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Factors Influencing Agriculture's Contribution to GDP: Latin America and the Caribbean

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Abstract

This paper identifies the factors that influence agriculture's percentage contribution to gross domestic (GDP) for a group of Latin American and Caribbean (LAC) countries that belong to the medium category of the UNDP Human Development Index (HDI). In line with theories of economic growth it was hypothesized that the percentage contribution of agriculture to GDP is influenced by factors associated with the level of economic development of the country and the degree of competitiveness of its agricultural sector. The analysis employed the use of a Random Effects panel regression model for a 30 year period (1980-2009) for the study countries. Based on the analysis, it was found that rural population, life expectancy, foreign direct investment, the rate of inflation, level of exports of all goods and services and the ratio of agricultural exports to agricultural imports significantly determined the percentage contribution of agriculture to GDP in the selected countries.

Keywords: Latin America, Caribbean, agriculture, GDP, trade

Introduction

Data obtained from the Human Development Reports (2009) show that for Latin American (LAC) nations categorized as Medium Human Development (MHD), agriculture's contribution to GDP tends to be very low for some countries, while for others within the same category, agriculture's contribution to GDP is much higher (Figure 1). This paper explores the causes of the variation in agriculture's percentage contribution to GDP in these countries, which could shed some light on the factors causing the agriculture sector to

decline in developing countries. The objective of this paper therefore is to identify the macro-economic factors which determine the percentage contribution of agriculture to GDP in Latin America and Caribbean countries.

Background/Theoretical Framework

Explanations of the importance of the agricultural sector in the economy as economic growth progresses have benefitted greatly from the dual sector theory of Arthur Lewis (Lewis 1954). In this theory, the modern or industrial sector

utilizes the surplus labour in the agricultural or primary sector as its source of growth, along with capital generated by the investment of savings, to expand its production and thus the gross output of the economy. As the industrial (modern) sector expands in importance, there is a concomitant reduction in the percentage contribution to gross output by the agricultural sector. This growth process thus generally requires the movement of labour from rural areas to the urban areas with a decline of the rural population as a percentage of the national population.

In recent years however, there has been increasing concern about the declining contribution of the agricultural sector to Gross Domestic Product (GDP), especially in developing countries. While as discussed it is established that as a country develops, its agriculture sector is expected to decline, in recent times, this decline has been rapid rather than gradual.

This decline has been taking place not only in developing countries, but in developed countries such as the United States. This situation is evidenced by Yamashita (2008), who provided statistics for Japan, which showed that agriculture's contribution to GDP fell by 8% between 1960 and 2005, Table 1 provides further details of the decline in the agricultural sector of Japan, where it can be seen that the number of farming households, the area cultivated, as well as the agricultural labour force have all been declining.

Another concern about the decline of the agricultural sector stems from the constant upward movement of food prices over the last few years, which is depicted using the international food price index in Figure 1. As seen in Figure 2 and confirmed by USAID (2009), global food prices peaked between March 2007 and March 2008, showing an increase of 43% over the period. This marked increase was felt most in developing countries and by the poorest members of the population, who spend the majority of their income on

food. The impacts of these high food prices did not only reduce the buying power of persons but also threatened food and nutrition security (USAID 2009). For instance, in the Democratic Republic of the Congo, cassava which constitutes 55% of calorie intake had prices increase by 60% in 2008-2009. Although food prices have since declined, the international food price index of 2009 was still 17% lower than 2008 but still higher than 2007 (The World Bank 2010). Global prices are expected to continue to remain high due to increasing fuel prices, one of the factors that contributed to the spike in 2008. In recent years, there has also been increased concern about agriculture's contribution to GDP as the number of undernourished persons in the world has steadily increased from 792 million (14% of undernourished persons in the world), 1995-1997 to 850 million (13%), 2005-2007 (FAO 2010b).

It is general knowledge that agriculture does not just contribute food and fiber to the economy, but also labour, capital and foreign exchange, which all go toward economic development. As Rao (1989) puts it, if agriculture fails to develop at a suitable pace, this could prove to be a critical constraint to the growth of the industrial sector as well as other sectors of the economy.

Methodology

This section presents the regression model as well as theoretical arguments that justify the eight variables used. The regression model was formulated as follows (the sources of the data for the variables are given in brackets):

$$AGDP_{it} = \beta_0 + \beta_1 PT_{it} + \beta_2 RP_{it} + \beta_3 LEB_{it} + \beta_4 FDI_{it} + \beta_5 ICP_{it} + \beta_6 EGS_{it} + \beta_7 EDS_{it} + \beta_8 EXIMa_{it} + \varepsilon_{it} \tag{1}$$

where:

$AGDP_{it}$ = agriculture's percentage

- contribution to GDP for country i in year t (the ratio of Agriculture's total value added to GDP of the country) (UNSTAT 2010).¹
- PT_{it} = the population of the country i in year t (World Bank 2010).
- RP_{it} = the percentage of the population of country i that is rural (rural population = people living in rural areas = the total population – the urban population of country i) (World Bank 2010).
- LEB_{it} = the life expectancy at birth of the population of country i (World Bank 2010).
- FDI_{it} = the foreign direct investment into country i (World Bank 2010).
- ICP_{it} = the rate of national inflation (World Bank 2010).
- EGS_{it} = the exports of goods and services from country i (expressed as a percentage of GDP) (World Bank 2010).
- EDS_{it} = the total external debt stocks of country i (expressed as a percentage of GNI) (World Bank 2010).
- $EXIMa_{it}$ = the ratio of agricultural trade. This is the ratio of exports and imports of total agricultural merchandise for country i (FAOSTAT 2010).
- ε_{it} = the stochastic disturbance or error term.

Factors Associated with the Level of Economic Development

(i) Rural Population as a Percentage of Total Population (RP)

In general if a country has been able to maintain a high percentage of its population in the rural sector then it could be expected that its agricultural sector would constitute a larger percentage of its gross output. In accordance with the Lewis Model, this will imply a large proportion of the country's labour has not transferred to the modern sectors and being resident in the rural sector is still engaged in the agricultural sector, which could be expected to be making a greater percentage contribution to GDP.

(ii) Population Growth (PT)

If a country experiences high population growth and therefore has a larger population base, then it can transfer labour to the expanding modern sectors, without reducing the agricultural labour supply. In fact a rapidly expanding population could allow a country to expand its labour surplus and thus allow a prolonged period of economic growth by expansion of both the agricultural and modern sector, particularly if there are technological innovations taking place in the agricultural sector, such as improved genetic planting material. Population growth could therefore allow the rural sector to play a role in fostering economic growth (Pemberton 2002). Under these circumstances PT could be expected to have a positive influence on the percentage contribution of agriculture to GDP.

However, according to Pender (1999), increasing pressures from population growth may result in land degradation, as these pressures encourage expansion of agricultural production onto marginal lands, causing lower land productivity. Thus increasing population is expected to adversely affect agriculture's contribution to GDP. Thus countries with larger populations could be expected to have lower agricultural contribution to GDP and the coefficient of PT can be hypothesized to have a negative sign. Thus the sign of

¹ Agriculture refers to agriculture, hunting, forestry and fishing.

the coefficient of PT could depend on the relative influence noted and hypothesized to be either positive or negative.

(iii) Life Expectancy (LEB)

As the process of economic growth proceeds it would be expected to be accompanied by a process of economic development, as the increasing gross output of the country is utilized by its citizens to improve the standard of living of the citizens. One important aspect of improved standard of living is the health status of the population and in particular the levels of maternal and child care. As these aspects of the population improve, they will have a direct impact on the life span of citizens, improving the life expectancy at birth of the population.

Thus it could be expected that the higher levels of life expectancy would be associated with countries at a higher state of economic development and hence countries with a lower percentage of agriculture sector in the gross output of the country, as argued above. Hence, the coefficient of LEB is expected to have a negative sign.

For countries where the foreign direct investment is largely into food and agriculture, the coefficient of FDI is hypothesized to have a positive sign. However, if the foreign direct investment in a country is into the non-agricultural sector, it is hypothesized that the coefficient of FDI will be negative.

(iv) Factors Associated with International Competitiveness

The Lewis Model considered a fairly closed developing economy with "some scope for international trade" (Pemberton 2002). However, in the recent international trade scenario international competitiveness has emerged as the major factor in determining the directions of international trade. Competitiveness on a whole refers to "the extent to which the goods of a firm or

industry can compete in the marketplace; this competitiveness depends on the relative prices and qualities of products" (Carbaugh 2002). Thus, countries that can produce commodities at lower levels of cost have a definite competitive advantage over higher cost producers as they will be able to offer lower export prices. Any factor contributing to higher domestic production costs, therefore reduce the international competitiveness of domestic production, reducing or eliminating prospects of exporting and also allowing imports of cheaper priced commodities into the domestic market further eroding prospects for domestic production. Especially in this era of the World Trade Organization (WTO), it has become increasingly difficult for developing countries to apply tariffs and non-tariff barriers to limit imports.

(v) Inflation Rate

Economic theory states that there are two sources of inflation, cost-push and demand-pull inflation (Lipsey and Chrystal 2003). When in a country there is demand-pull inflation, due to increasing demand for food, producers are expected to invest more in the agricultural sector, resulting in increased production and as a consequence increasing demand pull inflation should lead to increasing percentage contribution of agriculture to GDP. ICP 's coefficient in this case is hypothesized to be positive. However, where cost-push inflation results, because of a decrease in aggregate agricultural supply, which may be caused by either an increase in wages or an increase in the prices of raw materials, the greater costs of agricultural production result in the amount of agricultural production falling, thus reducing the percentage contribution of agriculture to GDP. The coefficient of ICP in this case, is expected to be negative. Thus, the coefficient of ICP is hypothesized to have either a negative or a

positive sign depending on the source of inflation in the countries.

(vi) Exports of All Goods and Services (EGS)

Similarly, the coefficient of exports of goods and services is hypothesized to be either positive or negative. The coefficient of *EGS* is expected to be positive, if the developing countries implement an outward-oriented trade policy with respect to agriculture. According to Carbaugh (2002), this policy initiates international competition to domestic markets, which in turn discourages inefficient ones. As a result of this more competitive environment, greater productivity is promoted and thus the greater the exports of goods and services, the greater the percentage contribution of agriculture to GDP.

By the same token, the coefficient of *EGS* is expected to be negative, if a developing country implements an inward-oriented trade policy for agricultural goods and an outward policy with respect to non-agricultural products. In this instance, the country is not focused on the export of agricultural commodities, but rather on non-agricultural commodities. Therefore, the agricultural sector becomes less competitive and productivity declines and ultimately agricultural output declines resulting in a reduction of the percentage contribution of agriculture to GDP.

(vii) Agricultural Exports as a Ratio of Agricultural Imports (EXIMa)

The coefficient of *EXIMa* is hypothesized to be positive, that is it is expected for a developing country that as the ratio of agricultural exports to agricultural imports increases, so will agriculture's percentage contribution to GDP.

(viii) External Debt (EDS)

It is expected that as the external debt of a country increases, perhaps caused by the international uncompetitiveness of its domestic production limiting exporting the country may not be able to import as much agricultural and food products, due to lower availability of foreign currency (Valazco 2001). Thus the country would be forced to produce more of its own food, resulting in increased agricultural production and an increased contribution of agriculture to GDP. Therefore, the higher the external debt of the country the greater the contribution of agriculture is expected to be and therefore the coefficient of *EDS* is hypothesized to be positive.

Country Selection

A panel regression model was used to determine the factors that influence the percentage contribution of agriculture to GDP. Secondary data on for the eight (8) variables noted in the model above were obtained for ten (10) Latin American and Caribbean countries (Table 2) for the period 1980-2009.

Approach to Regression Analysis

In estimating the above model, a number of steps were undertaken. Firstly, the data for the nine variables for all ten countries were collected and set up as a panel. Given that regression of a non-stationary time series on another non-stationary time series may produce a spurious regression (Gujarati 2003), it is imperative to determine if the series are non-stationary. Thus, the time series of the nine variables were tested for stationarity using the augmented Dickey-Fuller test. If the series are non-stationary, then it is important to determine whether they are cointegrated. Thus, the augmented Engle-Granger test was carried out to determine whether a cointegrated regression existed. Next, given that cointegrating vectors exists, the

Fixed Effects (FE) and Random Effects (RE) models were both estimated and the Hausman test was carried out to determine which of the two models was more appropriate to estimate the regression. The results of the Hausman test favoured the RE model.

Thus, the RE model was estimated using maximum likelihood estimation (MLE), which avoided problems associated with autocorrelation and heteroscedasticity. Next, hypothesis testing of the individual regression coefficients was carried out. Additionally, the Likelihood Ratio (LR) test was carried out on the regression results to determine the overall significance of the model. Then, using the information generated from the MLE, the McFadden R-squared value was obtained. Finally, the elasticities for the variables were calculated using the results obtained from the regression.²

Results and Discussion

This section presents the results obtained from the estimation of equation (1) using the statistical programmes *EViews 6* and *Limdep (NLOGIT 4.0)*. Based on the augmented Dickey-Fuller test, AGDP (the dependent variable), FDI, ICP, EGS, EDS and EXIMa were found to be non-stationary while PT, RP and LEB were found to be stationary (Table 6). The results of the augmented Engle-Granger test for cointegration (Table 7) found that there was a long term or equilibrium relationship between the variables. These results indicated that the null hypothesis of no cointegration was rejected, leading to the conclusion that the regression was not

spurious, that is, there was a meaningful long-run relationship between the percentage contribution of agriculture to GDP and the eight independent variables. Additionally, the Hausman statistic 18.32 (p-value: 0.0189) indicated that the null hypothesis (H_0 = the fixed effects model is suitable) be rejected. That is, the Random Effects model was favoured over Fixed Effects model.

The estimated equation results are given in Table 3. Using a 10% level of significance, only national population (PT) and external debt (EDS) were found to be statistically insignificant (Table 3). Life expectancy (LEB), foreign direct investment (FDI), exports of goods and services (EGS) were found to be negative and statistically significant. While rural population (RP), the rate of inflation (ICP) and the ratio of agricultural exports to imports were found to be positive and statistically significant.

Table 4 presents the results obtained from the calculation of the elasticities for the significant variables used in the regression model, based on the results obtained in Table 3. The results show that 10% increases in life expectancy at birth, foreign direct investment and the exports of all goods and services would result in a 20%, 0.3% and 2% decreases in the percentage contribution of agriculture to GDP in this group of Latin America and Caribbean countries. However, for rural population, inflation and the ratio of agricultural exports to imports it was found that 10% increases in these variables would result in 4%, 0.03% and 0.7% increases in the percentage contribution of agriculture to GDP respectively.

Displayed in Table 5 are the results of the Likelihood ratio (LR) test, which show a chi-squared value of 139.47 (p-value = 0.0000) was obtained, indicating that the null hypothesis should be rejected. Thus, together all the regressors have a significant impact on the percentage contribution of agriculture to GDP. In

²Elasticity was calculated as $\beta_j \times \frac{\bar{X}_j}{\bar{Y}}$, where β_j is

the coefficient of the specific variable j and \bar{X}_j

and \bar{Y} are the means of the specific variable j and the mean of the dependent variable, respectively.

addition, the results of the McFadden- R^2 gave a value of 0.2231, which was fairly low, suggesting a fair fit of the model (Amaya-Amaya, Gerard and Ryan 2008).

Conclusions

Several conclusions can be drawn from the major findings presented in Table 3. Firstly, the key factors that determine agriculture's percentage contribution to GDP in the LAC countries are the size of the rural population, life expectancy at birth, foreign direct investment, the rate of inflation, exports of all goods and services and the ratio of agricultural exports to agricultural imports. All the significant variables had the expected signs as indicated in Figure 3.

The first conclusion is that the size of the rural population positively determined the percentage contribution of agriculture to GDP. Thus for countries with larger rural populations the percentage contribution of agriculture to GDP was higher suggesting the greater supply of rural labour was responsible for relatively higher agricultural production.

Countries with higher life expectancy had lower percentage contribution of agriculture to GDP. For developing countries, like those in Latin America and the Caribbean increased life span of individuals is associated with higher levels of development in the country. Thus, since increased life expectancy can be viewed as a measure of development, then it may be associated with a greater shift of resources from agriculture to services and manufacturing sectors.

Exports of all goods and services had a significantly negative impact on the percentage contribution of agriculture to GDP and in this instance the negative sign suggests that countries with a higher level of exports of all goods and services had a lower agriculture percentage contribution to GDP. Table 8 shows that the main exports of many of these countries are

commodities such as oil, minerals, apparel and natural gas. Thus, in these countries with an export focus away from agriculture, the sector may become less competitive resulting in a decline in the percentage contribution of agriculture to GDP.

The rate of inflation and the ratio of agricultural exports to agricultural imports are also determinants of the percentage contribution of agriculture to GDP. In the case of inflation, the implication of the positive elasticity is that there is a high demand for food commodities among the LAC group which is contributing to demand-pull inflation. In response agricultural producers increase their production to meet the high demand for food which results in a larger percentage contribution of agriculture to GDP with higher inflation.

With respect to the ratio of agricultural exports to agricultural imports, the positive and significant coefficient for EXIMa implies that countries with higher agricultural exports relative to imports had a higher percentage contribution of agriculture to GDP. Table 8 shows that for the LAC group, agricultural commodities are the important exports, thus further reinforcing the conclusion that agricultural exports are fueling increased agricultural production in these countries.

Recommendations

With the issue of food security at the forefront, it is recommended that LAC countries continue expanding their agricultural sectors thereby reducing their dependence on imported food products, especially in light of the recent food crisis situations. Furthermore, these countries should try to diversify their exports, so that the export focus is not just on non-agricultural commodities, but also agricultural commodities. This shift in focus may help make the sector a more viable option for investors and as a consequence increase its overall productivity.

Several Latin American and Caribbean countries that fall into the Medium Human Development category were not included in this research as relevant data for them was not available. It is hoped that improved data availability may allow these countries to be included in future research in this area. It is therefore recommended that Latin American and Caribbean countries strive to improve their macroeconomic collection and availability.

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Table 1: Japanese Declining Agricultural Land and Agricultural Working Population

Indicator	1965	1985	2005
Area of cultivated land (million ha)	6.00	5.38	4.69
Total number of farming households (million)	5.66	4.23	2.85
Agricultural working population (million)	11.51	5.43	3.35
Core agricultural workers (million)	8.94	3.46	2.24
<i>Source: Yamashita 2008.</i>			

Table 2: Study Countries and their 2009 HDI Rank

LAC Countries (2009 HDI Rank)	
Belize (93)	Haiti (149)
Bolivia (113)	Honduras (112)
Dominican Republic (90)	Jamaica (100)
El Salvador (106)	Paraguay (101)
Guatemala (122)	St. Vincent (91)
<i>Source: HDR 2009</i>	

The countries used were chosen based on:

- Belonging to the Medium Human Development (MHD) category for 2009;
- Belonging to the Latin American and Caribbean (LAC) region; and
- The availability of data for the desired period, 1980-2007.

Table 3: Estimated Random Effects Regression Model

Variable	Coefficient	Standard Error	t-ratio	p-value	Mean of X	
National Population (PT)	0.1830	0.1515	1.2080	0.2271	5.3061	
Rural Population (RP)	0.1224	0.0590	2.0730	0.0382	51.3880	**
Life Expectancy (LEB)	-0.4834	0.0950	-5.0890	0.0000	67.0073	**
Foreign Direct Investment (FDI)	-0.0024	0.0008	-2.9820	0.0029	199.0226	**
Inflation (ICP)	0.0008	0.0003	2.9470	0.0032	61.7889	**
Exports of Goods & Services (EGS)	-0.0943	0.0284	-3.3210	0.0009	34.5638	**
External Debt (EDS)	-0.0138	0.0090	-1.5270	0.1269	54.2572	
Exports/Imports (EXIMa)	1.9434	1.0397	1.8690	0.0616	0.5790	*
Constant	44.3440	8.8869	4.9900	0.0000		
Note: ** Significant at 5% level and * Significant at 10% level. Mean of Dependent Variable: 15.5159 Hausman Statistic = 18.32 (p-value: 0.0189)						

Table 4: Elasticity of Significant Variables

Variable	Elasticity
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Variable	Elasticity
Rural Population (RP)	0.4054
Life Expectancy (LEB)	-2.0876
Foreign Direct Investment (FDI)	-0.0308
Inflation (ICP)	0.0032
Exports of Goods & Services (EGS)	-0.2101
Agriculture Exports/Agriculture Imports (EXIMa)	0.0725

Table 5: Results of the Likelihood Ratio Test

Likelihood Ratio (LR) Test	
Log likelihood function	-661.5851
Restricted log likelihood	-851.5355
Chi squared (χ^2)	379.9007
Probability (Chi-Squared > value)	0.0000
McFadden Pseudo R-squared (R^2_{MCF})	0.2231

Table 6: Results of the Augmented Dickey-Fuller (ADF)

Variable	DF (τ)
AGDP	-1.7185
PT	-1.2601
RP	-0.5434
LEB	-0.2713
FDI	-5.3249
ICP	-11.2182
EGS	-4.1376
EDS	-8.3131
EXIMa	-2.0323
Note: Test at a 0.05 (-1.95) Critical Value	

Table 7: Augmented Engle-Granger Cointegration Test

Dependent Variable: D(RESID)				
Method: Least Squares				
Sample (adjusted): 1982 2007 (213 after adjustments)				
	Coefficient	Standard Error	t-Statistic	Probability
RESID(-1)	-0.0575	0.0178	-3.2263	0.0014
D(RESID(-1))	0.2029	0.0640	3.1715	0.0017

Table 8: Highest-Valued Exported and Imported Products

Country	Exports – Commodities (%)	Imports – Commodities (%)
Belize	Sugar, bananas, citrus, clothing, fish products, molasses, wood, crude oil.	Machinery and transport equipment, manufactured goods; fuels, chemicals, pharmaceuticals; food, beverages, tobacco.
Bolivia	Natural gas, soybeans and soy products, crude petroleum, zinc ore, tin.	Petroleum products, plastics, paper, aircraft and aircraft parts, prepared foods, automobiles, insecticides, soybeans.
Dominican Republic	Ferronickel, sugar, gold, silver, coffee, cocoa, tobacco, meats, consumer goods.	Foodstuffs, petroleum, cotton and fabrics, chemicals and pharmaceuticals.
El Salvador	Offshore assembly exports, coffee, sugar, textiles and apparel, gold, ethanol, chemicals, electricity, iron and steel manufactures.	Raw materials, consumer goods, capital goods, fuels, foodstuffs, petroleum, electricity.
Guatemala	Coffee, sugar, petroleum, apparel, bananas, fruits and vegetables, cardamom.	Fuels, machinery and transport equipment, construction materials, grain, fertilizers, electricity.
Haiti	Apparel, manufactures, oils, cocoa, mangoes, coffee.	Food, manufactured goods, machinery and transport equipment, fuels, raw materials.
Honduras	Apparel, coffee, shrimp, wire harnesses, cigars, bananas, gold, palm oil, fruit, lobster, lumber.	Machinery and transport equipment, industrial raw materials, chemical products, fuels, foodstuffs.
Jamaica	Alumina, bauxite, sugar, rum, coffee, yams, beverages, chemicals, wearing apparel, mineral fuels.	Food and other consumer goods, industrial supplies, fuel, parts and accessories of capital goods, machinery and transport equipment, construction materials.
Paraguay	Soybeans, feed, cotton, meat, edible oils, electricity, wood, leather.	Road vehicles, consumer goods, tobacco, petroleum products, electrical machinery, tractors, chemicals, vehicle parts.
St. Vincent & the Grenadines	Bananas, eddoes and dasheen (taro), arrowroot starch; tennis racquets.	Foodstuffs, machinery and equipment, chemicals and fertilizers, minerals and fuels.
<i>Source:</i> CIA 2010a and 2010b.		
Note: This is a listing of the highest-valued exported and imported products.		

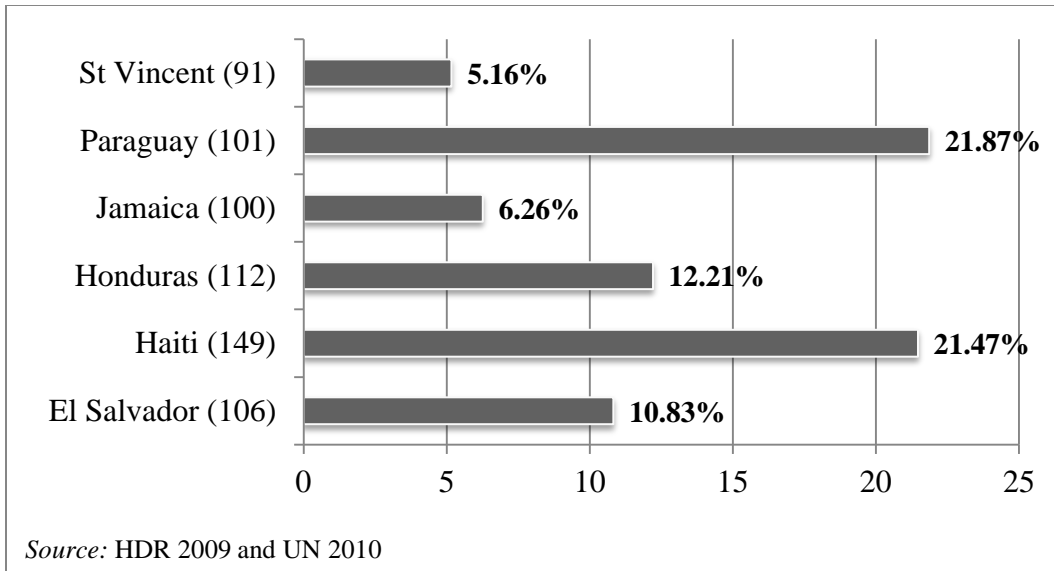


Figure 1: Selected Latin American and Caribbean Medium Human Development Countries with Agriculture's Percentage Contribution to GDP (%) and 2009, Human Development Ranking in Brackets

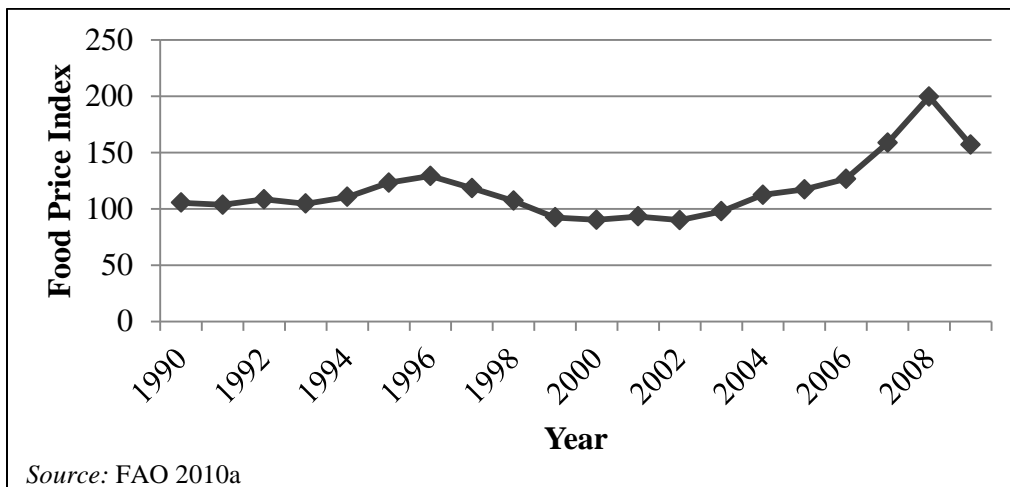


Figure 2: Annual International Food Price Index, 1990-2009