ON THE DYNAMICS OF TRADE PATTERNS♦

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Abstract

In this paper we analyse the dynamics of trade patterns in the six largest industrialised countries and in eight fast growing Asian economies. For each of these countries we study the shape of the sectoral distribution of an index of trade specialisation and its evolution over time. Our analysis shows a marked difference between the advanced and the emerging countries as far as the degree of persistence is concerned: the former have in fact a highly persistent trade pattern, whereas the latter show a rapidly changing trade specialisation. However, the two groups of countries are more similar as far as the evolution of the degree of specialisation is concerned: although emerging countries are still more specialised than the industrialised countries, both groups show a tendency toward a reduced polarisation and a more symmetric distribution of the specialisation index. This evidence is in line with the traditional trade theory, in which changing comparative advantage is the determinant of a changing trade pattern. On the contrary, this evidence does not support the idea that self-reinforcing mechanisms are prominent in international trade specialisation.

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1 Introduction

This paper is a contribution to the empirics of trade patterns dynamics. The renewed interest for the topic (see Proudman and Redding, 1998a,b, Laursen, 1998) partly stems from the predictions of the endogenous growth and trade literature, showing that international specialisation may affect the growth prospects of a country even in the long run. In particular, a strand of this literature (Lucas, 1988, Young, 1991, Grossman and Helpman, 1991) has shown that the growth rate of a country may be permanently reduced by a "wrong" specialisation, i.e. in the less technologically progressive industries. The reason is that in the presence of self-reinforcing mechanisms driven by country-specific learning-by-doing, initial conditions dictate the long run trade pattern and growth rate. This raises concerns on the part of developing countries governments about the timing of trade liberalisation.

In this paper we analyse the dynamics of trade patterns of two groups of countries in the time period 1970-1995; one includes the six largest industrialised countries (France, Germany, Italy, Japan, United Kingdom and United States); the other includes eight East Asian countries: the four NIEs (Taiwan, South Korea, Hong Kong and Singapore), and four ASEAN countries, Indonesia, Malaysia, Philippines and Thailand.

For each of these countries we study the shape of the sectoral distribution of an index of trade specialisation and its evolution over time. This kind of analysis allows us to ask whether there is a tendency toward an increased polarisation of these countries trade specialisation, as implied by much of the new growth and trade literature. Further, we analyse the intra-distribution dynamics, in order to assess the degree of persistence of international trade patterns.

Overall, our analysis shows a marked difference between the advanced and the emerging countries as far as the degree of persistence is concerned: the former are in fact characterised by a highly persistent trade pattern, whereas the latter show a rapidly changing specialisation. However, the two groups of countries are more similar as far as the evolution of the degree of specialisation is concerned: although emerging countries are still more specialised than the industrialised countries, both groups show a tendency toward a reduced polarisation and a more symmetric distribution of the specialisation index.

What does this evidence suggest ? Maybe that the change in relative factor endowments is associated with a changing trade pattern, whereas the persistence of specialisation is the consequence of a stable relative position in the international economy (i.e. a roughly constant relative capital-labour ratio). This simple conclusion would be in line with the traditional trade theory, in which changing comparative advantage is the determinant of a changing trade pattern. On the contrary, this evidence does not support the idea that self-reinforcing mechanisms are prominent in international trade specialisation.

The paper is organised as follows. Section 2 summarises the main theoretical predictions concerning the evolution of trade patterns. Section 3 discusses previous empirical evidence. Section 4 presents our results on the dynamics of specialisation for the two groups of countries. Section 5 concludes.

2 Dynamics of specialisation: main theoretical predictions

Before turning to the empirical analysis it is useful to summarise the main theoretical predictions on the dynamics of trade patterns.

As far as the standard Heckscher-Ohlin model is concerned, it implies a very close relation between factor composition and trade dynamics: *the pattern of specialisation changes if and only if trading countries experience a change in their relative factor endowments*. This embarrassingly simple conclusion implies, however, that the evidence of persistence of trade patterns is wholly consistent with the Heckscher-Ohlin model if it concerns countries whose relative factor composition has not changed much with respect to their main trade partners.

In the presence of increasing returns to scale, the picture becomes more complex, depending on the specific assumptions about the nature of increasing returns.

If economies of scale are internal to the firm, as shown by Helpman (1981) and Helpman and Krugman (1985) in the context of a Chamberlin-Heckscher-Ohlin approach, the main implications of the factor proportions theorem are substantially unaltered.

In the presence of output generated national external economies, trade patterns dynamics crucially depend on the effects of the external economies on the slope of the production possibility frontier. As shown by Kemp (1969) and by Markusen and Melvin (1981), if external economies are negligible with respect to the factor-intensity differences between the two sectors, then the relative supply curve is positively sloped[1] and the same implications as in the standard Heckscher-Ohlin model apply.

The results change dramatically if national external economies are relevant, so that the production possibility frontier is globally convex. In particular, it is possible to demonstrate[2] that *in the presence of strong national external economies, the world trade pattern does not follow the changing comparative advantage of trading countries. In fact, it is entirely determined by initial comparative advantage.*

The above result build on the assumption that external economies are national rather than international in scope. This assumption has been questioned by Ethier (1979,1982), who argues, instead, that increasing returns depend on the size of the world economy. Ethier shows, in particular, that *under the alternative assumption of internationally decreasing costs, increasing returns do not influence the pattern of inter-industry trade. In fact, we are back in the traditional trade theory and, as a consequence, the lock-in effect generated by the national external economies wholly disappears.*

As far as the truly dynamic trade theory is concerned, its implications closely parallel those of the static trade models mentioned above. However, the main advantage of this approach is that it explicitly takes into account that one of the most important sources of economies of scale lies in the dynamic process by which industries improve their technologies.

[1] More precisely, as shown by Kemp (1969), if the production function for good i is homogeneous of degree $T > 1$, then the relative supply curve is always negatively sloped in the neighbourhood of $X_i = 0$.
[2] See Wong (1995, ch. 5).

Grossman and Helpman (1990, 1991, ch.7) build a three sector growth model, in which the state of the technology is endogenous, in order to study the determinants of the evolution of the pattern of trade. The two sectors producing final output are distinguished by the intensity with which they employ two primary inputs that are available in fixed supply even in the long run. The engine of growth is innovation, which takes place in the R&D labs and employs primary resources and knowledge as inputs. In this model knowledge capital is a pure externality arising from innovation activity. *Under the crucial assumption that knowledge spillovers are international in scope*, they demonstrate that *the history of the production structure of a country does not influence its long run trade pattern, which only depends on the relative endowment of primary resources.*

At the opposite extreme, we find models in which dynamic scale economies arising from learning by doing are country-specific and imply a lock-in effect for the pattern of specialisation. [3] These models are the dynamic equivalent of static trade models assuming national external economies. For instance, Krugman (1987), Lucas (1988), Grossman and Helpman (1991a, ch.8), show that in the presence of dynamic scale economies the long run trade pattern is fully determined by initial comparative advantage.

In particular, Krugman's model proves useful for later empirical analysis. It builds on Dornbusch, Fischer and Samuelson (1977) by assuming two countries producing a continuum of goods with a single production factor, labour. Because of sector specific dynamic scale economies due to learning by doing, this model implies that a pattern of specialisation, once established according to initial comparative advantage, will be strengthened and preserved by the operation of dynamic scale economies.

Figure 1 clarifies the point. The density function $f(T_t)$ represents the initial distribution of an index T of sectoral trade performance. Because of dynamic scale economies, sectors of initial comparative advantage become stronger overtime, whereas sectors of initial comparative

[3] An exception is Eicher (1999), whose model implies convergence of relative factor endowment and of international trade patterns even in the absence of international knowledge spillovers.

disadvantage become weaker[4]. As a consequence, sectors of intermediate trade performance tend to disappear and the frequency mass concentrates on the extreme values of the trade index. This is shown in Figure 1 by the density function $f(T_{t+s})$.

In short, the main empirical implication of this strand of literature is that *international trade patterns tend to become more polarised.*

3 Measuring trade specialisation: relation to the preceding empirical literature

The most commonly used indicator of a country's trade specialisation is the Balassa (1965) 'Revealed Comparative Advantage' (RCA) index[5], defined as follows:

$$RCA_{ij} = \frac{X_{ij} / \sum_j X_{ij}}{\sum_i X_{ij} / \sum_i \sum_j X_{ij}} \qquad [3.1]$$

where the ratio in the numerator is the share of country j in sector i world exports, whereas the ratio in the denominator represents the same share for total merchandise exports. This index takes values between 0 and $+\infty$. A value less than 1 characterises sectors in which a country is relatively less specialised with respect to the world economy. On the contrary, a value of the index greater than 1 denotes sectors in which a country is relatively more specialised.

The reason why RCA has gained wider acceptance among applied international trade economists than the measures based on net exports is that it is a more comprehensive indicator of the concept of specialisation. Consider for example the ratio at the numerator of [3.1] and compare it to net exports. The former compares country j exports in sector i to the rest of the world exports in sector i (i.e. the comparison is with respect to all competitors of country j in sector i whether or not they export to country j); the latter compares country j exports in sector i

[4] In this simple model the above statement is literally true only in terms of relative productivity, and not in terms of sectoral trade performance. The reason is that, being Ricardian in spirit, this model implies complete specialisation in the free trade equilibrium.
[5] In a Heckscher-Ohlin framework net exports are the theory-based measure of trade patterns. See the discussion in Bowen, Hollander and Viaene (1998), Leamer and Levinsohn (1995), Deardorff (1984).

to country *j* imports in sector *i* (i.e. the comparison is only with respect to country *j* competitors that export to country *j*). Therefore we believe that the former is a better measure of the overall specialisation pattern of a country[6].

Note, however, that there are no clear theoretical foundations for this measure[7].

A useful transformation of the RCA index is the following:

$$RCAS_{ij} = \frac{RCA_{ij} - 1}{RCA_{ij} + 1} \qquad [3.3]$$

This index takes values between –1 and 1. Its properties are similar to the logarithmic transformation, in the sense it is a monotonic transformation of the RCA index that reduces the weight of extreme observations. Further, contrary to RCA, it is a symmetric index[8].

To analyse the evolution of trade patterns most studies have adopted two synthetic measures. The first is the OLS estimated coefficient of a regression of the sectoral RCA in the final year on the sectoral RCA in the initial year. The second is a comparison of the standard deviation of the sectoral RCA in the initial and final year.

[6] Kunimoto (1977) provides a statistical framework in which [3.1] can be interpreted as the ratio between actual and expected trade:

$$RCA_{ij} = \frac{X_{ij}}{E(X_{ij})} \quad ; \quad E(X_{ij}) = (\sum_j X_{ij}) \frac{\sum_i X_{ij}}{\sum_i \sum_j X_{ij}} \qquad [3.2]$$

where expected exports of commodity *i* by country *j* are total exports of country *j* times the share of commodity *i* in world exports. An assumption behind this formulation is that the determinants of a country's total exports can be separated from the determinants of the commodity distribution of its trade. Hence, in a country in which exports are allocated among sectors according to the relative importance of each commodity in world trade, the RCA will take values equal to one. Values above or below one identify sectors of relative strength or weakness.

Bowen (1983) argues that in order to obtain [3.2] we also need the assumption that countries export all goods. The plausibility of this restriction in an empirical analysis depends on the sectoral aggregation of the data, and on the type of country analysed. This assumption is generally satisfied in our data.

[7] An attempt to clarify the link between the RCA index and the ratio of relative autarchic prices (i.e. comparative advantage), has been pursued by Hillman (1980). For cross-country comparisons of RCA, he derives a necessary and sufficient condition for monotonicity between RCA and pre-trade relative prices (see Marchese and Nadal De Simone (1989) for an application). On the contrary, for cross-industry comparisons he shows that RCA is independent from comparative advantage.

[8] One problem with the raw Balassa index is that revealed comparative disadvantage sectors are concentrated between 0 and 1, whereas revealed comparative advantage industries are spread between 1 and infinity.

Balassa (1977), utilises data on 73 3-digits manufacturing sectors to show a reduction in trade specialisation for Japan, Italy, France and Germany and an increase in specialisation for the United Kingdom and the United States between '53 and '71.

Amendola, Guerrieri and Padoan (1992) utilise more recent data (1970-1987) for 38 (not only manufacturing) sectors to show a reduction in specialisation[9] for Japan, Italy, Germany and United Kingdom, and an increase in specialisation for the United States and France.

Dalum, Laursen and Villumsen (1999) utilise the RCAS index to perform the same kind of analysis for the period 1965-1992 relative to 60 manufacturing sectors. Their results are slightly different, showing a substantial stability of specialisation for Japan, Italy and the United States and a decrease in specialisation for other OECD countries.

Proudman and Redding (1998a,b) utilise data relative to 22 sectors for the period 1970-1993 to show a reduction in the dispersion of the RCA[10] for United Kingdom, Germany and the United States.

Overall, the picture emerging from these studies is of a general decrease in specialisation, with a few exceptions (notably that of the USA)[11].

These studies usually complement the previous analysis with a Galtonian regression (or correlation analysis) of RCA in the final year on RCA in the initial year. The limits of this technique have been clarified within the debate on per capita income convergence (Quah (1996)). As far as the studies mentioned above are concerned, the authors are aware of the limitations of this approach, in particular with respect to the so-called Galton Fallacy (Cantwell, 1989). Nonetheless, they generally tend to draw general conclusions about the dynamics of trade patterns from simple regression estimates[12].

[9] Their measure of inequality is the coefficient of variation.
[10] They adopt a linear transformation of the RCA by dividing it by the average RCA across sectors. The standard deviation of this transformation equals the coefficient of variation of the raw RCA.
[11] The limited comparability of the results reported in these studies is due not only to the differences in the time period considered, in the level of sectoral aggregation and in the index utilised, but also in the set of countries utilised to compute the denominator of RCA.
[12] For example, most of the cited authors discuss the path dependency of the pattern simply on the basis of the standard β estimates. Laursen (1998) pool data over three dimension (time, country and sectors) to estimate a variant of the Galtonian regression. He allows heterogeneity across countries and sectors not

In general, the study of this kind of economic issues requires an analysis of the entire distribution of the trade specialisation index (its shape) and its evolution over time (shape and intra-distribution dynamics). In this respect, following Quah (1998), in this paper we adopt as a framework of analysis a model of explicit distribution dynamics (MEDD).

4. Distribution dynamics

In this section we illustrate some stylised facts on the evolution of trade patterns. We follow the approach suggested by Quah (1996,1997) in the context of the empirics of cross-country per capita income convergence. The basic idea is to study the evolution of the entire distribution of the specialisation index rather than simply estimating its first and second moments. Proudman and Redding (1998 a,b) apply a similar approach on a transformation of the RCA index. In this paper we extend their analysis in various directions. First, we analyse the intra-distribution dynamics not only via transition matrices, but also via stochastic kernels. Second, we compare these results with those obtained by standard regression analysis. Third, we analyse a larger set of countries which also includes a group of emerging industrial countries that experienced a substantial economic transformation during the period of analysis. Finally, our analysis includes a larger number of sectors, and is not confined to manufacturing sectors.

Our measures of specialisation are both [3.1] and [3.3]. Contrary to most empirical studies, we measure the RCA index with respect to total merchandise exports (instead of total manufacturing exports) and total world exports (instead of total OECD exports). The former feature of our index is important since we also study the trade evolutions for a group of catching-up countries that had a strong specialisation in non-manufacturing activities at the beginning of the period of analysis. The latter takes into account that about 30% of total world exports are accounted for by non-OECD countries (OECD, 1999).

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only for the intercept but also for the slope (the β). However, the basic critique that the analysis focuses on average behaviour rather than on the dynamics of the distribution is still valid (Quah, (1996)).

The source of our data, covering the period 1970-1995, is the Statistics Canada World Trade Database (WDTB). This database recompiles UN trade data on a consistent basis[13]. Our sample includes 14 countries and 65 sectors at the two digit (SITC Rev. 2) level of aggregation; these sectors are reported in Table A1.

4.1 Shape of the distribution

Table 1 reports some measures of dispersion of the two specialisation indices. The table shows a general decrease in international specialisation between 1970 and 1995, both considering the standard deviation and the coefficient of variation. In many cases this tendency is not monotonic: in particular for Italy, the U.S., Japan and Taiwan the dispersion increases during the seventies and then decreases in the subsequent 15 years.

France is an exception, showing an increase in specialisation. The picture for UK is less clear-cut: RCA shows a strong increase in specialisation, while RCAS goes slightly in the opposite direction.

A more complete picture can be obtained by an analysis of the sectoral distribution of RCAS[14] at the beginning and the end of the time period. This is shown in Figure 2. Each graph illustrates, for each country, the estimates of the density function[15] in 1970 and 1995[16].

Note that the density function of the emerging countries is markedly more right skewed than that of the industrialised countries, denoting a much higher degree of specialisation. The difference was more evident in 1970, where most industrialised countries (Japan is an exception) had a slightly left skewed density function.

Note also that over time all[17] densities become more symmetric, denoting a general tendency toward a reduced specialisation. Moreover, the trade pattern becomes less polarised (i.e. the

[13] For the details on the criteria adopted to compile this database, see Feenstra, Lipsey and Bowen (1997).
[14] From now on, we present only the results relative to the RCAS index. The reason is that, as mentioned above, the RCA index is too asymmetric. This makes difficult the interpretation of the distribution dynamics.
[15] For the details concerning the estimation of the density functions, see the methodological appendix.
[16] For lack of data, in a few cases the final year is 1992.
[17] Singapore and Hong Kong have a fairly stable density over time

frequency mass concentrates more around intermediate values). In both respects Japan is an outlier.

In summary, our evidence shows that, although emerging countries are still more specialised than the industrialised countries, both groups show a marked tendency toward a less polarised specialisation. As illustrated in section 2, these results are in contrast with the implications of much of the endogenous growth and trade literature, predicting, on the contrary, a gradual polarisation of trade patterns.

4.2 Intra-distribution dynamics

The previous analysis gives information on the evolution of the distribution of the RCAS index, but does not tell us whether, for instance, the tails of the distribution contain the same sectors both in the initial and the final year. In other words, the analysis in the previous section ignores information on transition dynamics.

As mentioned above, a common approach to analyse mobility overtime within the cross-section distribution of the specialisation index relies upon regression analysis. The results of this kind of analysis are illustrated in Figure 3. For each country a scatter diagram is reported, measuring the value of RCAS in 1995 on the vertical axis and the value of RCAS in 1970 on the horizontal axis. An OLS regression line is superimposed. Note that all regression lines are positively sloped and less steep than the bisector. This implies that phenomena of average reversal or strengthening of initial specialisation are absent from our sample. Note, also, that the slope of the regression line is generally greater for industrialised countries than for emerging economies. This implies a higher mobility in the latter group of countries.

The slope of the regression line gives information only on the conditional average of the distribution. while we are also interested in a complete picture of the mobility of sector specialisation within the distribution. In this respect, the appropriate framework is the Markov transition analysis initially applied by Quah (1996, 1997, 1998 for example) to the study of cross-country income convergence, and by Proudman and Redding (1998 a, b) to the study of specialisation patterns.

Figure 4 reports, for a subset of four countries[18], the three dimensional stochastic kernel together with the corresponding two dimensional contour plot[19]. In order to interpret the three dimensional graphs note that, by cutting horizontally the stochastic kernel, we obtain the conditional distribution of RCAS at time *t* +15 given its value at time *t*. The contour plots are the vertical projections of the kernels and indicate different levels of iso-probs, the outer ones indicating a lower probability. Note also that if the ridge of the stochastic kernel has as its vertical projection the positive sloped diagonal, then there is high persistence. The degree of persistence is higher the lower is the width of the iso-probs around it (i.e. the lower is the conditional variance). Movements of the ridge of the kernel toward the right imply a certain degree of mobility (in the extreme case in which the ridge is parallel to the period *t* +15 axis, specialisation at the end of the period is independent from specialisation at the beginning of the period). A tendency toward a complete convergence of specialisation corresponds to a kernel parallel to the period *t* axis. Finally, a reversal in the pattern of specialisation corresponds to a kernel ridge along the negative sloped diagonal.

The main feature of Figure 4 is that the specialisation pattern of industrialised countries is much more persistent than that of the emerging economies. This is evident by comparing both the ridge location relative to the positive sloped diagonal and the width of the isoprobs for the two groups of countries.

One way to attach some numbers to this visual inspection comes at the cost of discretisation of the RCAS index. Table 2 reports, for each country, a matrix of transition probabilities. The interpretation of the matrix is analogous to that of the stochastic kernel. Each cell (i,j) contains

[18] In order to save space, stochastic kernels for the remaining ten countries have been omitted. Those relative to the industrialised countries are surprisingly similar to one another. The same is true, though to a lesser extent, for the stochastic kernels of the emerging countries.
[19] Technical details concerning the estimation of stochastic kernels are reported in the methodological appendix.

the probability that a sector in the relative specialisation group i transits to the relative specialisation group j. The probabilities along the same row add to one.[20]

Table 2 confirms the relative persistence of the international trade pattern of industrialised countries, because of the high probabilities on the main diagonal of the transition matrix for these countries. These probabilities are lower, however, than in Proudman and Redding (1998 a,b), mainly because their estimates are relative to a shorter (one year) transition period. Note, also, that emerging economies show a less persistent trade pattern[21].

The ergodic distributions reported in Table 2 can be interpreted as a limit to which a specialisation pattern would tend if the evolutions that characterised the period of analysis went on indefinitely. These ergodic distributions show that symmetry is confirmed for all industrialised countries, but for Japan and France, which tend toward a right skewed distribution. The emerging economies show, on the contrary, an ergodic distribution that is left skewed.

5 Conclusions

In this paper we have analysed the dynamics of trade patterns for two groups of countries, one including the six largest industrialised countries, the other including eight South-East-Asian emerging countries. As a measure of sector specialisation we have utilised the symmetric revealed comparative advantage index (RCAS). The main findings of our empirical analysis can be summarised as follows. As far as the distribution of the index is concerned, which gives information on the degree of specialisation of a country, the industrialised countries generally show a more symmetric distribution of the index, which denotes a low degree of specialisation. In this respect, Japan is an exception, since its distribution is more asymmetric and polarised.

[20] Figures in the left column in Table 2 represent the number of observations belonging to each group.
[21] We have also computed the transition matrices for different number of states. The results are generally robust with respect to the choice of the number of states.

South-East Asian countries, instead, generally show an asymmetric and right-skewed distribution of the index, which denotes a higher degree of specialisation.

Although Asian countries are still more specialised than the industrialised countries, both groups show a marked tendency over time toward a more symmetric and less polarised distribution of the index.

Finally, as far as the intra-distribution dynamics are concerned, which give information on the degree of persistence of trade patterns, we have shown that the emerging countries show a much lower persistence than the industrialised countries.

How to link these stylised facts to the theory predictions surveyed in section 2 ? A complete answer would require more economic structure in our empirical analysis. This is left for further research. Nonetheless, the evidence illustrated in this paper may suggest the following conclusions.

First, the tendency toward a more symmetric and less polarised distribution of the specialisation index, which characterises, with a few exceptions, both the industrialised and the emerging countries, is in accordance with the predictions of the Heckscher-Ohlin framework. The countries in our sample have in fact experienced, in the last decades, a rapid process of per capita income convergence. This phenomenon is likely associated with a process of convergence in terms of relative factor endowments. In such a dynamic context, the traditional theory would imply a tendency toward a reduced trade specialisation, which is what we observe in most cases.

Second, our evidence does not support the idea that the self-reinforcing mechanisms emphasised by much of the endogenous growth and trade literature are relevant at this level of analysis. These mechanisms would in fact imply a tendency toward a more polarised distribution of the specialisation index, which we do not observe. For this reason the evidence of relative persistence of trade patterns in the industrialised countries seems to be more consistent with the prediction of the H-O framework, given the substantial stability of the relative position of these countries in the international economy in the period covered by our empirical analysis.

Methodological appendix

Marginal densities

In order to estimate the marginal densities reported in Figure 2 we have adopted the following non-parametric approach. First, an Epanechnikov kernel function is centred around each observation x_i; then, for each x_i, the average of this function is computed in order to obtain the density function.

A crucial problem in estimating density functions is the choice of the bandwidth that determines the width of the density window around each point, since it determines the degree of smoothness of the estimated density function. Figure 2 shows the density functions estimated by one of the data driven bandwidth selectors suggested by Silverman (1986). The chosen bandwidth (h) is based on the following formula: $h = (0.9m)/n^{0.2}$ where n is the number of observations and m = min(standard deviation; (inter-quartile range)/1.349).

Stochastic kernels

The statistical approach underlying the stochastic kernels reported in Figure 4 can be summarised as follows. Let F_t denote the distribution across sectors of RCAS at time t and f_t the associated probability measure. Then the evolution of the distribution can be modelled as:

$$f_t = T(f_{t-1}, u_t) \qquad \text{[A.1]}$$

where T is an operator that maps disturbances and probabilities into probability measures and u_t is a sequence of disturbances. Equation A.1 describes the evolution overtime of the distribution of the RCAS index. If we treat RCAS as a continuous time variable, then we can compute kernel density estimates of the conditional distribution of $RCAS_t$ given $RCAS_{t-n}$[22].

The operator T can be estimated as follows (for the details, see the appendix in Durlauf and Quah, 1999). First, the joint density function of the distributions for the two periods is estimated non parametrically. This is done along the lines traced above for the marginal density estimation, except that the kernel is bivariate in this case. Second, the implied marginal probability distribution of the first period is computed by integration. Finally, the conditional distribution is obtained by dividing the joint density by the marginal density.

Transition matrices

Transition probability matrices are obtained by dividing the range of values taken by the RCAS index into a certain number of states. In this framework the operator T in [A.1] becomes a matrix of transition probabilities. In Table 2 the 5 states are uniformly-defined, i.e. they are such that the number of observations in each state in the initial period is the same.

Finally, the ergodic distribution is computed by iterating the difference equation in probability measures implied by [A.1], then obtaining a relationship between ϕ_{t+s} and ϕ_t and taking it to the limit as $s \rightarrow +\infty$.

[22] All estimates of stochastic kernels and transition matrices have been computed using Quah's TSRF econometrics package.

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Table 1 – Summary measures of dispersion

Country	*Year*	*Standard deviation*		*Coefficient of variation*
		RCA	RCAS	RCA
GERMANY	1970	.775	.430	.801
	1980	.708	.364	.666
	1995	.467	.289	.549
ITALY	1970	1.334	.471	1.248
	1980	1.411	.487	1.164
	1995	.973	.419	1.199
FRANCE	1970	.743	.335	.690
	1980	.864	.339	.734
	1995	1.441	.329	1.165
U.K.	1970	.811	.438	.792
	1980	.802	.402	.788
	1995	1.284	.367	1.261
U.S.A.	1970	.941	.381	.810
	1980	1.108	.400	.859
	1995	.733	.345	.720
JAPAN	1970	.918	.496	1.127
	1980	.970	.490	1.328
	1995	.657	.470	1.208
TAIWAN	1970	2.378	.558	1.755
	1980	3.324	.576	2.198
	1992	0.944	.496	1.156
SOUTH KOREA	1970	3.466	.607	2.560
	1980	2.645	.589	1.783
	1995	.794	.452	1.196
SINGAPORE	1970	4.774	.458	3.065
	1980	2.438	.444	2.042
	1995	.921	.407	1.339
HONG KONG	1970	2.694	.562	2.265
	1980	2.459	.538	2.008
	1995	2.731	.508	1.037
INDONESIA	1970	4.310	.567	3.728
	1980	1.933	.524	2.718
	1995	3.224	.585	1.799
MALAYSIA	1970	6.172	.521	4.073
	1980	5.407	.538	3.396
	1995	2.818	.482	2.198
PHILIPPINES	1970	4.656	.585	2.947
	1980	3.960	.607	2.385
	1995	2.590	.495	2.528
THAILAND	1970	3.288	.615	2.533
	1980	2.949	.592	2.145
	1995	2.134	.493	1.842

Table 2 – Transition probabilities, 15-year transitions, 1971-1995

Table 2a – *Transition probabilities, 15-year transitions*, 1971-1995 **GERMANY**					
Upper endpoint	-0.45	-0.23	0.02	0.21	0.54
169	0.56	0.34	0.08	0.01	0.01
91	0.02	0.60	0.34	0.03	0.00
106	0.08	0.31	0.48	0.11	0.02
117	0.01	0.11	0.34	0.49	0.05
167	0.01	0.02	0.12	0.39	0.46
Ergodic distrib.	0.08	0.39	0.36	0.12	0.02

Table 2b – *Transition probabilities, 15-year transitions*, 1971-1995 **ITALY**					
Upper endpoint	-0.62	-0.28	-0.08	0.27	0.80
140	0.69	0.25	0.06	0.01	0.00
136	0.18	0.40	0.34	0.09	0.00
91	0.05	0.23	0.64	0.07	0.01
144	0.00	0.10	0.35	0.30	0.26
129	0.00	0.02	0.00	0.39	0.60
Ergodic distrib.	0.20	0.24	0.36	0.11	0.08

Table 2c – *Transition probabilities, 15-year transitions*, 1971-1995 **FRANCE**					
Upper endpoint	-0.31	-0.07	0.05	0.20	0.84
124	0.73	0.17	0.01	0.05	0.04
119	0.28	0.46	0.14	0.08	0.04
133	0.09	0.30	0.35	0.18	0.08
158	0.03	0.22	0.34	0.20	0.21
116	0.00	0.04	0.08	0.22	0.66
Ergodic distrib.	0.31	0.24	0.14	0.12	0.17

Table 2d – *Transition probabilities, 15-year transitions*, 1971-1995 **U.K.**					
Upper endpoint	-0.52	-0.19	0.01	0.21	0.86
145	0.66	0.23	0.08	0.02	0.00
106	0.21	0.50	0.21	0.08	0.00
98	0.00	0.31	0.44	0.19	0.06
144	0.01	0.13	0.51	0.30	0.06
157	0.01	0.04	0.13	0.31	0.52
Ergodic distrib.	0.19	0.31	0.29	0.14	0.05

Table 2e – *Transition probabilities, 15-year transitions*, 1971-1995

U.S.A.

Upper endpoint	-0.39	-0.15	0.06	0.26	0.74
130	0.80	0.16	0.04	0.00	0.00
123	0.15	0.59	0.21	0.04	0.00
130	0.00	0.28	0.54	0.17	0.02
138	0.05	0.07	0.30	0.47	0.10
129	0.03	0.00	0.01	0.22	0.74
Ergodic distrib.	0.27	0.29	0.24	0.12	0.06

Table 2f – *Transition probabilities, 15-year transitions*, 1971-1995

JAPAN

Upper endpoint	-0.93	-0.73	-0.32	0.09	0.68
116	0.74	0.25	0.01	0.00	0.00
115	0.43	0.50	0.06	0.00	0.00
125	0.10	0.30	0.50	0.09	0.00
152	0.01	0.12	0.26	0.41	0.21
142	0.00	0.04	0.04	0.37	0.56
Ergodic distrib.	0.58	0.33	0.05	0.01	0.00

Table 2g – *Transition probabilities, 15-year transitions*, 1971-1992

TAIWAN

Upper endpoint	-0.86	-0.60	-0.30	0.24	0.92
87	0.77	0.16	0.07	0.00	0.00
95	0.16	0.40	0.33	0.12	0.00
87	0.10	0.18	0.36	0.29	0.07
89	0.03	0.12	0.15	0.45	0.25
90	0.00	0.07	0.11	0.14	0.68
Ergodic distrib.	0.24	0.18	0.19	0.19	0.18

Table 2h – *Transition probabilities, 15-year transitions*, 1971-1995

SOUTH KOREA

Upper endpoint	-0.93	-0.69	-0.26	0.20	0.93
145	0.59	0.23	0.12	0.06	0.00
143	0.13	0.33	0.35	0.19	0.01
98	0.14	0.22	0.27	0.36	0.01
121	0.02	0.10	0.33	0.35	0.20
143	0.00	0.03	0.13	0.24	0.59
Ergodic distrib.	0.16	0.18	0.25	0.25	0.13

Table 2j – *Transition probabilities, 15-year transitions*, 1971-1995 **SINGAPORE**					
Upper endpoint	-0.68	-0.48	-0.23	0.05	0.95
111	0.59	0.17	0.10	0.11	0.03
148	0.37	0.31	0.14	0.12	0.06
126	0.17	0.24	0.29	0.26	0.04
102	0.08	0.14	0.30	0.37	0.11
163	0.07	0.06	0.13	0.30	0.44
Ergodic distrib.	0.31	0.19	0.18	0.21	0.09

Table 2k – *Transition probabilities, 15-year transitions*, 1971-1995 **HONG KONG**					
Upper endpoint	-0.87	-0.67	-0.36	0.14	0.92
158	0.52	0.28	0.11	0.08	0.01
152	0.18	0.33	0.34	0.15	0.00
100	0.03	0.08	0.45	0.40	0.04
101	0.04	0.08	0.19	0.48	0.22
139	0.03	0.01	0.10	0.27	0.59
Ergodic distrib.	0.09	0.11	0.24	0.33	0.20

Table 2l – *Transition probabilities, 15-year transitions*, 1971-1995 **INDONESIA**					
Upper endpoint	-0.98	-0.88	-0.62	-0.01	0.94
239	0.09	0.18	0.34	0.24	0.15
135	0.07	0.16	0.24	0.32	0.20
92	0.09	0.09	0.32	0.38	0.13
87	0.05	0.09	0.14	0.41	0.31
87	0.00	0.01	0.06	0.13	0.80
Ergodic distrib.	0.02	0.05	0.12	0.24	0.54

Table 2m – *Transition probabilities, 15-year transitions*, 1971-1995 **MALAYSIA**					
Upper endpoint	-0.89	-0.73	-0.51	-0.06	0.98
188	0.35	0.19	0.27	0.10	0.09
156	0.03	0.20	0.32	0.34	0.11
99	0.02	0.12	0.24	0.47	0.14
89	0.03	0.02	0.25	0.45	0.25
108	0.00	0.02	0.06	0.25	0.68
Ergodic distrib.	0.02	0.05	0.17	0.36	0.38

Table 2n – *Transition probabilities, 15-year transitions*, 1971-1995 **PHILIPPINES**					
Upper endpoint	-0.95	-0.76	-0.41	0.20	0.97
166	0.36	0.26	0.14	0.17	0.07
164	0.17	0.29	0.30	0.15	0.08
101	0.00	0.12	0.48	0.31	0.10
90	0.01	0.02	0.23	0.50	0.23
119	0.00	0.00	0.08	0.33	0.60
Ergodic distrib.	0.02	0.06	0.25	0.37	0.29

Table 2o – *Transition probabilities, 15-year transitions*, 1971-1995 **THAILAND**					
Upper endpoint	-0.91	-0.68	-0.26	0.26	0.93
207	0.23	0.36	0.26	0.11	0.05
111	0.05	0.18	0.50	0.20	0.06
92	0.07	0.24	0.05	0.48	0.16
100	0.06	0.15	0.17	0.38	0.24
130	0.00	0.08	0.18	0.31	0.44
Ergodic distrib.	0.05	0.16	0.20	0.33	0.22

Table A1 - *2 digit SITC Rev. 2 sectors*

00	Live animals other than animals of division 03
01	Meat and meat preparations
02	Dairy products and birds' eggs
03	Fish, crustaceans, molluscs and preparations thereof
04	Cereals and cereal preparations
05	Vegetables and fruits
06	Sugar, sugar preparations and honey
07	Coffee, tea, cocoa, spices, and manufactures thereof
08	Foodstuff for animals (excluding unmilled cereals)
09	Miscellaneous edible products and preparations
11	Beverages
12	Tobacco and tobacco manufactures
21	Hides, skins and fur skins, raw
22	Oil seeds and oleaginous fruits
23	Crude rubber (including synthetic and reclaimed)
24	Cork and wood
25	Pulp and waste paper
26	Textiles fibres and their wastes
27	Crude fertilisers other than division 56, and crude minerals
28	Metalliferous ores and metal scrap
29	Crude animal and vegetable materials, n.e.s.
32	Coal, coke and briquettes
33	Petroleum, petroleum products and related materials
34	Gas, natural and manufactured
35	Electric current
41	Animal oils and fats
42	Fixed vegetable oils and fats, crude, refined or fractionated
43	Processed Animal and vegetable oils and fats
51	Organic chemicals
52	Inorganic chemicals
53	Dyeing, tanning and colouring materials
54	Medicinal and pharmaceutical products
55	Essential oils for perfume materials and cleaning preparations
56	Fertilisers other than group 272
57	Plastics in primary forms
58	Plastics in non-primary forms
59	Chemical materials and products, n.e.s.
61	Leather, leather manufactures and dressed fur skins
62	Rubber manufactures, n.e.s.
63	Cork and wood manufactures (excluding furniture)
64	Paper and paper manufactures
65	Textile yarn and related products
66	Non metallic mineral manufactures, n.e.s.
67	Iron and steel
68	Non-ferrous metals
69	Manufactures of metal, n.e.s.
71	Power generating machinery and equipment
72	Specialised machinery
73	Metal working machinery
74	Other industrial machinery and parts
75	Office machines and automatic data processing machines

76 Telecommunication and sound recording apparatus
77 Electrical machinery, apparatus and appliances, n.e.s.
78 Road vehicles
79 Other transport equipment
81 Prefabricated buildings, sanitary, heating and lighting fixtures, n.e.s.
82 Furniture and parts thereof
83 Travel goods, handbags, etc.
84 Articles of apparel & clothing accessories
85 Footwear
87 Professional and scientific instruments, n.e.s.
88 Photo apparatus, optical goods, watches and clocks
89 Miscellaneous manufactured articles, n.e.s.
93 Special transactions & commodities not classified
96 Coin (other than gold coin), not being legal tender
97 Gold, non-monetary (excluding gold ores & concentrates)

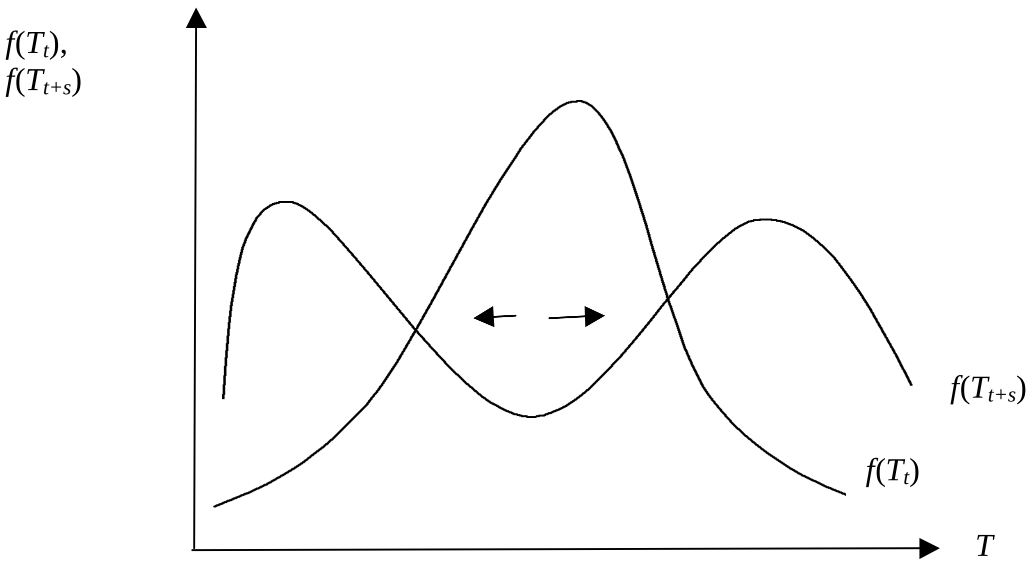
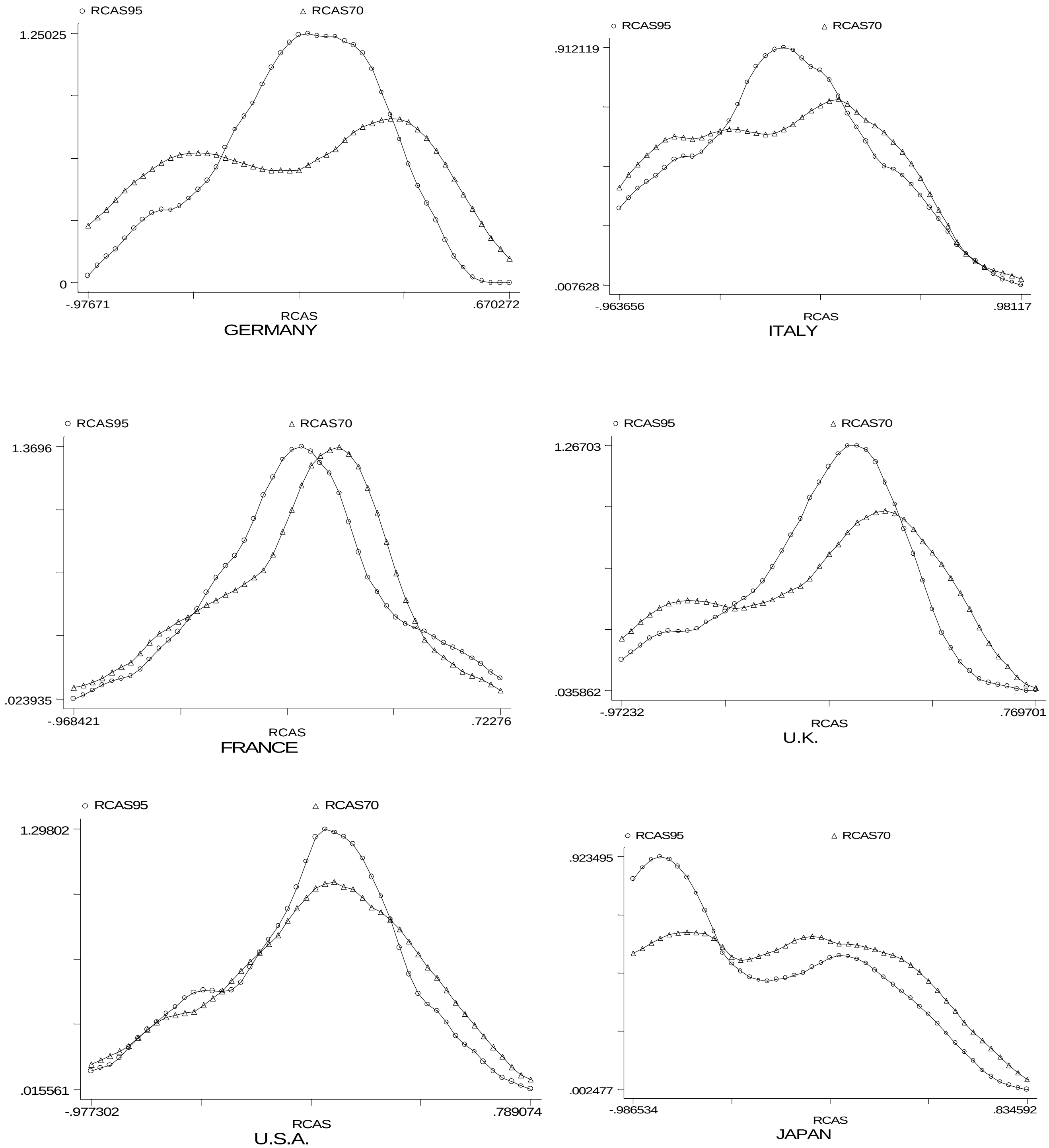
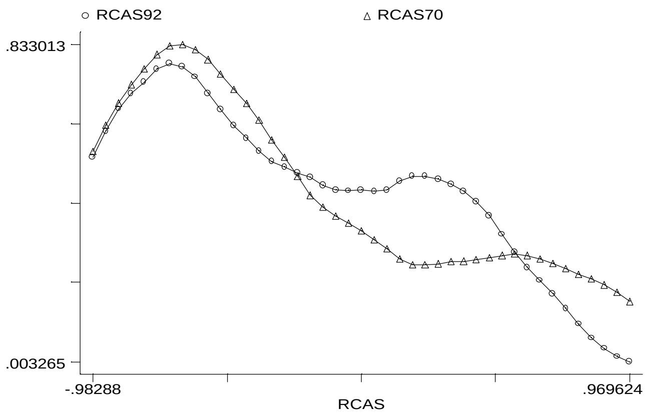


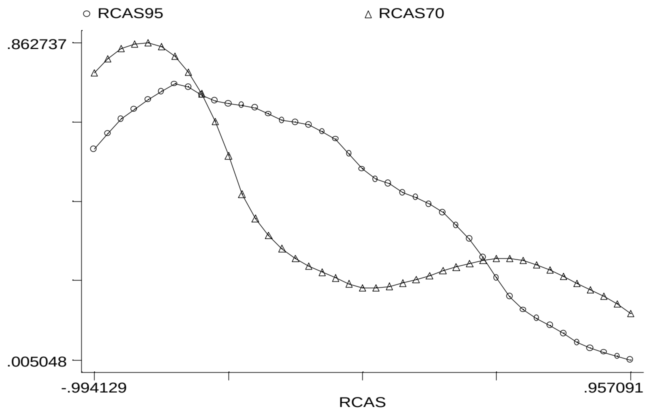
Figure 1

Figure 2 – Marginal densities

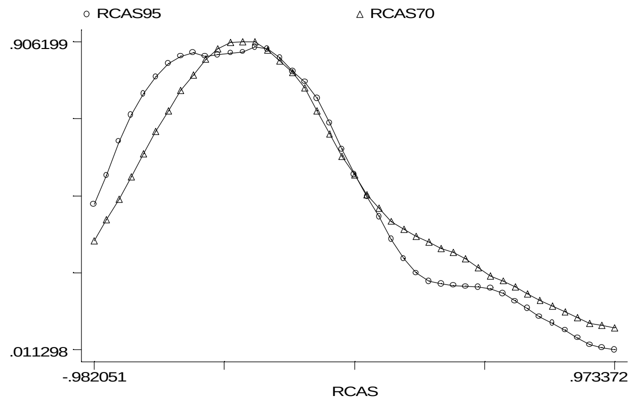




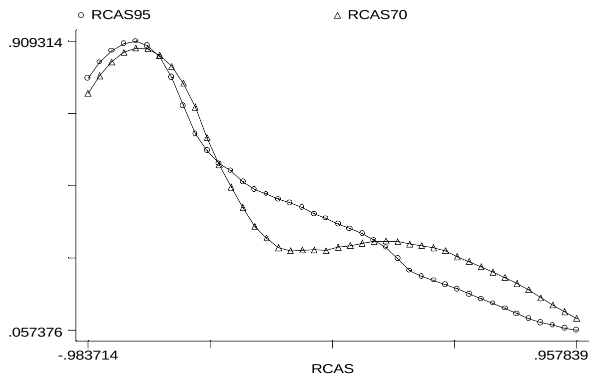
TAIWAN



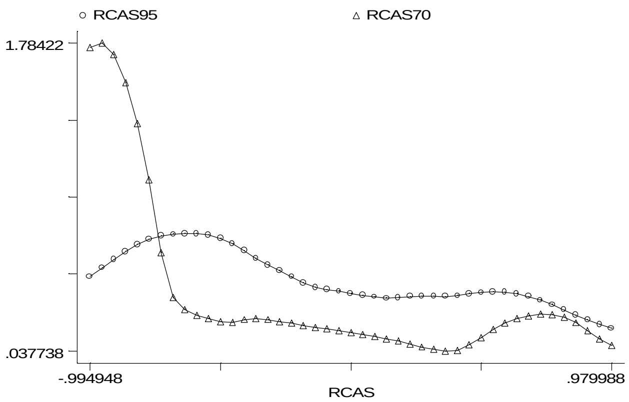
SOUTH KOREA



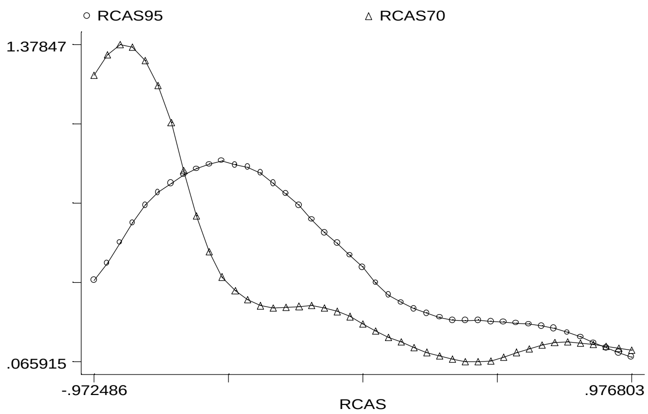
SINGAPORE



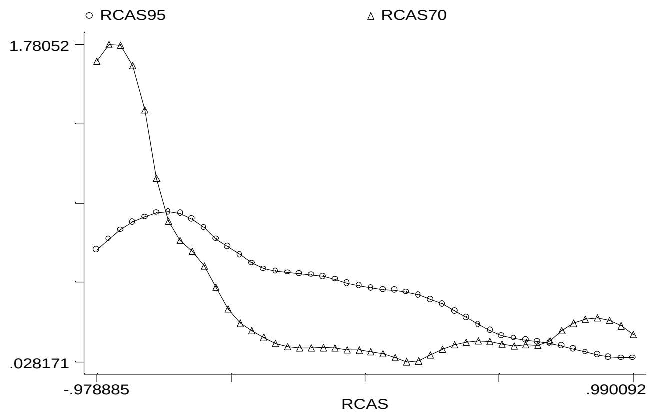
HONG KONG



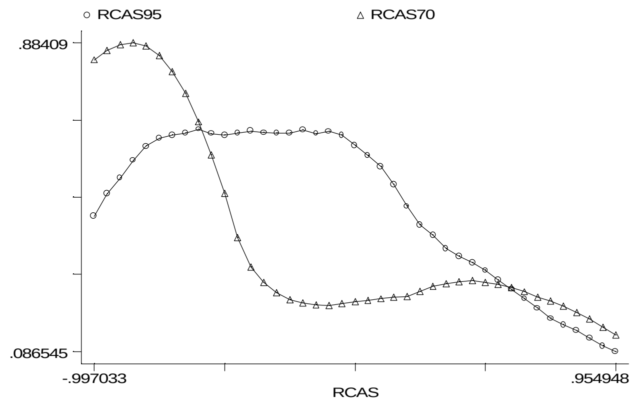
INDONESIA



MALAYSIA

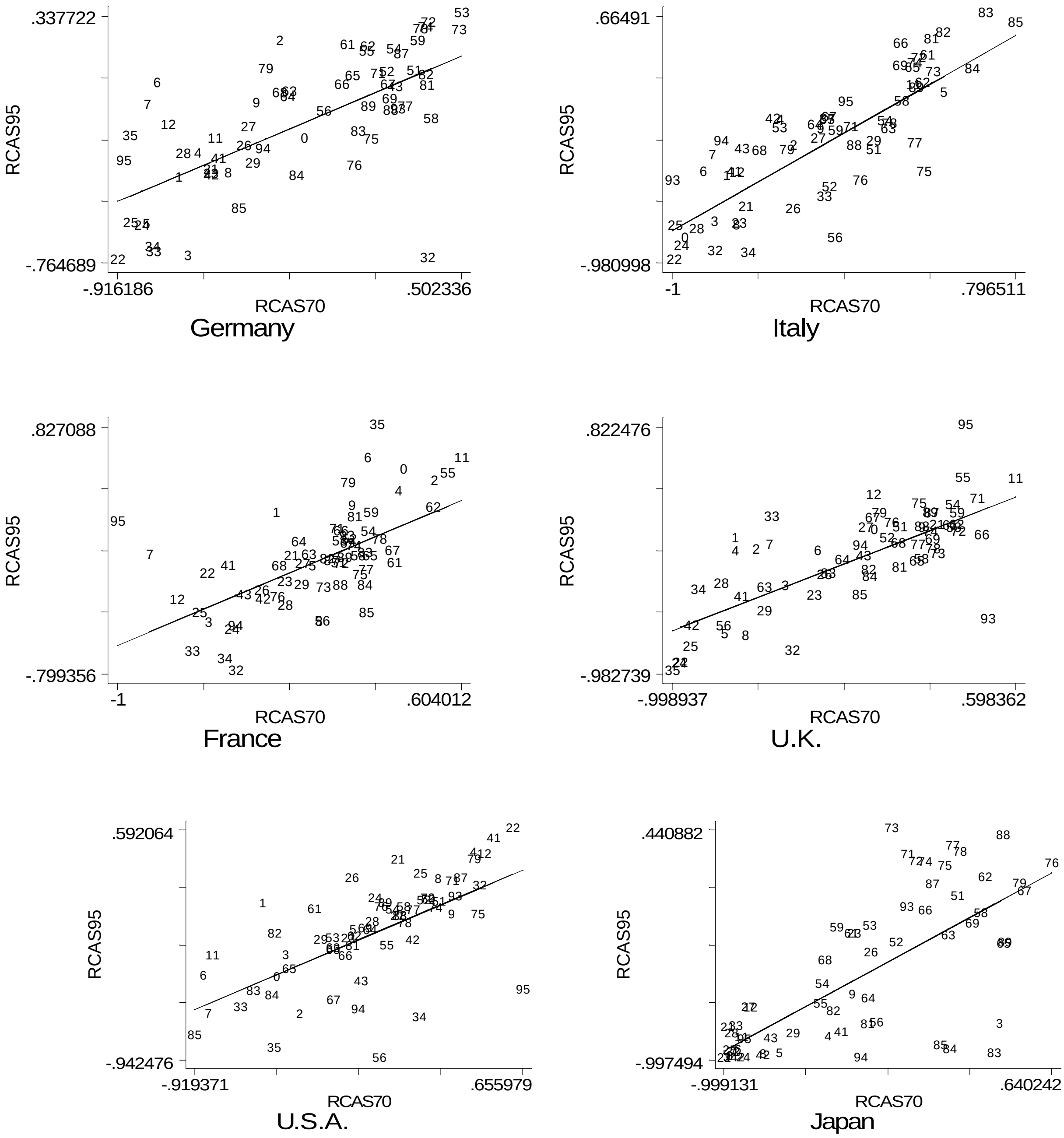


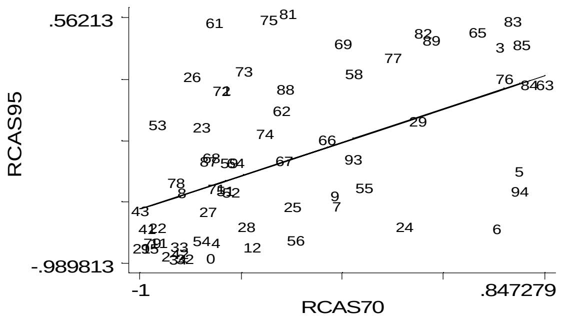
PHILIPPINES



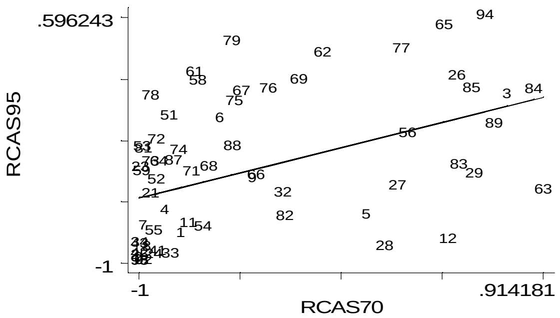
THAILAND

Figure 3 - Scatter diagrams: RCAS95 versus RCAS70

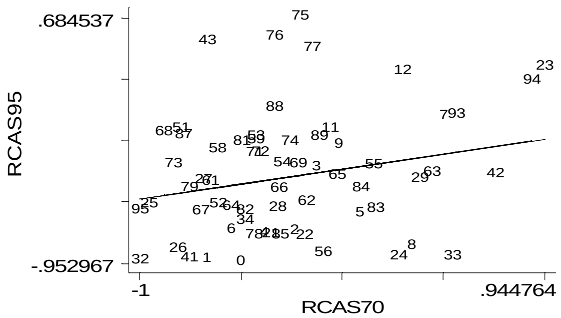




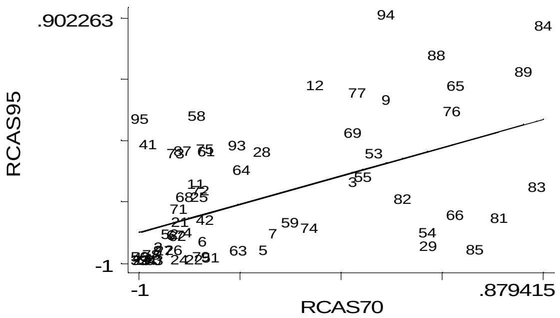
Taiwan



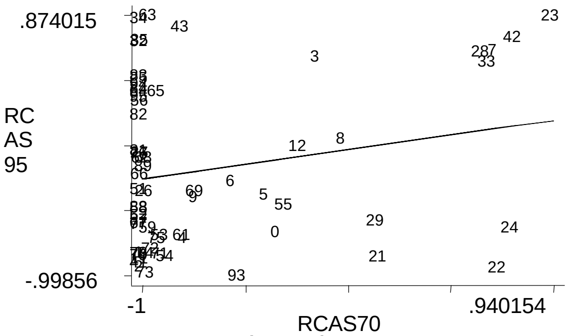
South Korea



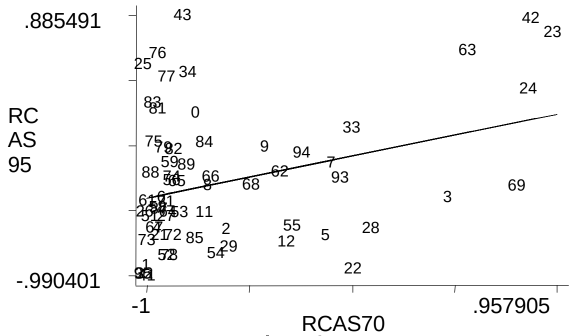
Singapore



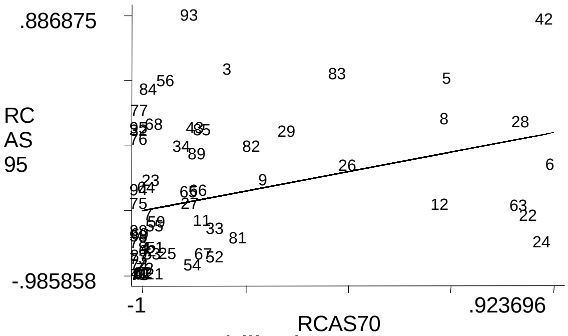
Hong Kong



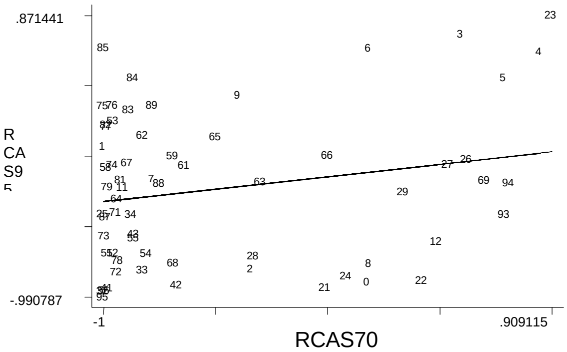
Indonesia



Malaysia

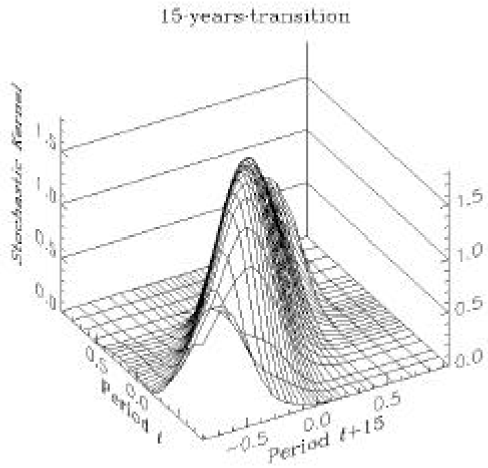


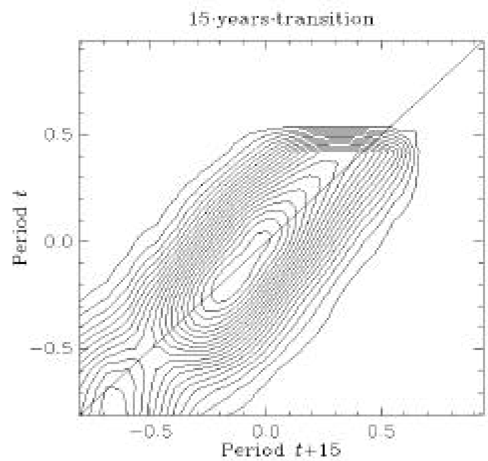
Philippines



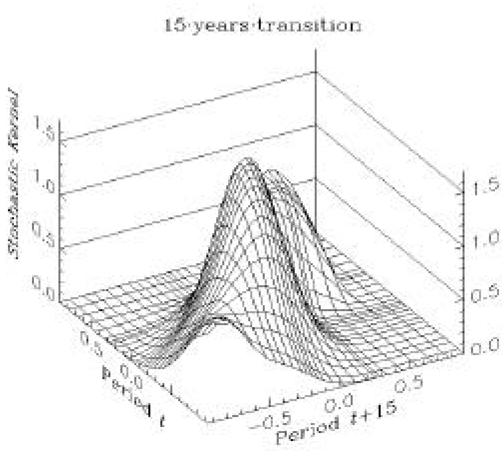
Thailand

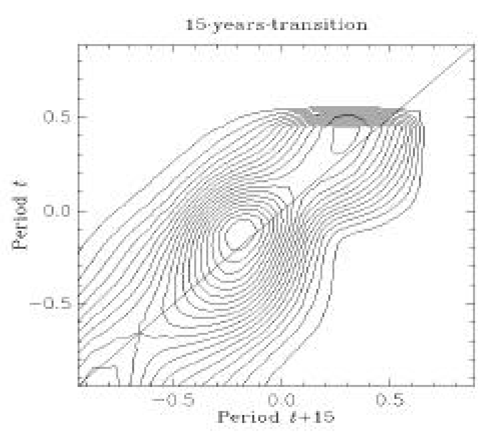
Figure 4 - Stochastic kernels



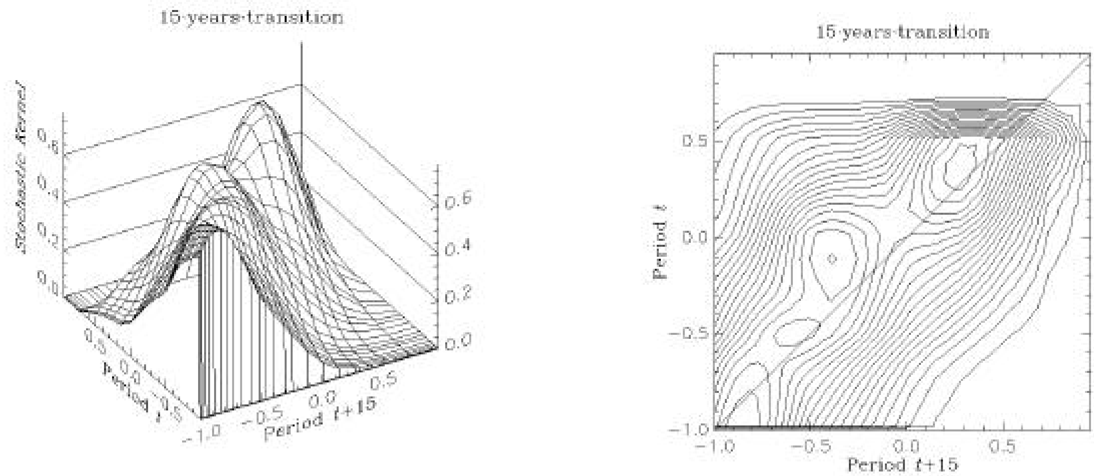


U.S.A.

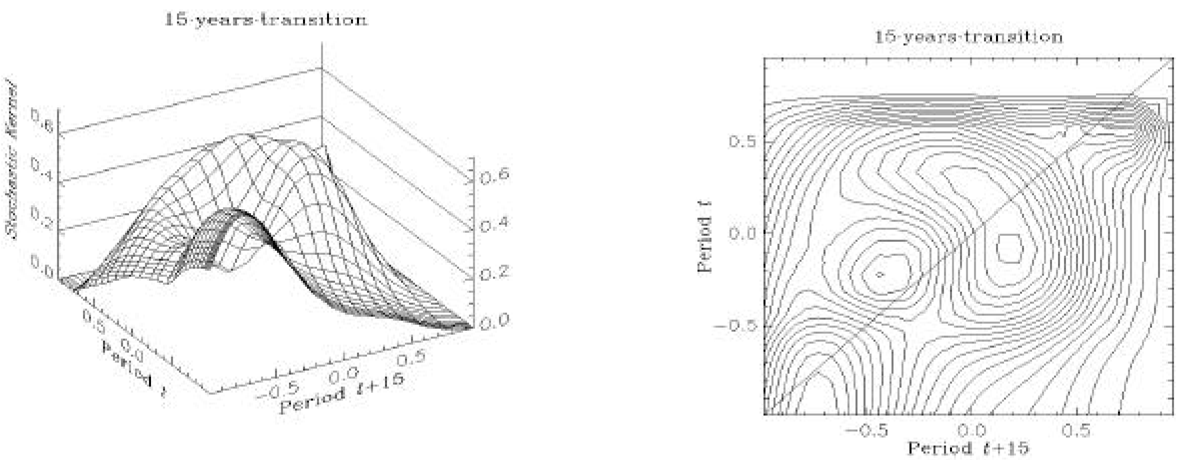




Italy



South Korea



Thailand