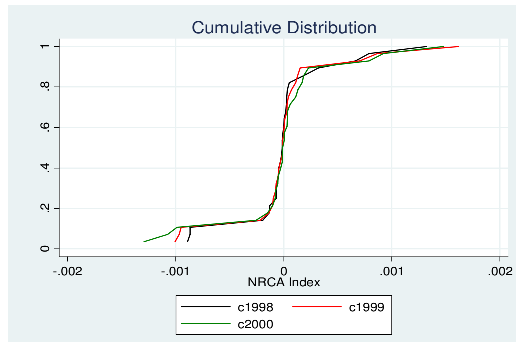


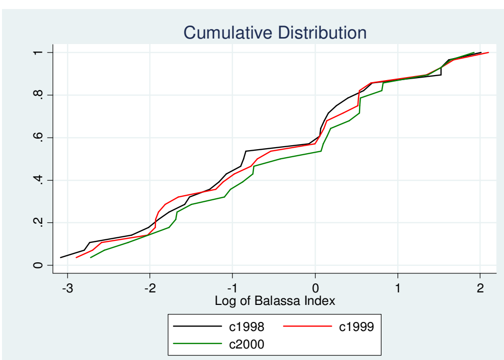
Figure A.4
Cumulative Distribution Plots for India

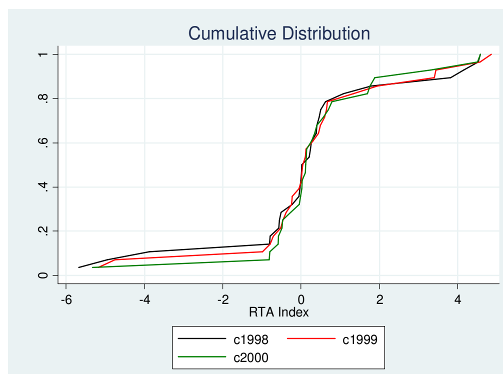












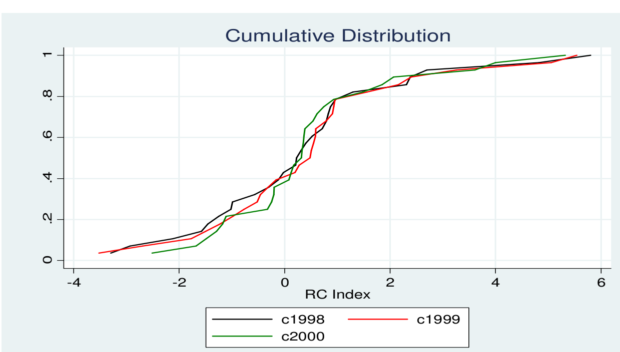


Figure A.5
Cumulative Distribution Plots for Italy

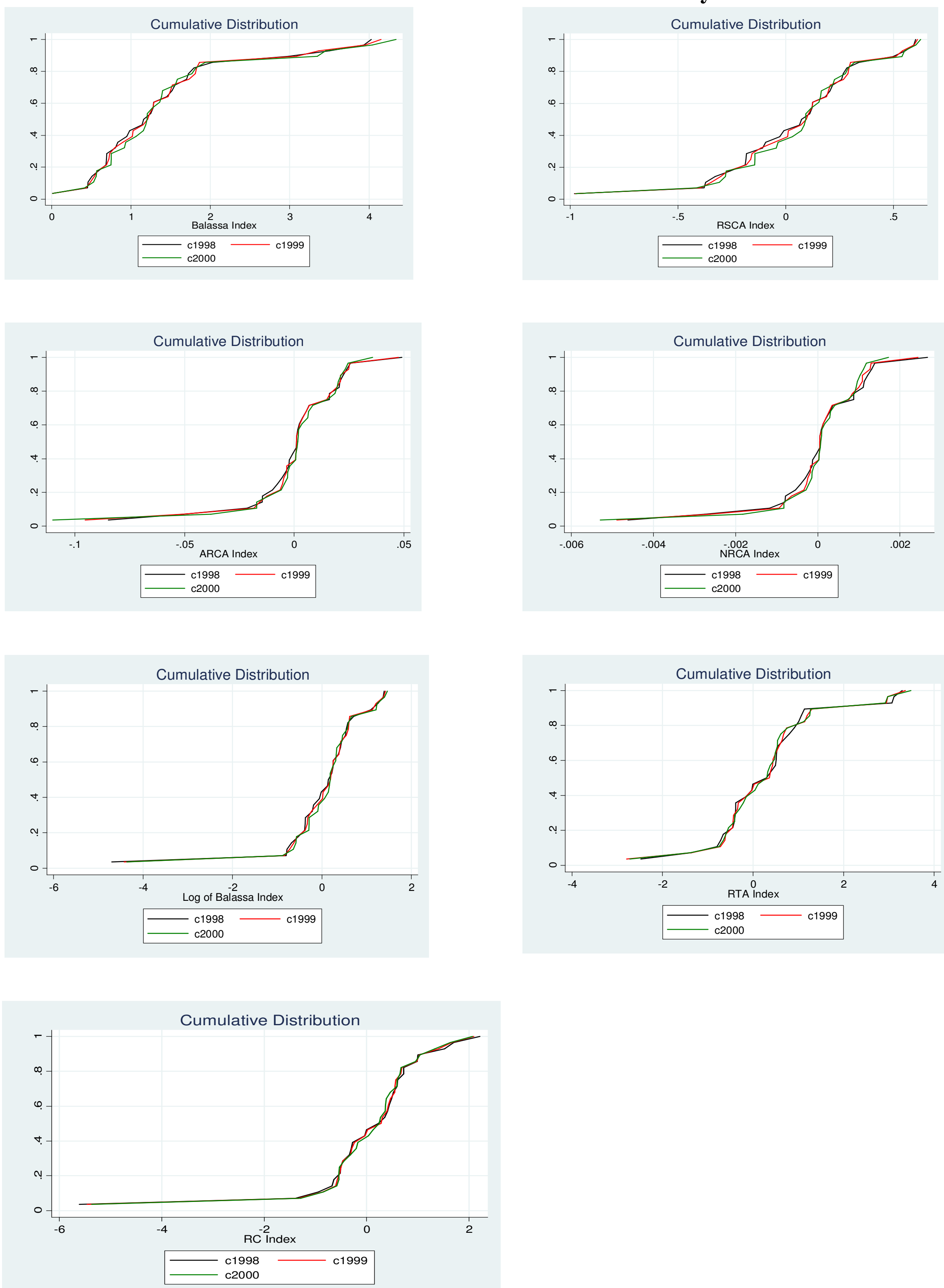


Figure A.6
Cumulative Distribution Plots for Japan

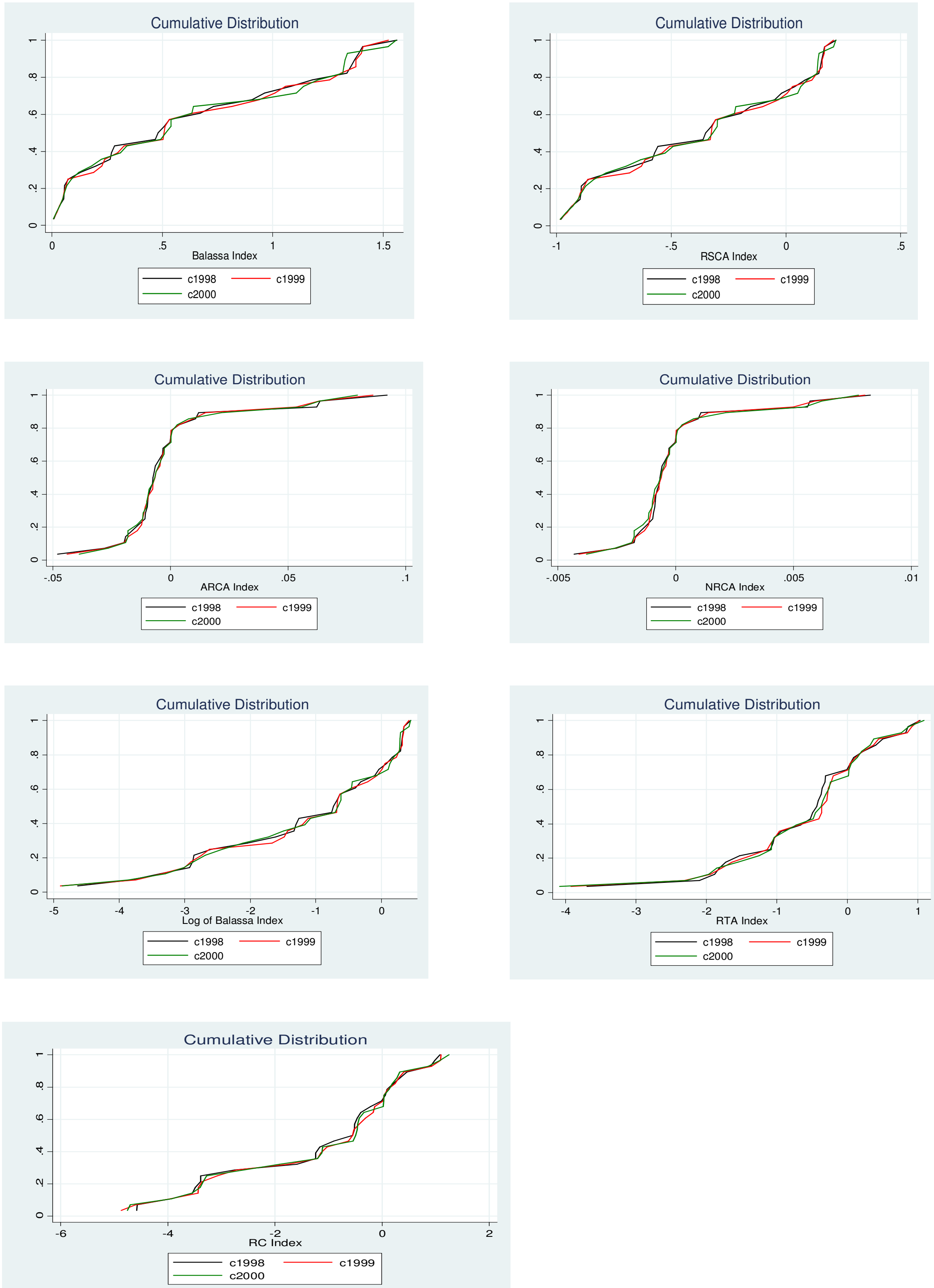


Figure A.7
Kernel Density Plots for China

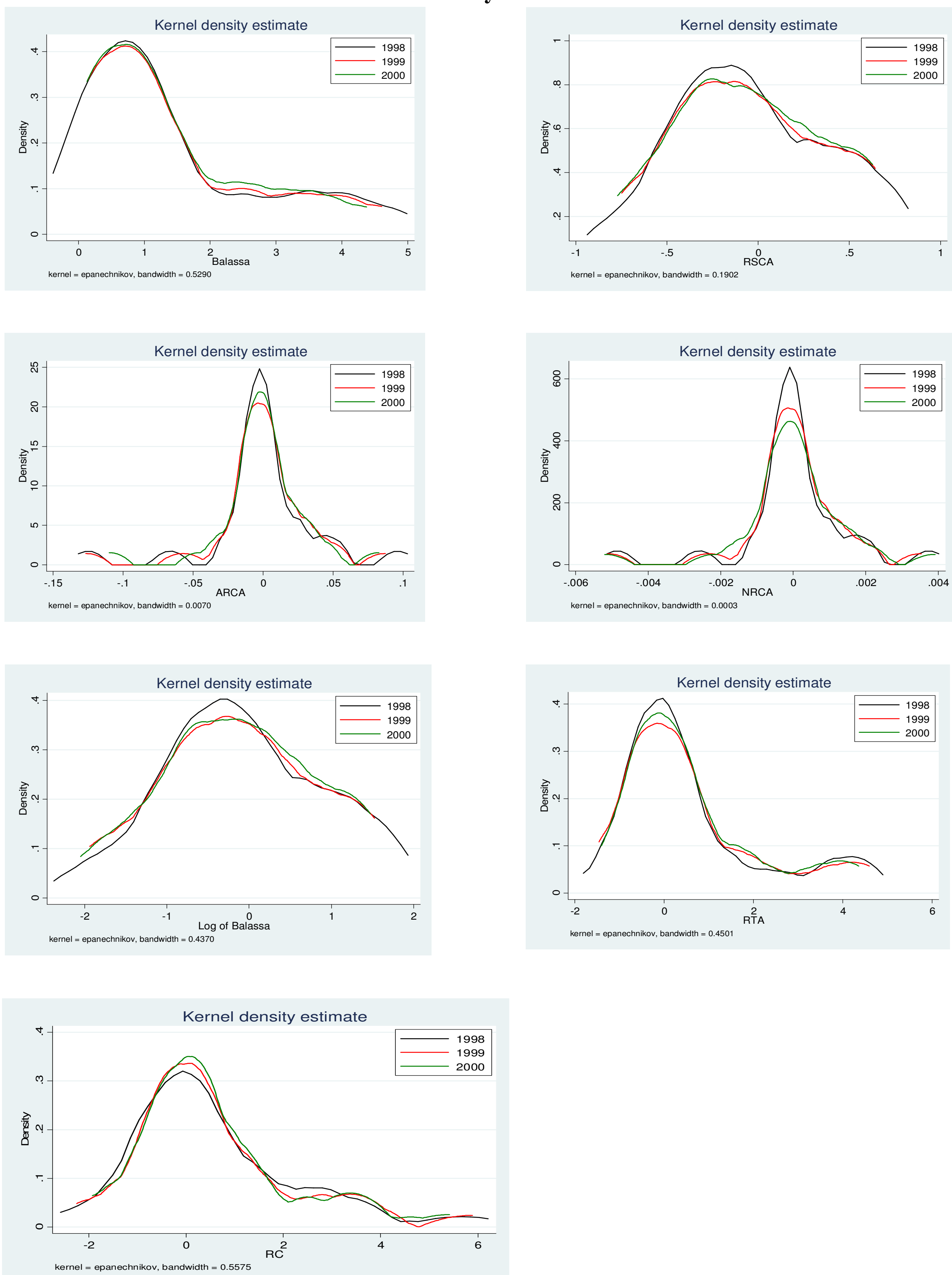


Figure A.8
Kernel Density Plots for France

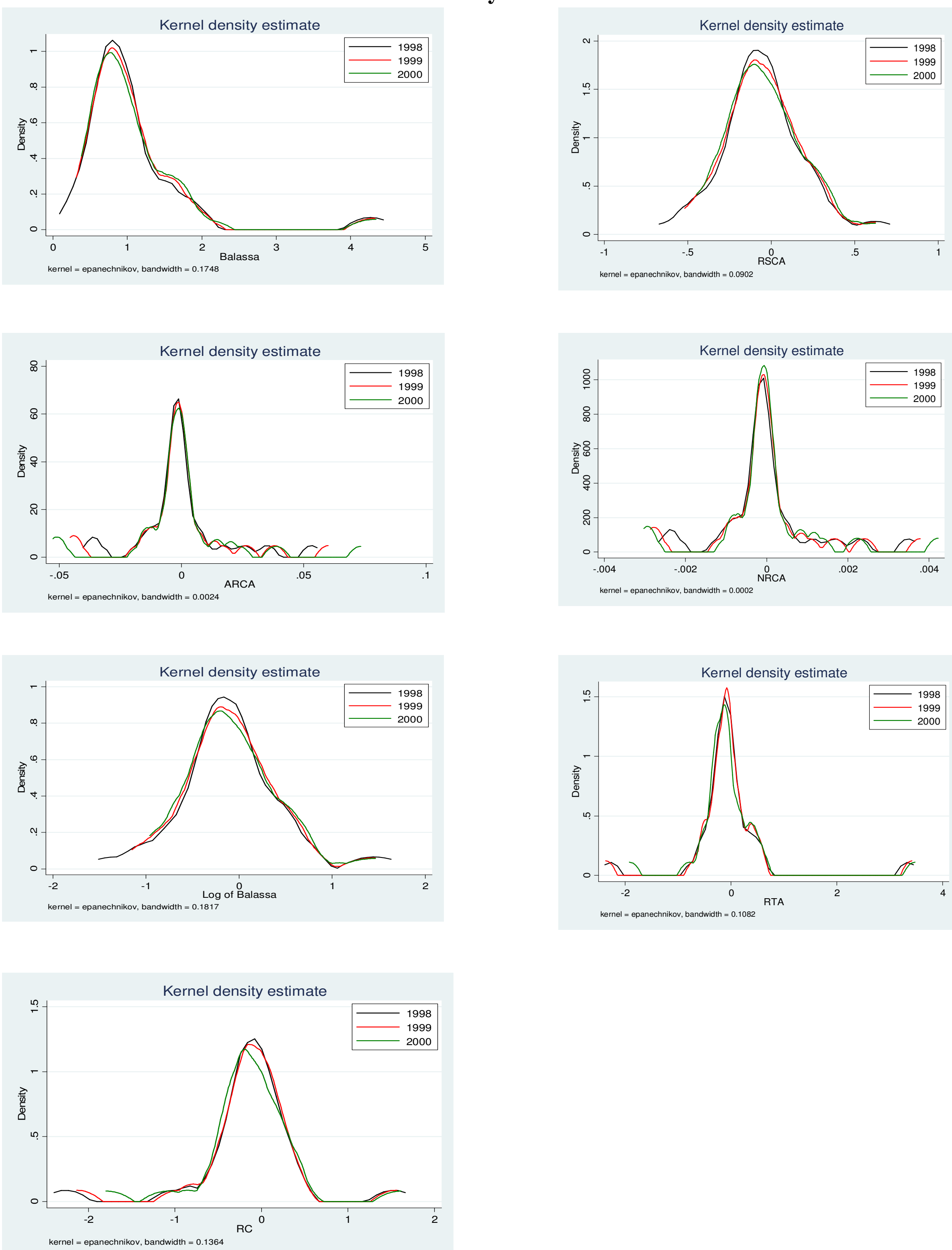
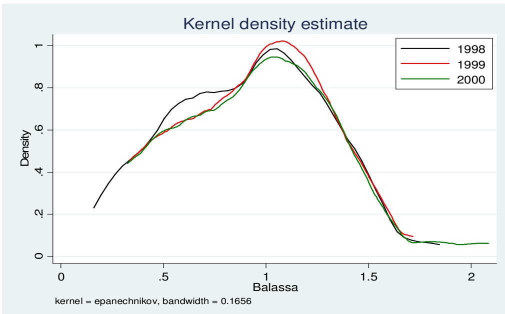
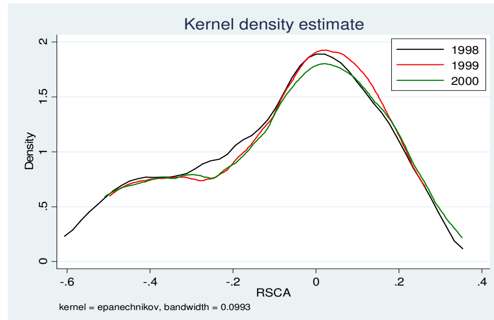
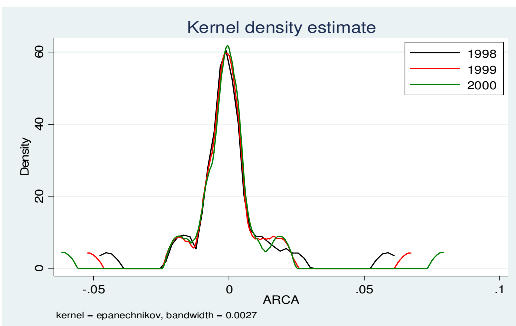
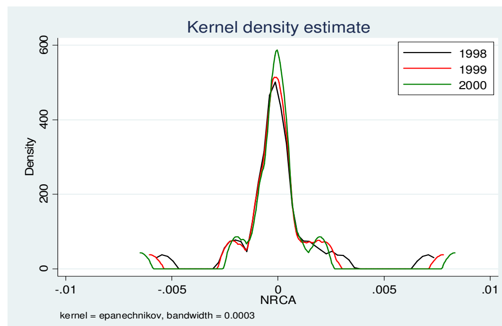


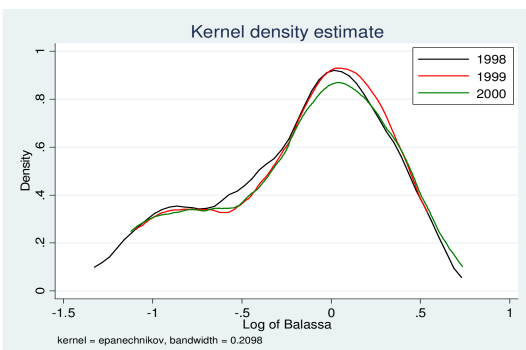
Figure A.9
Kernel Density Plots for Germany

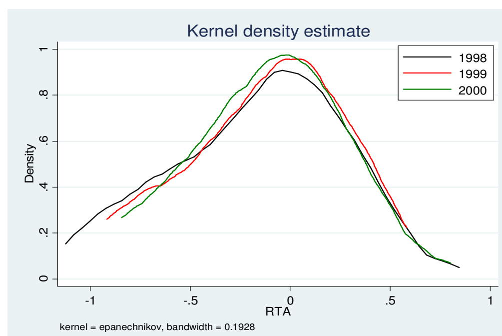












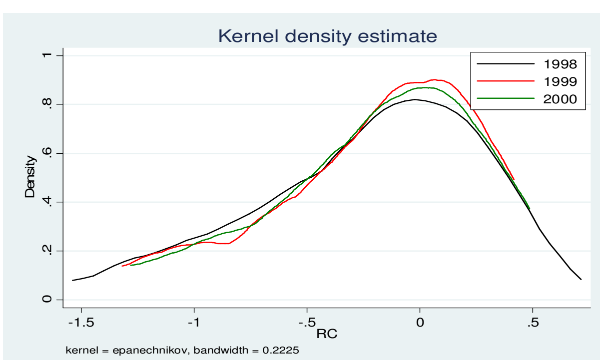


Figure A.10
Kernel Density Plots for India

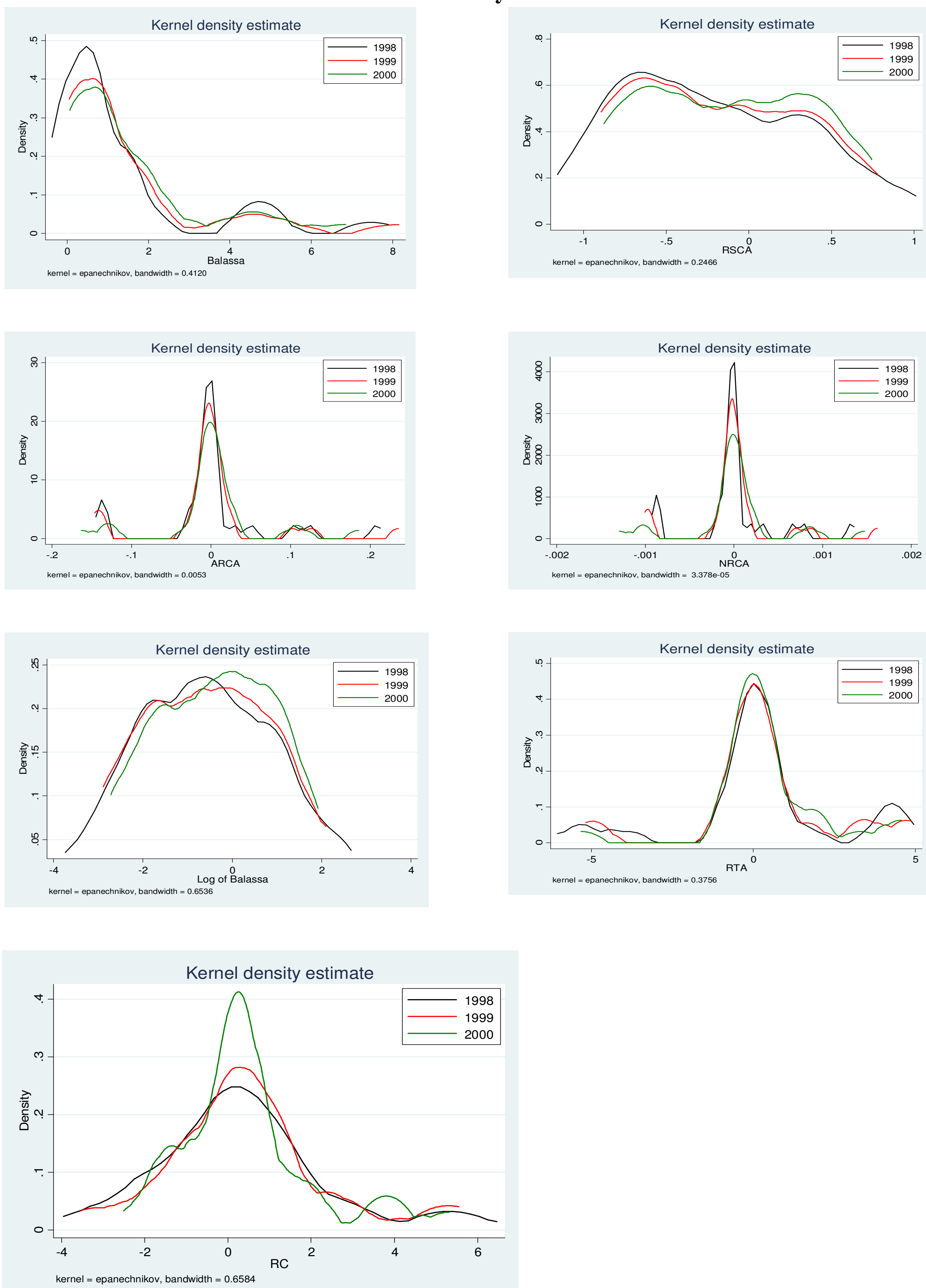


Figure A.11
Kernel Density Plots for Italy

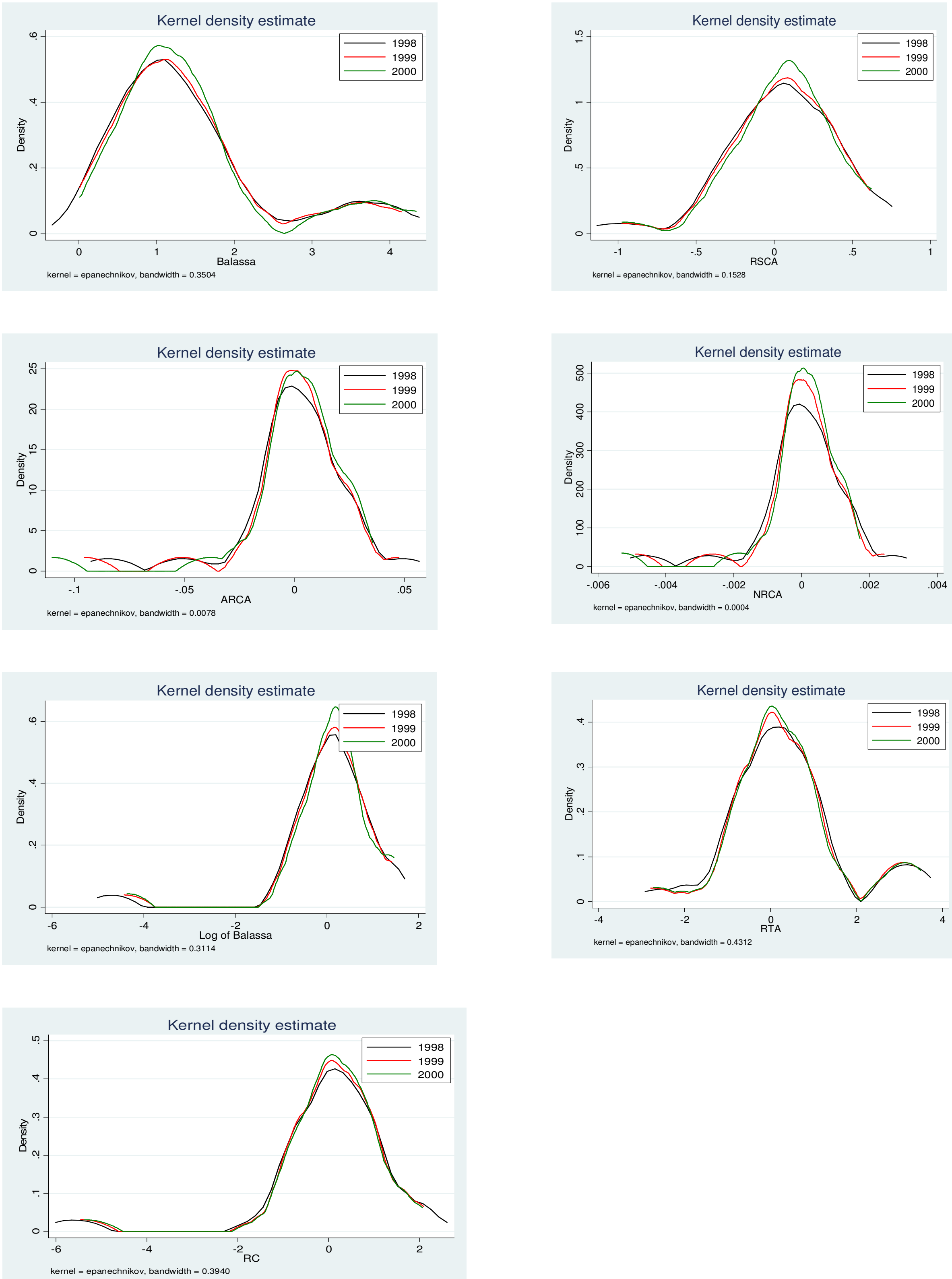


Figure A.12
Kernel Density Plots for Japan

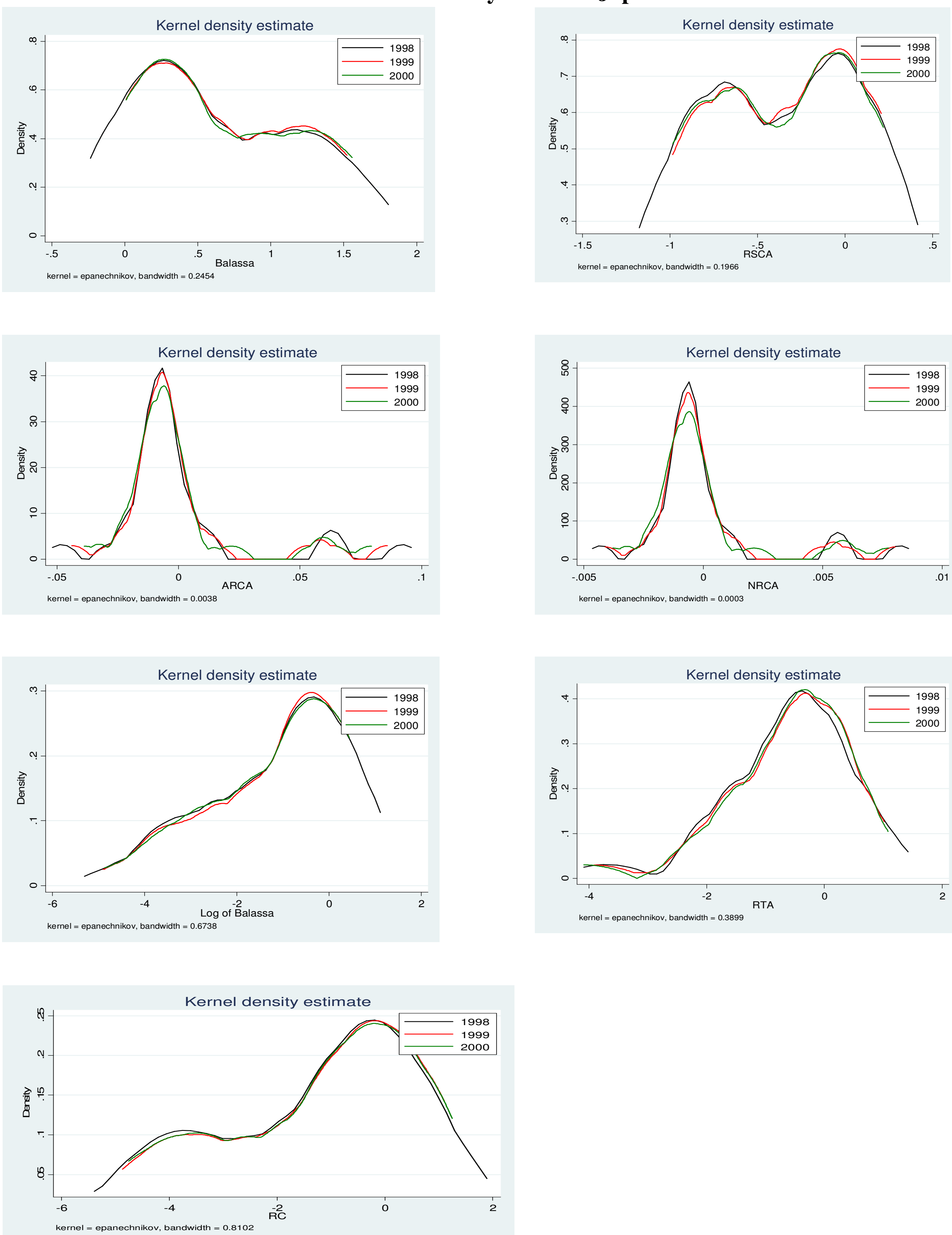


Table 2
Results for Wilcoxon's Signed Rank Test for Countries

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	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	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	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	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	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)
Japan	1999-2000	0.205	-0.068	-1.207	0.182	-0.273	0.228	<0.001

		(0.838)	(0.946)	(0.228)	(0.855)	(0.785)	(0.820)	(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)
	Accepted cases	3	3	3	3	3	3	3
	Total no. of accepted cases for null hypothesis	14	15	18	18	15	17	18

Note: For each index only the standardized normal approximation of the test statistic and the corresponding p value is reported. * denotes significant at 5% level. ** denotes significant at 1% level. Reported numbers of cases for each index are out of 3 for each country, and out of 18 for all countries together.

Table 3
Results for Wilcoxon's Signed Rank Test for Sectors

ISIC Codes	Year Combinations	Balassa	RSCA	ARCA	NRCA	Log of Balassa	RTA	RC
	1998-1999	0.994 (0.320)	1.458 (0.145)	1.163 (0.245)	1.244 (0.214)	1.428 (0.153)	1.494 (0.135)	2.319* (0.020)
	1999-2000	1.347 (0.178)	1.796 (0.073)	1.737 (0.082)	1.141 (0.254)	1.561 (0.119)	2.407* (0.016)	2.194* (0.028)
	1998-2000	1.759 (0.079)	2.746** (0.006)	2.047* (0.041)	1.708 (0.088)	2.466* (0.014)	1.936 (0.053)	3.489** (0.001)
321	Accepted cases	3	2	2	3	2	2	0
	1998-1999	0.493 (0.622)	1.038 (0.299)	0.486 (0.627)	0.037 (0.971)	0.913 (0.361)	0.530 (0.596)	2.15* (0.032)
	1999-2000	0.648 (0.517)	1.907 (0.057)	1.178 (0.239	0.361 (0.718)	1.62 (0.105)	1.053 (0.293)	3.062** (0.002)
	1998-2000	0.670 (0.503)	1.708 (0.088)	1.112 (0.266)	0.773 (0.440)	1.340 (0.180)	0.751 (0.453)	3.254** (0.001)
322	Accepted cases	3	3	3	3	3	3	0
	1998-1999	1.310 (0.190)	2.002** (0.045)	1.259 (0.208)	1.185 (0.236)	1.737 (0.082)	1.259 (0.208)	1.575 (0.115)
	1999-2000	0.913 (0.361)	1.090 (0.276)	1.045 (0.296)	0.317 (0.752)	0.891 (0.373)	0.905 (0.365)	1.178 (0.239)
	1998-2000	1.053 (0.293)	1.929 (0.054)	1.148 (0.251)	1.296 (0.195)	1.656 (0.098)	0.751 (0.453)	2.238* (0.025)
323	Accepted cases	3	2	3	3	3	3	2
	1998-1999	-0.420 (0.675)	0.213 (0.831)	-0.802 (0.422)	-0.434 (0.664)	0.309 (0.757)	0.088 (0.930)	0.770 (0.441)
324	1999-2000	2.746** (0.006)	3.467** (0.001)	0.604 (0.546)	-0.346 (0.729)	3.335** (0.001)	3.026** (0.003)	5.109** (<0.001)

	1998-2000	2.694** (0.007)	3.107** (0.002)	0.427 (0.669)	-0.604 (0.546)	2.830** (0.005)	2.967** (0.003)	4.061** (<0.001)
	Accepted cases	1	1	3	3	1	1	1
351	1998-1999	0.015 (0.988)	-0.346 (0.729)	-0.420 (0.675)	-0.928 (0.354)	-0.317 (0.752)	1.274 (0.203)	-0.353 (0.724)
	1999-2000	-0.059 (0.953)	-0.066 (0.947)	0.199 (0.842)	-0.839 (0.401)	<0.001 (1.000)	0.125 (0.900)	-0.037 (0.971)
	1998-2000	-0.515 (0.606)	-0.655 (0.512)	-0.707 (0.480)	-0.810 (0.418)	-0.508 (0.612)	1.119 (0.263)	-0.110 (0.912)
	Accepted cases	3	3	3	3	3	3	3
352	1998-1999	0.361 (0.718)	0.817 (0.414)	1.141 (0.254)	1.207 (0.227)	0.802 (0.422)	0.361 (0.718)	1.06 (0.289)
	1999-2000	-2.039* (0.041)	-2.128* (0.033)	-2.878** (0.004)	-1.031 (0.303)	-2.231** (0.026)	-0.081 (0.936)	-1.200 (0.230)
	1998-2000	-0.368 (0.713)	-0.236 (0.814)	-1.310 (0.190)	0.640 (0.522)	-0.169 (0.866)	0.633 (0.527)	1.097 (0.273)
	Accepted cases	2	2	2	3	2	3	3
385	1998-1999	0.670 (0.503)	0.449 (0.653)	3.291** (0.001)	1.561 (0.119)	0.536 (0.592)	-0.854 (0.393)	-0.762 (0.446)
	1999-2000	0.876 (0.381)	0.824 (0.410)	3.136** (0.002)	1.325 (0.185)	0.707 (0.480)	-1.789 (0.074)	-1.038 (0.299)
	1998-2000	1.583 (0.114)	1.458 (0.145)	3.401** (0.001)	3.320** (0.001)	1.298 (0.194)	-1.575 (0.115)	-1.034 (0.301)
	Accepted cases	3	3	0	2	3	3	3
	Total no. of accepted cases for null hypothesis	18	16	16	20	17	18	12

Note: For each index only the standardized normal approximation of the test statistic and the corresponding p value is reported. * denotes significant at 5% level. ** denotes significant at 1% level. Reported numbers of cases for each index are out of 3 for each sector, and out of 21 for all sectors together.

Table 4
Results for Wilcoxon's Rank Sum Test for Sectors

Sector Combinations	Balassa	RSCA	ARCA	NRCA	Log of Balassa	RTA	RC
321-322	-0.698 (0.485)	-0.698 (0.485)	-0.724 (0.469)	-0.835 (0.404)	-0.698 (0.485)	-3.506** (0.001)	-3.769** (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** (0.005)	2.813** (0.005)	-0.289 (0.773)	0.168 (0.867)	2.813** (0.005)	-0.966 (0.334)	-0.310 (0.757)
321-351	2.283* (0.022)	2.283* (0.022)	3.826** (0.0001)	0.630 (0.529)	2.283* (0.022)	1.386 (0.166)	1.554 (0.120)
321-352	2.141* (0.032)	2.141* (0.032)	2.771** (0.006)	0.446 (0.656)	2.141* (0.032)	1.622 (0.105)	1.832 (0.067)
321-385	5.144** (<0.001)	5.144** (<0.001)	5.983** (<0.001)	2.215* (0.027)	5.144** (<0.001)	1.275 (0.202)	2.981** (0.003)
322-323	1.107 (0.268)	1.107 (0.268)	0.525 (0.600)	0.877 (0.381)	1.107 (0.268)	1.538 (0.124)	2.173* (0.030)
322-324	3.181** (0.002)	3.181** (0.002)	0.924 (0.356)	1.081 (0.280)	3.181** (0.002)	2.519* (0.012)	2.462** (0.014)
322-351	2.677** (0.007)	2.677** (0.007)	4.351** (<0.001)	1.386 (0.166)	2.677** (0.007)	4.928** (<0.001)	4.745** (<0.001)
322-352	2.383* (0.017)	2.383* (0.017)	3.349** (0.001)	1.081 (0.280)	2.383* (0.017)	5.044** (<0.001)	4.970** (<0.001)
322-385	4.934** (<0.001)	4.934** (<0.001)	6.083** (<0.001)	2.467* (0.014)	4.934** (<0.001)	4.740** (<0.001)	5.543** (<0.001)
323-324	2.294* (0.022)	2.294* (0.022)	1.139 (0.255)	0.709 (0.479)	2.294* (0.022)	1.491 (0.136)	1.139 (0.255)
323-351	1.774 (0.076)	1.774 (0.076)	3.559** (0.0004)	1.391 (0.164)	1.774 (0.076)	4.225** (<0.001)	3.511** (0.0004)
323-352	1.359 (0.174)	1.359 (0.174)	2.467* (0.014)	0.919 (0.358)	1.359 (0.174)	4.314** (<0.001)	3.921** (0.0001)
323-385	4.267** (<0.001)	4.267** (<0.001)	6.876** (<0.001)	3.706** (0.0002)	4.267** (<0.001)	4.430** (<0.001)	4.792** (<0.001)
324-351	-1.197 (0.231)	-1.197 (0.231)	3.023** (0.003)	1.029 (0.304)	-1.197 (0.231)	2.414* (0.016)	1.097 (0.273)
324-352	-1.296 (0.195)	-1.296 (0.195)	1.979* (0.048)	0.504 (0.614)	-1.296 (0.195)	2.698** (0.007)	1.380 (0.168)
324-385	1.317 (0.188)	1.317 (0.188)	6.598** (<0.001)	3.338** (0.001)	1.317 (0.188)	1.806 (0.071)	2.194* (0.028)
351-352	-0.189 (0.850)	-0.189 (0.850)	-1.811 (0.070)	-0.226 (0.821)	-0.189 (0.850)	0.493 (0.622)	0.441 (0.659)
351-385	3.517** (0.0004)	3.517** (0.0004)	0.793 (0.428)	1.375 (0.170)	3.517** (0.0004)	-0.436 (0.663)	1.753 (0.080)
352-385	3.307** (0.001)	3.307** (0.001)	3.223** (0.001)	1.664 (0.096)	3.307** (0.001)	-1.485 (0.137)	1.244 (0.214)

No of accepted cases for null hypothesis	9	9	8	17	9	10	9

Note: For each index only the standardized normal approximation of the test statistic and the corresponding p value is reported. Reported numbers of cases are out of a total of 21 cases for each index.

Table 5
Results for Wilcoxon's Rank sum 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 (1.00)
China-Italy	-1.18 (0.238)	-1.18 (0.238)	-0.77 (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

Note: For each index only the standardized normal approximation of the test statistic and the corresponding p value is reported. Reported numbers of cases are out of a total of 15 cases for each index.

Table 6
Results for Kolmogorov Smirnov 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)
321-385	0.4000** (<0.001)	0.4000** (<0.001)	0.5167** (<0.001)	0.3667** (0.001)	0.4000** (<0.001)	0.2167 (0.120)	0.2500* (0.047)
322-323	0.1500 (0.509)	0.1500 (0.509)	0.3500** (0.001)	0.2500* (0.047)	0.1500 (0.509)	0.2000 (0.181)	0.3000** (0.009)
322-324	0.2833* (0.016)	0.2833* (0.016)	0.3667** (0.001)	0.2833* (0.016)	0.2833* (0.016)	0.2500* (0.047)	0.2333 (0.076)
322-351	0.3833** (<0.001)	0.3833** (<0.001)	0.4000** (<0.001)	0.2333 (0.076)	0.3833** (<0.001)	0.5000** (<0.001)	0.5667** (<0.001)
322-352	0.2667* (0.028)	0.2667* (0.028)	0.3000** (0.009)	0.2333 (0.076)	0.2667* (0.028)	0.4167** (<0.001)	0.5500** (<0.001)
322-385	0.4333** (<0.001)	0.4333** (<0.001)	0.5167** (<0.001)	0.4500** (<0.001)	0.4333** (<0.001)	0.5333** (<0.001)	0.5833** (<0.001)
323-324	0.2667* (0.028)	0.2667* (0.028)	0.2167 (0.120)	0.1667 (0.375)	0.2667* (0.028)	0.3167** (0.005)	0.3500** (0.001)
323-351	0.2833* (0.016)	0.2833* (0.016)	0.5833** (<0.001)	0.2333 (0.076)	0.2833* (0.016)	0.3667** (0.001)	0.3167** (0.005)
323-352	0.1667 (0.375)	0.1667 (0.375)	0.5500** (<0.001)	0.2333 (0.076)	0.1667 (0.375)	0.4500** (<0.001)	0.3333** (0.003)
323-385	0.4000** (<0.001)	0.4000** (<0.001)	0.7833** (<0.001)	0.4500** (<0.001)	0.4000** (<0.001)	0.3833** (<0.001)	0.3833** (<0.001)
324-351	0.2667* (0.028)	0.2667* (0.028)	0.5833** (<0.001)	0.1833 (0.266)	0.2667* (0.028)	0.2667* (0.028)	0.3667** (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* (0.047)	0.2500* (0.047)	0.8000** (<0.001)	0.3667** (0.001)	0.2500* (0.047)	0.3500** (0.001)	0.3833** (<0.001)
351-352	0.1833 (0.266)	0.1833 (0.266)	0.2667* (0.028)	0.0833 (0.985)	0.1833 (0.266)	0.1667 (0.375)	0.1167 (0.809)
351-385	0.3500** (0.001)	0.3500** (0.001)	0.2667* (0.028)	0.2333 (0.076)	0.3500** (0.001)	0.2167 (0.120)	0.1667 (0.375)
352-385	0.2833* (0.016)	0.2833* (0.016)	0.2833* (0.016)	0.2833* (0.016)	0.2833* (0.016)	0.3000** (0.009)	0.1333 (0.660)
No. of accepted cases for null hypothesis	6	6	2	14	6	8	4

Note: For each index the test statistics and the asymptotic p values are reported. 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. Reported numbers of cases are out of a total of 21 cases for each index.

Table 7
Results for Equality of Distributions over Countries using Kolmogorov Smirnov Test

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

Note: For each index the test statistics and the corresponding asymptotic p values are reported. Reported numbers of cases are out of a total of 15 cases for each index.

References

Balassa, B. 1965. "Trade Liberalization and 'Revealed' Comparative Advantage." *Manchester School of Economics and Social Studies* 33: 99-123.

Ballance, R.H., H. Forstner and T. Murray. 1987. "Consistency Tests of Alternative Measures of Comparative Advantage." *The Review of Economics and Statistics* 69(1): 157-161.

Batra, A. and Z. Khan. 2005. "Revealed Comparative Advantage: An Analysis for India and China." Indian Council for Research on International Economic Relations (ICRIER), New Delhi. Working Paper No. 168.

Benedictis, L.D. and M. Tamberi. 2001. "A Note on Balassa Index of Revealed Comparative Advantage." Dipartmento di Economia, Universita' Politecnica delle Marche. Working Paper No. 158.

Benedictis, L.D. and M. Tamberi. 2004. "Overall Specialization Empirics: Techniques and Applications." *Open Economies Review* 15: 323-346.

Bowen, H. P. 1983. "On the Theoretical Interpretation of Indices of Trade Intensity and Revealed Comparative Advantage." *Weltwirtschaftliches Archiv* 119: 464-472.

Campbell, M.J. 2006. "Teaching Non-parametric Statistics to Students in Health Sciences." ICOTS 7, IASE, ISI, Salvador, Bahia, Brazil.

Conover, W.J. 1999. *Practical Nonparametric Statistics*. New Delhi: Wiley India.

Dalum, B., K. Laursen and G. Villumsen. 1998. "Structural Change in OECD Export Specialisation Patterns: Despecialisation and 'Stickiness'." *International Review of Applied Economics* 12: 423-443.

Deb, K. and P. Basu. 2011. "Indices of Revealed Comparative Advantage and their Consistency with the Heckscher-Ohlin Theory: A Cross Sectional Analysis." *Foreign Trade Review* 46: 3-28.

Dimaranan, B., E. Ianchovichina and W.J. Martin. 2007. "China, India, and the Future of the World Economy: Fierce Competition or Shared Growth?" Policy Research Working Paper No. 4304, World Bank, Washington, DC.

Epanechnikov, V.A. 1969. "Non-Parametric Estimation of a Multivariate Probability Density." *Theory of Probability and Applications* 14(1): 153-158.

Hart, A. 2001. "Mann-Whitney test is not just a test of medians: differences in spread can be important." *British Medical Journal* 323(7309): 391-393.

Hassan, M. 2013. "An Analysis of Competitiveness of Pakistan's Agricultural Export Commodities." *Journal of Business and Management* 11: 29-34.

Hiley, M. 1999. "The dynamics of changing comparative advantage in the Asia-Pacific region." *Journal of the Asia Pacific Economy* 4: 446-467.

Hinloopen, J. and C. Marrewijk. 2004. "Dynamics of Chinese Comparative Advantage", Tinbergen Institute Discussion Paper No. 2004-034/2.

Hoen, A. R., and J. Oosterhaven. 2006. "On the Measurement of Comparative Advantage." *The Annals of Regional Science* 40: 677-691.

Karaalp, H. S. 2011. "Competitiveness of Turkey in Eurasia: A Comparison with CIS Countries." *China-USA Business Review* 10: 727-744.

Kijboonchoo, T. and K. Kalayanakupt. 2003. "Comparative Advantage and Competitive Strength of Thai Canned Tuna Export in the World Market: 1982-1998. *ABAC Journal* 23: 19-33.

Lafay, G. 1992. "The measurement of revealed comparative advantages." In M.G. Dagenais, and P.A. Muet eds., *International Trade Modeling*. London: Chapman & Hall.

Laursen, K. 1998. "Revealed Comparative Advantage and the Alternatives as Measures of International Specialisation." Danish Research Unit for Industrial Dynamics. Working Paper No. 98-30.

Lehmann, E.L. 2006. *Nonparametrics: Statistical Methods Based on Ranks*. USA: Springer.

Leromain, E. and G. Orefice. 2014. "New Revealed Comparative Advantage Index: Dataset and Empirical Distribution." *International Economics* 139(2014): 48-70.

Nicita, A. and M. Olarreaga. 2007. "Trade, Production and Protection Database 1976-2004." *World Bank Economic Review* 21: 165-171.

Proudman, J. and S. Rdding. 1998. *Openness and Growth*. UK: Bank of England.

PTI. 2015, August 18. "India's turn to become factory of the world: China state media." *The Times of India*. Accessed from http://timesofindia.indiatimes.com/business/india-business on 3.9.2015.

Smirnov, N.V. 1939. "Estimate of Deviation between Empirical Distribution Functions in Two Independent Samples." (Russian) *Bulletin Moscow University* 2(2): 3-16.

Smyth, D. A. 2005. "Ireland's Revealed Comparative Advantage." *Quarterly Bulletin.* Central Bank of Ireland, Dublin 1: 101-114.

StataCorp. 2013. *Stata 13 Base Reference Manual*. College Station, TX: Stata Press.

Ullah, A. 1988. "Non-Parametric Estimations of Econometric Functionals." *The Canadian Journal of Economics* 21: 625-658.

Vollrath, T. L. 1991. "A Theoretical Evaluation of Alternative Trade Intensity Measures of Revealed Comparative Advantage." *Weltwirtschaftliches Archiv* 127: 265-280.

Wignaraja, G. 2011. "Economic Reforms, Regionalism and Exports: Comparing China and India." East-West Centre Policy Studies 60.

Wilcoxon, F. 1945. “Individual Comparisons by Ranking Methods.” *Biometric Bulletin* 1: 80-83.

Yu, R., J. Cai, and P. Leung. 2009. “The Normalized Revealed Comparative Advantage Index.” *The Annals of Regional Science* 43: 267-282.

Yeats, A. J. 1985. “On the Appropriate Interpretation of the Revealed Comparative Advantage Index: Implications of a Methodology based on Industry Sector Analysis.” *Weltwirtschaftliches Archiv* 121: 61-73.