Transition Probability Matrix, Revealed Comparative Advantage Persistence and the Dutch Disease in a small oil-based economy

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Abstract

This paper evaluates the dynamics and persistence of comparative advantage of a small petroleum-rich economy, Trinidad and Tobago (T&T) as measured by export shares and the Balassa index using 3-digit export data for the period 1991 – 2008. The paper calculates and the examines the Balassa Index to determine how the pattern of trade has changed over the time period using Galtonian Regressions, Markov Chains, Transition Probability Matrices, and Mobility Indices. Furthermore the paper goes on to investigate for the presence of Dutch Disease in Trinidad and Tobago and how the associated symptoms of the Dutch Disease has affected the pattern of trade and revealed comparative advantage. Based on the findings of the paper several policy recommendations are made.

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List of Diagrams

All diagrams were generated by the authors

Section 1.0 - Introduction

Whereas absolute advantage refers to the ability of a party (an individual, or firm, or country) to produce more of a good or service than competitors, using the same amount of resources, comparative advantage refers to the ability of a party to produce a good, product or service at a lower opportunity or marginal cost. David Ricardo outlined the theory of comparative advantage in his book "On the principles of political economy and taxation". He cited costs and technological differences as the source of comparative advantage among nations. Other theories such as the widely accepted Heckscher-Ohlin theory considered factor endowments (land, labor and capital) as the reason for a nation's comparative advantage. Vernon (1966 and 1979) developed a model that attributes comparative advantage in the production of new products to sources that may change over the life cycle of the products. One other theory developed Gary Becker and Theodore Schultz placed emphasis on the concept of human capital.

Whatever the sources of comparative advantage it's role has great importance in guiding international trade and commerce. Comparative advantage is a key concept in explaining sources of trade. Policymakers utilize this concept to determine economic welfare, trade strategies and to direct an economy's trade and investment strategy. This paper will conduct a rigorous analysis on the exports of Trinidad and Tobago over the period 1991 – 2008. The paper will identify the industries that possess a revealed comparative advantage as measured by the widely accepted Balassa Index. Furthermore this study will seek to identify whether the pattern of exports has changed significantly over the period using numerous tools outlined in the literature. Finally an investigation into the presence of the Dutch Disease phenomenon will be explored and associated policy recommendations will be made.

Section 2.0 - Revealed Comparative Advantage

In his seminal 1965 paper "Trade Liberalisation and Revealed Comparative Advantage", Bela Balassa introduced the concept of revealed comparative advantage. Balassa suggested that comparative advantage could be "revealed" by observed trade patterns that reflect differences in factor endowments across nations. Since then, the theory of RCA has been widely used and applied in many studies as a measure of international trade specialization.

Structural changes in economic policies impacts a country's revealed comparative advantage. By employing a more open trade policy stance, many countries can increase their comparative advantage in products and sectors. This is due to new efficiencies in production and adoption of new technologies that developing countries could gain from developed countries.

In their study of revealed comparative advantage in Asian and Latin American markets, Bender and Lui (2001) noted that a number of economies in Latin America underwent economic structural changes that were linked to trade liberalization and new outward looking trade policies. They argued that more efficient trade policies reduced distortions in factor allocations. Using the Lawrence and Beneficial index to measure structural changes in both markets, they concluded that Latin America experienced positive structural change since the 1990's and that "economic structural changes increased the share of export products (sectors) that were dynamic in the world markets." Their improvements in revealed comparative advantage and trade diversification reflected more their governments change in trade and liberalization strategies (which countries such as Mexico, Argentina, Chile and Peru experienced during the 80's and 90's) than changes in factor endowments.

Lutz (1987) argued that the emergence of newly industrialized countries (NIC's) onto the international arena of manufacturing exports was a direct consequence of shifts in comparative advantage in the world economy. This was as a result of production facilities moving from industrialized countries to the newly open NIC's to take advantage in the last stage of the product life cycle of lower wages. The factories will produce for both the export and domestic markets eventually replacing imports within the local market. In the long term these facilities will export to industrialized states. Thus by changing their economic structure, newly industrialized countries can experience a shift in their comparative advantage. Studies on the Asian economies (Kuznets (1984), Kojima (1985), Lo et. al. (1987), Rana (1990), Yamazawa (1990), Fukasaku (1992) and Hobday (1995) have stated that emphasis on trade and foreign direct investment gave these economies great capacity for structural change and allowed them to gain comparative advantage in many markets and develop rapidly.

Kilduff and Chi (2006)[1] stated that in the early stages of development, countries will focus on labor intensive sectors. However, over the course of industrialization and through the transfer of technologies and techniques, specialization in more capital intensive products and processes will emerge. Over time industrialized nations may experience a decline in overall comparative advantage as newly industrialized markets enter the fold. Chow (1990) in his analysis of the Newly Industrialized Nations of South East Asia observed that in order for these economies to survive they must shift their focus and specialization towards skill intensive, technology intensive markets.

[1] Longitudinal patterns of comparative advantage in the textile complex – part : Journal of Fashion Marketing and Management Vol. 10 No. 2, 2006 pp. 134-149 *q* Emerald Group Publishing Limited 1361-2026 DOI 10.1108/13612020610667469

Shifts in revealed comparative advantage can be attributed to increased global demand for a commodity or resource. In a relatively poor economy, demand is limited and its composition does not necessarily correspond to sectors of comparative advantage. The global economy is huge in comparison and at the right prices and costs; demand is, for practical purposes, unlimited. So, once the challenge of identifying industries in which the country can invest in acquiring a comparative advantage is met, growth in exports will not be constrained by demand, and growth in the economy can occur at a rate determined by the savings and investment rates. Much of that investment in the early stages will go to the export sector which can grow at rates high enough to pull the economy along. As seen in Japan, Korea, Singapore and now China, the growth of exports can set in motion a process of sustained growth which is transmitted to the whole economy and could not be achieved by relying on domestic demand alone.

Section 2.1 - Measuring Revealed Comparative Advantage

Historically, measuring comparative advantage has proved to be problematic. This is due to the fact that it is defined in terms of autarkic price relationships that economists and statisticians cannot readily observe (Hoen and Oosterhaven 2004). DeBenedictis and Tamberi (2001) stated that relative autarkic prices are unobservable variables and this hampers the identification of true or shadow comparative advantage. Balassa (1965 pg 100) states that "Comparative advantage appears to be the outcome of a number of factors, some measurable, others not, some easily pinned down, others less so."

Liesner (1958) was the first to use post trade data in order to measure comparative advantage. He was interested in developing a methodology to assess the effects of Britain's entry into the EU. His index was calculated as:

$$LI_a^i = (X_a^i / X_c^i) / (X_d^i / X_c^i) = X_a^i / X_d^i$$

Where: LI_a^i is the comparative advantage in country a in product i,

X_a^i is country a's exports in product i, and

d and e are identified markets.

However, Liesner's work was characterized by a variety of problems. One such problem identified by Liesner himself was the unrealistic assumption that inflationary pressures are the same as far as one country's exports are concerned. In addition, his results regarding the precise

order of product comparative advantage cannot be taken as definite. Thus Leisner was not able to make any firm conclusions with regard to broad sectors of industries.

In his seminal 1965 paper, Balassa argued that the true pattern of comparative advantage can be observed from post-trade data. Specifically he noted that "One wonders, therefore, whether more could not be gained if, instead of enunciating general principles and trying to apply these to explain actual trade flows, one took the observed pattern of trade as a point of departure". RCA measures can be employed to analyze the changing pattern of comparative advantage across commodities (or industries) as a result of a process of accumulation of physical and human capital that characterizes economic development.[2]

To measure comparative advantage Balassa derives an index (hereafter referred to as the RCA Index) that measures a country's comparative advantage. Balassa's RCA index is the first and most widely used RCA measure in the literature (Bojnec 2001, Havrila and Gunawardana 2003). The RCA index tries to identify whether a country has a "revealed" comparative advantage rather than to determine the underlying sources of comparative advantage. The basic logic behind RCA is to evaluate comparative advantage on the basis of a country's specialization in exports relative to some reference group (in most cases total world exports). Balassa's approach, essentially says that the pattern of trade that emerges in free trade will reflect the underlying comparative advantage. [3].

[2] Balassa 1979. "The Changing Pattern of Comparative Advantage in Manufactured Goods". Review of Economics and Statistics Vol. 61, No. 2, 259-66.

[3] Hillman (1980) derives conditions under which comparative advantage in an industry is replicated by the RCA Index. Essentially, as long as an economy does not specialize only in the export of that product or is not a monopolist in world markets, then RCA in an industry signifies comparative advantage. This is known in the literature as the Hillman Condition

The Revealed comparative advantage is an index used for calculating the relative advantage or disadvantage of a certain country in a certain class of goods or services as evidenced by trade flows. Balassa's Index is given by:

$$\mathbf{RCA_{ij} = (X_{ij} / X_{it}) / (X_{nj} / X_{nt})} \qquad \mathbf{(1)}$$

Where:

X = exports

i = country index

j = commodity index

n = set of countries

t = set of commodities.

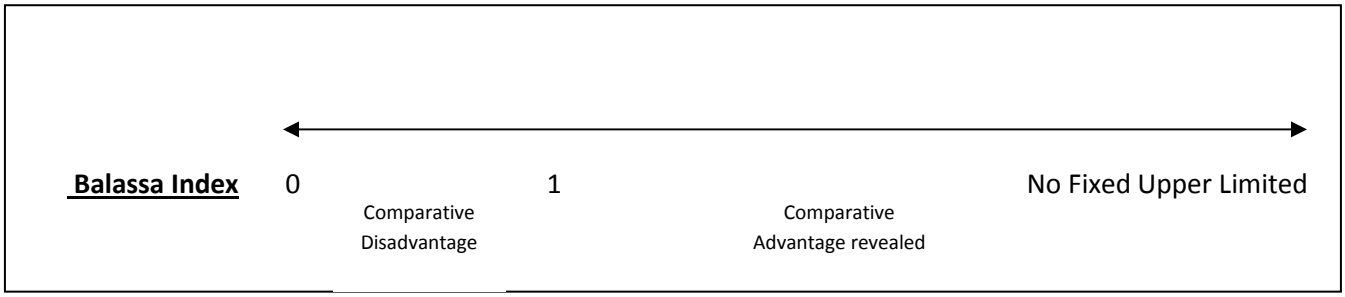
RCA_{ij} >1, indicates that country i has comparative advantage in product j. A value of RCA_{ij} < 1 indicates that country i has comparative disadvantage in commodity j*;* and a value of RCA_{ij} equal to 1 indicates that country i has "neutral" comparative advantage in commodity j.

Ballance, Forstner and Murray (1987) suggested that the RCA index can be interpreted in three ways. Firstly each index provides a demarcation between countries, that reveal a comparative advantage in a particular sector and those countries that do not. This is done by observing that value of the index and using the analysis stated above. Secondly, it quantifies the sector specific degree of comparative advantage enjoyed by one country or set of countries. Thirdly, it allows for possible cross country and cross sector rankings according to their specific values.

De Benedictis and Tamberi (2004) stated that "while a cardinal interpretation of the RCA index values should be considered informative for comparative analysis across countries and across time, a general ordinal analysis, both in space and in time, of the entire RCA Index sectoral distribution, can provide many interesting insights of the comparative advantage of the considered areas."

While Balassa's RCA Index is useful in assessing whether or not a country has comparative advantage in a commodity, its utility in comparative studies is limited and problematic (Hillman 1980, Bowen 1983, 1985, 1986, Ballance et al. 1985, 1986 Deardorff 1994, Hoen and Oosterhaven 2006). The major shortcoming of the RCA index is its asymmetric property. The RCA index has a fixed lower bound of 0 with 1 being the comparative advantage neutral point, while its upper bound in general is not delimited. See diagram below:

Diagram 1: The Range of the Balassa Index



In order to give additional interpretational range to the distribution of the RCA Index, Hinloopen and Marrewijk (2001) have gone further to divide the theoretical range of the RCA Index into four additional classes. These classes outline the strength of a country's comparative advantage rather than state in absolute whether comparative advantage is revealed.

Table 1: The States of Comparative Advantage

Class	Value of Balassa Index	Result
State A	0 – 1	Industries with comparative disadvantage
State B	1 – 2	Industries with weak comparative advantage
State C	2 – 4	Industries with medium comparative advantage
State D	Greater than 4	Industries with strong comparative advantage

Source: Hinloopen and Marrewijk (2001)

The RCA Index in theory can only signify whether or not a country has comparative advantage in a commodity, as its magnitude has neither the ordinal property nor the cardinal property (Hillman 1980, Yeats 1985). Yeats (1985) observed that using the RCA Index to measure a countries' comparative advantage tends to give inconsistent and misleading results, as it has a bias to signify strong comparative advantage for countries with a small market share in the world export market, i.e., small E_i/E ("small" countries) and commodities which comprise only a small market share of the world export market, i.e., small E_j/E ("small" commodities). In another paper, Hoen and Oosterhaven (2006) concluded "that to theoretically derive the distribution of the standard Balassa Index appears to be impossible, because it depends on the number of countries and sectors, while its mean is unstable and larger than the theoretically expected value of 1."

Despite its shortcomings listed above, the Balassa Index continues to be the most widely accepted and widely used measure of international specialization and comparative advantage.

While other proposed indices and measures of RCA have their advantages, they all present their own shortcomings and in some cases presents more problems that those identified by the Balassa Index. Thus the Balassa Index has persevered and continues to be used to this day. Recent studies such as Georgiou (2009) who looked at entrepreneurship and its effect on RCA identified the Balassa Index as the preferred measure of comparative advantage. Bernatonyte (2009) in her study on Intra-Industry Trade in Lithuania identifies the Balassa Index as a dominating measure of export specialization. Grigorovici (2009) who in analyzing specialization in Romania's services sector states noted that the Balassa Index "is the most used for estimating the comparative advantage in the commercial relations between countries." Giorgiou (2010) utilized the Balassa Index to investigate the relationship between debt and comparative advantage. It is in this context that this study labors on with the Balassa Index as the preferred choice for assessing revealed comparative advantage.

Section 3.0 - Statistical Analysis of Trinidad and Tobago's Comparative Advantage

In order to observe the pattern of trade and the persistence of revealed comparative advantage over the period 1991 – 2008 this study will compare the average Balassa scores for the period 1991 – 1993 to the period 2006 – 2008 using various statistical techniques.

Firstly the Balassa Index is calculated using S.I.T.C data at the 3 digit level. The data source is the United Nations Comtrade database.

Table 2 below shows the RCA scores for both periods. The Hillman Condition which is illustrated in equation 2 was applied to all data used in this study. In all cases the Hillman condition was satisfied meaning that the Balassa Index can be used as a sufficient measure of comparative advantage.

$$\mathbf{1 - X^{j}_{i,t} / X^{j}_{t} > X^{j}_{i,t} / X_{i,t} (1 - X_{i,t} / X_{t})} \qquad \mathbf{(2)}$$

Where

$X^{j}_{i,t} / X^{j}_{t}$ = market share i.e. the country's share of exports in a particular sector relative to the total exports in that sector of the group of reference countries

$X^{j}_{i,t} / X_{i,t}$ = degree of export specialization i.e. the share of a country's exports in a particular sector relative to total exports

$X_{i,t} / X_{t}$ = country size i.e. the share of a country's exports relative to total exports of the group of reference countries.

Table 2: Industries in Trinidad and Tobago with RCA Scores >1 (91-93 and 06-08)

Industry	Average 91 -93	Average 06-08
046 - MEAL AND FLOUR OF WHEAT AND FLOUR OF MESLIN		1.57
048 - CEREAL PREPARATIONS AND PREPARATIONS OF FLOUR OR STARCH OF FRUITS OR VEGETABLES	2.68	1.34
059 - FRUIT JUICES (INCL. GRAPE MUST) AND VEGETABLE JUICES, UNFERMENTED AND NOT CONTAINING ADDED SPIRIT, WHETHER OR NOT CONTAINING ADDED SWEETENING MATTER	1.25	1.59

061 SUGARS, MOLASSES, AND HONEY	6.30	
062 SUGAR CONFECTIONERY	1.86	
072 COCOA	2.98	
073 CHOCOLATE AND OTHER FOOD PREPARATIONS CONTAINING COCOA	1.11	
75 SPICES	1.11	
081 FEEDING STUFF FOR ANIMALS	1.21	
091 MARGARINE AND SHORTENING	3.13	1.19
111 NONALCOHOLIC BEVERAGES	5.93	3.78
112 ALCOHOLIC BEVERAGES	1.46	
122 TOBACCO, MANUFACTURED		1.59
278 CRUDE MINERALS		1.08
281 IRON ORE AND CONCENTRATES		4.98
333 PETROLEUM OILS AND OILS FROM BITUMINOUS MINERALS	7.33	1.90
334 PETROLEUM OILS AND OILS FROM BITUMINOUS MINERALS (OTHER THAN CRUDE), AND PRODUCTS THEREFROM CONTAINING 70% (BY WT) OR MORE OF THESE OILS, N.E.S.	16.10	5.49
335 RESIDUAL PETROLEUM PRODUCTS, N.E.S. AND RELATED MATERIALS	3.93	
342 LIQUEFIED PROPANE AND BUTANE	9.97	12.71
343 NATURAL GAS, WHETHER OR NOT LIQUEFIED		22.38
344 PETROLEUM GASES AND OTHER GASEOUS HYDROCARBONS	6.28	17.85
512 ALCOHOLS, PHENOLS, PHENOL-ALCOHOLS AND THEIR HALOGENATED, SULFONATED, NITRATED OR NITROSATED DERIVATIVES	11.17	24.14
522 INORGANIC CHEMICAL ELEMENTS, OXIDES AND HALOGEN SALTS	27.14	26.13
554 SOAP, CLEANSING AND POLISHING PREPARATIONS	2.56	
562 FERTILIZERS	10.99	5.28
582 PLATES, SHEETS, FILM, FOIL AND STRIP OF PLASTICS		1.17
635 WOOD MANUFACTURES	1.02	
642 PAPER AND PAPERBOARD, CUT TO SIZE OR SHAPE, AND ARTICLES OF PAPER OR PAPERBOARD	1.61	1.12
661 LIME, CEMENT, AND FABRICATED CONSTRUCTION MATERIALS, EXCEPT GLASS AND CLAY MATERIALS	3.54	
665 GLASSWARE	2.02	
671 PIG IRON AND SPIEGELEISEN, SPONGE IRON, IRON OR STEEL GRANULES AND POWDERS AND FERROALLOYS	6.28	6.47

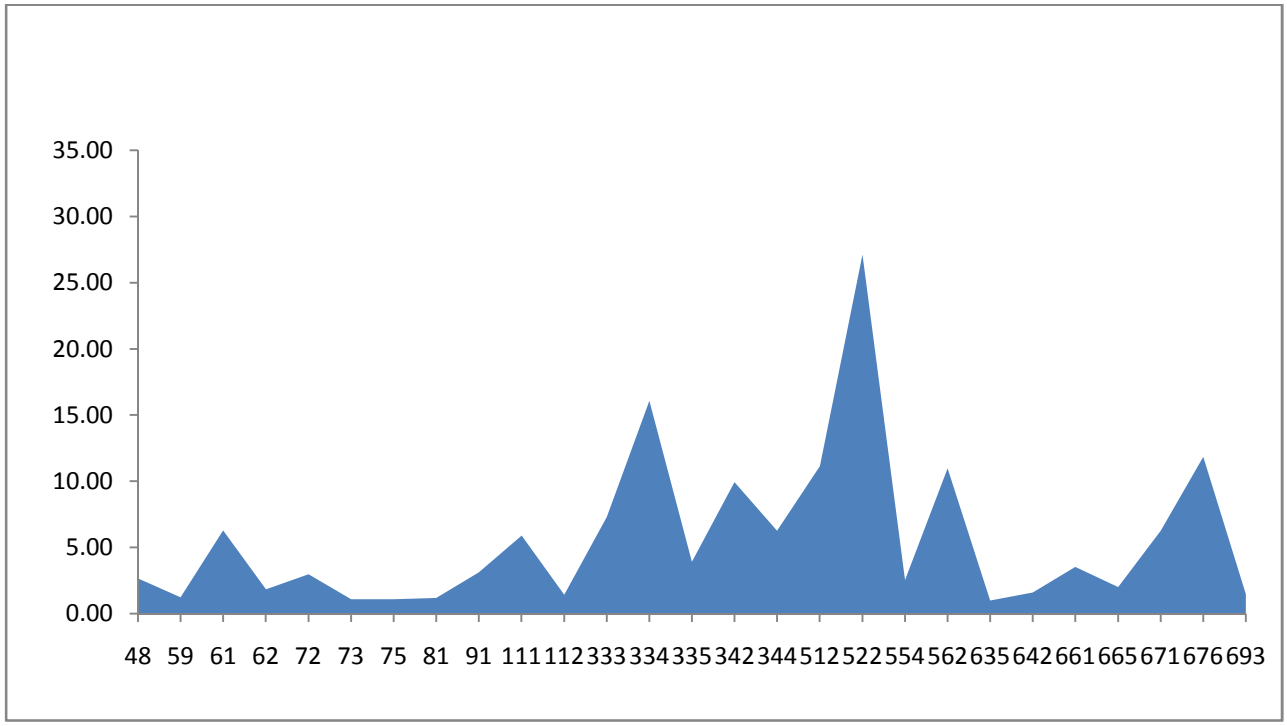
676 IRON AND STEEL BARS, RODS, ANGLES, SHAPES AND SECTIONS, INCLUDING SHEET PILING	**11.88**	**2.59**
693 WIRE PRODUCTS (EXCLUDING INSULATED ELECTRICAL WIRING) AND FENCING GRILLS	**1.50**	
Total	***27***	***20***

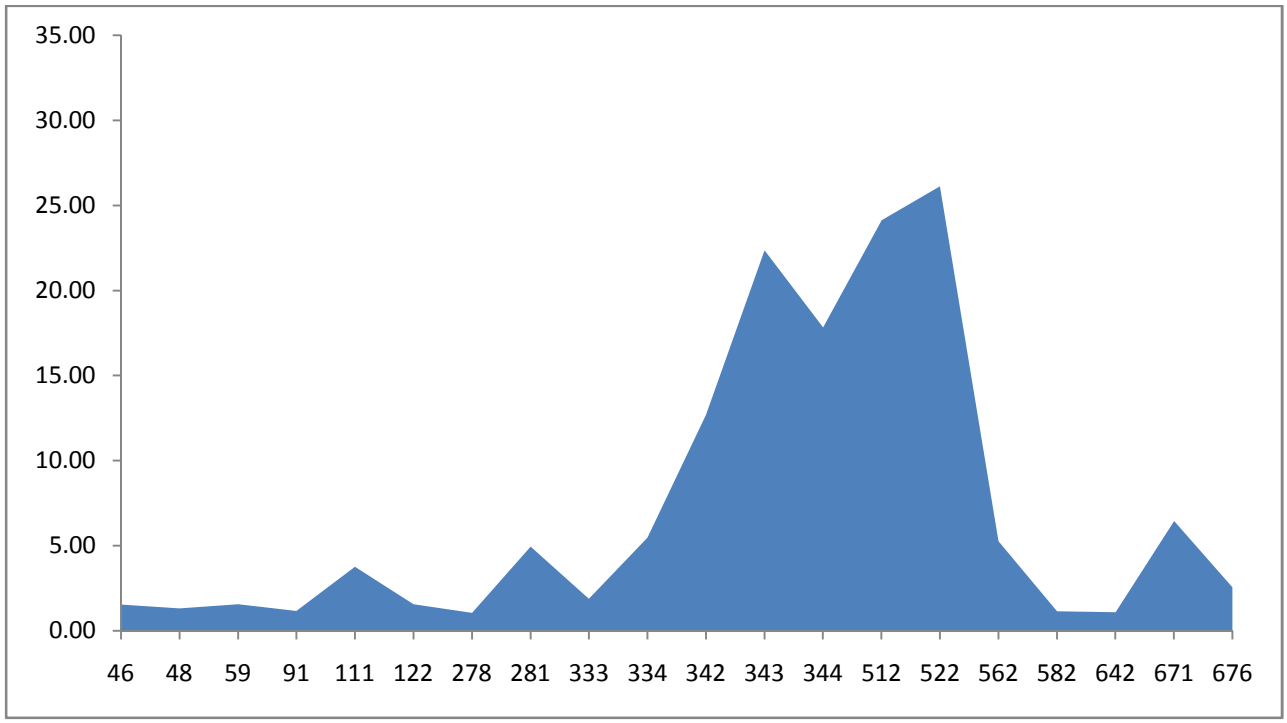
Based on the calculations it can be seen for 1991 - 1993, Trinidad and Tobago had a revealed comparative advantage in 27 industry categories. However for 2006 - 2008, this fell to 20 of Trinidad and Tobago's industry categories had a comparative advantage. The fact that fewer industries possessed a comparative advantage in the second period would suggest a degree of polarization of the pattern of RCA in the Trinidad and Tobago economy.

A visual inspection of the plots of the RCA scores for both periods would give us further clues as to the degree of persistence of comparative advantage in Trinidad and Tobago exports as industries with RCA scores greater than one in one period should demonstrate the same high scores for the second period. Inspection of the diagram suggests that there appears to be a change in pattern of RCA over the two time periods as both the energy and petrochemical sectors[4] have increased their comparative advantage scores while areas of weaker comparative advantage have disappeared. Therefore it would seem to suggest that Trinidad and Tobago has become more specialized in its trading patterns.

[4] SITC 3 – Oil and Gas, SITC 5 – Petrochemicals.

Diagram 2: Average RCA Scores 91 – 93 vs Average RCA Scores 06-08





Section 3.1 - Cumulative Distribution Function (CDF)

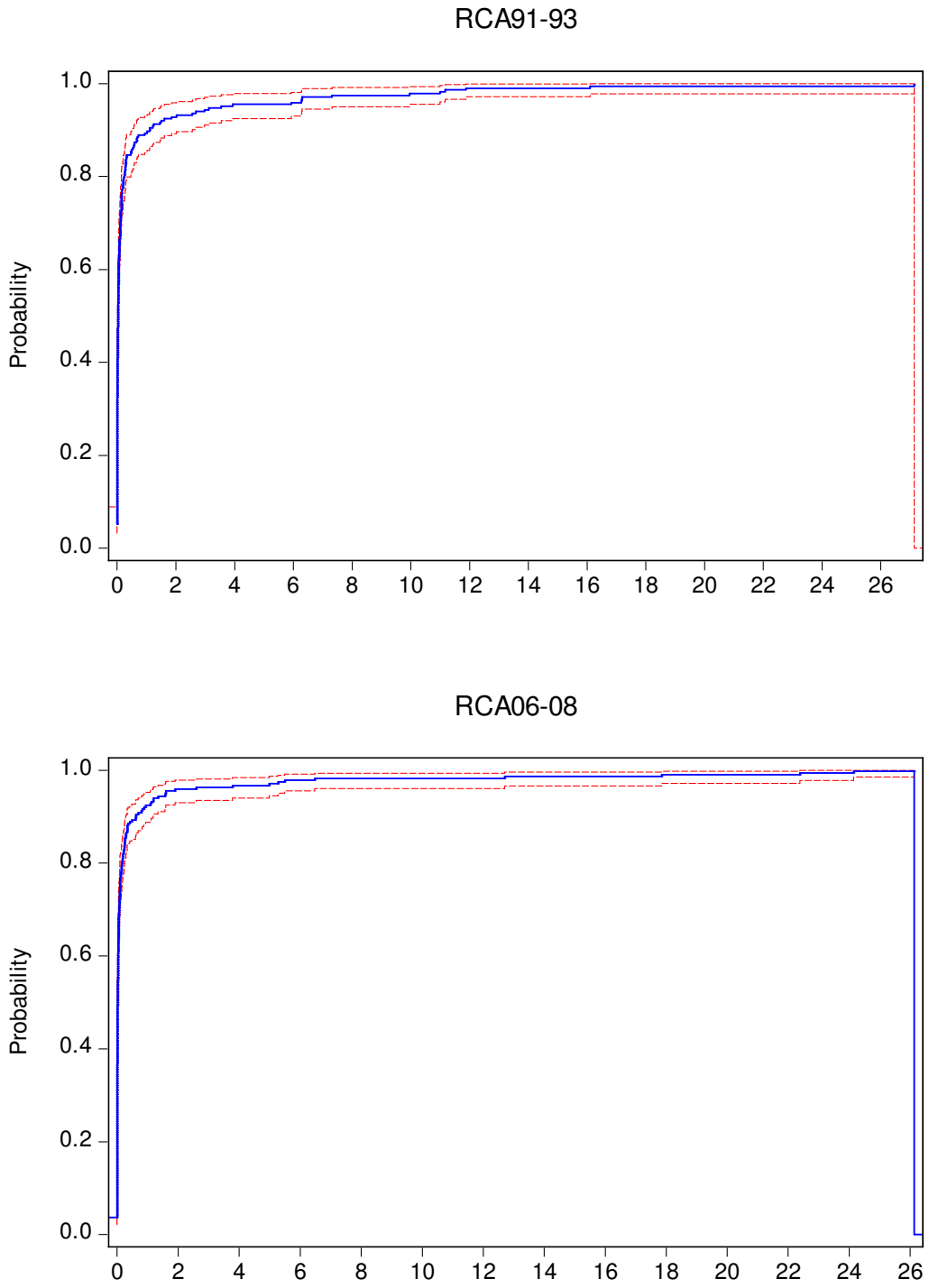
The CDF completely describes the probability distribution of a real-valued random variable, in this case RCA. It plots the probability of not observing a value from the data which does not exceed a specific value.

For every real number *x*, the CDF of a real-valued random variable *X* is given by

$$x \mapsto F_X(x) = \mathrm{P}(X \leq x),$$

Here the right-hand side of the equation represents the probability that the random variable X takes on a value less than or equal to x. The probability that X lies in the interval [a, b] is therefore FX(b) − FX(a) if a < b. For the case of RCA the CDF will analyze the probability that a distribution will have a score over one thus indicating that the country has a revealed comparative advantage in a product category. In looking at the Balassa scores we have already identified that each year only has a small number of product categories that possess scores of one or greater (less than 10% in both periods). Therefore the CDF plots are expected to support these results. The CDF Plots for the RCA distribution for the two periods are shown below:

Diagram 3: Cumulative Distribution Functions for 91-93 and 06-08



An analysis of the two cumulative distribution function plots above show that the majority of product categories have a very high probability of having an RCA score equal or closer to zero.

Based on the results in calculating the Balassa Index, it is seen that over 90% of product categories for both periods have a comparative disadvantage i.e. scores less than one.

In addition the CDF plots tell us that the distributions are asymmetrical which would indicate that the mean of the distributions are not an appropriate measure of its statistical properties.

We can now take a closer look at the statistical attributes of the RCA scores for both periods

Table 3: The Statistical Properties of the three distributions

	RCA91_93	RCA06_08
Mean	0.665046	0.628195
Median	0.028490	0.015216
Maximum	27.13540	26.12518
Minimum	0.000000	0.000000
Std. Dev.	2.549074	3.007380
Skewness	6.552863	6.795862
Kurtosis	55.78771	51.00832
Jarque-Bera	31678.49	26658.75
Probability	0.000000	0.000000
Sum	170.9167	161.4461
Sum Sq. Dev.	1663.432	2315.350
Observations	257	257

For the period 91-93 to 06-08 the mean values of the RCA moved from 0.66 to 0.62.

Chew (1990) as well de Benedictis and Tamberi argued that the mean is not a strong indicator of the distribution of an index when it is characterized by a high degree of skewness (in this case 6.55 and 6.79 for 91-93 and 06-08 respectively). This is consistent with the empirical observations from the CDF plots. This high degree of skewness gives the arithmetic mean little meaning as mentioned by Chew 1990 pg 125 - "Note that the arithmetic mean is a very poor synthetic indicator in cases where the underlying distribution is characterized by a pronounced skewness."

This would give rise to the question of what should be used as a better indicator of distribution.

Chew stated in this case the median values would function as a stronger indicator of distribution as it is not influenced by extreme values. Hosein (2008, pg 141) stated that "some sectors having a BI above unity means that at least one other sector would have a Balassa score below unity, so that there is no statistical sense in saying that the mean of the Balassa Index is greater than or less than one." De Benedictis and Tamberi (2004, pg 334) stated "in contrast the median values have an immediate interpretation in that a high median value implies that an economy has a large number of its industries with comparative advantage whilst an economy with a low median value is one which has a high degree of comparative disadvantage." Hinloopen (2004, pg 15) noted also that "the mean is a poor indicator for the statistical properties of the distribution and it is better to focus on the distribution of the percentiles"

An examination of the median values for the two periods indicates that they are very close to zero (0.028 in 91-93 and 0.015 in 06-08). The conclusion being that half of the 257 industry categories have a score less than 0.028 in 91-93 and 0.015 in 06-08, thus supporting the results that a vast majority of sectors have a comparative disadvantage. This also reaffirms what the CDF plots shows in that both distributions are asymmetrical.

The Jarque-Bera (JB) test can be used to test for normality in the distributions. The Jarque Bera test measures the difference between skewness and kurtosis of a distribution from the normal distribution. The JB indicates that both distributions are not normally distributed. Based on an analysis of the statistical attributes of both periods, it can be concluded that both distributions are

abnormally distributed and skewed to the right. They also indicate a greater degree of polarization in export specialization in Trinidad and Tobago.

The next step in the analysis is to compare both distributions to see if the pattern of revealed comparative advantage has changed significantly between both periods. This paper utilizes a number of tools to explore the evolution of comparative advantage between the two time periods.

Section 3.2 - Galtonian Regression

One such tool in econometric analysis that is available to observe the structural changes in trade specialization is the Galtonian Regression. This technique was originated by Galton (1889) and utilized by Hart and Praise (1956) to analyze business concentration. Subsequent to this, the Galtonian regression has been used in a variety of areas such as Cantwell (1989)[5], Hart (1976)[6] and Hart (1995)[7]. More importantly researchers such as Frantzen (2008), Laursen (1998), Sharma and Dietrich (2007), Worz (2005) and Hosein (2008) have used it to help analyze changes in trade specialization patterns using RCA indices. In the same vein this study uses Galtonian regressions to determine whether the T&T economy has become more or less specialized in each of the three digit industry categories. This simple OLS method allows us to compare two cross-sections at two different points of time, and tells us how much change in the structure of trade specialization in a given country is made between the periods of interest.

A Galtonian regression takes the form:

$$\mathbf{RCA_{t2} = \alpha_o + \beta_1 RCA_{t1} + e_1} \qquad \mathbf{(3)}$$

[5] To examine technological specialization patterns
[6] To examine changes in income distribution
[7] To examine convergence of productivity levels over time

With RCA_{t2} being the Balassa scores for time period 06-08 and RCA_{t1} being Balassa scores for time period 91-93.

The value of the β coefficient can be interpreted as follows:

- $\beta = 1$: there is no change in the degree of specialization between the two time periods.
- $\beta > 1$: the economy has become more specialized in its area of comparative advantage and less specialized in product categories in which it carried a low level of specialization.
- $0 < \beta < 1$: product categories with initially high values of RCA experience a decline between the listed time periods whilst those with initially low scores experience growth over time and so overall a β score in this range indicates that the specialization pattern has not changed.
- If $\beta < 0$, it means that there is a sharp reversal in comparative advantage.

Let $\lambda = 1 - \beta$

The size of variable λ measures the regression effect. A low value of λ (i.e. for high values of β) there is a concentration of the pattern of specialization. A high value of λ indicates a significant change in the pattern of revealed comparative advantage.

The Galtonian regression was run with RCA06-08 as the dependent variable and RCA91-93 as the independent regressor. The results of the Galtonian regression are shown in table 4 below

Table 4: Galtonian Regression Results (Dependent Variable RCA 06-08)

Variable	Coefficient	Std. Error	t-Statistic	Prob.
RCA91_93	1.238186	0.051994	16.12086	0.0000
C	0.070763	0.136723	0.517567	0.6052

R-squared	0.504741	Mean dependent var	0.628195
Adjusted R-squared	0.502799	S.D. dependent var	3.007380
S.E. of regression	2.120578	Akaike info criterion	4.349007
Sum squared resid	1146.697	Schwarz criterion	4.376626
Log likelihood	-556.8473	Hannan-Quinn criter.	4.360114
F-statistic	259.8823	Durbin-Watson stat	1.232204
Prob(F-statistic)	0.000000		

The estimated value of β is 1.23 and this indicates that overall the T&T economy has become more specialized i.e. the pattern of specialization has widened. The magnitude of the regression which is calculated to be 0.23 indicates a concentration in the pattern of specialization. This conclusion is supported by the fact that for the period 91-93 the Trinidad and Tobago economy had a comparative advantage in twenty seven (27) industry categories and for 06-08 this fell to twenty (20).

Of necessity this paper raises and answers the question of whether the regression coefficient (1.23) is significantly different from 1.

Table 5: Wald Test (Null Hypothesis: β = 1)

Test Statistic	Value	df	Probability
F-statistic	6.267875	(1, 255)	0.0052
Chi-square	6.267875	1	0.0048

Using a Wald test is was found that $\beta \neq 1$. This supports the earlier conclusions that the economy has become more specialized.

Section 3.3 - Transition Probability Matrix

In looking at how the pattern of comparative advantage has evolved over time one can utilize Markov Chains and Transition Probability Matrices. A Markov Chain may be simply defined as a sequence of random values whose probability values at time period t hinges on the value of the number in the time interval t-1. The overall controlling factor in a Markov Chain is the transition probability. A transition probability matrix is defined as a square array of non negative numbers such that the rows tally to unity and represent a discrete Markov chain.

Proudman and Redding (2000), Brasili et al. (2000) and Hinloopen and van Marrewijk (2001), all employed transition probability matrices to identify the persistence and mobility of revealed comparative advantage as measured by the Balassa Index.

The estimated transition probability matrix for the two time periods are shown in table 6 below:

Table 6: Transition Probability Matrix (91-93 to 06-08)

		To			
		a	b	c	d
From	a	0.974	0.017	0.000	0.009
	b	0.778	0.222	0.000	0.000
	c	0.714	0.286	0.000	0.000
	d	0.091	0.091	0.182	0.636

In interpreting the results of the transition probability matrix we can see that the first diagonal element of 0.974 indicates that there is a high degree of persistence amongst the comparative disadvantage class. In other words a commodity with a comparative disadvantage in one time

period (class a) is likely not to change in the second period. The other diagonal elements are 0.222, 0.000 and 0.636 respectively. The relatively high values of the elements along the leading diagonal point to some degree of persistence. The matrix suggests that the areas of no comparative advantage and strong comparative advantage experience a high degree of persistence as the probability that they change is very low. However, the areas of weak (class A) and moderate comparative advantage (class B) have a very high probability of moving towards no comparative advantage.

A further block of detail in the changing pattern of specialization is now undertaken using mobility indices.

Section 3.4 - Indices of Mobility

Proudman and Redding (1998, p24) proposed to utilize mobility indices to observe the changing specialization patterns in a country's exports. These mobility indices attempts to reduce information about mobility from the transition probability matrices into one single statistic. For the purposes of this paper we will outline and calculate three indices. Each of these indices places emphasis on different aspects of the transition probability matrices.

Shorrocks (1978) proposed an index of mobility that evaluates the trade (tr) of the transition probability matrix. This index captures the relative magnitude of both diagonal and off-diagonal elements of the transition probability matrix and can also be shown to equal the amount of the harmonic mean of the expected duration of remaining in a given cell. The Shorrock's Index is calculated using the formula

$$M_1 = K\text{-}tr(P)/K\text{-}1 \quad (4)$$

Where K is number of classes and tr(P) is the trace of the transition probability matrix (the sum of the diagonal elements). The Shorrock's Index is interpreted in that a higher value of the index indicates greater mobility, with a value of zero indicating perfect immobility.

Bartholomew (1973) introduced an index that presented information on the average number of class boundaries crossed by an individual originally in state k weighted by the corresponding proportions π_k of the ergodic distribution. Hinloopen van Marrewijk (2000) went on to state that M_2 uses these as weights to calculate an extended version of M_1 while simultaneously "penalizing" large movements.

$$M_2 = \Sigma_k \pi_k \Sigma_l p_{kl} \left| k\text{-}1 \right| \quad (5)$$

Where p is the transition probability matrix and π_k is its ergodic distribution

Shorrocks (1978) also proposed a second mobility index referred to as M_3 . This index analyses the determinant of the matrix. The product of the eigenvalues of the transition probability matrix is equal to the determinant. M3 is calculated as:

$$M_3 = 1 - \det(P) \quad (6)$$

Finally Sommers and Conlisk (1979) proposed their own index (M_4) which is based on the eigenvalues of the matrix. Hinloopen van Marrewijk (2000 p16) stated that "Since P is a transition probability matrix there is always one eigenvalue equal to 1 and the modulus of the other eigenvalues is bounded from above by 1. Convergence to the ergodic distribution occurs at

a geometric rate given by powers of the eigenvalues. The smaller the modulus of an eigenvalue, the faster its corresponding component converges. Moreover, the dominant that is the slowest, convergence term is given by the second largest eigenvalue."

$$\mathbf{M_4 = 1 - \lambda_2} \qquad \mathbf{(7)}$$

Where λ_2 is the second largest eigenvalue of *P*

Fields and Ok (1999) note that there has been no consensus view in the literature that indicate which is the best index to use. For the purposes of this paper M_1 and M_4 will be utilized as they both focus on different aspects of the transition probability matrix (M_1 analyses the trace of the matrix and M_4 looks at the eigenvalues).

The value of the two indices for the two periods is shown in the **table** below:

Table 7: Mobility Indices for 91 – 93 to 06-08

From	M_1	M_4
91-93 to 06-08	0.722	0.379

The values of M_1 show that there is a high degree of mobility from 91-93 to 06-08. The results for M_4 show the same effect. This indicates that there has been a change in the overall specialization pattern of RCA over the period 91-93 to 06-08. The values of the indices (which quantify the results of the transition probability matrix) as well as the number of product categories with an RCA score > 1 all reinforce each other.

Section 4.0 - Exploring the presence of Dutch Disease in Trinidad and Tobago

The term Dutch Disease was first coined to describe the decline of the manufacturing sector in the Netherlands and the rise in unemployment that accompanied it following the discovery of natural gas in the 1960s. It is broadly understood to denote the harmful economic consequences that may arise in certain conditions from a sudden increase in a country's wealth, following, for example, a natural resource discovery, a surge in export commodity prices or any other positive exogenous shock generating large foreign exchange inflows (OECD 2006). Dutch Disease is characterized by an increase in the real effective exchange rate due to the increase in the country's total exports and demand for currency. This appreciation would effectively squeeze out manufacturing exports as they become more expensive in international markets.

In order to make a stronger assessment of the effects and presence of Dutch Disease phenomenon in Trinidad and Tobago, this study undertakes a comprehensive analysis of Trinidad and Tobago's revealed comparative advantage industries as it relates to factors such as oil prices and the real effective exchange rate, which would indicate the presence of the phenomenon.

During the period 2000 – 2006 Trinidad and Tobago went through a second oil boom due to a combination of a new discoveries as well as large increases in global oil prices. **Diagram 4** below illustrates the relationship between the Real Oil Prices and the REER for 1991 – 2008. The plot shows that as real oil prices increase there is a corresponding increase in the REER as Trinidad and Tobago began to export more oil and gas to international markets

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Diagram 4: REER vs. Real Oil Prices (1991 – 2008)

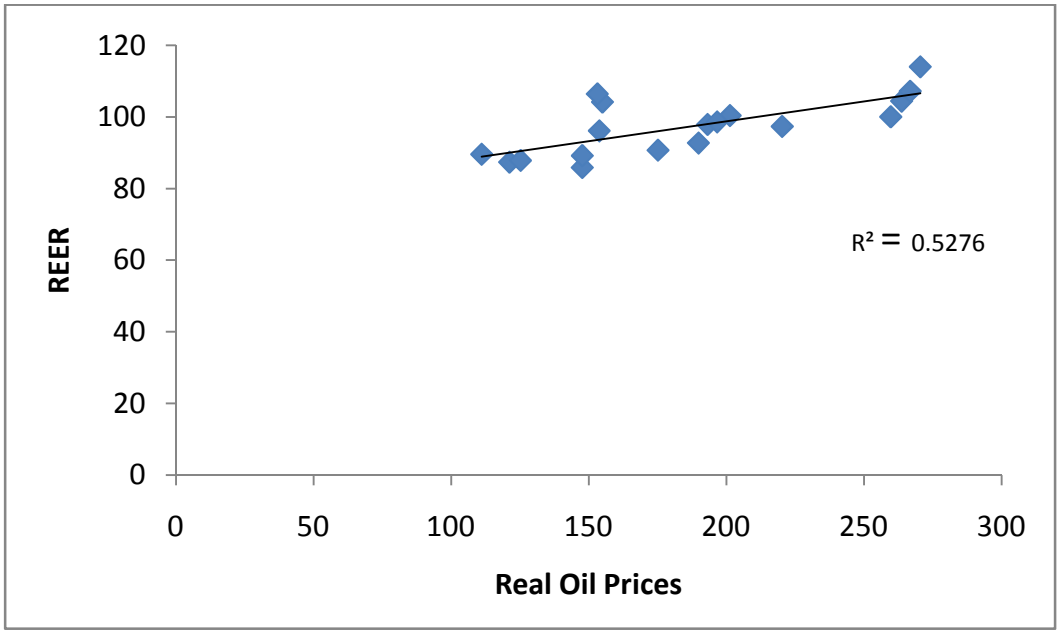
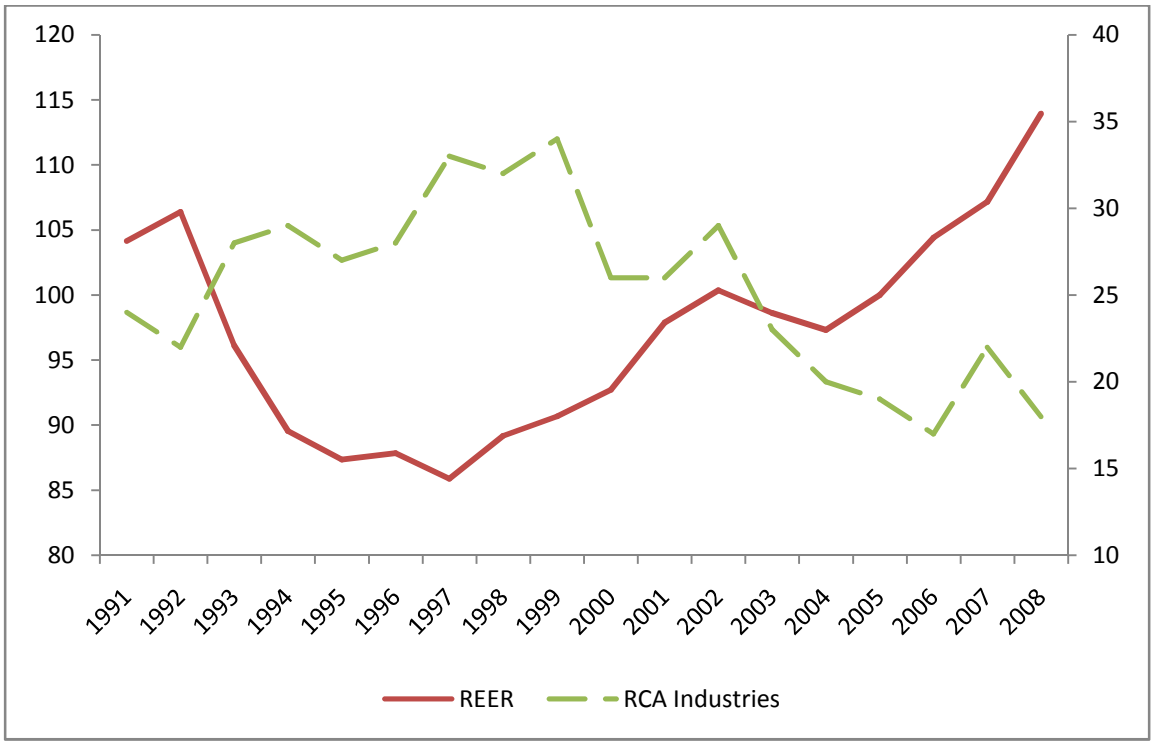


Diagram 5 illustrates the number of industry categories that have a RCA (as defined by a Balassa Index score of one or greater) against the real effective exchange rate (REER) in order to determine if there is a relationship between the number of sectors with RCA and the REER in Trinidad and Tobago.

Diagram 5: REER vs. Index of Real Oil Prices vs. Number of Products with RCA>1 (1991 – 2008)



There appears to be an inverse relationship between the increase in the REER and the number of products categories with a revealed comparative advantage in Trinidad and Tobago. This suggests that as petroleum exports increased there has been a squeezing out of the comparative advantage of other non-energy sectors. This provides strong evidence as to the presence of Dutch Disease.

In order to investigate trade mobility this study went on to calculate a mobility index from 1991 to all subsequent years in order to get a clear picture about how the structure of Trinidad and Tobago trade has changed. For the purposes of this study the mobility index M_4 as defined above was used due to its popularity in the literature.[8] The results are shown in the **table** below:

[8] Studies such as Buchinsky and Fields (2003), Shahar (2008) utilized M4.

Table 8: Mobility Indices from 1991 – 2008

Period	M4
91 - 92	0.167
91 - 93	0.010
91 - 94	0.182
91 - 95	0.021
91 - 96	0.065
91 - 97	0.196
91 - 98	0.032
91 - 99	0.073
91 - 00	0.069
91 - 01	0.135
91 - 02	0.179
91 - 03	0.183
91 - 04	0.188
91 - 05	0.188
91 - 06	0.280
91 - 07	0.287
91 - 08	0.377

Diagrams 6 and 7 below inspect the export share of major exports in the non-energy sector against the REER. Diagram 6 plots the share of agriculture sector (SITC 0 and 1) against the REER while diagram 7 reveals the relationship between the share of manufacturing sector exports (SITC 7 and 8) and the REER.

Diagram 6: Share of Agriculture Exports vs. REER (91-08)

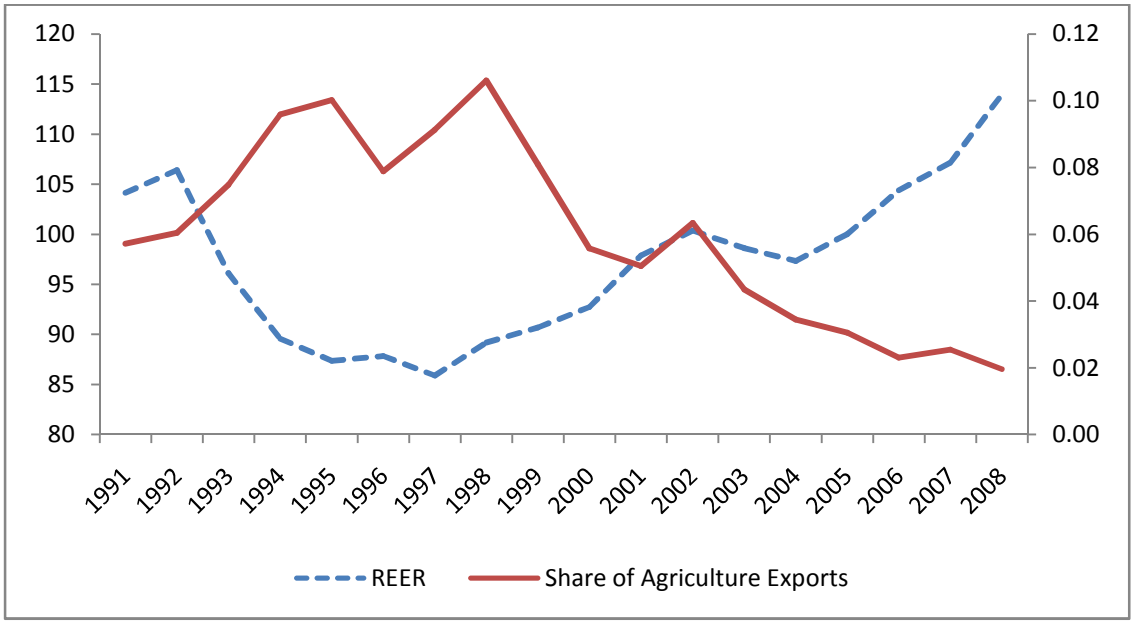
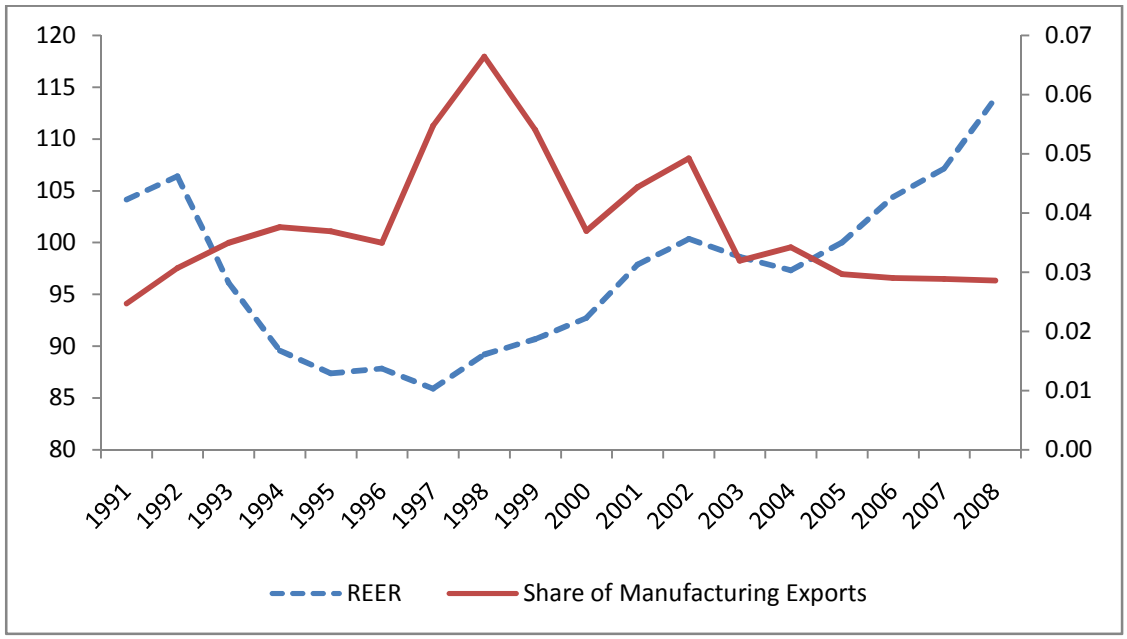


Diagram 7: Share of Manufacturing Exports vs. REER (91-08)



Both diagrams suggest that as the REER appreciated there was a significant reduction in share of both agriculture exports as well as manufacturing sector exports. It would appear that increased oil prices and appreciations in the REER are squeezing out exports of non-energy products.

The paper then analyzes whether the change in the pattern of exports was actually caused by the REER, oil prices and export mobility. To analyze this on a statistical level a series of Granger Causality tests were utilized. The results of three Granger Causality tests are shown and interpreted below in **table 9**. The first test asks the question of whether the numbers of products with a RCA score of greater than one is caused by changes in real oil prices. The first null hypothesis of "Real Oil Prices does not Granger cause the number of Products with RCA >1" is rejected at the 5% confidence level. The second null of "Products with RCA >1 does not Granger cause Real Oil Prices" cannot be rejected at all significant confidence level. This infers that Granger Causality runs one way from real oil prices to number of products with RCA>1 and not the other way. The conclusion being that an increase in real oil prices has a direct causal relationship on the pattern of revealed comparative advantage. This supports a case for the presence of Dutch Disease.

The second test investigated whether the REER causes or is caused by changes in export patterns as measured by M_4. The results indicate that the null of "M_4 does not Granger Cause REER" can be rejected. The results however does not allow for the rejection of the null of "REER does not Granger Cause M_4." Therefore there is a direct causal relationship between the export mobility and the real effective exchange rate. This supports a case for the presence of Dutch Disease in that movement in export patterns has impacted on the real effective exchange rate.

The third test investigates the relationship between the M_4 index and the number of products with RCA >1.

Table 9: Granger Causality Tests

Granger Test #1			
Null Hypothesis:	**F-Statistic**	**Prob.**	**Conclusion**
Real Oil Prices does not Granger Cause RCA Industries	3.64525	0.0410	*Rejected*
RCA Industries does not Granger Cause Real Oil Prices	2.01752	0.1793	*Not Rejected*
Granger Test #2			
Null Hypothesis:	**F-Statistic**	**Prob.**	**Conclusion**
REER does not Granger Cause M4	0.74092	0.4990	*Not Rejected*
M4 does not Granger Cause REER	10.8825	0.0025	*Rejected*
Granger Test #3			
Null Hypothesis:	**F-Statistic**	**Prob.**	**Conclusion**
RCA Industries does not Granger Cause M4	2.07216	0.0723	*Rejected*
M4 does not Granger Cause RCA Industries	1.48528	0.2685	*Not Rejected*

Based on the results the study rejects the null that "Number of products with RCA >1 does not Granger Cause M1" at the 10% level. The null of "M_1 does not Granger Cause number of products with RCA >1 cannot be rejected. Therefore the paper concludes that Granger Causality runs one way from RCA Industries to M_1 and not the other way. This is logical in that the change in pattern of exports has an overall effect on export mobility.

The results of the Granger Causality tests as well as other analysis provide strong evidence that there is a relationship between the pattern of exports (the persistence of RCA) and the presence of Dutch Disease.

Conclusion

Based on the calculations of the Balassa Index and the subsequent analysis performed on the Balassa scores for the time periods 91-93 and 06-08 the paper found that over 92% of product categories in both time periods are at a comparative disadvantage with total world exports. On this basis the paper concludes that there has been a shift in the pattern of specialization from the period 1991-93 to 06-08. According to the transition probability matrix there is a high probability of persistence in industries with an initial very strong comparative advantage (RCA>4) and those with no comparative advantage (RCA<1). However industries with weak comparative advantage have a high probability of moving towards being a position of a comparative disadvantage. This shows that there is mobility in pattern of trade. Overall, this is reinforced by the results of the mobility indices. Trinidad and Tobago currently exports a concentrated basked of goods and it appears to be getting more and more concentrated.

With respect to the Dutch Disease phenomenon, the evidence suggests that it is very present in Trinidad and Tobago. The rise in oil prices and the subsequent effect that increased energy exports had on the REER in turn affected the pattern of trade in the non-energy sector in Trinidad and Tobago. Manufacturing and food and beverage exports have declined in share as the REER appreciated and the number of industries that had a RCA score of greater than unity has declined. It should be noted that products in the agriculture sector which a revealed comparative advantage in 91-93 moved to a position of comparative disadvantage in 06-08. In addition products in the petroleum and chemical sectors increased their comparative advantage position. Statistical tests such as Granger Causality establish that the decline in non-energy RCA is due to an appreciation of the REER.

From a policy standpoint means it is clear that Trinidad and Tobago is becoming too heavily reliant on the energy sector. This along with the Dutch Disease syndrome can be very dangerous. This is especially so as proven oil and gas reserves are on the decline (estimated at 728,300,000 barrels of oil and 14.4 billion cubic feet as at Jan 1st 2010).[9] The government of Trinidad and Tobago needs to enact further policies to promote diversification of the economy so as to ensure that there is greater persistence in comparative advantage across all sectors and not just the energy sector. Special attention needs to be placed on areas that have shown a comparative advantage in years past or have RCA values of close to unity. The export base needs to expand further so that Trinidad and Tobago is not just focused on areas that are dependent on the oil and gas industry.

The Dutch Disease syndrome has also resulted in high inflation and wage increases. The Government must also continue to put in place policies that promote competitiveness in manufacturing and services sectors so as to increase the value added within these sectors. Seven priority sectors in the non-energy sector were identified for development as part of the strategy for diversification. However these sectors need to be revisited as they are may not be as relevant in terms of growth and comparative advantage.

One firm strategy to ensure that diversification is achieved is the continued development of the human capital of the country. As such policies which target education (G.A.T.E, etc) are a step in the right direction as an educated and motivated population would provide the base necessary to ensure the country remains competitive.

[9] Ryder Scott Company Report 2009

In addition to development of its human capital, Trinidad and Tobago needs to create a culture of innovation and research and development. According to the World Economic Forum Global Competiveness Report 2010 out of 139 countries, Trinidad and Tobago ranked 84th in competitiveness. In addition the country ranks 94th out of 139 in innovation, 138th out of 139 in capacity for innovation and 114th out of 139 in company spending on research and development activities. Innovation and entrepreneurship are key factors towards sustainable economic diversification and policies need to be enacted by government to foster an innovative and entrepreneurial culture.

In terms of comparing the distributions of comparative advantage it appears that both distributions are abnormal and skewed to the right, however a comprehensive comparative analysis on the distributions need to be done utilizing such tools and pp plots, qq plots and Harmonic Mass Index. This is proposed to be the subject of a second research paper.

References

Archibugi D and Pianta M. 1992. Specialization and Size of Technological Activities in Industrial Countries: The Analysis of Patent Data Research Policy, vol. 21, no. 1, 1992, pp. 79-93]

Balassa, B., 1965. "Trade Liberalization and 'Revealed' Comparative Advantage." The Manchester School, Vol. 33, 99–123.

Balassa, B. 1979. "The Changing Pattern of Comparative Advantage in Manufactured Goods". Review of Economics and Statistics Vol. 61, No. 2, 259-66

Balance, R., Forstner, H. and Murray, T. (1987), "Consistency tests of alternative measures of comparative advantage", Review of Economics and Statistics, Vol. 69, pp. 157-61.

Bender and Li. 2002 – The Changing Trade and Revealed Compratiave Advantages of Asian and Latin American Manufacture Exports, Yale University Center Discussion Paper No. 843

Bojnec, S. (2001), "Trade and revealed comparative advantage measures: regional and central and east European agricultural trade," *Eastern European Economics*, 39 (2), 72-98.

Bowen HP (1983) On the theoretical interpretation of indices of trade intensity and revealed comparative advantage. Weltwirtschaftliches Arch 119:464–472

Chew, S. H. 1990. "Mean Value". In The New Palgrave—Time Series and Statistics, edited by John Eatwell, Murray Milgate, and Peter Newman. Basingstoke, UK: MacMillan.

Chow, Peter C. Y., 1990, "The Revealed Comparative Advantage of The East Asian NICs", *The International Trade Journal*, 5 (2), Winter: 235-262.

Dalum, B., K. Laursen and G. Villumsen. 1998. "Structural Change in ECD Export Specialization Patterns: De-specialization and Stickiness." International Review of Applied Economics Vol 12, 447-467.

De Benedictis, L. and M. Tamberi. 2001. "A note on the Balassa index of revealed comparative advantage. Working Papers #158, Dipartimento di Economia, Universita' Politecnica delle Marche (I)

De Benedictis, L M. Gallegati and M. Tamberi. 2004. Overall Specialization and Development.

Fagerberg J. 1994. "Technology and International Differences in Growth Rates." Journal of Economic Literature, Vol. 32, 1147-75.

Ferto, I., and L.J. Hubbard. 2003. "Revealed Comparative Advantage and Competitiveness in Hungarian Agri-Food Sectors." World Economy, 26 (2) 247-259.

Grigorovici, C. (2009), "Analyzing the Degree of Specialization in Romania's Services Trade", Romanian Journal of Economic Forecasting, 10(1): 95-115.

Hillman, A. 1980. Observations on the Relation between "Revealed Comparative Advantage and Comparative Advantage as Indicated by pre-Trade Relative Prices." Weltwirtshafliches Archiv. Vol. 116, No. 1-2, 315-321.

Hinloopen, J., and C. van Marrewijk. 2001. "On the Empirical Distribution of the Balassa Index." Weltwirtschaftliches Archiv, 137, 1- 35.

Hinloopen, J., and C. van Marrewijk.. 2005. "Empirical Relevance of the Hillman condition and Comparative Advantage: 10 Stylized Facts."

Hinloopen, J., and C. van Marrewijk 2005 Dynamics of Chinese Comparative Advantage TI 2004-034/2 Tinbergen Institute Discussion Paper

Hoen AR, Oosterhaven J (2006) On the measurement of comparative advantage. Ann Reg Sci 40:677–691

Hosein 2008 – "The Evolving Pattern of Trade in a small Hydrocarbon Exporting Economy and some policy recommendations for sustainable development, 122 / Business, Finance and Economics in Emerging Economies Vol. 3 No 1 2008

Krugman, P. 1989. "Differences in Income Elasticities and Trends in Real Exchange Rates. "European Economic Review Vol. 33, 1031-1054.

Krugman, P. 1994. "Competitiveness: a Dangerous Obsession." Foreign Affairs Vol. 73, 28-44.

Lall, S. 2000. "The Technological Structure and Performance of Developing Country Manufactured Exports, 1985-1988." Oxford Development Studies, Vol. 28, 337-369.

Laursen, K. 1998. "Revealed Comparative Advantage and Alternatives as Measures of International Specialization." DRUID Working Paper no. 98-30.

Liesner, H.H. (1958), "The European Common Market and British industry," *Economic Journal* 68: 302-316.

Lutz, J. (1987), ''Shifting comparative advantage, the NICs and the developing countries'', The International Trade Journal, Vol. 1 No. 4, pp. 339-58.

Proudman, J., and S. Redding. 1988. "Evolving patterns in international trade" Nuffield College Economics Discussion Paper, 144.

Shorrocks, A. 1978. "The Measurement of Mobility." Econometrica Vol. 46, 1013-24.

Soete, L.L.G. and B. Verspagen. (1994). “Competing for Growth: the Dynamics of Technology Gaps.” In Economic Growth and the Structure of Long Term Development edited by L. Pasinetti and R. Solow, London: MacMillan.

Vernon, R. (1966), ‘‘International investment and international trade in the product cycle’’, Quarterly Journal of Economics, Vol. 80, pp. 190-207.

Vollrath, T.L. (1991), ‘‘A theoretical evaluation of alternative trade intensity measures of revealed comparative advantage’’, Weltwirtschaftliches Archiv, Vol. 127, pp. 265-80.

Yeats AJ (1985) On the appropriate interpretation of the revealed comparative advantage index: implications of a methodology based on industry sector analysis. Weltwirtschaftliches Arch 121:61–73

Yu R, J Cai · PS Leung.(2007). “The normalized revealed comparative advantage index.” Ann Reg Sci (2009) 43:267–282 DOI 10.1007/s00168-008-0213-3

Zaghini, A. (2003). “Trade Advantages and Specialization Dynamics in Acceding Countries.” European Central Bank, Working Paper Series, No. 249.