# ON THE DYNAMICS OF TRADE PATTERNS[1]

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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, Amendola *et al.*, 1992) partly stems from the predictions of the endogenous growth 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, 1991a) 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 the governments of developing countries 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 4 NIEs, i.e. Hong Kong, Singapore, South Korea and Taiwan, and 4 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 literature. Further, we analyse the intra-distribution dynamics, in order to assess the degree of persistence of international trade patterns.

Overall, our analysis show 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, while the latter's specialisation is highly mobile. 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 rapid growth and factor accumulation is associated with a mobile 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 factor endowment). 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 surveys the main implications arising from the trade literature as far as the determinants of trade evolutions are concerned. Section 3 discusses previous empirical evidence and some issues concerning the measurement of trade specialisation. Section 4 presents our results on the dynamics of specialisation for the two groups of countries. Section 5 concludes.

## 2. Dynamics of specialisation: some implications from the trade literature

### 2.1 "Dynamics" of specialisation in the static trade models

This section explores some implications arising from the trade literature on the time evolution of trade patterns. It is useful to start our analysis by looking at static trade models. As noted by Helpman and Krugman (1985, p.38), these models can be a good proxy for dynamic models, provided we interpret them carefully[2]. Indeed, as we will see below, many implications of the recent developments in the dynamic trade theory are already implicit in these simpler models.

#### 2.1.1 Constant returns to scale and factor endowments

In the standard Heckscher-Ohlin model, the relative cost function is upward sloping; this implies a concave transformation curve and an offer curve which is convex with respect to the axis of the exported good. Figure 1 shows the offer curves for the domestic country ($OC_H$) and the foreign country ($OC_F(t_0)$). The slope in the origin of the offer curves equals the relative

autarchic price ($P_2/P_1$) in the two countries. Assume that good 2 is capital intensive. Figure 1 then implies that the domestic country is capital abundant and that it exports good 2 in the free trade equilibrium (point A).

Now, performing a comparative statics exercise, assume that the foreign country experiences an exogenous increase in the capital-labour ratio. As a consequence, its offer curve rotates downwards. This implies that the foreign country's imports of the capital intensive good are reduced. If the process of capital accumulation goes on in the foreign country, the trade pattern will eventually be reversed. As shown in the figure by the offer curve $OC_F(t_1)$, when the foreign country becomes capital abundant it starts to export the capital intensive good (point B).

The Heckscher-Ohlin model then 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.

### 2.1.2 Increasing returns to scale

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 model on the trade patterns 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 frontier. Assume, in particular, that one of the two sectors is characterised by a production function homogeneous of degree $T > 1$. As shown by Kemp (1969) and by Markusen and Melvin (1981), the smaller is T and the larger is $|1-k_1/k_2|$, where $k_1$ and $k_2$ are the two sectors' capital intensities, the more likely it is that the production frontier is locally concave. In words, the lower the importance of increasing returns and the greater the factor intensities differences between the two sectors, the more likely it is that the relative supply curve is upward sloping[3]. The intuition is that, in the presence of markedly different factor intensities, it is costly to change the sector composition of output because of the increase in the price of the factor intensively used in the production of the good whose output expands. On the contrary, increasing returns to scale imply, ceteris paribus, a falling relative cost when relative supply expands. The net effect depends on the relative magnitude of these two forces. If external economies are negligible with

respect to the factor intensities differences between the two sectors, then the relative supply curve is positively sloped[4] and the offer curves for the two countries are equivalent to those shown in Figure 1. Hence, under the above specified conditions, the same implications about the dynamics of specialisation apply.

Now assume that national external economies are important, so that the relative supply curve is globally negatively sloped. We can employ a simple 2X2X2 model to illustrate the main implications for the evolution of trade patterns. In this case, the offer curves are concave with respect to the axis of the exported good, as shown in Figure 2. Note, also, that in the neighbourhood of complete specialisation the offer curves bend backwards (see Kemp, 1969).

In the example shown in the figure, the domestic country is initially labour abundant with respect to the foreign country, because $OC_H(t_0)$ is steeper than $OC_F$ in the origin. Note that the international equilibrium is not unique. In the figure we have shown three equilibria, corresponding to the intersection of two offer curves at A, B and C. B implies despecialisation of both countries, while A and C imply complete specialisation of at least one country. Using a Marshallian adjustment rule[5], Wong (1995, ch. 5) shows that equilibrium at B is unstable, while equilibria at A and C are stable. So we are left with two stable equilibria. In particular, C implies specialisation according to comparative advantage, while A implies perverse specialisation, i.e. in the good which uses intensively the scarce factor.

As is well known, complete specialisation, multiplicity of equilibria and the consequent indeterminacy of the trade pattern are a typical consequence of the assumption of national external economies. However, Ethier (1982a) suggests a stronger result: if the productions of the sectors adjust according to the above mentioned Marshallian adjustment rule, then it is possible to exclude the equilibrium with perverse specialisation[6].

Now consider the following comparative statics exercise. Assume that the initial equilibrium is at a point like C, where the trade pattern follows comparative advantage. Now assume that the domestic country experiences an increase in the capital-labour ratio that reverses its initial comparative advantage. This implies that the new domestic country's offer curve $OC_H(t_1)$ is flatter than the foreign's in the origin. In words, the domestic country is now capital abundant and has a comparative advantage in the capital intensive good. However, since the equilibrium at C is stable, it is easy to show that using the above mentioned adjustment rule the new equilibrium is at a point like C', where the world trade pattern is unchanged.

To summarise, we have shown 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 intuition is that, in the presence of a negatively sloped relative supply curve, international specialisation causes a divergence of relative costs (whereas in the standard neoclassical model the converse in true, i.e. international trade brings about a convergence of relative costs). Hence, whichever the initial specialisation, it tends to be reinforced over time, locking the world trade pattern in.

The above results build on the assumption that external economies are national rather than international in scope. This is equivalent to assume that positive externalities among firms are limited in scope and require geographical concentration of production. This assumption has been questioned by Ethier (1979,1982b), who argues, instead, that continuous progress in the communication and transport technology no longer requires proximity between producers in order to exploit increasing returns. As a consequence, increasing returns are international rather national in scope and thus depend on the size of the world economy. In particular, they consist of the efficiency gains allowed by a finer international division of labour through the exchange of intermediate inputs. Thus, *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.*

## 2.2 Dynamics of specialisation in the dynamic trade models

As far as the truly dynamic trade theory is concerned, its implications closely parallel those of the static trade models surveyed above[7]. However, as noted by Helpman and Krugman (1985), 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.

For instance, Grossman and Helpman (1990, 1991a, 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 which imply a lock-in effect for the pattern of specialisation. These models are the dynamic equivalent of static trade models assuming national external economies. For instance, Lucas (1988), Grossman and Helpman (1991a, ch.8), Redding (1999)[8] show that in the presence of dynamic scale economies the long run trade pattern is fully determined by initial comparative advantage.

### 2.2.1 Dynamics of specialisation in Krugman's (1987) model

An intermediate case is illustrated in Krugman (1987), where partial internationalisation of learning is assumed. The model builds on Dornbusch, Fischer and Samuelson (1977) by assuming two countries producing a continuum of goods with a single production factor, labour. This model proves quite useful for later empirical analysis, so we summarise its main features and slightly generalise it by removing the assumption of symmetry of industries in order to allow comparative advantage to enter the picture.

Let: $x_i(t) = a_i(t)L_i(t)$, $x^*_i(t) = a^*_i(t)L^*_i(t)$, $i = 1,..n$ be the production functions at time $t$ for good $i$ in the two countries. Asterisks denote foreign variables. $L_i(t)$ is the labour devoted to good's $i$ production and $a_i(t)$ is its productivity. Because of sector specific dynamic scale economies due to learning by doing, productivity depends on an index $K$ of cumulative experience:

$$a_i(t) = h_i K_i(t)^{\varepsilon}, \qquad a^*_i(t) = h^*_i K^*_i(t)^{\varepsilon}, \qquad 0 \le \varepsilon \le 1, \text{ where:}$$

$$K_i(t) = \int_{-\infty}^{t} \left(x_i(z) + \delta x^*_i(z)\right) dz, \quad K^*_i(t) = \int_{-\infty}^{t} \left(x^*_i(z) + \delta x_i(z)\right) dz, \; 0 \le \delta \le 1.$$

$\delta$ captures the degree of international knowledge spillovers. Note that we have added a parameter $h$ to the Krugman's model, which varies across sectors and countries, in order to allow sectoral asymmetries, i.e. comparative advantage. $h$ can be thought of as a parameter translating cumulative experience into higher productivity. It may vary across sectors because of the different sectoral importance of experience, and across countries, e.g. because of the different quality of the labour force.

Assuming Cobb-Douglas preferences implies that in autarchy an equal share of labour is devoted to the production of each good in the two countries ($L_i = L/n$ in the domestic country, $L_i^* = L^*/n$, in the foreign country). In the absence of knowledge spillovers, it is easy to show that the steady state autarchic relative productivity are given by: $\frac{a_i}{a^*_i} = \left(\frac{L}{L^*}\right)^{\frac{\varepsilon}{1-\varepsilon}} \left(\frac{h_i}{h^*_i}\right)^{\frac{1}{1-\varepsilon}}$ .Note

that, ceteris paribus, the larger country tends to be more efficient in all goods because it takes a greater advantage from dynamic scale economies.

When the two countries open to trade, the balance of payments equilibrium condition (call it *ww** curve) implies: $\frac{w}{w^*} = \frac{\sigma}{1-\sigma}\frac{L^*}{L}$, where $w/w^*$ is the relative wage of the domestic country and $\sigma = n_H /n$ is the share of goods produced by the domestic country in the free trade equilibrium. As shown in Figure 3, the trade pattern is determined by the intersection of the *ww** curve with the *aa** curve, obtained by ranking industries according to their relative productivity.

This simple model implies complete specialisation in the free trade equilibrium. As a consequence, $L_i$ and $L^*_i$ go to zero in the sectors of comparative disadvantage and to $L/\sigma n$ and $L^*/(1-\sigma)n$, respectively, in the sectors of comparative advantage.

Assume, now, that there are no international knowledge spillovers, i.e. $\delta = 0$. In this case the *aa** curve becomes vertical in the long run, because the domestic relative productivity goes to zero in the sectors of comparative disadvantage and to infinity in the sectors of comparative advantage. This 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. A subsequent change of comparative advantage or country size would have no effect on the long run trade pattern.

An empirical implication of this framework is a tendency toward persistence of trade patterns. An additional feature is that the pattern of comparative advantage tends to become more polarised. In fact, sectors of initial comparative advantage will become stronger in terms of relative productivity, and sectors of initial comparative disadvantage will become weaker[9].

Assume, now, that knowledge flows instantaneously and costlessly across national boundaries, i.e. $\delta = 1$. In this case, it is easy to show that, for $i = 1..n$, $K_i = K^*_i$ in the long run free trade equilibrium. This implies that the *aa** curve equals $h_i /h^*_i$, so that the model reduces to a static Ricardian model with a continuum of goods. Hence, if knowledge spillovers are pervasive, the dynamics of specialisation are the same as those implicit in static trade models with constant returns to scale. Empirically, we should observe countries experiencing a rapid change in their comparative advantage to show a highly mobile trade pattern. On the contrary, countries whose relative productivities are roughly unchanged should experience a persistent trade pattern with no sign of polarisation.

In the presence of dynamic scale economies which are international in scope, the main difference with the traditional theory lies in the scale effect. Assume, for instance, that the domestic country is larger than the foreign country. This implies that the steady state autarchic

*aa** curve is higher than the $h_i / h^*_i$ curve, which represents the free trade long run relative productivities. When trade opens, if knowledge flows instantly across the two countries, then the scale effect immediately disappears and the *aa** curve suddenly shifts downwards, so that the domestic country exports goods in the range $(0,\underline{\sigma}_S)$ and imports those in the range $(\underline{\sigma}_S,1)$. On the contrary, if we assume, more realistically, that knowledge takes time to disseminate across the two countries, so that the scale effect vanishes only slowly, then in short run the domestic country will export also goods in the range $(\underline{\sigma}_S, \underline{\sigma})$.

If these conclusions are empirically relevant, we should observe large countries gradually loosing specialisation in the range $(\underline{\sigma}_S, \underline{\sigma})$, and small countries gaining specialisation in the range $(\underline{\sigma}_S, \underline{\sigma})$. As shown in Figure 3, these sectors are intermediate in terms of relative productivities, and thus we expect greater mobility among intermediate sectors.

Finally, in the case analysed by Krugman, in which partial international knowledge spillovers are assumed, i.e. $0 < \delta < 1$ (and no sectoral asymmetries are allowed), the long run *aa** curve takes a step shape, as shown in Figure 4. This implies that there are a lower and an upper bound to the long run relative productivities, whose distance is inversely related to the intensity of international knowledge spillovers. In this case, dynamic scale economies tend to strengthen initial comparative advantage, as is the case for $\delta = 0$. However, the main difference is that the long run relative productivities take on finite values instead of exploding. Hence the possibility arises of a change in the trade pattern as a consequence of an exogenous shock (i.e. a change in relative country size) that shifts the *ww** curve.

Note that Krugman's model implies a sort of club convergence of relative productivities around two steady state values, $(1/\delta)^{\varepsilon}$ and $\delta^{\varepsilon}$, where the former refers to sectors of comparative advantage, while the latter refers to sectors of comparative disadvantage. Stepping a bit outside the model, we could say that an empirical implication of this model is that a country's trade performance in its comparative (dis)advantage sectors will tend to converge to a common value in the long run free trade equilibrium.

As noted above, Krugman's original model assumes no sectoral asymmetries, i.e. no intrinsic comparative advantage. In the presence of such asymmetries, the "convergence clubs" result partly disappears. In fact, it is easy to show that in this case the long run *aa** curve is given by:

$$\frac{a_i}{a^*_i} = \frac{h_i}{h^*_i}\left(\frac{1}{\delta}\right)^{\varepsilon} \quad \text{in } (0,\underline{\sigma})$$

$$\frac{a_i}{a^*_i} = \frac{h_i}{h^*_i}(\delta)^{\varepsilon} \quad \text{in } (\underline{\sigma},1)$$

which implies that international specialisation amplifies initial differences among comparative advantage sectors and squeezes them among comparative disadvantage sectors. This curve is shown as a dashed line in Figure 4.

### 2.2.2 Trade, convergence and leapfrogging

Krugman (1987) assumes that technological progress is a pure externality. Eicher (1999) builds a three sectors overlapping generations model in which technological progress and factor accumulation are endogenous. The three sectors are distinguished by their factor intensities and their technological sophistication. More precisely, a High Tech sector utilises skilled labour, unskilled labour and the newly invented technology. A Low Tech sector employs unskilled labour and the old technology. Finally, an Education sector employs students, teachers and the most recent technology to produce new technology and skills. Thus, human capital accumulation and technological progress are costly processes arising from investment in education.

Eicher assumes no international spillovers. As shown above, this assumption generally implies that trade tends to reinforce initial differences, locking specialisation patterns in. On the contrary, Eicher shows that, in the presence of endogenous human capital accumulation and technological progress, international trade narrows either the technology gap either the differences in the factor endowments. The key to this result is the interaction between human capital accumulation and technical change. In particular, international trade generates a contraction of the skill-intensive High Tech sector in the less developed country. This, in turn, frees skilled labour and reduces the direct cost of education. As a consequence, the investment in education increases, with a positive effect on human capital endowment and the technology level in the laggard country.

Empirically, this model implies convergence of relative factor endowments and, as a consequence, of international trade patterns.

A stronger result is in Mountford (1998), who shows how, by adding a simple dynamic structure to the standard 2X2X2 Heckscher-Ohlin model, the long run implications of international trade can be the reverse of the static ones. The author utilises an overlapping generations model in which, as in Galor (1992) investment is proportional to wages, to show that a country with the lowest autarkic steady state relative price of a good may not export that good in the international trade steady state. As a consequence, a capital-abundant country may export the labour-intensive good in the long run free trade equilibrium.

Krugman (1987) assumes that technological change proceeds incrementally and that it is driven by learning by doing. As a consequence, it will occur most rapidly in those countries

with an established technological advantage, and thus technological overtaking is impossible for laggard countries. Brezis *et al.* (1993) argue that a different picture emerges if we assume that at intervals fundamentally new technologies are invented[10]. Assume, in particular, that new and old technologies are subject to learning by doing, and that, for a given amount of experience, the new technology is more efficient then the old one. Then it is possible that, because of the large experience accumulated in the old technology, the leading country will find it not profitable to shift to the new technology. On the contrary, the laggard country, which has little or no experience in the old technology, may find it relatively convenient to invest in the new technology. Under these assumptions, because of the greater efficiency of the new technology, the laggard country will become, sooner or later, the new technological leader.

Empirically, technological "leapfrogging" implies that at intervals whose length is determined by the timing of major technological inventions, comparative advantage and trade patterns are reversed. Note, however, that such technological breakthroughs do not occur very often, so that the above argument may be of little empirical relevance.

An other strand of literature, building upon Vernon's concept of product cycle, emphasises that goods are initially produced in high income countries and later in low income countries. Krugman (1979) is the first to formalise this concept in a model in which knowledge diffusion is exogenous.

Grossman and Helpman (1991b) build a dynamic general equilibrium quality ladders model in order to study the product cycle. They assume that innovation occurs in the North through investment in R&D, while technological diffusion occurs in the South through costly imitation. In this model, only the highest quality level of each product sells in equilibrium, so that successful imitation leads to a displacement of production from North to South. Contrary to the standard product cycle model, this framework predicts the reversal in the patterns of specialisation when a new generation of higher quality goods are invented in the North in the same industry. As a consequence, this model implies that the tension between innovation in the North and imitation in the South leads to a high volatility of trade patterns.

As noted by Glass (1997), an unappealing feature of Grossman and Helpman's model is that it implies that Southern market penetration is either zero or one. On the contrary, Glass builds a model which resembles Grossman and Helpman (1991b), but introduces differences in willingness to pay for quality improvements across consumers to permit multiple quality levels to sell in equilibrium. A major implication of this assumption is that the South gradually penetrates into Northern markets as Southern firms imitate higher quality levels of existing products.

This section has shown that the theoretical literature is rich enough to generate contrasting implications on the trade patterns evolutions, depending on the specific assumptions underlying the different approaches. However, we can draw some general conclusions from the preceding analysis.

First, under certain conditions, the dynamics of specialisation over time are the outcome of a tension between some kind of increasing returns to scale and comparative advantage: on the one hand, changing comparative advantage pushes in the direction of a change in the trade patterns; on the other hand, the existence of strong external scale economies (static or dynamic) tends to reinforce the existing specialisation locking trade patterns in.

Second, trade patterns dynamics are closely linked to the process of international knowledge diffusion. At one extreme, in the absence of international knowledge spillovers, persistence and polarisation of trade patterns are the most likely outcomes. At the other extreme, in a world in which knowledge flows instantly and costlessly across borders, trade patterns closely follow the changing comparative advantage of trading countries.

Third, models endogenising the process of knowledge creation and knowledge diffusion by assuming costly innovation and costly imitation imply that, as long as Southern firms penetrate Northern markets, a gradual movement of Southern countries' marginal distribution of the specialisation index toward higher values, together with a movement toward lower values of the index for Northern countries should be observed.

## 3. Measurement of the pattern of specialisation

The international specialisation of a country is generally measured by one of two types of indicators ( Balassa, 1965). One utilises both export and import data, for instance the sectoral export-import ratio, or net exports divided by gross sectoral trade [11]. The other utilises the relative export shares. In the latter class, the most commonly used indicator is the 'Revealed Comparative Advantage' (RCA) index, defined as:

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

where the ratio in the numerator represents the share of sector $i$ in country $j$ total exports, while the ratio in the denominator represents the same share for the world economy. This index takes values between 0 and $+\infty$. A value less than 1 characterise sectors in which a country is

relatively de-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 specialised.

The reason why this indicator has gained wide acceptance among applied international trade economists is that it allows to compare the export structure of a country to that of the world economy (or of any subset of countries). Note, however, that there are no clear theoretical foundations for this measure. An attempt in this direction is in Kunimoto (1977), who provided a statistical framework in which [3.1] can be interpreted as the ratio between actual and expected trade:

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

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 specialisation or de-specialisation[12]. Accordingly, in this paper we interpret RCA as a direct measure of international relative specialisation[13].

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 fact it is a monotonic transformation of the RCA index which reduces the weight of extreme observations. Further, contrary to RCA, it is a symmetric index.

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.

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 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[14] 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[15] 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) [16].

These studies usually complement the previous analysis with a Galtonian regression (or correlation analysis) of the RCA in the final year on the 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[17].

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. Distributional 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 [3.2]. 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).

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[18]. We focus on 14 countries: France (F), Germany (G), Italy (I), United Kingdom (UK), Japan (J), United States (US), the 4 NIEs (Hong Kong (HK), Singapore (SIN), South Korea (SK), Taiwan (TAW)) and 4 ASEAN countries (Philippines (PHI), Indonesia (INDO), Malaysia (MAL), Thailand (THA)). The level of aggregation of our data is the 2-digit SITC Rev.2 (65 sectors).

## 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 I, US, J and TAW 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 the RCAS[19] for each country at the beginning and the end of the time period. This is shown in Figure 5. We have adopted the following non-parametric approach: a kernel function is centred around each observation $x_i$, and then for each $x_i$ the average of this function is computed in order to obtain the density function. We have adopted the Epanechnikov kernel.

Probably the most important choice in estimating density functions is that 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 5 shows the density functions

estimated by one of the data driven bandwidth selectors suggested by Silverman (1986)[20]. Each graph illustrates the estimates of the density function in 1970 and 1995[21] for each country.

Note that the density function of the Asian countries is markedly more right skewed than that of the industrialised countries. 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 densities tend to become more symmetric. The only exceptions are Japan, whose density becomes more right skewed, and Singapore and Hong Kong, whose density is fairly stable over time.

An interesting question is whether any stratification can be identified. The concept of stratification, as defined by Quah (1997), relates to the number of modes in a density distribution. Visual identification of modes is highly dependent on bandwidth choice. Ceteris paribus, a smaller bandwidth tends in fact to highlight more modes.

A way to assess the statistical significance of modes is to use bootstrap multi-modality tests (Silverman (1986), Bianchi (1995)). These are based on the concept of critical bandwidth. Since the number of modes is a decreasing function of the bandwidth, the critical bandwidth $h_{crit}(m)$ is defined as the smallest possible bandwidth producing a density estimate with at most m modes. For instance, if a density has two modes, then, when one tests for the presence of only one mode, $h_{crit}(1)$ will be large. This is "because a considerable amount of smoothing is required to obtain a unimodal density estimate from a bimodal density" (Bianchi 1995). For assessing "how large is large" one can generate a number of bootstrapped samples from the original one[22] and then count the number of samples for which $h_{crit}(m)$ is larger than the original one. This clearly equals the number of bootstrapped samples that have more than m modes. The achieved significance level ($\alpha_m$) is just the proportion of this number on the total number of samples. Thus in testing the null hypothesis of 2 modes against the alternative of more than 2 modes, one fails to reject the null if $\alpha_m$ is larger than the usual significance levels.

The results of the tests are reported in Table 2. The density function is uni-modal in both years for UK, France, US, Singapore and Hong Kong. On the contrary, Germany, South Korea, Indonesia, Philippines, Malaysia and, less clearly, Italy, show a polarised density (i.e. two modes) in 1970 that evolves into a uni-modal density in 1995. Finally, Japan is persistent in its polarised specialisation and Thailand becomes polarised in 1995.

## 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 6. 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 impliies a higher mobility in the latter group of countries. However, the slope of the regression line gives information only on the conditional average of the distribution, while we are also interested in a more complete picture of mobility of sector specialisation within the distribution. In this respect, a more 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.

Let $F_t$ denote the distribution of RCAS at time t across sectors and $\phi_t$ the associated probability measure. Then the evolution of the distribution can be modelled as:

$$\phi_t = T(\phi_{t-1}, u_t) = T_{u_t}(\phi_{t-1}) \qquad [4.1]$$

where $T$ is an operator that maps disturbances and probabilities into probability measures and $u_t$ is a sequence of disturbances. Equation 4.1 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 $RCAS_{t-n}$[23].

Figure 7 presents for each country the three dimensional stochastic kernel together with the corresponding two dimensional contour plot[24]. In order to interpret the three dimensional graphs note that by cutting horizontally the stochastic kernel from each RCAS value on the period t axis, we obtain the conditional distribution at time t+15 given the cutting value at time t. This conditional distribution integrates to one. The contour plots are the vertical projections of the kernel 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, the level of 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[25] 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 7 is that the specialisation pattern of industrialised countries is more persistent than that of the emerging economies. This is shown both by the ridge location relative to the positive sloped diagonal and by the width of the isoprobs.

It is also possible to complement the previous analysis on the number of modes[26] by considering the relative maxima that are located on the main diagonal. For most industrialised countries there is only one relative maximum which is located approximately in the centre of the graphs, confirming our previous conclusions about the symmetry of the marginal densities (as before, Japan is an exception to this pattern).

One way to attach some numbers to this visual inspection comes at the cost of discretisation of the RCAS index. This implies dividing the range of values taken by the RCAS index into a certain number of states. In this framework the operator $T_u$ in [4.1] becomes a matrix of transition probabilities. In table 3 the 5 states are uniformly-defined (i.e. such that the number of observations in each state in the initial period is the same)[27]. The interpretation of the matrix is analogous to that of the stochastic kernel. Each cell $(i,j)$ contains 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.

Table 3 confirms the relative persistence of the international trade pattern of industrialised countries, because of the high probabilities on the main diagonal of the transition matrices 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 more mobile pattern..

The ergodic distributions[28] reported in Table 3 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 pattern 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. In this respect, Japan is an exception, since its distribution is more asymmetric and polarised. South-East Asian countries, instead, generally show an asymmetric and right-skewed distribution of the index.

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 higher mobility 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 some general 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 implies a tendency toward a reduced trade specialisation, which is what we observe in most cases.

Second, our evidence does not support the idea that self-reinforcing mechanisms driven by country and sector specific external economies 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 relative factor endowments experienced by these countries in the period covered by our empirical analysis.

Third, our evidence lends support to some updated versions of the product cycle theory, in particular to those models implying a gradual penetration of Southern firms into Northern markets. These models would in fact imply a gradual movement toward the right of the density function of RCAS in the Southern countries, and a movement toward the left in the industrialised countries. This is what we observe in our data.

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## Tables

**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 - Multimodality tests***

| *Country* | *year* | m = 2 | m = 2 | m =3 |
|---|---|---|---|---|
| GERMANY | 1970 | 0.26 | 0.14 | 0.1 |
| | | 0.03 | 0.11 | 0.05 |
| | 1995 | 0.12 | 0.1 | 0.08 |
| | | 0.20 | 0.08 | 0.04 |
| ITALY | 1970 | 0.22 | 0.18 | 0.10 |
| | | 0.24 | 0.02 | 0.34 |
| | 1995 | 0.16 | 0.12 | 0.08 |
| | | 0.28 | 0.28 | 0.57 |
| FRANCE | 1970 | 0.1 | 0.06 | |
| | | 0.75 | 0.18 | |
| | 1995 | 0.24 | 0.08 | |
| | | 0.73 | 0.18 | |
| UNITED KINGDOM | 1970 | 0.22 | 0.1 | |
| | | 0.13 | 0.50 | |
| | 1995 | 0.16 | 0.14 | |
| | | 0.15 | 0.05 | |
| JAPAN | | 0.01 | 0.02 | 0.31 |
| | 1995 | 0.28 | 0.16 | 0.06 |
| | | 0.03 | 0.06 | 0.79 |
| SOUTH KOREA | 1970 | 0.38 | 0.12 | 0.08 |
| | | 0.01 | 0.59 | 0.83 |
| | 1995 | 0.24 | 0.18 | 0.08 |
| | | 0.07 | 0.02 | 0.70 |
| SINGAPORE | 1970 | 0.14 | 0.12 | 0.1 |
| | | 0.72 | 0.47 | 0.40 |
| | 1995 | 0.14 | | 0.12 |
| | | 0.38 | | 0.03 |
| HONG KONG | 1970 | 0.28 | 0.16 | 0.14 |
| | | 0.72 | 0.47 | 0.40 |
| | 1995 | 0.18 | 0.16 | 0.14 |
| | | 0.59 | 0.21 | 0.06 |
| INDONESIA | 1970 | 0.4 | 0.16 | 0.12 |
| | | 0.003 | 0.33 | 0.19 |
| | 1995 | 0.32 | 0.14 | 0.12 |
| | | 0.08 | 0.47 | 0.19 |
| MALAYSIA | 1970 | 0.32 | 0.16 | 0.14 |
| | | 0.04 | 0.30 | 0.04 |
| | 1995 | 0.18 | 0.12 | 0.1 |
| | | 0.48 | 0.50 | 0.38 |
| PHILIPPINES | 1970 | 0.44 | 0.16 | 0.14 |
| | | 0.001 | 0.31 | 0.042 |
| | 1995 | 0.2 | 0.16 | 0.14 |
| | | 0.35 | 0.18 | 0.04 |
| THAILAND | 1970 | 0.22 | 0.08 | 0.06 |
| | | 0.86 | 0.99 | 0.99 |
| | 1995 | 0.26 | 0.14 | 0.12 |
| | | 0.04 | 0.42 | 0.17 |

Note: m = number of modes; the critical bandwidth $h_{crit}(m)$ is reported in the row corresponding to each year. The Achieved Significance Level (ASL) is reported below $h_{crit}(m)$.

## Table 3 – Transition probabilities, 15-year transitions, 1971-1995

Table 3a – *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 3b – *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 3c – *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 3d – *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 3e – *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 3f – *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 3g – *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 3h – *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 3j – *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 3k – *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 31 – *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 3m – *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 3n – *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 3o – *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 | Feedstuff for animals (excluding unmilled cereals) |
| 09 | Miscellaneous edible products and preparations |
| 11 | Beverages |
| 12 | Tobacco and tobacco manufactures |
| 21 | Hides, skins and furskins, 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 fertilizers 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 | Fertilizers 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 furskins |
| 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) |

# Note

[1] We would like to thank Maria Luisa Mancusi for valuable help and technical support.

[2] According to the authors, "the danger is in misinterpreting the nature of the mapping from dynamics into statics". In particular, "when a static model is used as a proxy for a dynamic world, it should be viewed as a representation of the whole time path of that world, not a snapshot at a particular point in time".

[3] We are implicitly assuming that the relative supply price and the marginal rate of transformation move in the same direction. As shown by Herberg and Kemp (1969), this is not necessarily true for general functional forms of the production functions.

[4] 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.

[5] The Marshallian concept of stability (see Wong 1995, p. 233) is based on the following assumptions: 1) when an economy is not in equilibrium, its exportable sector adjusts its output while the consumption of goods and the production of the importable remain fairly constant; 2) the firms in a sector increase (decrease) their outputs when the demand price is greater then the supply price.

[6] The argument can be summarised as follows. Assume that the domestic country has a comparative advantage in good 1. When trade opens, the domestic producers in sector 1 notice that the foreign relative price of good 1 is higher than the domestic relative price. As a consequence, they expand their production and thus their unit costs fall, inducing a further expansion of production and exports of good 1. The opposite occurs in the foreign country. The process continues until the stable equilibrium with specialisation according to comparative advantage is reached

[7] With respect to trade patterns determinants in a neoclassical growth model, Findlay (1970) has distinguished between static or temporary comparative advantage, determined as in the H-O model by relative factor endowments and long run or dynamic comparative advantage, depending on the capital-labour ratio to which the system tends in the long run. The capital-labour ratio is determined by the savings rate and the labour growth rate.

[8] Note, however, that Redding (1999) identifies the conditions under which there is a potential for the commercial policy to induce a change in comparative advantage and trade patterns.

[9] Note, however, that this kind of dynamics can also be generated by the simple Heckscher-Ohlin model. Take, for instance, a capital rich country experiencing rapid growth or a stagnating capital poor country. The former will strengthen its initial comparative advantage in the capital intensive sectors, the latter in the labour intensive productions. As a consequence, the dynamic trade pattern of these countries will be characterised by persistence and polarisation, just as would be the case in the presence of national dynamic scale economies.

[10] See also, on this subject, Ohyama and Jones (1995).

[11] In a Hecksher-Ohlin framework net exports are the theory-based measure of trade patterns. See the discussion in Bowen, Hollander and Viaenne (1998), Leamerand Levinsohn (1995), Deardorff (1984).

[12] Bowen (1983) argues that in order to obtain [3.2] we also need the assumption that countries exports 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.

[13] 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.

[14] Their measure of inequality is the coefficient of variation.

[15] They adopt a linear transformation of the RCA dividing it by the average RCA across sectors. As a consequence their standard deviation correspond to the coefficient of variation of the RCA.

[16] The limited comparability of the results reported in these studies is due not only to the different period, level of sectoral aggregation and index utilised, but also to the set of countries used to compute the denominator of RCA.

[17] For example, most of the cited authors discuss the path dependency of the pattern simply on the basis of the standard $\beta$ 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 only for the intercept but also for the slope (the $\beta$). However, the basic critique that the analysis focuses on average behaviour rather than on the dynamics of the distribution is still valid (Quah, (1996)).

[18] For the details on the criteria adopted to compile this database, see Feenstra, Lipsey and Bowen (1997).

[19] 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 distributional dynamics.

[20] 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).

[21] For lack of data, in a few cases the final year is 1992.

[22] Since bootstrapped samples have a larger variance than the original one, following Silverman (1986) we have re-scaled them.

[23] 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 density estimation, except that the kernel is bivariate in this case. Second, the implied marginal probability distribution of the first period is calculated by integration. Finally, the conditional distribution is obtained by dividing the joint density by the marginal density.

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

[25] Remind that RCA measures can be interpreted as measuring the export structure of a country relative to that in the world.

[26] Note, however, that now we utilise a 15-year window, while in the analysis of the marginal densities we compared over a 26 years period.

[27] 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.

[28] It is computed by ignoring the disturbance term and iterating the difference equation in probability measures implied by [4.1], then obtaining a relationship between $\phi_{t+s}$ and $\phi_t$ and taking it to the limit as $s \rightarrow +\infty$.

# Appendix

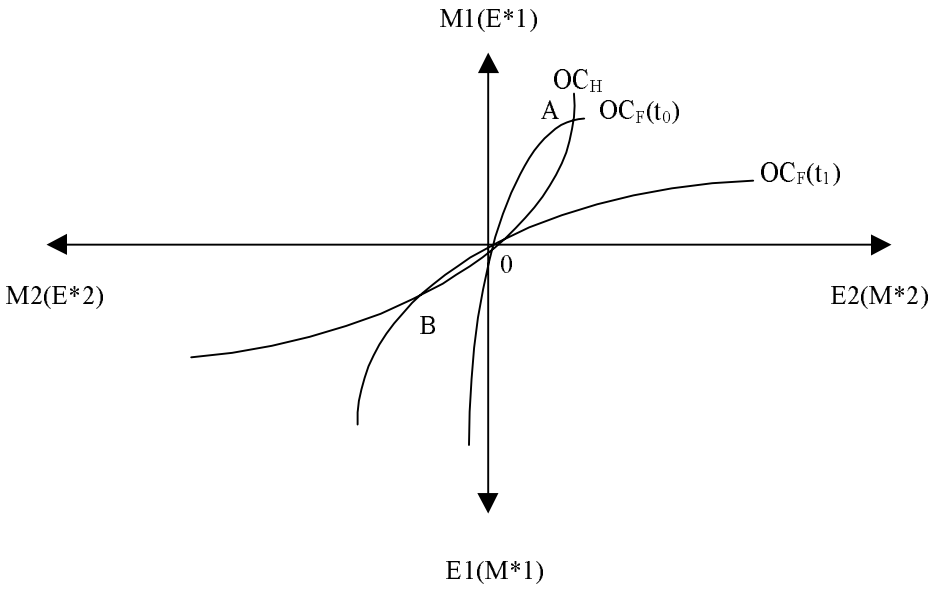



**Figure 1**

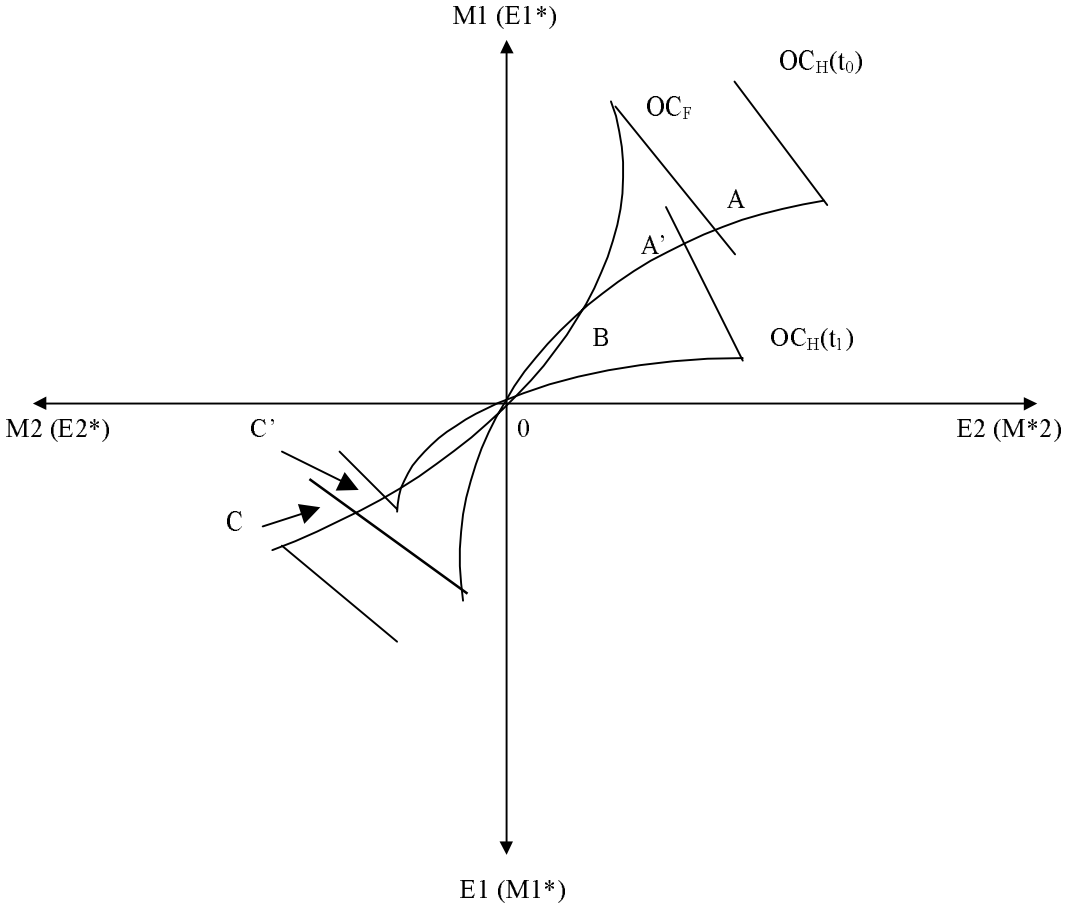



**Figure 2**

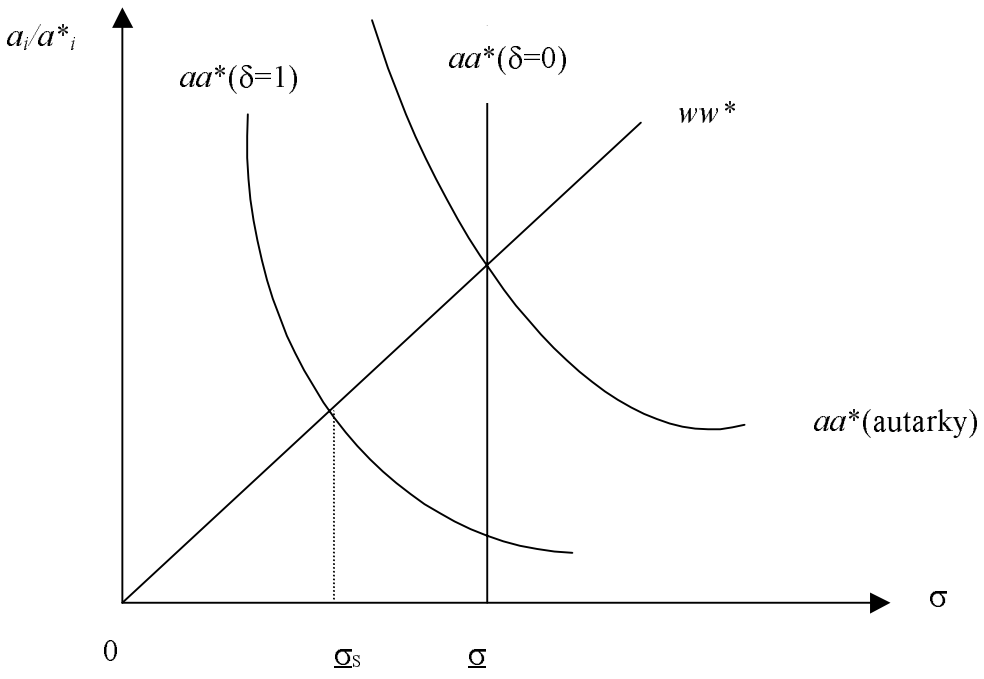



**Figure 3**

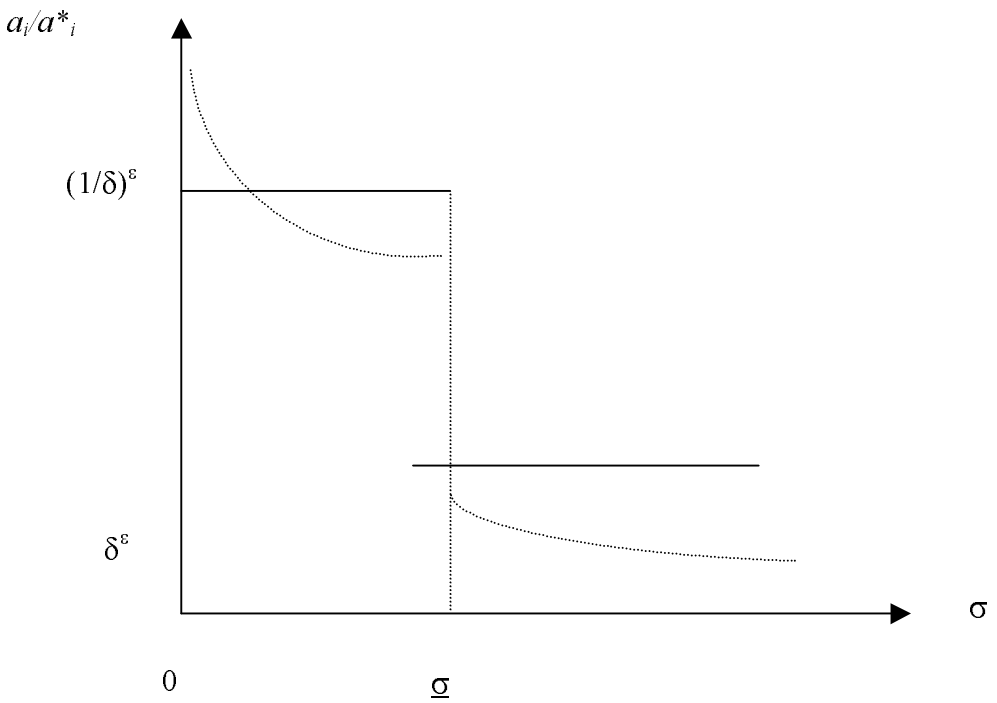
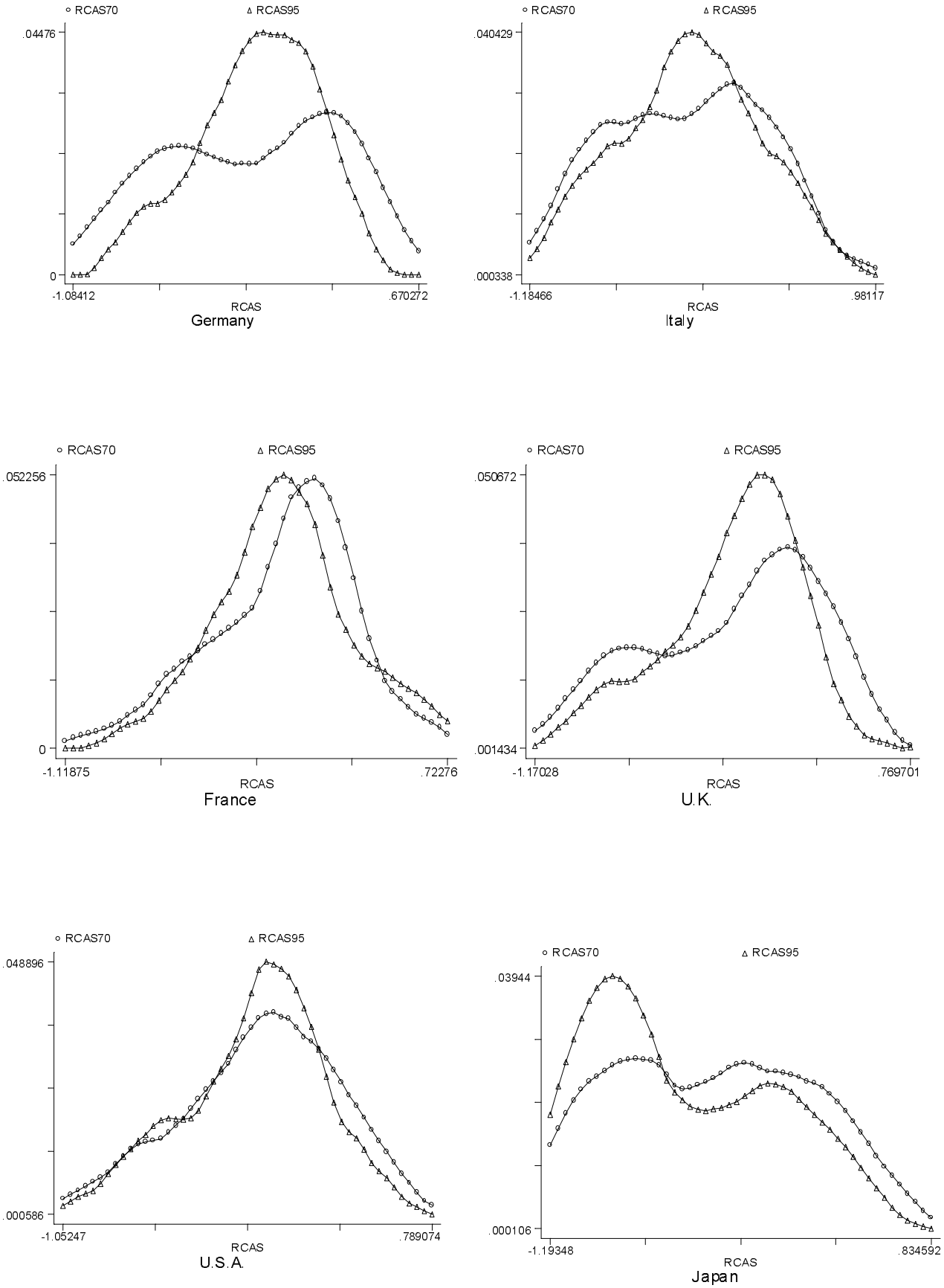
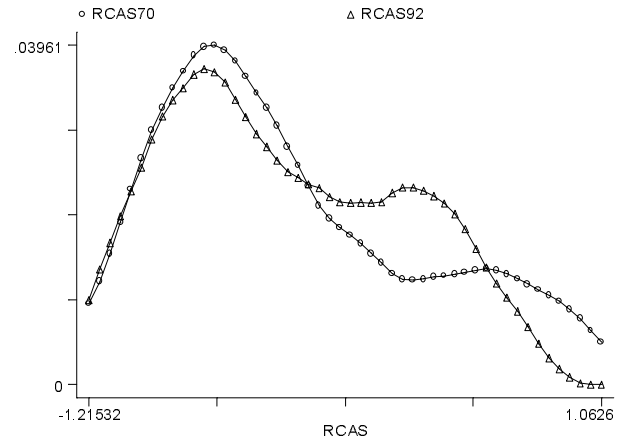


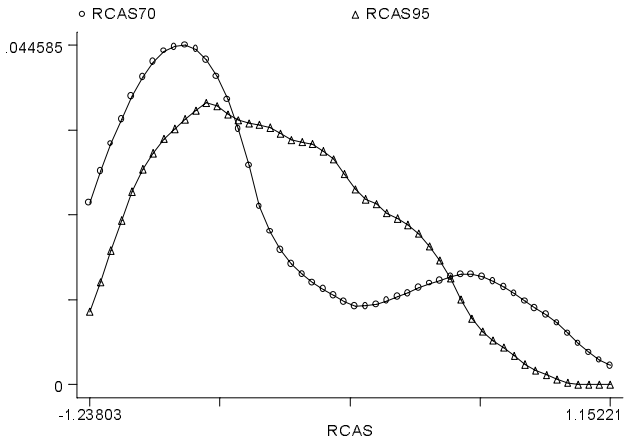

**Figure 4**

**Figure 5 - Marginal densities**

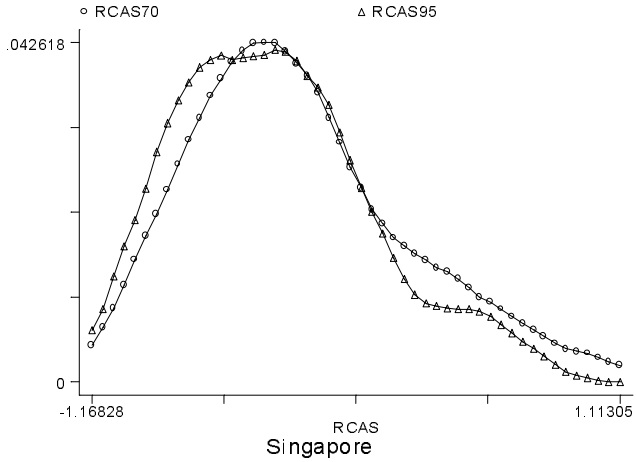




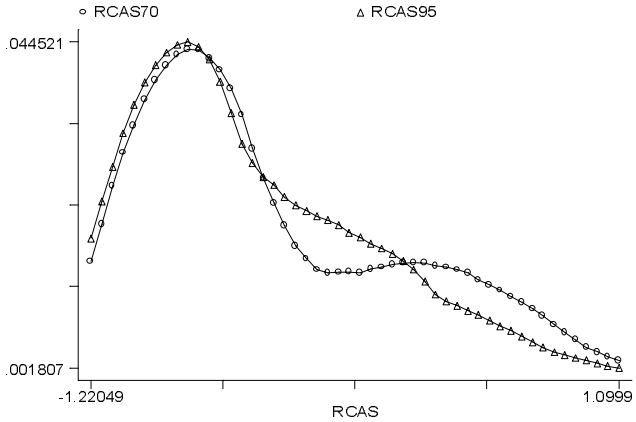
Taiwan



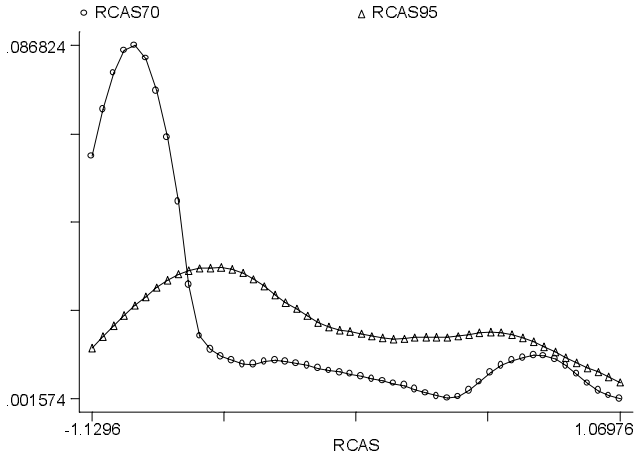
South Korea



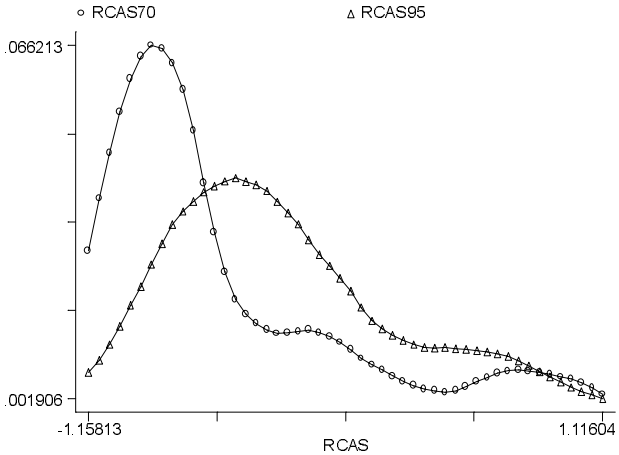
Singapore



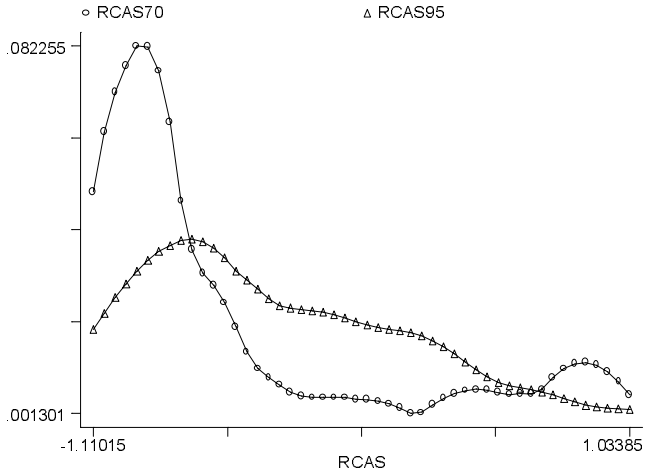
Hong Kong



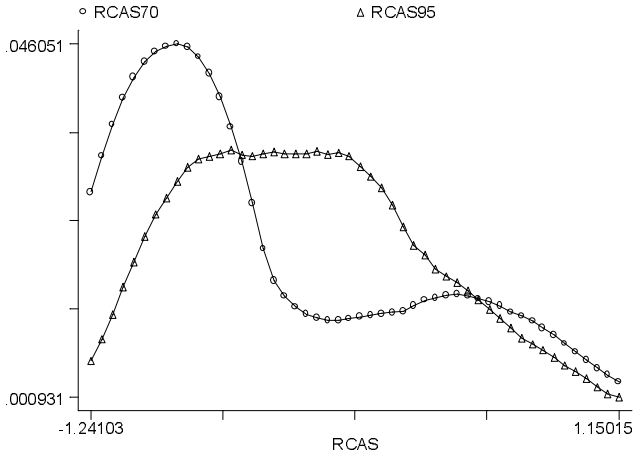
Indonesia



Malaysia

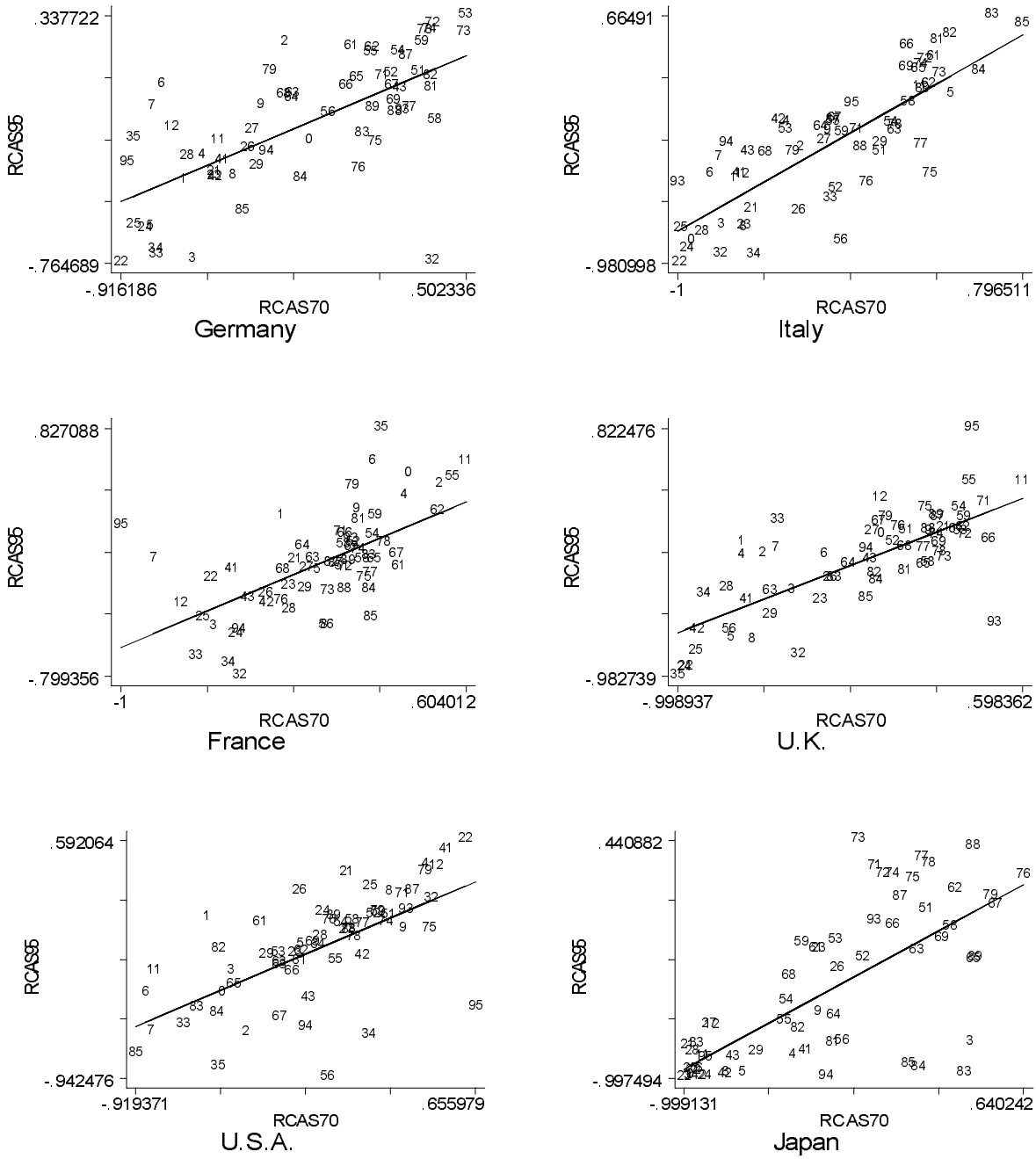


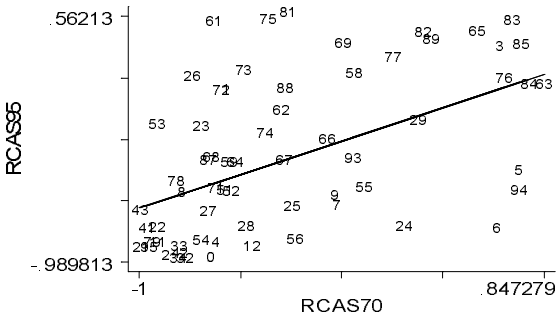

Philippines



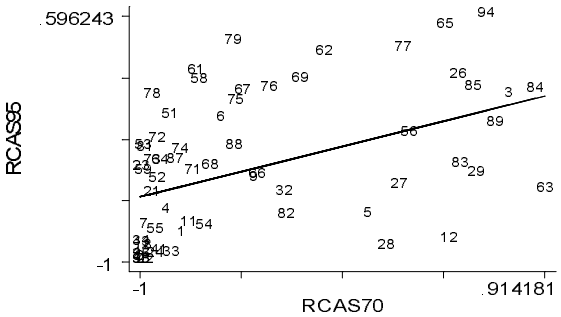

Thailand

**Figure 6 - Scatter diagrams: RCAS95 versus RCAS70**

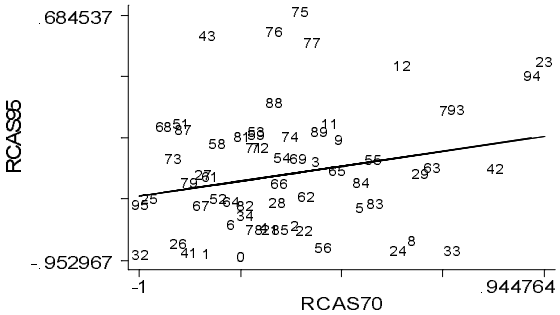




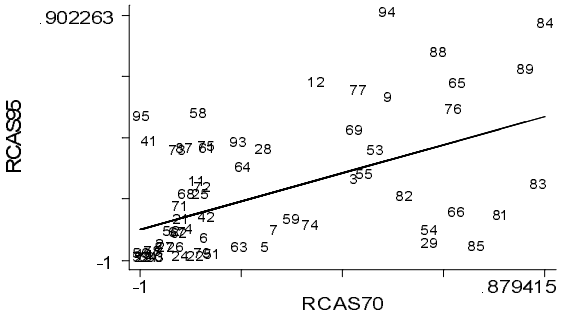
Taiwan



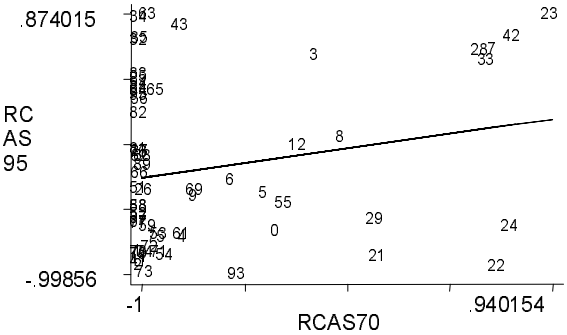
South Korea



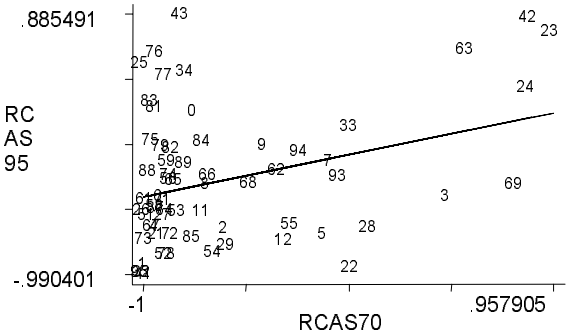
Singapore



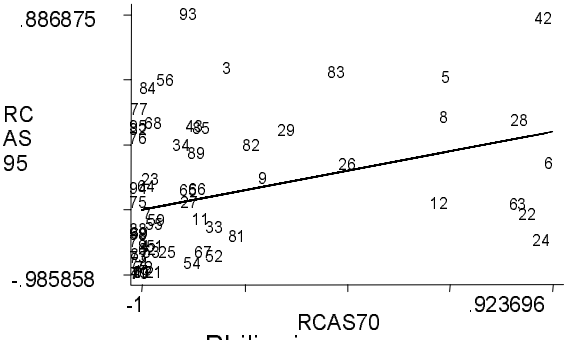
Hong Kong



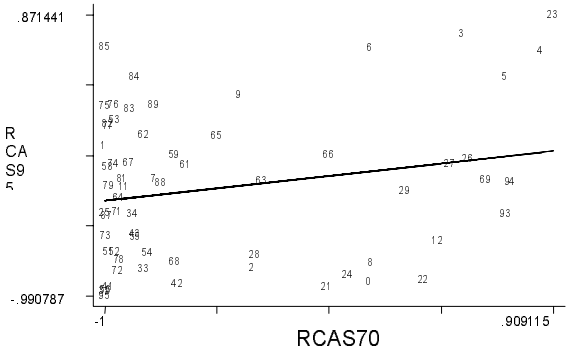
Indonesia



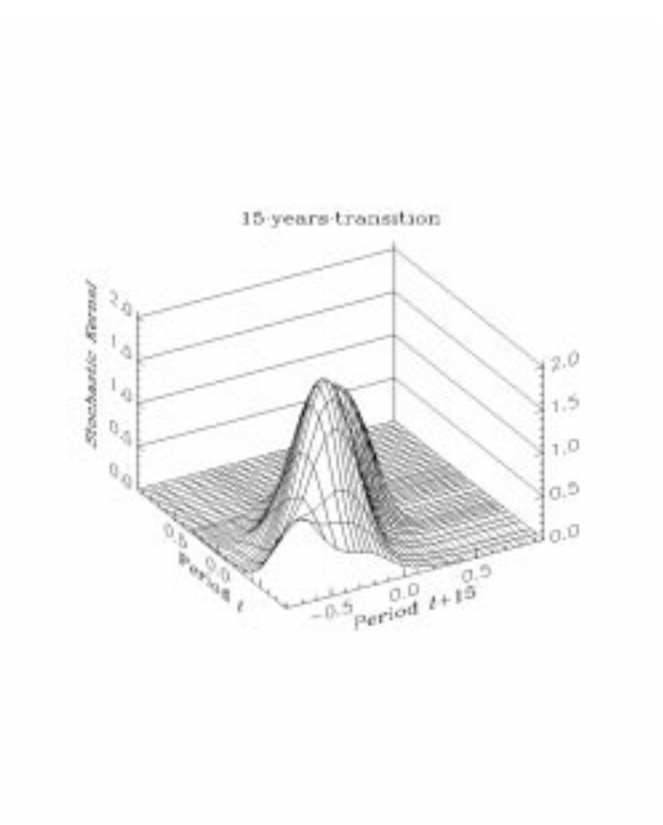
Malaysia

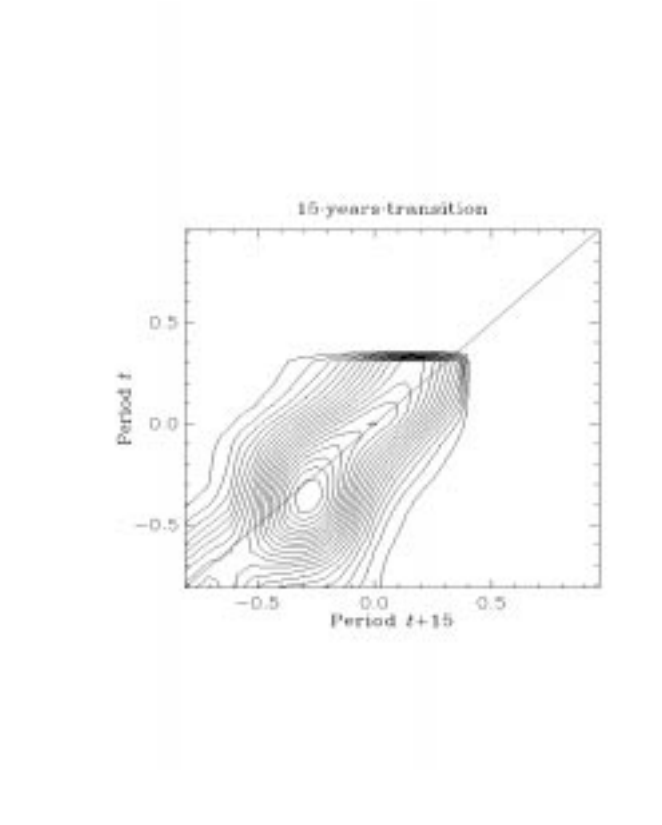


Philippines

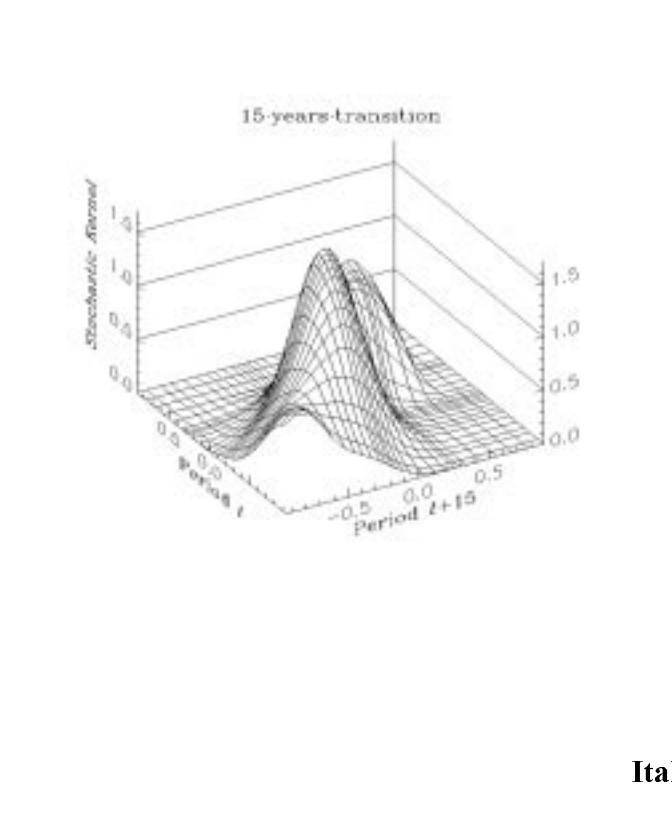


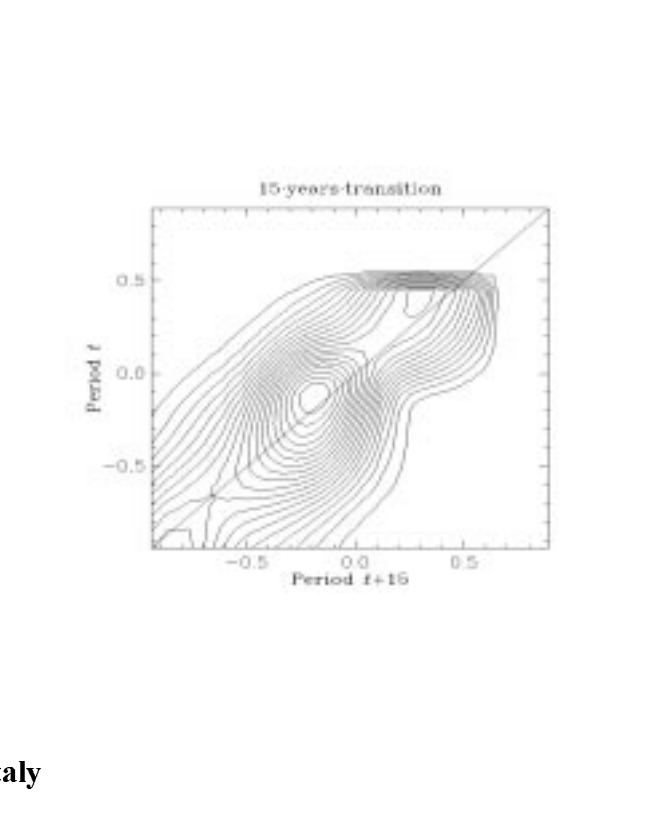
Thailand



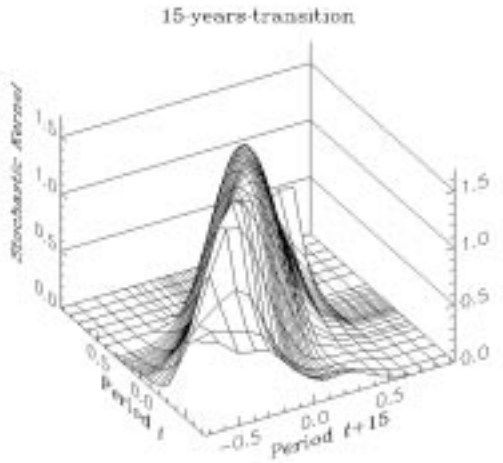




**Germany**




**Italy**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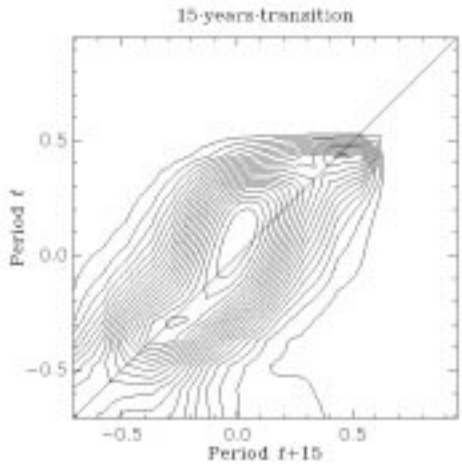
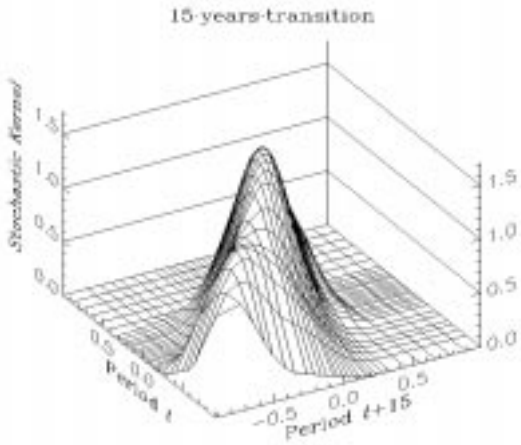
Stochastic Kernel
Period t
Period t+15


15-years-transition
Period t
Period t+15

**France**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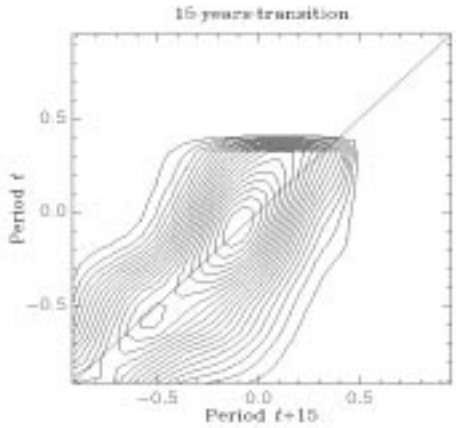
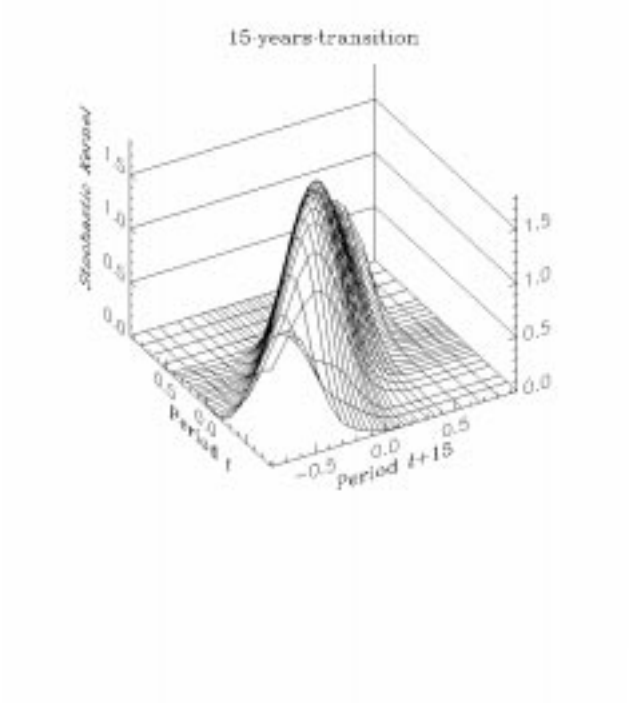
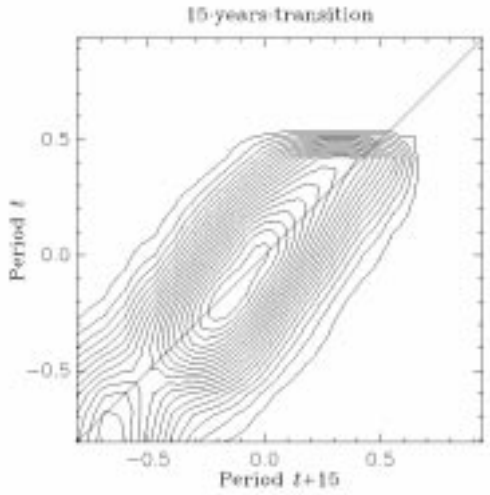
Stochastic Kernel
Period t
Period t+15

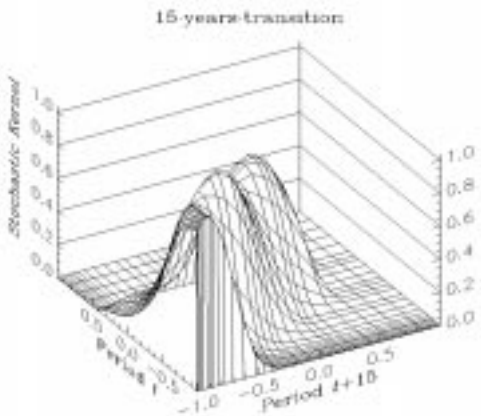

15-years-transition
Period t
Period t+15

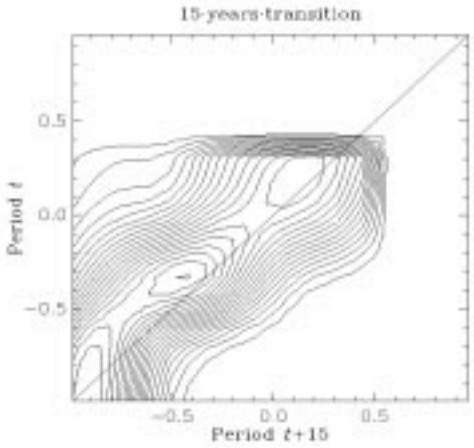
**U.K.**


15-years-transition
Stochastic Kernel
Period t
period t+15

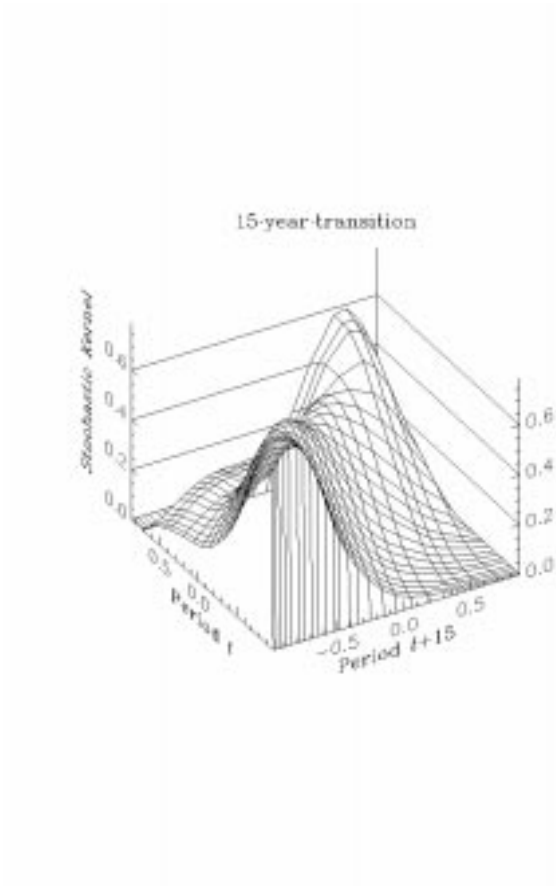

15-years-transition
Period t
Period t+15

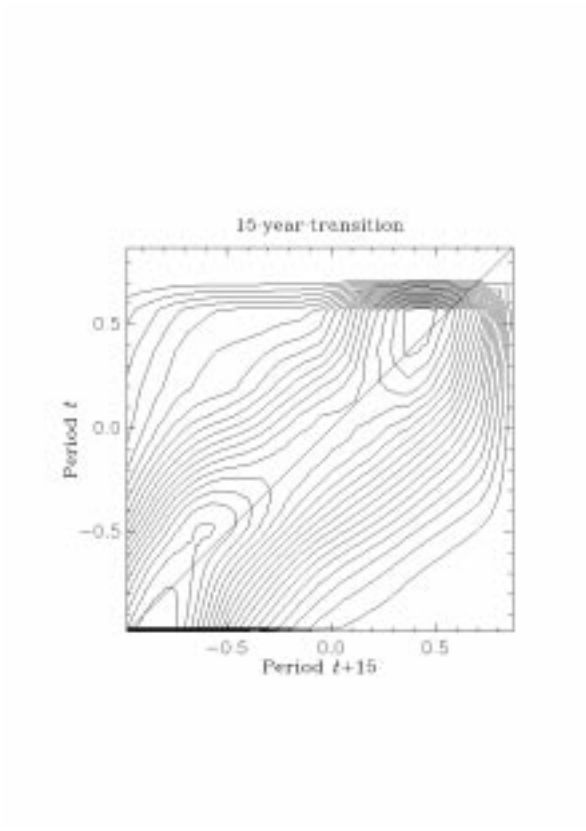
**U.S.A.**


15-years-transition
Stochastic Kernel
Period t
Period t+15

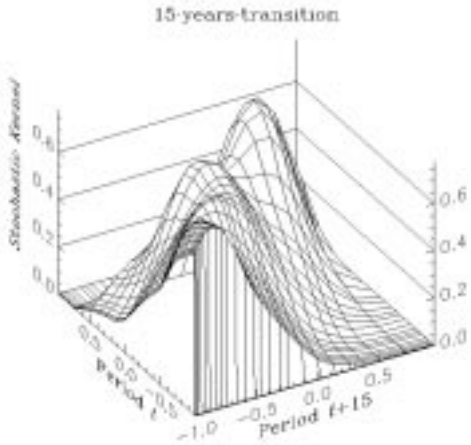

15-years-transition
Period t
Period t+15

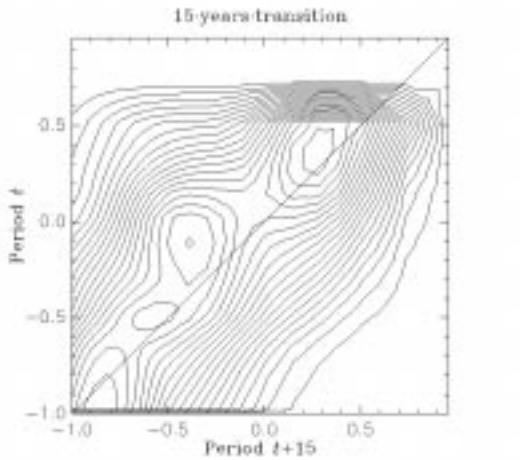
**Japan**



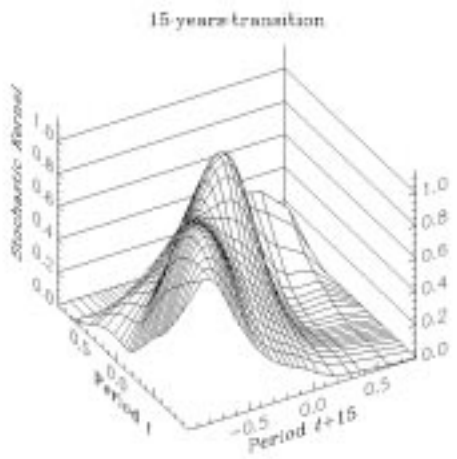



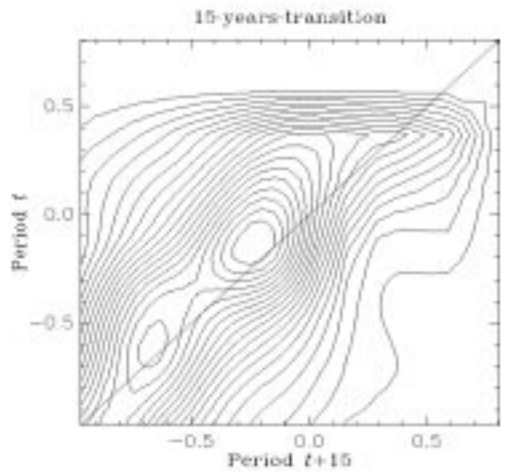

**Taiwan**



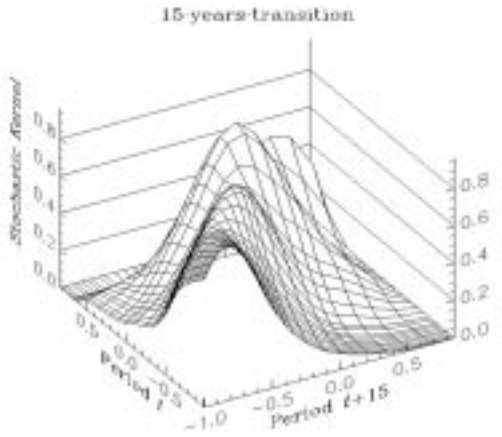



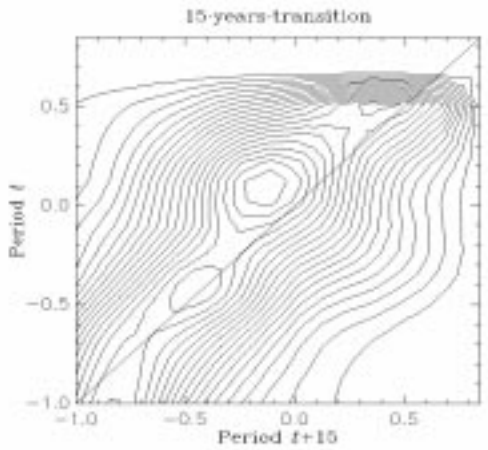

**South Korea**



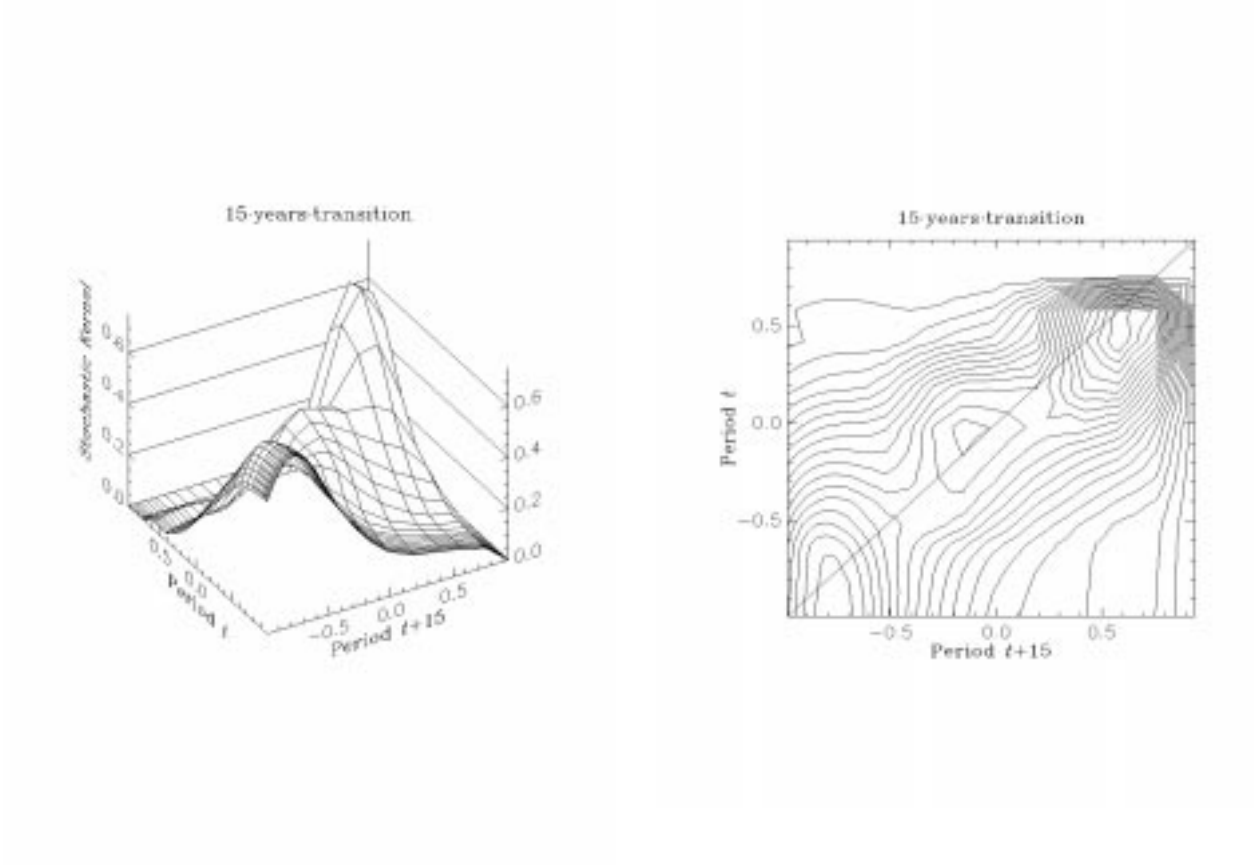




**Singapore**

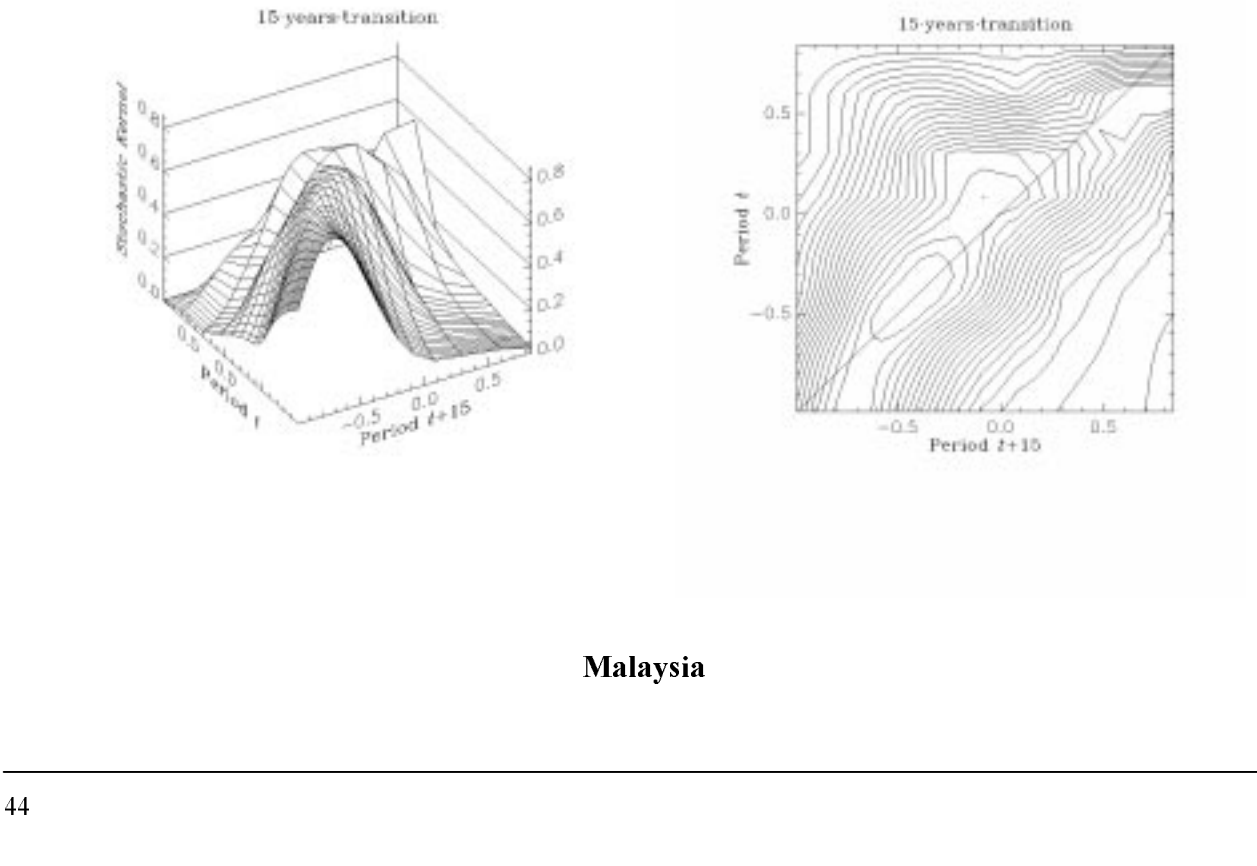


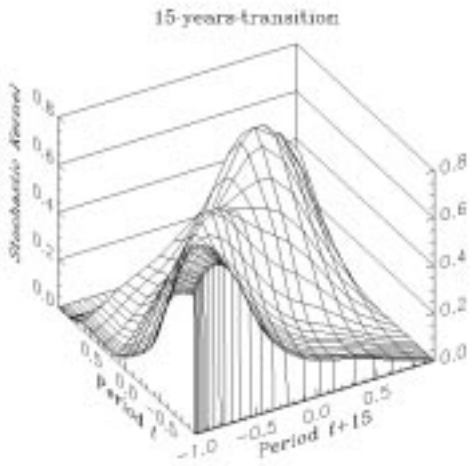

**Hong Kong**

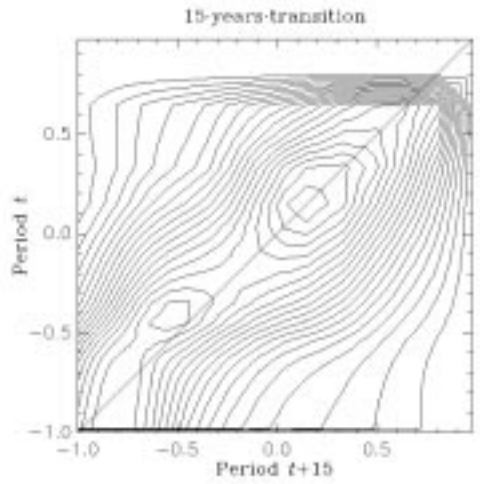



**Indonesia**

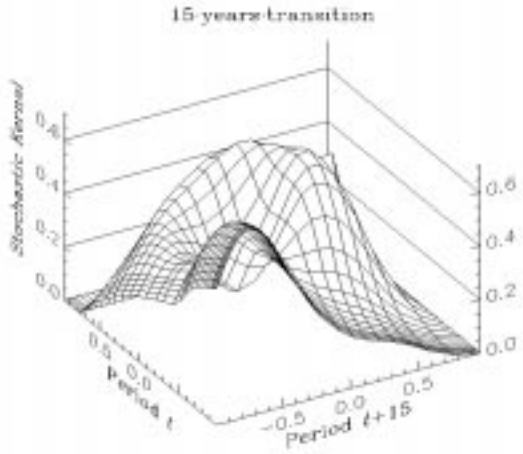


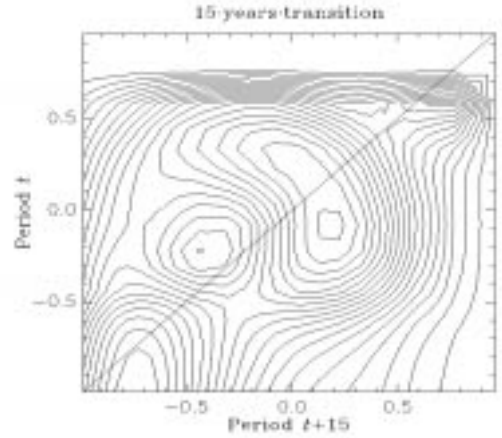

**Malaysia**




**Philippines**




**Thailand**