AGRICULTURAL DIFFUSION, WTO, AND ECONOMIC GROWTH IN THE ORGANIZATION OF THE EASTERN CARIBBEAN STATES

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1. INTRODUCTION

Small nation states, like those forming the Organization of the Eastern Caribbean States (OECS), have always been skeptical of the benefits derivable from the World Trade Organization (WTO). Banana exports in the Windward Islands (Dominica, St. Vincent, St. Lucia, and Grenada) and sugar exports in the Leeward Islands (Antigua and St. Kitts) form the bulk of their total exports and contribute significantly to their Gross Domestic Product (GDP). Under the GATT/WTO trade liberalization regime, these countries stand to lose preferential treatment for banana and sugar exports, which they enjoyed under the first Lomé Convention trade provisions and subsequent conventions. It is believed that the elimination of preferential treatment received by the OECS on banana and sugar exports will have serious repercussions on the economies of these countries.

Agricultural development has been considered the backbone of economic development for the OECS in the past decades. Agriculture contributes significantly not only to their Gross National Product (GNP), but also to employment. The Caribbean Banana Export Association CBEA (1996) stated that the banana industry is responsible for 90 per cent of all primary exports of some of the Windward Islands. According to Williams et al. (1999) the banana industry employs 56,428 workers in the these islands. Like most developing economies, the Windward

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Islands depend heavily on agriculture, and it is considered the engine of economic growth.

Koester (1993) states that the impact of agricultural development on trade is stronger, the smaller the countries involved. Therefore, small countries, in particular, will expand trade as a consequence of agricultural development, if a free market exists. On the contrary, many of these small countries have experienced declines in agricultural exports, and hence a reduction of investments in agriculture because of reduction of trade preferences received for their main exports.

In the case of the OECS, uncertainty in the prices of bananas and sugar have resulted in marked decreases in technology diffusion in their agricultural sectors. In this paper, we examine the implications of the effects of GATT/WTO on agricultural technology diffusion in the OECS.

In recent years the percentage contribution of agriculture to GDP of the OECS has significantly declined (Figure 1a & b). For the Windward Islands, agriculture contributed about 20 percent of the GDP in 1980, but only 13.8 percent in 1995 (Figure 1a). In 1980 agriculture contributed 8.0 per cent of the GDP of Antigua and 17.0 per cent of that of St. Kitts, but in 1995 it contributed about 4.0 per cent for Antigua and 10.0 per cent for St. Kitts (Figure 1b). The decrease in agricultural contribution has been sharper in the Windward Islands since 1994; this period coincided with the signing of the Marakesh declaration. However, the shocks of variable agricultural contribution began since 1988. A look at Figure 3 shows that agricultural export fluctuation began in the 80s and continued up to 1993 when the attempts at price liberalization were initiated in Europe. These declines resulted from international price fluctuations for the main commodities exported by the OECS and fluctuation in agricultural export value, and thus a drop in contribution to the GDPs of the countries (Figure 2). Such price uncertainty within the agricultural sectors of the OECS has caused a number of banana and sugar producers to exit the industries. With falling prices emanating from trade liberalization, agriculture's contribution to GDP will continue to fall and so too will the rate of diffusion of technology in agriculture.

Agriculture's role in the economic growth of the OECS countries has been unbalanced. In spite of the decline in contribution to GDP, agriculture is still the major employer of most of the people in the island nations, and contributes significantly to the balance of payments. Agricultural workers purchase large quantities of goods from the other sectors. It is evident that the agricultural sector is necessary for economic growth in the OECS, and a

decrease in technological growth in the sector, generated by external shocks, can affect the entire OECS' economy. Williams et al. (1999) examined the likely effects of price shocks on the economies of the Windward Islands due to the removal of the preferential treatment. In their study they felt that the price shocks will cause economic contraction on these islands, especially Dominica.

Technology diffusion has been linked to a country's international competitive position. The technology-trade relationship was critically examined by Krugman (1979), and more recently by Grossman and Helpman (1991), and Romer (1990). These studies examined endogenous technological change and monopolistic competition. According to Martinez-Zarzoso and Suarez-Burguet (2000), the technology-gap trade framework indicates that innovation and technological change influence the patterns and direction of trade flows. According to Krugman, countries that innovate are able to gather quasi-rents from these innovations and invest in the production process and remain competitive. With trade liberalization, prices of primary exports from the OECS countries will fall, and the rents received from preferential treatment will dissipate. It means that these countries will be unwilling to make innovations in the agricultural sector and output will finally decline. Hence, it is important to examine the likely effects of GATT/WTO on agricultural technological diffusion in the OECS and the implications for growth in the OECS. We shall proceed by examining the effects of technology diffusion on growth, and present a model to analyze the factors influencing technology diffusion in the agricultural sector, and examine the likely effects of WTO on future technology diffusion within the OECS agricultural sector.

2. OBJECTIVE

The countries in the OECS, which have been receiving preferential treatment for their prime export crops, have suffered immediate shocks to their economies with falling prices received for bananas and sugar since they have lost the WTO appeal for continued preferential treatment. These shocks, emanating from a drastic fall in prices and a fall in the value of exports, will affect technology diffusion rates and the growth of the sector. The objective of this paper is to examine the effects of WTO and trade liberalization on agriculture technology diffusion within the agriculture sector of the OECS.

3. METHOD

A two-stage method is used to investigate growth paths of technology diffusion in agriculture, and to determine the factors that influence

agriculture innovation in the OECS. It is hypothesized here that technology diffusion mirrors the dynamic diffusion process. Hence, logistic functions of the share of agriculture in GDP over time are estimated for each of the Windward and Leeward Islands to determine the rate at which agriculture technology has diffused in the economies of the island states. The rate at which technology diffuses in a given economy has been studied by a number of researchers (David 1969, Otani and Villanueva 1990, Clark et al. 1993, and Berry and Kaserman 1993). The logistic growth function provides a logical and appropriate method of examining technological diffusion rates at the macro level. The logistic function assumes that there exists some maximum attainable share of the agricultural sector in the GDP of the countries being studied. The technology is assumed to be embodied in the product or commodity produced by the industry (Ireland and Stoneman 1986). Agricultural contribution in a given island state is assumed to attain a maximum share of GDP and is thus presented as:

$$\ln\frac{SA_{it}}{K_i - SA_{it}} = B_0 + B_{it} + u_i \qquad (1)$$

Where, SA_{it} = share of agricultural contribution of country i in time t to the GDP.

K_i = upper limit of the agricultural sector contribution to GDP of country i ($K_i<1$).

In the second stage, the slope of the logistic growth curve functions as the dependent variable, and representing the rate of technology diffusion, is employed in a neo-classical growth model. The agriculture diffusion rate is regressed against independent variables to determine the factors responsible for inter-country differences in the observed rates of agricultural diffusion (Clark et al.1993). Since the data will be for the period 1980 to 1994 and for the six island states which represent the OECS, a Time Series Cross Section (TSCS) regression model is used to examine the factors influencing technology diffusion in the agriculture sectors of the OECS. The model is described by Fuller and Battese (1974) and is presented below:

$$y_{it} = \sum_{k=1}^{p} X_{itk}\beta_k + u_{it} \qquad (2)$$

$$I = 1,\ldots,N;\ t = 1,\ldots,T$$

Where i is the number of cross sections, t is the length of the time series for each cross section, and p is the number of independent variables. The error component (u_{it}) for this model is given by:

$$u_{it} = v_i + e_t + \varepsilon_{it} \qquad (3)$$

Where the errors v_i, e_t, and ε_{it} are

independently distributed with zero means and variances

$\sigma_v^2 > 0$, $\sigma_e^2 > 0$, and $\sigma_\varepsilon^2 > 0$, respectively.

The explicit function is stated as:

$$B_i = f(exp, chem, trade, time, service, indus, ser\ x\ agdif, ind\ x\ agdif, D_1 \ldots D_5) \quad (4)$$

where:

exp = valued agricultural exports in dollars for each of the countries. Increase in agricultural contribution is expected to be positively related to agricultural exports.

chem = value of chemical fertilizers and pesticides used during the time in question. A positive relationship is expected between agricultural output and chemicals used.

trade = trade deficit of the countries of the OECS. As the trade deficit increases, the country is expected to increase agricultural output to improve its balance of payments.

time = time trend variable. A positive diffusion rate is expected at the beginning; and then a negative diffusion rate begins.

service = diffusion rates for service calculated using equation 1.

indus = diffusion rates for industry calculated using equation 1.

ser x agdif = interaction term for service and agricultural diffusion rates.

ind x agdif = interaction term for service and agricultural diffusion rates.

D1...D5 = dummy variables for Windward and Leeward Islands.

4. RESULTS

The model shows that agricultural diffusion rates increased in the 80s, but decreased in the 90s for all states (Figure 3). The decline in technology diffusion rates has been more acute since 1983. The diffusion rates varied from island to island. The Windward group experienced a surge in agricultural technology diffusion rates in 1993, but again the diffusion rates declined. The diffusion rates for the Leeward Islands increased slightly during 1986 to 1988, but then began to decrease. General Least Squares (GLS) and double log regression equations are used to evaluate the factors that explain technology diffusion rates in the OECS. The variables that explain agriculture diffusion rates are seen in Tables 1a and b, and 2a and b. Trade deficit is not included in the model in table 1a, but included in table 1b. The models seem to have good fit. The models are characterized by low Root Mean Square Errors (Table 3). The variance components for cross sectional analysis and variance error are all significant at α=0.05 which means that there are no fixed effects, but the time components are different from zero indicating that the diffusion rates over time are significantly different by country. The explanatory variables explained 94 and

93 per cent of the variation in the diffusion rates.

The estimated coefficients for the model, without trade deficit, were all significant at $\alpha = 0.05$. Three dummy variables, D1, D2, and D3 in the first model are not significant at $\alpha = 0.05$, which indicates that the three Windward Islands- Dominica, St. Lucia and St. Vincent-are similar in patterns of agricultural diffusion rates whereas Grenada is different. This is demonstrated by the significance of D4 at the $\alpha = 0.05$ level. The significance of D5 also means that the Leeward Islands, Antigua and St. Kitts, are different in technological diffusion rates from the Windward Islands.

Export value is positively related to the diffusion rates, which means that as exports increase by 1.0 per cent the diffusion rate increases by 0.8 per cent. The use of chemicals also influences the technology diffusion rate in agriculture. Similar results have been found by Jolly and Ligeon (1999). Technology diffusion rate is also positively related to time, but inversely related to technology diffusion rates in the service and industry sectors, and positively related to the interaction between the service and agricultural sectors, and the industry and agricultural sectors. A 1.0 per cent increase in the diffusion rate in the service sector and the industrial sector, respectively, cause a 5.5 and a 1.17 per cent decline in the agricultural technology diffusion rate.

In table 1b, when the trade deficit model was run, all variables were significant at $\alpha = 0.05$, except the chemical use variable which was significant at the $\alpha = 0.10$. Trade deficit had no effect on agricultural technology diffusion.

The islands are modelled into two separate groups, the Windward and the Leeward (Tables 2a and 2b). For the Windward group, all variables are significant at the $\alpha = 0.05$ level, with the exception of exports, and all the equations had anticipated signs. The magnitudes of the elasticities are similar to that of the combined islands. For the Leeward group, exports positively influence agriculture technology diffusion, but chemical use does not. The interaction between agriculture technology diffusion and industry is not significant. However, the elasticities for service diffusion and agriculture diffusion (-7.5), and industry diffusion (2.3) are much larger than that of the Windward Islands. Agriculture technology diffusion in the Leeward Islands is positively related to time.

5. DISCUSSION

The OECS agricultural sectors vary drastically. In Dominica, St. Lucia, and to a lesser extent St. Vincent, the countries' dependence on a single export crop, banana, is the same. In Grenada there is more dependence on nutmeg export. In the Leeward Islands, there is even more diversity. St. Kitts' economy

is heavily based on sugar exports, while in Antigua, the agricultural exports are composed of a large range of vegetables. However, Antigua is less dependent on agricultural exports than the other OECS members. All these countries are affected directly or indirectly by GATT and WTO.

Total value of exports for the Windward Islands increased from 1986 to 1993 and then began to decline. The contribution of agriculture to the islands' GDP has been declining for all of the Windward Islands since 1988. The contribution of exports to total GDP for the Leeward Islands has varied, but remained constant throughout the years, but the contribution of agriculture to total GDP declined. The patterns of growth of exports and the contribution of agriculture to GDP may signify that exports will continue to decline in the OECS in the future, and total exports will contribute less to the GDP of these countries under trade liberalization. The models show that exports are significantly linked to the diffusion rates of agriculture into the economy. Agriculture is responsible for a large share of exports in some of the islands. Hence a decline in agricultural exports resulting from a WTO/GATT ruling will have a negative effect on exports and thus the rate of technology diffusion in agriculture. It is a bit perturbing that the fall in exports will affect technological diffusion in agriculture in the OECS up to the point where agricultural exports of OECS prime commodities will almost disappear.

It is expected that these countries, though being disadvantaged by the rulings of WTO, will act as one, but the economic conditions in each of the countries differ and prevent them from behaving as a unified entity, even when their interests are at stakes. Williams et al (1999) examining the effects of shocks of banana price on the economies of the OECS, showed that Dominica will have its greatest impact after three quarters. For Grenada, it was two quarters. When taken together, the banana shock will have long lasting effects on the Windward Islands and the effects will reverberate on the whole of the OECS.

The reduction of agricultural exports by OECS countries means that investments in agriculture will fall and the economic slack will have to be taken up by the other sectors. The results show that as technology diffusion in services increases, the islands' agriculture technology diffusion rates will fall. As Williams et al. suggest, the islands will have to depend on services and industry. In the Windward Islands, the dependence on industry will be greater than on services, while the Leeward Islands will depend more on services than on industry. The results show that technology diffusion rates in the agricultural sectors of the OECS will decline as the diffusion rates in services and industry increase. The interaction

between the diffusion rates, industry, and services and agriculture is positive. This means that positive agriculture diffusion rates will depend on linkages established between agriculture and industry.

The Windward Islands have shown that there are differences in agriculture diffusion rates and that the slowing down of agricultural exports brought about by low prices and quasi rent dissipation coming from the removal of preferences the OECS enjoyed prior to WTO will have telling effects on their economies.

The islands have been experiencing a slowing down of agriculture technology diffusion rates which is expected to accelerate with trade liberalization and a fall in agricultural prices. Service and industry will play a greater part in these islands' economies. The role of the service and industrial sectors post GATT/WTO hinges on investment funds, which can only come from foreign direct investments. The countries' ability to attract foreign direct investments will determine how much their economies will grow in the future. Agriculture must also play a crucial role in these countries' development since progress in these countries' service and industrial sectors will be determined by the linkages established between the agricultural and the service and industrial sectors.

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Figure 1a: Contribution of Agriculture to GDP of OECS, Windward Islands, 1980-1994.

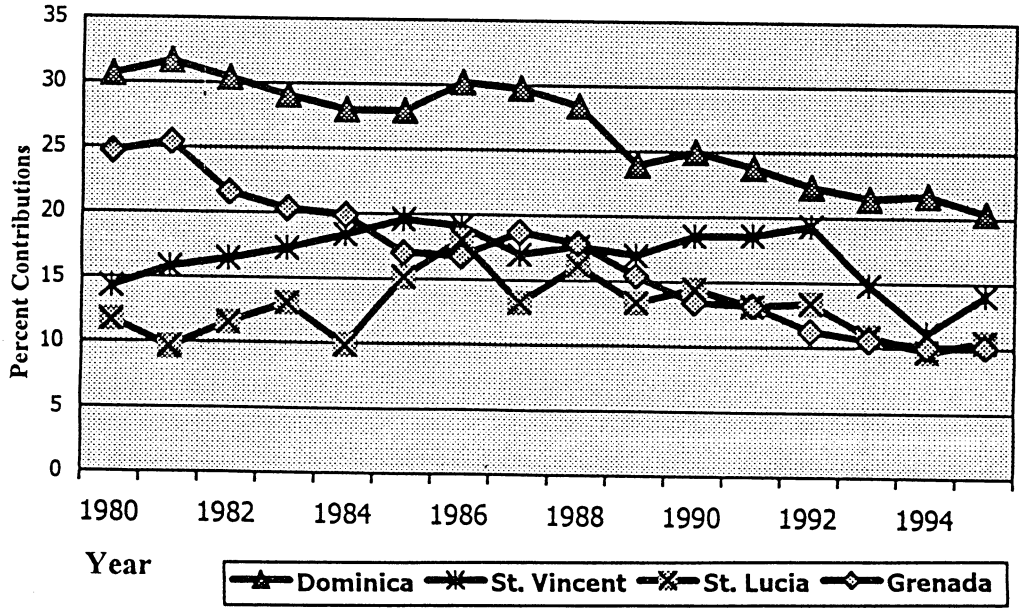

Figure 1b: Contribution of Agriculture to GDP of OECS, Leeward Islands, 1980-1994.

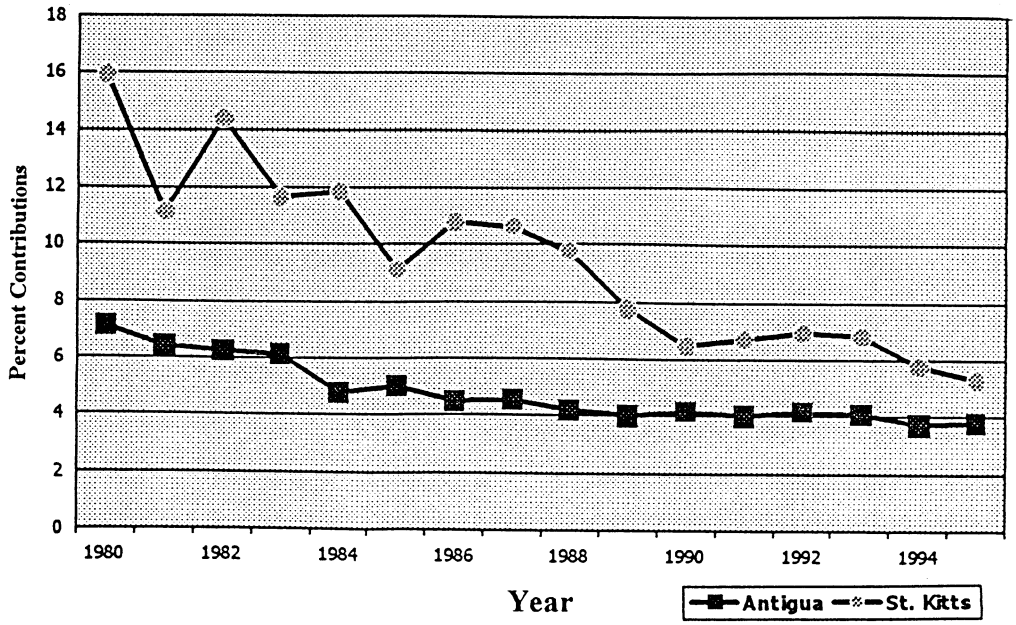

Figure 2a: Export Value in 1,000 Dollars for the OECS, Windward Islands, 1980-1994.

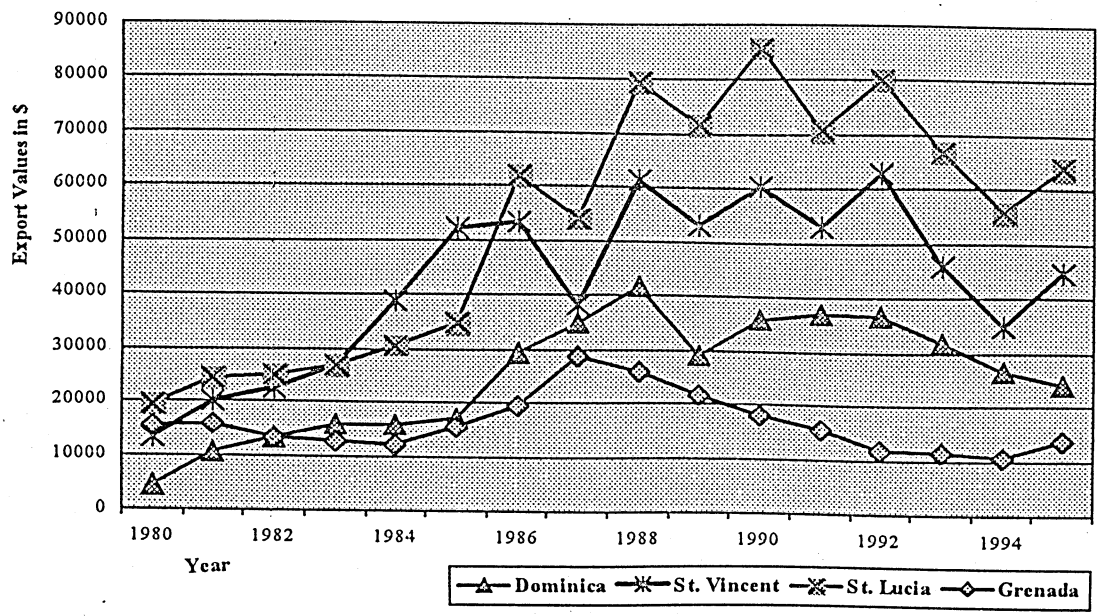

Figure 2b: Export Value in 1,000 Dollars for the OECS, Leeward Islands 1980-1994.

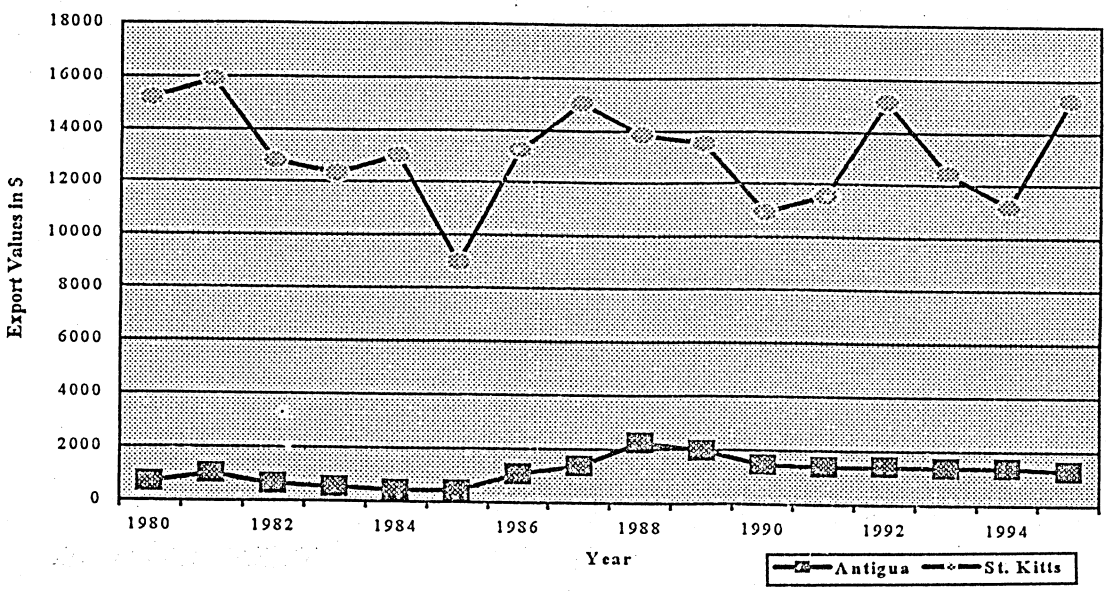

Figure 3: Agricultural Diffusion Rates for OECS, 1980-1994.

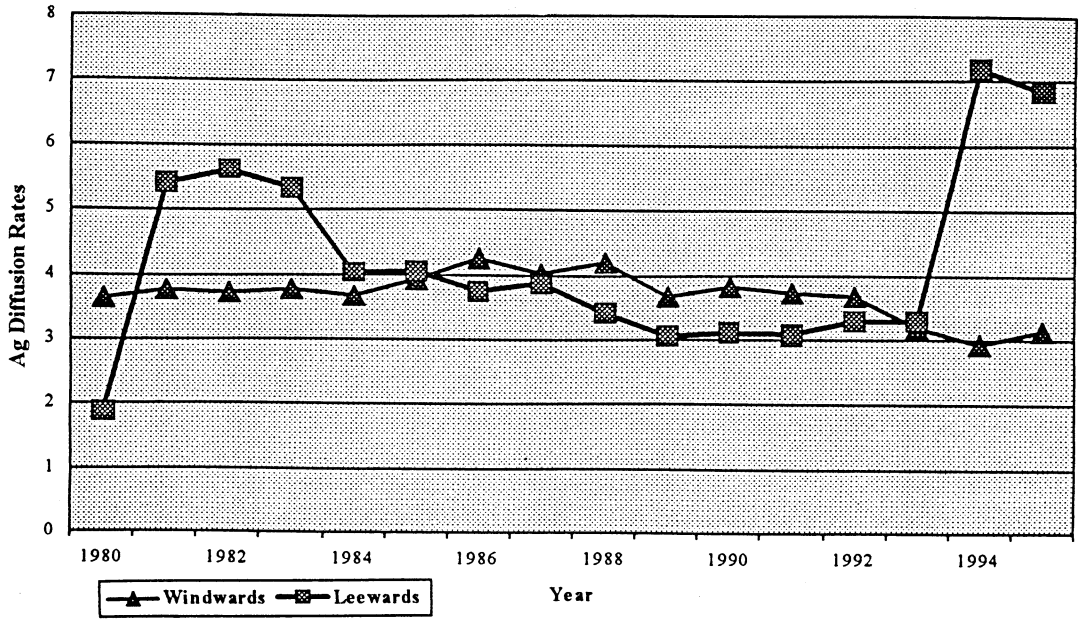

Table 1a: Determinants of Agricultural Diffusion Rates for the OECS Without Trade Deficit

Variable	Parameter Estimate	T for Ho: Parameter = 0	Prob > T
Intercept	1.184	3.830	0.0002
X_2 - Exports	0.078	3.424	0.0010*
X_3 - Chemical Used	0.062	2.379	0.0197*
Time	0.080	4.047	0.0001*
X_7 Service Diffusion Rates	-5.530	-19.261	0.0001*
X_8 - Industry Diffusion Rates	-1.167	-11.122	0.0001*
X_{13} - Interaction Service x Agriculture	0.737	12.953	0.0001*
X_{14} - Interaction Industry x Agriculture	0.123	4.141	0.0001*
D_1 - Dummy variables for OECS	-0.019	-0.180	0.8577
D_2 - Dummy variables for OECS	-0.057	-0.579	0.5639
D_3 - Dummy variables for OECS	0.151	1.392	0.1678
D_4 - Dummy variables for OECS	0.176	1.782	0.0785**
D_5 - Dummy variables for OECS	0.328	2.676	0.0090*

*Significant at □ = 0.05, ** Significant at □ = 0.10

Table 1b: Determinants of Agricultural Diffusion Rates for the OECS with Trade Deficit

Variable	Parameter Estimate	T for Ho: Parameter = 0	Prob > T
Intercept	1.205	3.929	0.0002
X_2 - Exports	0.080	3.431	0.0010*
X_3 - Chemical Used	0.051	1.691	0.0949*
X_4 - Trade Deficit	0.002	1.144	0.2561
Time	0.081	4.115	0.0001*
X_7 Service Diffusion Rates	-5.574	-18.304	0.0001*
X_8 - Industry Diffusion Rates	-1.177	-10.683	0.0001*
X_{13} - Interaction Service x Agriculture	0.735	12.073	0.0001*
X_{14} - Interaction Industry x Agriculture	0.126	4.042	0.0001*
D_1 - Dummy variables for OECS	-0.029	-0.366	0.7157
D_2 - Dummy variables for OECS	-0.051	-0.723	0.4718
D_3 - Dummy variables for OECS	0.151	1.832	0.0708**
D_4 - Dummy variables for OECS	0.163	2.296	0.0244**
D_5 - Dummy variables for OECS	0.351	3.453	0.0009*

*Significant at □ = 0.05, ** Significant at □ = 0.10

Table 2a: Determinants of Agricultural Diffusion Rates for Windward Islands

Variable	Parameter Estimate	T for Ho: Parameter = 0	Prob > T
Intercept	1.998	5.842	0.0001
X_2 - Exports	0.005	0.157	0.8758
X_3 - Chemical Used	0.093	4.092	0.0001*
Time	0.071	3.826	0.0003*
X_7 Service Diffusion Rates	-5.483	-15.865	0.0001*
X_8 - Industry Diffusion Rates	-1.148	-10.020	0.0001*
X_{13} - Interaction Service x Agriculture	0.694	7.783	0.0001*
X_{14} - Interaction Industry x Agriculture	0.124	3.869	0.0003*

*Significant at □ = 0.05

Table 2b: Determinants of Agricultural Diffusion Rates for Leeward Islands

Variable	Parameter Estimate	T for Ho: Parameter = 0	Prob > T
Intercept	0.231	0.409	0.6863
X_2 - Exports	0.164	3.450	0.0022*
X_3 - Chemical Used	0.055	0.869	0.3938
Time	0.144	4.356	0.0002*
X_7 Service Diffusion Rates	-7.513	-8.934	0.0001*
X_8 - Industry Diffusion Rates	-2.398	-5.443	0.0001*
X_{13} - Interaction Service x Agriculture	0.523	1.967	0.0613*
X_{14} - Interaction Industry x Agriculture	0.219	1.351	0.1899

*Significant at □ = 0.05

Table 3: Diagnostics for the Different Models

	OECS Model without Trade Deficit	OECS Model With Trade Deficit	Windward Is. model with-out Trade Deficit	Leeward Is. Model with-out Trade Deficit
Variance component for cross section	0.005	0.002	0.018	0.052
Variance component for time series	0.139	0.139	0.003	0.004
Variance component for error	0.0026	0.003	0.0021	0.02
MSE	0.002	0.002	0.002	0.003
RMSE	0.046	0.003	0.046	0.032
R^2	0.93	0.94	0.92	0.93

MSE = Mean Square Error; RMSE = Root Mean Square Error