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TRADE SPECIALIZATION INDICES: TWO COMPETING MODELS

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ABSTRACT

Revealed Comparative Advantage (RCA) index by Balassa (1965) is intensively applied in empirical studies on countries' comparative advantage or trade specialization. Asymmetric problem in the criteria of RCA index encourages Dalum et al. (1998) and Laursen (1998) to make Revealed Symmetric Comparative Advantage (RSCA) index. These two indexes are commonly employed in econometric models for analyzing countries' trade specialization. This paper aims to compare theoretically and empirically the two competing econometric models, one using RCA and the other using RSCA. The ASEAN countries' comparative advantages are presented for the empirical case studies. This paper concludes that RSCA can, to some extent, reduce the "outlier problem" of RCA in the econometric model; therefore, the model using RSCA can be more statistically reliable than the model using RCA. The two econometric models might not be suitable for forecasting purposes since the estimated values could theoretically violate their criteria of comparative advantage and disadvantage. In the cases of ASEAN countries, we find empirically that the model using RSCA is statistically more reliable than the one using RCA. The ASEAN countries have exhibited de-specialization.

JEL classification: F10, F14, F17

Keywords: *Revealed Comparative Advantage (RCA), Revealed Symmetric Comparative Advantage (RSCA).*

INTRODUCTION

Comparative advantages determine countries' trade specialization. In international trade theories, the concept of difference in comparative advantage is defined in term of autarkic (pre-trade) relative prices. Any difference in the autarkic relative prices between two countries indicates the possibilities for them to gain from trade. Since the autarkic relative prices are not observable in post-trade equilibriums, in empirical works the concept must be measured indirectly using post-trade data.

Hence, nowadays there have been many empirical alternative measures applied in various studies of comparative advantage. Balance *et al*. (1987) discuss comprehensively several available empirical measures of comparative advantage, i.e. the ratio of exports to production, the ratio of imports to consumption, the ratio of net trade to production, the ratio of production to consumption, the ratio of actual net trade to "expected" production, the ratio of the deviation of actual from expected production to expected production, the ratio of the deviation of actual from expected consumption to expected production, the ratio of the net trade from the total trade, the ratio of actual exports to expected exports[(1)], and the Donges and Riedel index[(2)]. Several other empirical measures are the Michaely index (Michaely, 1962), net trade index (Bowen, 1983), the contribution to the trade balance (CEPII, 1983), and the χ^2 measure (Archibugi and Pianta, 1992) [(3)]. However, Revealed Comparative Advantage (RCA) index by Balassa (1965) is the most intensively applied one (e.g. Aquino, 1981; Crafts and Thomas, 1986; Peterson, 1988; Crafts, 1989; Porter, 1990; van Hulst *et al.*, 1991; Amiti, 1999; Dowling and Cheang, 2000; Isogai *et al*., 2002; Ng and Yeats, 2003).

Several researchers, such as Volrath (1991), Dalum *et al.* (1998), Laursen (1998) and Wörz (2005), among others, have noted several shortcomings of the RCA index, especially when it is applied in an econometric model for analyzing countries' dynamic comparative advantage. Dalum *et al*. (1998) and Laursen (1998), therefore, recommend an index namely Revealed Symmetric Comparative Advantage (RSCA), which is, in fact, a simple transformation of RCA index. This paper aims to compare both theoretically and empirically the two competing econometric models commonly used in the empirical studies for analyzing countries' dynamic comparative advantage: one using RCA and the other using RSCA. The rest of this paper is organized as follows. Part 2 exhibits the two empirical econometric models for analyzing countries' dynamic comparative advantage. Part 3 describes the empirical results in the cases of the ASEAN (Association of South East Asian Nations) countries' dynamic trade specialization. Finally, several conclusions are presented in Part 4.

THE ECONOMETRIC MODELS

1. The Generic model

A simple econometric model (1) is commonly applied to examine the dynamics of trade specialization:

$$ICA_{ij,T} = \alpha + \beta\ ICA_{ij,0} + \varepsilon_{ij} \qquad (1)$$

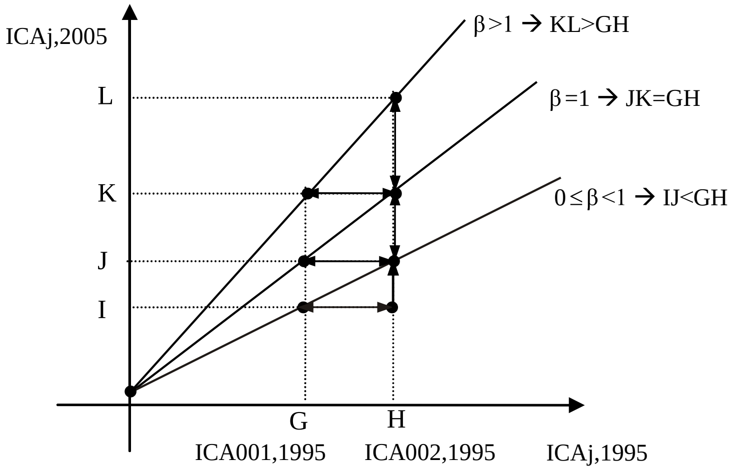
where $ICA_{ij,T}$ and $ICA_{ij,0}$ are any index of comparative advantage of country i in product j for years T and 0, respectively, and ε_{ij} denotes white noise error term[(4)]. The coefficient β specifies whether the existing trade specialization has been reinforced or not during the observation (Dalum *et al*., 1998; Laursen, 1998; and Wörz, 2005). To explain the specification, let us consider Figure 1, which describes the ICA for groups of products SITC (Standard International Trade Classification) 001 and SITC 002 in 1995 (horizontal axis) and 2005 (vertical axis), respectively. In the case of β is not significantly different from one (β=1), there is no change in the overall trade specialization. The difference between $ICA_{001,1995}$ and $ICA_{002,1995}$ (GH) equals the difference between $ICA_{001,2005}$ and $ICA_{002,2005}$ (JK). In the case of β>1, it indicates the increase in specialization. The difference between $ICA_{001,1995}$ and $ICA_{002,1995}$ (GH) is smaller than the difference between $ICA_{001,2005}$ and $ICA_{002,2005}$ (KL). Finally, 0<β<1 indicates the de-specialization (IJ<GH) – that is, a country has gained comparative

(1) Revealed Comparative Advantage (RCA) or Balassa index by Balassa (1965) is included in this category.

(2) For this index, please see Donges and Riedel (1977).

(3) For the good discussion on these indexes, please see Laursen (1998).

(4) White noise means that the error terms fulfil all the classical regression assumptions. Error terms are normally independently distributed (NID) with zero mean (0) and constant variance (σ^2) i.e. $\varepsilon_{ij} \sim NID(0,\sigma^2)$.



Source: Author

Figure 1. Changes in Trade Specialization

advantage in industries where it did not specialize and has lost competitiveness in those industries where it was initially heavily specialized. In the event of β≤0, no reliable conclusion can be drawn on purely statistical grounds; the specialization pattern is either random, or it has been reversed.

To test statistically whether β equals one or not, we apply the Wald test. The statistic of the test is formulated as follows[5]:

$$F_W = \frac{\left(R_{UR}^2 - R_R^2\right)}{\left(1 - R_{UR}^2\right)} \frac{n-k}{m} \qquad (2)$$

Where R_{UR}^2 and R_R^2 are the coefficients of determination of the unrestricted regression and the restricted regression, respectively[6]; n is the number of observations (data); k is the number of coefficients (including constant), and *m* is the number of restrictions. The statistic (ratio) F_W is distributed following the *F* distribution with m and n-k degree of freedom.

2. Two empirical measures of comparative advantage

There are many empirical measures of comparative advantage[7]. Revealed Comparative Advantage (RCA) index by Balassa (1965) is the most intensively applied measure in many empirical works. The RCA index, which is also known as the Balassa index, is formulated as follows:

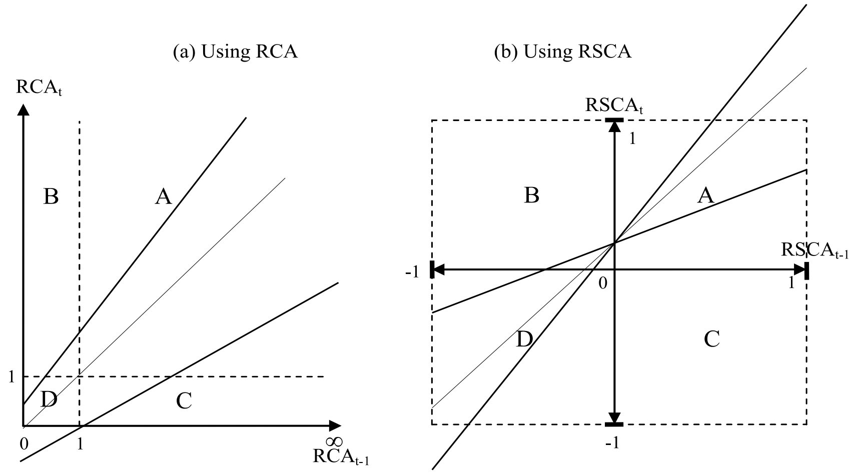
$$RCA_{ij} = (x_{ij} / x_{in}) / (x_{rj} / x_m) \qquad (3)$$

where RCA_{ij} stands for revealed comparative of country i for group of products (SITC) j and x_{ij} denotes total exports of country i in group of products (SITC) j. Subscript r represents all countries without country i, and subscript n refers all groups of products (SITC) except group of product j. The index represents a comparison of national export structure (the

[5] See Intriligator *et al.* (1996) for the detailed explanation about the Wald coefficient restrictions test.

[6] The Wald test calculates the test statistic by estimating the unrestricted regression (subscript UR) and the restricted regression (subscript R)- without and with imposing the coefficient restrictions specified by the null hypothesis, H_o. The hypothesis are H_o:β=1 and H_o:β≠1. The Wald statistic measures how close the unrestricted estimates come to satisfying the restriction under the null hypothesis. If the restrictions are in fact true, then the unrestricted estimates should come close to satisfying the restrictions.

[7] See, for example, Balance *et al.* (1987), Vollrath (1991) and Laursen (1998) for good discussions on several empirical measures of comparative advantage.



Source: Author

Figure 2. Possible Regression Lines of the Two Competing Econometric Models

numerator) with the world export structure (the denominator). The values of the index vary from 0 to infinity ($0 \leq RCA_{ij} \leq \infty$). RCA_{ij} greater than 1 implies that country i has comparative advantage in group of products j. In contrast, RCA_{ij} less than 1 means that country i has comparative disadvantage in product j.

Since RCA_{ij} turns out to produce values that cannot be compared on both sides of 1, the index is made to be a symmetric one. The new index is called Revealed Symmetric Comparative Advantaged (RSCA), which is formulated as (Dalum *et al.*, 1998; Laursen, 1998):

$$RSCA_{ij} = (RCA_{ij} - 1)/(RCA_{ij} + 1) \qquad (4)$$

$RSCA_{ij}$ index varies from -1 to +1 (or $-1 \leq RSCA_{ij} \leq 1$). The interpretation of RSCA is similar with that of RCA. $RSCA_{ij}$ greater than 0 implies that country i has comparative advantage in good j. In contrast, $RSCA_{ij}$ less than 0 implies that country i has comparative disadvantage in product j.

3. The two competing econometric models

In this paper, we examine two competing econometric models. The first model applies RCA in the above econometric model (1). The model becomes:

$$RCA_{ij,T} = \alpha + \beta \ RCA_{ij,0} + \varepsilon_{ij} \qquad (5)$$

Where $RCA_{ij,T}$ and $RCA_{ij,0}$ are the values of RCA index country i in product j for years T and 0, respectively. ε_{ij} denotes white noise error term.

For the econometric model (5), several researchers, such as Dalum *et al.* (1998), Laursen (1998) and Wörz (2005), among others, have noted some shortcomings of RCA index, especially when it is applied in an econometric model for analyzing countries' dynamic comparative advantages. *First,* RCA is basically not comparable on both side of unity since the index ranges from zero to infinity. A country is said not to be specialized in a given product if the index varies from zero to one. In contrast, a country is said to be specialized in a given product if the index ranges from one to infinity. *Second,* if RCA is used in estimating the econometric model, one might obtain biased estimates. RCA has disadvantage of an inherent risk of lack of normality. A skewed distribution violates the assumption of normality of the error term in regression analysis, thus not providing reliable inferential statistic. *Third,* the use of RCA in regression analysis gives much more weight to values above one, when compared to observation below unity. In Figure 2 Panel (a), this is clearly shown by the much smaller quadrants D, B, and C than the quadrant A. In contrast, when one uses RSCA instead of RCA, the quadrants A, B, C and D are exactly the same.

Hence, Dalum *et al*. (1998), Laursen (1998) and Wörz (2005) argue that Revealed Symmetric Comparative Advantage (RSCA) is more suitable for the econometric model:

$$\mathrm{RSCA}_{ij,T} = \alpha + \beta\ \mathrm{RSCA}_{ij,0} + \varepsilon_{ij} \qquad (6)$$

where $\mathrm{RSCA}_{ij,T}$ and $\mathrm{RSCA}_{ij,0}$ are the values of RSCA index country i in product j for years T and 0, respectively. ε_{ij} denotes white noise error term.

4. Theoretical analysis

The use of either RCA or RSCA in the econometric model needs some considerations in the estimation. *First*, if RCA has disadvantage of an inherent risk of lack of normality, we would argue that the transformation from RCA to RSCA cannot guarantee automatically the normality distribution of RSCA; since the transformation is only a decreasing monotonic one[8]. It is right that RSCA has symmetric criteria of comparative advantage with the central value 0, i.e. $-1 \le \mathrm{RSCA}_{ij} \le 1$. However, the symmetric in the criteria does not automatically guarantee the normality distribution of RSCA. Theoretically, a (continuous) random variable x, with the mean μ and the standard deviation σ has a normal distribution if its probability density function (pdf) has the following form:

$$f(x) = \frac{1}{\sigma\sqrt{2\pi}} \exp\left(-\frac{1}{2}\frac{(x-\mu)^2}{\sigma^2}\right)$$

for $-\infty < x < \infty$ (Gujarati, 1995:771).

Although the ordinary least squares (OLS) does not require the normality distribution of the error terms, the assumption of normality is for the purpose of statistical inference. If RCA has disadvantage of an inherent risk of lack of normality, RSCA will also have the disadvantage since RSCA is only a decreasing monotonic transformation of RCA. Therefore, either non-normally distributed RCA or RSCA used in estimating the econometric model, one might obtain biased estimates.

Second, even if the mean of error terms is zero ($E[\varepsilon_{ij}] = 0$) and there is no serial correlation ($E[\varepsilon_{ij}\varepsilon_{ik}] = 0$, for $j \ne k$), it can no longer be guaranteed that the error terms are homoscedastic ($E[\varepsilon_{ij}^2] = \sigma^2$). It is important to note that the econometric equations (5) and (6) are ones of comparing two cross-sections at two points of time; i.e. there is no element of time in the observation. As the nature of cross-sections, we might face heteroscedastic. Therefore, the Ordinary Least Squares (OLS) might be not suitable for the estimation.

Third, since the linear econometric model is applied, the use of RSCA, as well as RCA, faces a problem of prediction or forecasting. There is no guarantee that $\widehat{\mathrm{RSCA}}$, the estimator $E(\mathrm{RSCA}_{ij,T}|\mathrm{RSCA}_{ij,0})$, will necessarily fulfil the restriction, $-1 \le \mathrm{RSCA}_{ij} \le 1$. This problem also might happen when RCA is employed. However, we would argue that the problem is more severe when we use RSCA than when we use RCA, since RSCA is both bounded-below and bounded-above index ($-1 \le \mathrm{RSCA}_{ij} \le 1$, or $[-1,1] = \{\mathrm{RSCA} \in \Re : -1 \le \mathrm{RSCA} \le 1\}$, where $\Re$ denotes rational number) while RCA is only bounded-below index ($1 \le \mathrm{RCA}_{ij} \le \infty$, or $[1,\infty] = \{\mathrm{RCA} \in \Re : 1 \le \mathrm{RCA}\}$)[9]. Figure 2 describes this problem for the use of RCA (Panel a) and for the use of RSCA (Panel b) in the econometric model. When the RCA is used,

[8] See Hoy *et al*. (1995) for the detailed explanation on the monotonic transformation.

[9] See Hoy *et al*. (1995) for the detailed explanation on the terms "bounded above" and "bounded below".

we might have such problem if only if the estimate constant (α) is negative, for any estimate coefficient β in Equation 5. Meanwhile, we might have the problem for any estimate constant estimate constant (α) is negative, for any estimate coefficient β in Equation 6. Therefore, we would suggest that analyzing the estimated values of RCA and RSCA ($\hat{RCA}$ and $\hat{RSCA}$) is necessary before using the regression for forecasting purposes.

THE EMPIRICAL ANALYSIS

1. Data

We use data on exports published by the United Nations (UN), namely the United Nations Commodity Trade Statistics Database (UN-COMTRADE). We choose the 3-digit SITC Revision 2 and focuses on 237 groups of products. The 3-digit SITC Revision 2 is chosen because it provides appropriately the detailed groups of commodities as well as the range of available data.

2. Are RCA and RSCA indexes normally distributed?

In the previous Part, we argue that since the transformation from RCA to RSCA by Dalum *et al.* (1998) and Laursen (1998) is only a decreasing monotonic one, it can not theoretically transform from the non-normal distributed index to the normal distributed one. To examine this, we apply a formal test of the normality distribution, namely the Jarque-Bera (1987) (JB) test of normality on both RCA and RSCA. The JB statistic is formulated as follows:

$$JB = n\left[\frac{S^2}{6} + \frac{(K-3)^2}{24}\right] \quad (4)$$

Where S denotes skewness and K represents kurtosis of RCA and RSCA. For a normal distribution, the value of skewness is zero and the value of kurtosis is 3. Under the null hypothesis that the residuals are normally distributed, Jarque and Bera (1987) show that asymptotically (i.e. in large sample) the statistic JB follows the chi-square distribution with degree of freedom 2 ($\chi^2_{df=2}$), which are equal to 7.779, 9.488 and 13.277 for the levels of significance 10%, 5% and 1%, respectively.

Table 1 summarizes some statistics, including JB statistic, of both RCA and RSCA for the ASEAN countries for the periods 1987, 1985, 1995 and 2005. Since the transformation from RCA to RSCA is only a decreasing monotonic one, it is clearly shown in Table 1 that the median, standard deviation (Std.Dev.), skewness and kurtosis statistics of RSCA are always less than those of RCA. From the JB statistics, we can conclude that both RCA and RSCA are not normally distributed for all the ASEAN countries and for all the periods. However, in a specific case, the transformation could possibly change from the non-normally distributed RCA to the normally distributed RSCA, i.e. when the skewness and kurtosis are statistically equal to zero and 3, respectively.

3. Estimation methods

Heteroscedasticity might be in our estimation since the data applied in this paper is cross sectional one. However, the existence of autocorrelation also might be possible. The Ordinary Least Squares (OLS) might not suitable for the estimation. Hence, we employ Heteroscedasticity and Autocorrelation Consistent Covariance (HAC) when the usual OLS have violated the homoscedasticity or no-autocorrelation assumptions[(10)]. There are two possible alternative approaches i.e. Heteroscedasticity Consistent Covariance (HAC) White and HAC Newey-West. White (1980) formulated a heteroscedasticity consistent covariance matrix estimator which provides correct estimates of the coefficient covariances in the presence of heteroscedasticity of unknown

[(10)] It is important to note that HAC (either the White or the Newey-West) does not change the point estimates of the parameters, only the estimated standard errors.

Table 1. Some Statistics of RCA and RSCA of the ASEAN Countries: 1979, 1985, 1995, 2005

Countries/ Statistics	RCA				RSCA			
	1979	1985	1995	2005	1979	1985	1995	2005
1. Indonesia								
a. Median	0.00	0.01	0.24	0.41	-0.99	-0.99	-0.61	-0.43
b. Std. Dev.	2.35	2.55	3.70	4.38	0.44	0.49	0.56	0.54
c. Skewness	6.21	5.57	5.26	6.86	2.56	1.92	0.86	0.57
d. Kurtosis	47.120	37.340	35.011	55.288	8.685	5.704	2.593	2.312
e. Jarque-Bera	20480.71	12705.39	11070.33	28490.67	571.55	214.69	30.60	17.51
(Probability)	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
2. Malaysia								
a. Median	0.06	0.11	0.23	0.31	-0.89	-0.81	-0.63	-0.53
b. Std. Dev.	6.12	5.37	2.88	2.41	0.46	0.47	0.49	0.47
c. Skewness	7.45	7.32	7.09	7.06	2.04	1.58	1.05	0.88
d. Kurtosis	59.72	58.63	66.83	61.47	6.61	4.89	3.38	3.05
e. Jarque-Bera	33533.77	32263.00	41678.72	35281.12	290.02	132.66	44.22	30.03
(Probability)	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
3. Thailand								
a. Median	0.07	0.15	0.38	0.55	-0.88	-0.75	-0.45	-0.29
b. Std. Dev.	7.30	6.06	3.04	3.36	0.58	0.60	0.53	0.51
c. Skewness	7.80	7.41	6.78	7.70	1.30	0.92	0.49	0.28
d. Kurtosis	77.24	71.29	55.85	73.21	3.36	2.51	2.06	2.12
e. Jarque-Bera	56104.17	47615.67	29023.16	50375.65	67.40	35.09	18.08	10.56
(Probability)	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.005
4. The Philippines								
a. Median	0.05	0.05	0.09	0.12	-0.91	-0.90	-0.83	-0.79
b. Std. Dev.	7.35	5.71	2.91	1.56	0.57	0.58	0.52	0.49
c. Skewness	6.85	5.79	6.78	6.05	1.55	1.29	1.14	1.13
d. Kurtosis	56.59	39.29	56.51	51.09	4.11	3.32	3.08	3.14
e. Jarque-Bera	29835.89	14146.62	29708.18	23975.83	105.96	66.18	50.52	49.60
(Probability)	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
5. Singapore								
a. Median	0.360	0.360	0.33	0.27	-0.48	-0.47	-0.51	-0.58
b. Std. Dev.	2.34	1.71	1.00	0.94	0.46	0.45	0.43	0.42
c. Skewness	6.95	4.60	3.47	4.92	0.88	0.81	0.72	0.79
d. Kurtosis	63.98	28.33	17.42	35.67	3.16	3.11	2.83	2.96
e. Jarque-Bera	38140.61	7077.17	2498.54	11349.93	30.28	25.49	20.37	24.18
(Probability)	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000

Source: UN-COMTRADE, *authors' calculation*

form. The White covariance matrix assumes that the residuals of the estimated equation are serially uncorrelated. Newey and West (1987) derived a more general estimator that is consistent in the presence of both heteroscedasticity and autocorrelation of unknown form.

4. Estimation results

Table 2 shows the estimation results of the econometric models (5) and (6), which are given the headings M1 and M2, respectively, for the periods 1979-1985, 1985-1995, 1995-2005 and 1979-2005 in the cases of five ASEAN countries i.e. Indonesia, Malaysia, the Philippines, Thailand and Singapore. Those periods are chosen to consider a short-period (6 years: 1979-2005), medium-periods (10 years: 1985-1995 and 1995-2005) and a long-period (26 years: 1979-2005). In general, we can say that almost all the estimation results using both RCA (model M1) and RSCA (model M2) indicate de-specializations of the ASEAN countries' comparative advantage. In the cases of Malaysia, the Philippines, Thailand and Singapore, all the coefficients β in the both models M1 and M2 are statistically significant different from zero and different from one at the levels of significance 1%, 5% or 10%, excepting in the model M1 of Thailand for the period 1995-2005, which is equal to 1.01 (statistically not different from 1).

It is interesting to discuss further the estimation results of the models M1 and M2 in the case of Indonesia, since some of them give different or even opposite conclusions. For the period 1979-1985, the coefficients β are 0.67 and 0.97 for the models M1 and M2, respectively. They are statistically significant different from zero, but statistically not different from one. Although the coefficient β of the model M1 is 0.67, it is statistically not different from one, because its standard deviation is relatively high. These coefficients indicate that Indonesia had lingered its specialization during that period. For the medium-term 1995-2005 and the long-term 1979-2005, the coefficients β of the model M1 are 0.91 and 0.97, respectively, which are statistically significant different from zero but not different from one. Therefore, if we use the Model M1 for our analysis, we will conclude that during those periods Indonesian specialization had remained constant. Let us turn to the model M2 for the same periods. The model M2 gives the coefficients 0.83 and 0.57, respectively, which are both statistically significant different from zero and from one. Those figures imply that Indonesia had exhibited de-specializations during those periods. Here, we have two different conclusions from the Model M1 and M2. More surprisingly, the models M1 and M2 give opposite results for the period 1985-1995. The coefficient β of the model M1 is 1.3, which is both statistically significant different from zero and from one; it implies that Indonesia has increasingly specialized in its exports. On the contrary, that of the model M2 is 0.75, which is also both statistically significant different from zero and different from one; it implies that Indonesia had exhibited de-specialization.

Hence, Indonesia is a good case study for comparing the two competing econometric model, one using RCA (model M1) and the other using RSCA (model M2). We would argue that such opposite conclusions happen due to the existence of "outlier problem" [11] in RCA. Panel (a) in Figure 3 shows clearly this problem. So many groups of products (SITC) have RCA lower than 1; in contrast, only few groups of products have RCA greater than 1. Out of 234 groups of products (SITC), we find that there are only 20, 26, 55 and 62 groups of products (SITC) with RCA greater than 1 or even with very high values of RCA in 1979, 1985, 1995 and 2005, respectively[12]. There is a sharp jump in the number of groups of products (SITC) with RCA greater than 1 in 1985-1995. Since the use of RCA in regression analysis gives much more weight to values above one, when compared to observation below one (Dalum *et al.*, 1989; Laursen, 1989), such a sharp jump in the number of groups of products, here as the "outliers", has affected the estimate.

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(11) In the Boxplot analysis, for example, the outliers are defined as the values between 1.5 and 3 box lengths from the upper or lower edge of the box. The box length is the inter-quartile range. The values more than 3 box lengths from the upper or lower edge of the box are referred to as "extreme" values.

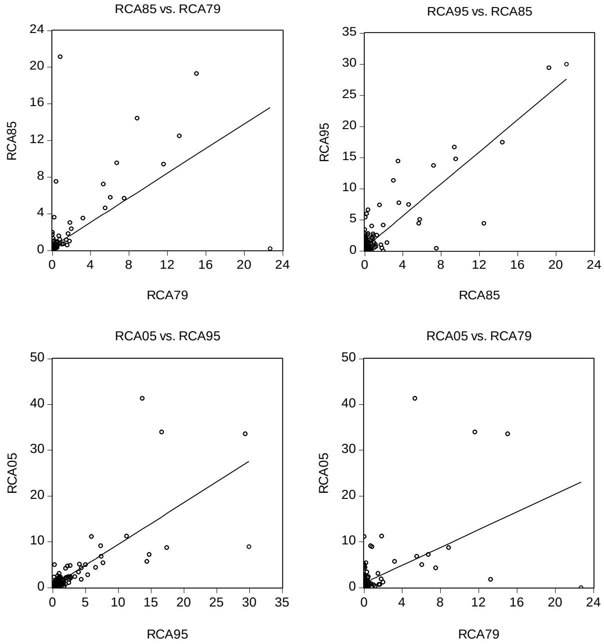
(12) The number of Malaysian groups of products (SITC) with RCA greater than one are 23, 27, 38 and 42, those of Thailand are 47, 59, 67 and 74; those of the Philippines are 40,47, 49 and 40, and those of Singapore are 46, 44, 38 and 37, in 1979, 1985, 1995 and 2005, respectively.

Table 2. The Estimated Coefficients (β)

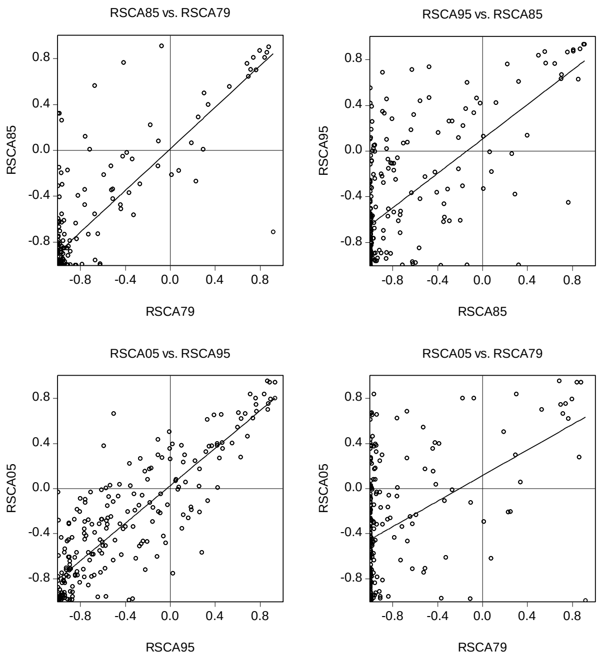
Period/Estimates	Indonesia		Malaysia		the Philippines		Thailand		Singapore	
	M1	M2	M1	M2	M1	M2	M1	M2	M1	M2
1. Period 1979-1985										
Constant (α)	0.33**	0.01	0.15*	0.02	0.60*	-0.06	0.36*	0.03	0.24*	-0.08**
	(0.13)	(0.06)	(0.05)	(0.03)	(0.17)	(0.05)	(0.10)	(0.04)	(0.05)	(0.03)
Coefficient (β)	0.67**	0.91*	0.85*,###	0.9*,#	0.56*,##	0.83*,#	0.76*,#	0.87*,#	0.65*,#	0.81*,#
	(0.29)	(0.06)	(0.08)	(0.03)	(0.18)	(0.05)	(0.07)	(0.04)	(0.06)	(0.05)
R-squared	0.39	0.68	0.94	0.78	0.52	0.65	0.84	0.73	0.8	0.67
Jarque-Bera Statistic of residual	37185.1	1030.1	22261.6	909.3	14651.1	409.0	14709.6	151.5	2829.6	253.7
(Prob. of Jarque-Bera)	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
2. Period 1985-1995										
Constant (α)	0.43*	0.1***	0.46*	-0.003	0.25*	-0.19*	0.42*	-0.08**	0.33*	-0.15*
	(0.08)	(0.05)	(0.12)	(0.03)	(0.09)	(0.05)	(0.09)	(0.03)	(0.06)	(0.03)
Coefficient (β)	1.3*,##	0.75*,#	0.44*,#	0.79*,#	0.41*,#	0.66*,#	0.43*,#	0.60*,#	0.38*,#	0.7*,#
	(0.13)	(0.05)	(0.09)	(0.04)	(0.10)	(0.06)	(0.07)	(0.04)	(0.08)	(0.04)
R-squared	0.79	0.43	0.69	0.58	0.64	0.55	0.72	0.45	0.41	0.54
Jarque-Bera Statistic of residual	3742.8	13.8	6204.3	96.0	21094.7	129.3	9319.1	17.0	4872.4	46.3
(Prob. of Jarque-Bera)	0.000	0.001	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
3. Period 1995-2005										
Constant (α)	0.26	0.02	0.12*	-0.05**	0.40*	-0.20*	0.12	-0.01	0.12	-0.14*
	(0.17)	(0.02)	(0.04)	(0.02)	(0.10)	(0.05)	(0.11)	(0.03)	(0.07)	(0.22)
Coefficient (β)	0.91*	0.83*,#	0.79*,#	0.83*,#	0.26*,#	0.64*,#	1.01*	0.73*,#	0.67*,##	0.80*,#
	(0.24)	(0.03)	(0.07)	(0.03)	(0.09)	(0.06)	(0.11)	(0.04)	(0.16)	(0.04)
R-squared	0.59	0.74	0.88	0.74	0.23	0.46	0.84	0.60	0.51	0.68
Jarque-Bera Statistic of residual	36121.0	13.5	30740.9	231.8	38570.8	116.9	5682.5	47.9	5003.7	9.5
(Prob. of Jarque-Bera)	0.000	0.001	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.009
4. Period 1979-2005										
Constant (α)	0.93*	0.11***	0.57*	-0.04	0.48*	-0.31*	0.76*	-0.08***	0.42*	-0.35*
	(0.18)	(0.06)	(0.10)	(0.05)	(0.10)	(0.06)	(0.10)	(0.04)	(0.07)	(0.03)
Coefficient (β)	0.97***	0.57*,#	0.27*,#	0.59*,#	0.09*,#	0.41*,#	0.30*,#	0.34*,#	0.14***,#	0.34*,#
	(0.51)	(0.07)	(0.08)	(0.06)	(0.01)	(0.07)	(0.07)	(0.05)	(0.08)	0.05
R-squared	0.27	0.22	0.48	0.33	0.16	0.22	0.43	0.15	0.12	0.13
Jarque-Bera Statistic of residual	20649.2	4.4	41533.5	25.6	35456.2	55.3	40584.8	6.0	6651.1	25.2
(Prob. of Jarque-Bera)	0.000	0.112	0.000	0.000	0.000	0.000	0.000	0.05	0.000	0.0000

Notes: M1 and M2 refer to the model with RCA (Equation 5) and the model with RSCA (Equation 6), respectively. Figures in parenthesis are standard errors. *,**,and *** mean statistically significant (different from zero) at the level of significances 1%, 5% and 10%, respectively. #, ## and ### mean that the coefficient (β) is statistically different from one (the Wald coefficient test) at the level of significances 1%, 5% and 10%, respectively.

Source: UN-COMTRADE, *authors' calculation*.



(a) Revealed Comparative Advantage (RCA)



(b) Revealed Symmetric Comparative Advantage (RSCA)

Source: Author

Figure 3. Scatter Diagram of RCA and RSCA: Indonesia (1979-1985, 1985-1995, 1995-2005, 1979-2005)

Applying RSCA (in model M2), therefore, can at least reduce the outlier problem, as shown in Table 1 as well as in Panel (b) of Figure 3 in the case of Indonesia. From Table 1, we can firmly say that the distribution of RSCA always has a lower standard deviation (Std.Dev) than that of RCA; since the transformation from RCA to RSCA is, in fact, a decreasing monotonic one. Since RCA can vary from zero to infinity ($0 \le RCA \le \infty$), the standard deviation could take any positive values. In contrast, since RSCA only have a range between -1 and 1 ($-1 \le RSCA \le 1$), the standard deviation will always less than 1. Hence, model M2 gives a lower standard deviation (measures of preciseness) of the estimate than model M1 gives. As presented in Table 2, for all cases the standard deviations of coefficient β of the model M2 are always smaller than those of the model M2, except in the case of the Philippines for the period 1979-2005. Again, the "outlier problem" is also faced in the case of the Philippines for this period as shown in Figure 4. The use of RCA (M1) give a very low estimate $\beta = 0.09$ with standard deviation 0.01. Surprisingly, this very low estimate is statistically significant different from zero and from one.

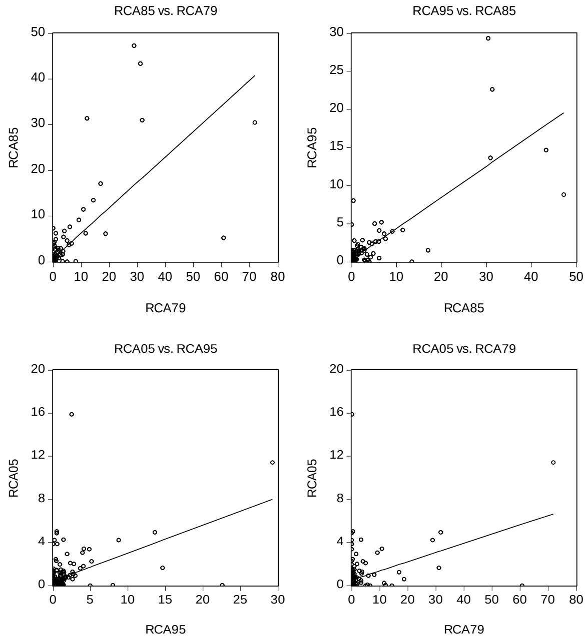
Table 2 also contains statistic R-squared (R^2). It is a measure "goodness of fit", which is tell us how well the sample regression line fits the data. Technically, it measures the proportion of the total variation in the explained (dependent) variable by the regression model. It varies from 0 to 1. The higher the R^2, the better the regression model fits the data. In our cases, there are 12 of out 20 regressions, where model M1 gives higher R-squared than that of model M2. We would argue that the both models M1 and M2 loss their robustness for explaining countries dynamic comparative advantages in the long-term. In other words, they are more suitable for the short-term or medium term analysis. The statistics R^2 for the long-term (1979-2005) are lower than those of the short-term (1979-1985) and the medium-terms (1985-1995 and 1995-2005). In the long-term, the dynamics of comparative advantage could take non-linear form, instead of linear one.

Table 2 also shows the results of the Jarque-Bera test for normality of the error terms (residuals). The null hypothesis of normality of the error terms can be rejected for all 20 regressions (= 5 countries x 4 the periods) (for all levels of significance 1%, 5% and 10%), when using RCA (model M1); while the hypothesis can still be accepted for 2 out of 20 regressions (= 5 countries x 4 periods), when using RSCA (model M2), i.e. in the cases of Indonesia and Thailand for the period 1979-2005. The normality assumption of error terms is needed for the purpose of drawing inferences. In our cases, however, we do not need to worry since we have 234 observations or groups of products in every regression (M1 or M2), which can be considered as a large sample(13).

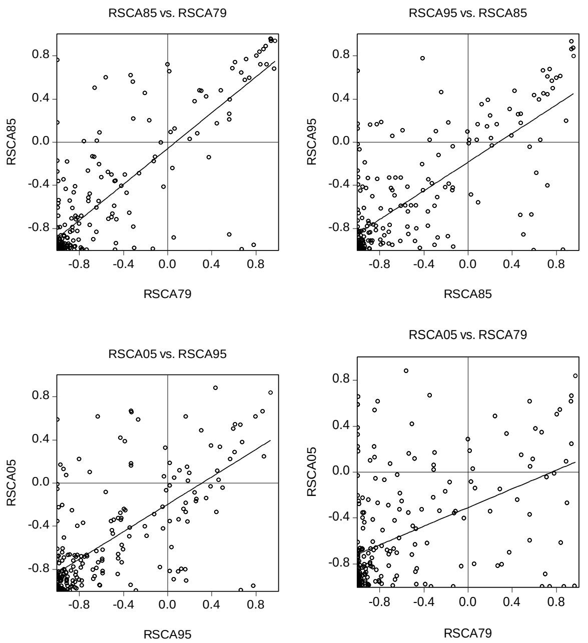
CONCLUSIONS

This paper examines both theoretically and empirically the two competing econometric models for analyzing dynamic trade specialization, one using Revealed Comparative Advantage (RCA) or Balassa index and the other using Revealed Symmetric Comparative Advantage (RSCA) index. Several conclusions are withdrawn. *First,* the transformation from RCA to RSCA does not automatically guarantee transforming from a non-normally distributed RCA to a normally distributed RSCA,

(13) The Central Limit Theorem postulates that as the sample size (n) becomes large, the sampling distribution of the sample mean can be approximated by a normal distribution with a mean of μ and a standard deviation of $\sigma/\sqrt{n}$, where μ is the mean of the population and σ is its standard deviation. Mansfield (1994:240) states that the normal approximation seems to be quite good so long as the sample size is larger than about 30, regardless the nature of the population. In small, or finite, samples the *t*, *F* and chi-square tests require the normality assumption, therefore, this assumption is important to be checked.



(a) Revealed Comparative Advantage (RCA)



(b) Revealed Symmetric Comparative Advantage (RSCA)

Source: Author

Figure 4. Scatter Diagram of RCA and RSCA: the Philippines (1979-1985, 1985-1995, 1995-2005, 1979-2005)

Since the transformation is only a monotonic decreasing one. However, in the econometric model the transformation can eliminate the "outlier problem" of RCA. Hence, the model using RSCA is more statistically reliable than the model using RCA. The former gives smaller standard deviation of the estimate coefficients than the latter. *Second*, the two econometric models might not be suitable for forecasting purposes since the estimated values could violate their criteria of $0 \leq RCA \leq \infty$ and $-1 \leq RSCA \leq 1$. This problem is theoretically more severe when we use RSCA than when we use RCA, since RSCA is both bounded-below and bounded-above index while RCA is only bounded-below index. Therefore, if one wants to use the estimates for forecasting purposes, it is necessary to consider such theoretical problem. *Third*, in the cases of ASEAN countries, we find that they have exhibited de-specialization.

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