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The Impact of External Shocks and Preferential Trade Arrangements on the Agricultural Gross Domestic Product of Peru, 1950-2007

by

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Abstract

This paper examines the impact of external shocks and six preferential trade arrangements faced by the Peruvian economy during the period 1950-2007. The focus was the agricultural gross domestic product (GDP), its external and internal components, and the associated two sets of relative prices. The main results are on the one hand, that the per capita GDP shocks have affected the per capita agricultural GDP, its two components, and the associated price indices of the external agricultural GDP component. The impact on the prices of the agricultural GDP, particularly on the internal component, has been weaker. On the other hand, the set of six preferential arrangements has not affected the rate of growth of the per capita agricultural GDP and its internal GDP component in a statistically significant way. These arrangements affected, with different degrees of robustness, the agricultural GDP associated prices, particularly the external component.

Keywords: External shocks, Preferential trade, Arrangements, Agriculture, Gross Domestic Product.

The financial crisis in the United States at the beginning of 2008 (described in a series of papers and presentations such as those of Alarco, 2008; Dancourt, Jiménez, & Mendoza, 2008; Rojas-Súarez, 2008; and special issues of *The Economists' Voice,* 2008) caused serious concerns about the impact of this crisis on the main productive sectors of developing economies, particularly on the output of the agricultural sector where most poor people are involved economically. Preferential trade arrangements[1] (PTA) such as the free trade agreements are also thought to cause serious damage to agricultural output, particularly for crops where one or some of the member countries of these PTA have a comparative advantage.

Recently, Tello (2009b) using a neoclassical growth theory has merged two branches of the empirical economic growth literature, one based upon external shock-growth (discussed for example by Edwards, 2007 and Blecker, 2009) and the other upon trade-growth literature (developed, among others, by Michaely, 1977; Edwards, 1998; Rodriguez & Rodrik, 2000; Dollar & Kraay, 2004; Rajagopal, 2006) in order to estimate the effects of external shocks and a set of six preferential trade arrangements on economic growth (measured by the rate of growth of the per capita real gross domestic product, GDP) of a particular developing economy, Peru, for the period 1950-2007. Tello found that Peru´s PTAs implemented between 1970 and 2001 have not changed the rate of growth of the per capita GDP of the economy in the long run in any significant statistical sense. This result may be explained by the development strategies implemented in Peru during the period 1950-2007 (both outward- and inward-looking) and the increasing number of non-tariff trade barriers (NTB). These

trade barriers were not eliminated or reduced in number despite the strong tariff liberalization and the proliferation of PTA that have occurred in Peru and in the world since the end of the Uruguay GATT (General Agreement on Trade and Tariffs)-WTO (World Trade Organization) around 1994. These NTBs have limited and still limit market access for Peruvian export products into the main trading partner countries.

On the other hand, although external shocks have not altered the rate of growth of the per capita GDP in the long run, in the short run, they did change this rate. The magnitude and the time horizon of the external shocks' effects varied according to the development strategies and stabilization programs implemented by the government to neutralize such effects) as well as the magnitude of these shocks.

Most of the empirical economic growth literature focuses mainly on the per capita GDP rate of growth of an economy and is based upon a standard partial and/or general equilibrium framework. In contrast, this paper focuses its analysis upon the rate of growth of one particular part of an economy, the agricultural sector. The aim is to test whether the above GDP growth results hold for the per capita agricultural GDP, its external (i.e., export market-oriented products) and internal (i.e., domestic market-oriented products) GDPs and their associated relative prices for the period 1950-2007. This paper is divided into 4 sections. Section 1 summarizes key features of the GDP growth process of the agricultural sector, its two components, and relative prices. Section 2 presents the specification to be estimated and lists the variables and data sources. Section 3 reports the results and Section 4 summarizes the main conclusions of the paper.

Features of the Growth of the Per Capita Agricultural Output[2] in Peru, 1950-2007(8)

Figures 1 to 5 and Table 1 show the growth features of the agricultural per capita GDP, its three price indices, and the per capita GDP of the Peruvian economy for the period 1950-2007 and some variables into 2008.

Table 1
Indicators of the Variability of the Annual Rate of Change of the Per Capita Agricultural GDP of Peru and its Relative Price Indices, 1951-2007

Indicators	Periods									
	51-60	61-70	71-80	81-90	91-2000	2001-07	51-67	68-90	91-2007	50-2007
1. Average Annual Rate of Growth (%)										
dlny	2.4	2.9	0.7	-3.2	2.1	3.7	3.0	-1.0	2.8	1.3
dlnya	-0.4	0.5	-2.6	-0.7	3.4	2.0	-0.1	-1.4	2.8	0.3
dlnyax	4.5	-2.1	-3.2	-1.7	2.3	2.9	1.8	-2.4	2.5	0.3
dlnyai	-1.5	1.1	-2.5	-0.5	3.6	1.9	-0.4	-1.2	2.9	0.3
dlnipra1	-0.1	-0.2	-2.0	-5.3	-3.3	-1.7	0.2	-3.5	-2.6	-2.1
dlnipra2	0.3	-0.5	-1.3	-12.1	-4.2	-0.3	0.0	-5.9	-2.6	-3.2
dlniprax1	-5.7	-5.3	-2.7	-8.4	-3.6	-0.3	-5.1	-5.9	-2.3	-4.5
dlniprax2	-5.2	-5.6	-2.0	-15.2	-4.4	1.0	-5.3	-8.3	-2.2	-5.6
dlniprai1	1.7	3.9	-1.7	-4.6	-3.3	-1.9	3.2	-2.7	-2.7	-0.9
dlniprai2	2.2	3.6	-1.1	-11.4	-4.1	-0.6	3.0	-5.1	-2.7	-2.0
2. Maximum Rate of Growth of the Period (%)										
dlny	6.3	6.0	5.7	9.2	10.3	7.1	6.3	9.2	10.3	10.3
dlnya	4.0	4.7	1.2	6.4	10.6	6.6	4.0	6.4	10.6	10.6
dlnyax	9.8	6.1	2.1	15.2	24.1	19.7	9.8	15.2	24.1	24.1
dlnyai	3.1	6.2	1.0	8.1	8.7	5.7	4.5	8.1	8.7	8.7
dlnipra1	9.0	13.5	8.0	25.5	6.0	1.0	13.5	25.5	6.0	25.5

→

dlnipra2	7.3	12.1	8.4	18.3	3.5	3.2	12.1	18.3	3.5	18.3
dlniprax1	4.4	20.6	26.8	26.7	69.8	26.2	20.6	26.8	69.8	69.8
dlniprax2	7.1	17.6	24.6	24.3	71.7	31.2	17.6	24.6	71.7	71.7
dlniprai1	24.5	31.8	24.2	27.5	13.1	7.1	31.8	27.5	13.1	31.8
dlniprai2	23.7	30.4	21.2	20.3	10.5	7.4	30.4	21.2	10.5	30.4
3. Minimum Rate of Growth of the Period (%)										
dlny	-3.4	-2.5	-6.5	-16.5	-2.4	-1.3	-3.4	-16.5	-2.4	-16.5
dlnya	-7.6	-6.3	-8.7	-11.2	-11.4	-2.9	-7.6	-11.2	-11.4	-11.4
dlnyax	-3.6	-12.7	-13.3	-23.5	-16.0	-8.0	-12.7	-23.5	-16.0	-23.5
dlnyai	-9.0	-7.6	-7.8	-9.9	-10.7	-3.8	-9.0	-9.9	-10.7	-10.7
dlnipra1	-8.3	-4.9	-22.4	-35.7	-17.2	-8.0	-8.3	-35.7	-17.2	-35.7
dlnipra2	-5.5	-8.1	-17.4	-50.0	-23.1	-7.7	-8.1	-50.0	-23.1	-50.0
dlniprax1	-24.9	-28.9	-44.6	-53.6	-50.4	-27.2	-28.9	-53.6	-50.4	-53.6
dlniprax2	-26.4	-32.9	-47.6	-64.8	-53.0	-27.0	-32.9	-64.8	-53.0	-64.8
dlniprai1	-26.0	-7.8	-26.9	-49.9	-19.8	-9.0	-26.0	-49.9	-19.8	-49.9
dlniprai2	-23.2	-8.7	-21.9	-64.2	-25.7	-8.1	-23.2	-64.2	-25.7	-64.2
4. Standard Deviation of the Growth Rate (%) for the Period										
dlny	2.9	2.5	3.6	8.5	4.1	2.8	2.5	6.3	3.6	5.0
dlnya	3.4	3.1	3.0	6.5	6.2	3.2	2.8	5.1	5.1	4.8
dlnyax	5.9	5.6	5.8	13.3	13.1	8.7	6.7	9.5	11.2	9.4
dlnyai	3.6	4.1	3.0	6.6	5.6	3.4	3.3	5.3	4.8	4.9
dlnipra1	4.6	5.3	9.8	16.3	7.7	3.1	5.1	12.2	6.1	8.9
dlnipra2	3.8	5.1	7.8	19.9	8.6	3.6	4.7	14.8	7.1	10.6
dlniprax1	10.2	12.8	21.5	33.9	37.5	20.7	12.1	25.9	30.9	24.1
dlniprax2	11.1	12.7	22.2	38.2	38.4	22.3	12.5	29.0	32.0	26.0
dlniprai1	15.9	11.2	15.0	22.8	11.2	5.7	14.6	17.6	9.1	14.6
dlniprai2	14.6	10.7	12.7	24.7	11.6	4.8	13.6	18.6	9.4	15.0

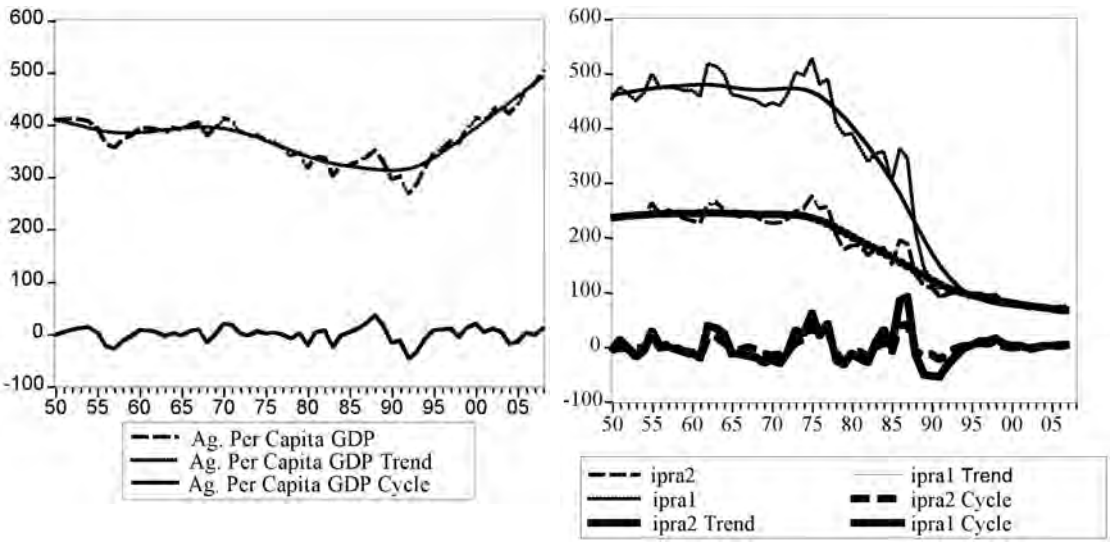

Figure 1. Trends and Cycles of the per capita Agricultural GDP and Its Relative Prices, 1950-2007/8

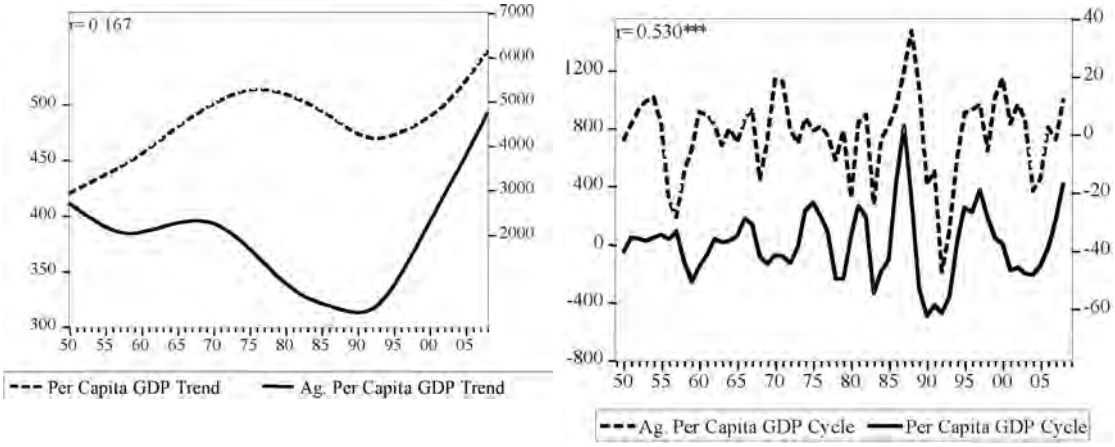

Figure 2. Synchronization of the Trend and Cycles of the per capita GDP of the Peruvian Economy and the Per Capita Agricultural GDP, 1950-2008.

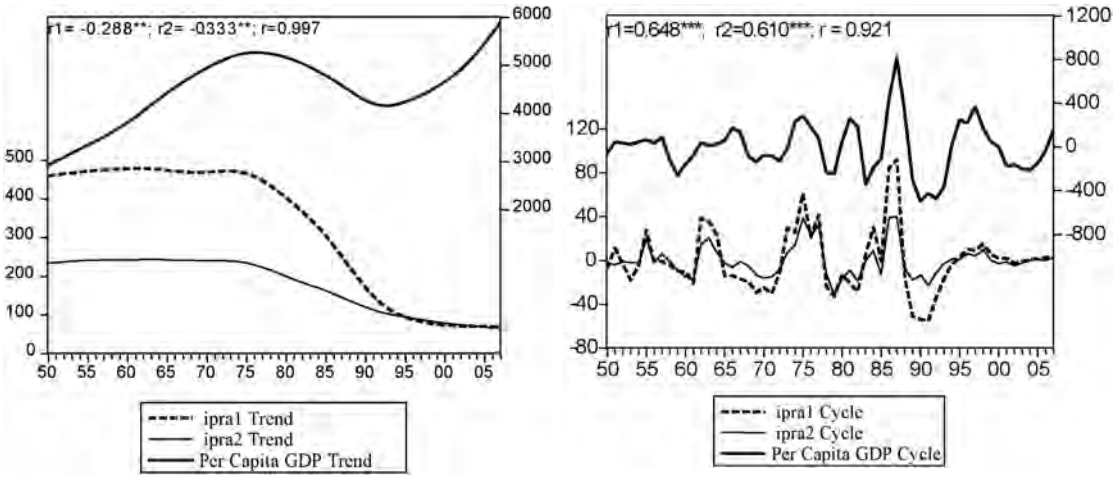

Figure 3. Synchronization of the Trend and Cycles of the per capita GDP of the Peruvian Economy and The Relative Price Indicators of the Agricultural Sector, 1950-2007.

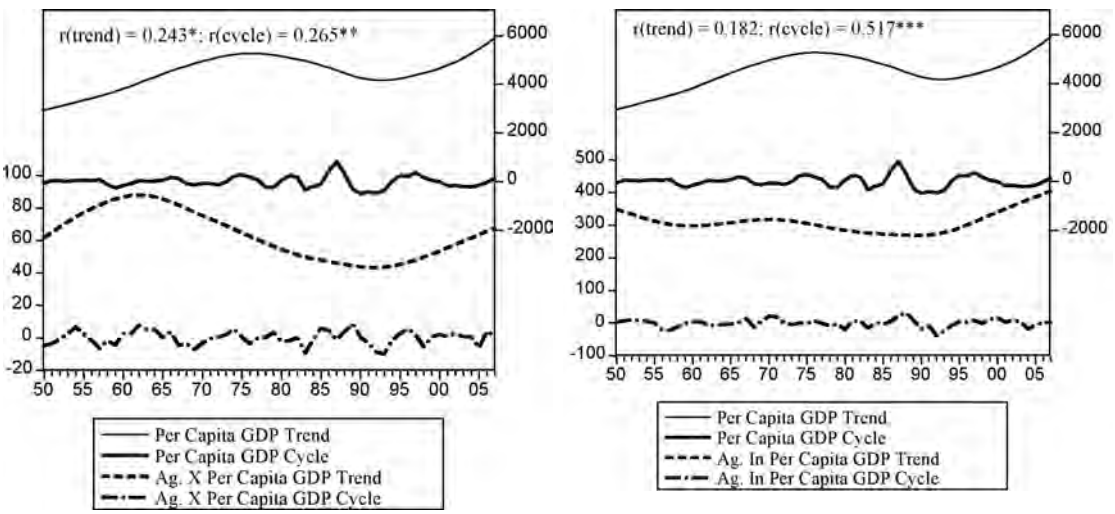

Figure 4. Synchronization of the Trend and Cycles of the per capita GDP of the Peruvian Economy and the Two Components of the Agricultural Sector, 1950-2007.

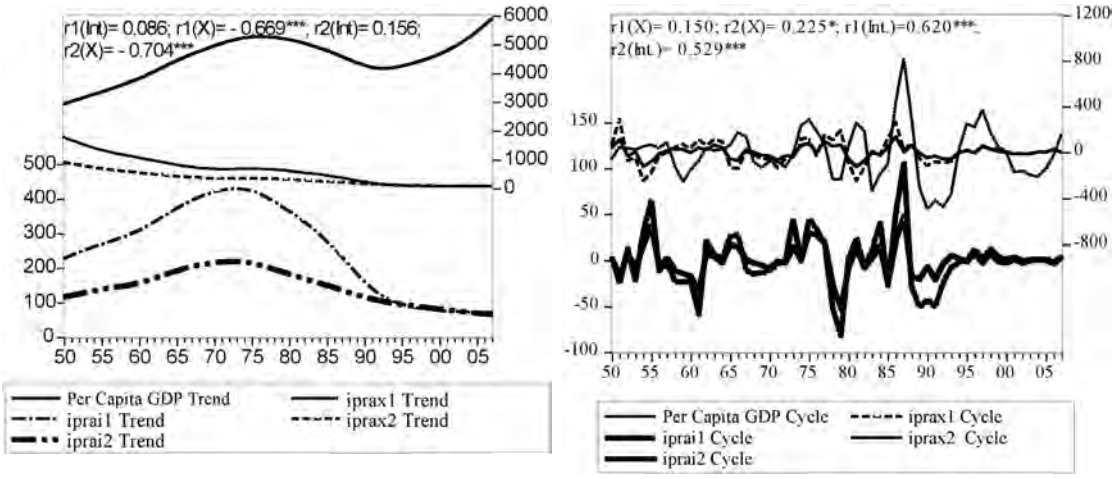

Figure 5. Synchronization of the Trend and Cycles of the per capita GDP and the Relative Prices Indices of the Two Components of the Agricultural Sector, 1950-2007

Table 1 shows the first growth feature where the average growth rate per capita in the agricultural GDP (dlnya) was practically zero for the period 1950-2007[3]. The base year for all the real variables and index numbers of this paper is 1994. The per capita agricultural GDP decreased between 1950 and 1990, recovering its past levels in the period of trade liberalization 1991-2007. Thus, from 2001 onwards, the per capita agricultural GDP has passed its maximum level registered in 1952. The agricultural output recovery occurred despite the decreasing trend of both relative price indicators: one price index relative to the consumer price index (ipr1) and the other relative to the implicit deflator of GDP (ipr2). Both relative prices have consistently decreased throughout the period 1950-2008.

A second growth feature shown in Figures 2 and 3 is that the trend[4] of the per capita agricultural GDP has not statistically and significantly synchronized[5] with the trend of the per capita GDP of the Peruvian economy. However, both associated agricultural prices and the per capita GDP are statistically significant and procyclically synchronized with the cycles of the per capita GDP of the Peruvian economy. In contrast, the trends of the associated agricultural price indices have been anticyclically synchronized to the trends of the per capita GDP of the economy[6].

The third growth feature relates to the association between the per capita GDP and the two per capita agricultural GDP components, as well as their respective associated price indices. The first component is the per capita GDP export component (yax in Table 1) derived from the set of export agricultural products. The second component is the per capita GDP non-export component (yai in Table 1) derived from the rest of the agricultural products produced mainly for the domestic market (non-tradable goods and products which are competing with imports)[7]. These associations shown in Figures 4 and 5 indicate that, except for the cycle of one of the associated price indices of the agricultural export component (iprax1), the cycles of the agricultural GDP associated price indices are statistically significant and procyclically synchronized to the cycles of the per capita GDP of the Peruvian economy. In contrast, neither the trend of the per capita non-export agricultural GDP nor the respective trend of its associated prices has been statistically synchronized to the trend of the per capita GDP of the economy. On the other hand, the trend of the per capita agricultural export GDP is statistically significant and procyclically synchronized to the trend of the per capita GDP. This is not the case for its associated price indices which are anticyclically synchronized to the trend of the per capita GDP of the economy. These results might suggest that only shocks (of internal or external sources) that actually affect the per capita GDP could impact the agricultural GDP through its non-export or internal component. However, the long run behavioral trend of the per capita GDP may not affect the agricultural product.

The fourth growth feature relates to the agricultural output and its prices: namely, the associations between the non-export and export agricultural components and the associations between their associated prices[8]. Since 1970, this aspect of growth has been similar for output and prices. The rate of growth of the per capita GDP for both agricultural components decreased from 1970 to 1990 and increased

in the period of trade liberalization 1991-2007. In contrast, the rate of growth for the price indices of both agricultural output components has been constantly negative since 1970 up to 2007. In the period 1950-1968, the rates of growth for the agricultural output components were different. The per capita non-export GDP decreased despite the fact that one price index increased and that the per capita export agricultural GDP increased in spite of the decreasing relative price indices.

The last two growth features of the behavior of the agricultural output and prices shed some light on the degree of instability of these variables (measured through the standard deviations of the rate of change of output and prices). Although the average degree of instability for both the per capita GDP of the whole economy and the agricultural sector has been similar for the period 1950-2007, in both periods of trade liberalization, namely 1950-1968 and 1991-2007, the degree of instability of the per capita agricultural GDP was greater than the degree of instability of the per capita GDP for the whole economy. In the protectionist period of 1968-1990, this difference was reversed with greater stability for the agricultural sector. Throughout the period 1950-2007, the degree of instability of the export agricultural GDP component has been greater than that of the non-export agricultural GDP component. For most of that period, the instability of the agricultural export prices has been greater than the instability of both the per capita agricultural GDP components and the associated price indices of the non-export agricultural GDP component. This last feature might suggest that external shocks are introduced into the economy through the instability of the associated prices of the agricultural export products.

In summary, the growth features of the per capita agricultural GDP, its two components, and their respective prices throughout the period 1950-2007 seem to suggest two main channels of transmission of external or internal shocks to the agricultural output in the Peruvian economy: namely, the shocks to the per capita GDP and the high degree of instability of the associated prices of export market-oriented agricultural products.

Specification and Sources of Information

This section presents two equations to estimate the impact of external shocks and preferential trade arrangements on the per capita agricultural GDP, its two components, and the prices. The theoretical foundation of these equations is based upon a standard partial equilibrium (supply and demand) framework following the methodology of Cagatay and Lattimore (2004). If the agricultural GDP is considered as a non-tradable good, an alternative theoretical interpretation of such an equation is based upon a standard general equilibrium framework as presented in Dixit and Norman (1980). Three specific facts may support this interpretation: (a) on average, for the period 1950-2007, 83% of the total GDP was oriented to the domestic market (Table A1), (b) in 2006 and 2007, imported and exported agricultural products represented around 3% of the total agricultural output, and (c) in 2007, the average for the 13 main agricultural export goods represented only 35% of the total output value of these goods. This means that not all of the export component of the agricultural GDP is exported. On average, in 2007, only 35% of this component was exported. The equations are as follows:

[2.1] $y_a = F(p, y, T, z)$;

[2.2] $p_a = G(p, y, T, z)$;

in which y_a, is the per capita agricultural GDP, p_a is the relative price, p represents the relative prices of tradable goods directly associated with international prices, y is the per capita GDP of the economy, T is the technology in the agricultural sector, and z is the set of economic policy variables and other incidental factors that may affect the agricultural GDP and its associated prices. Under the first theoretical interpretation, these equations are reduced forms of a standard supply and demand framework for the agricultural product. Demand factors are variables y and p, supply factors are variables T and y (as proxy of labor costs), and z relates to other variables which may affect demand and supply equations.

In this framework, y affects the output and prices positively if the demand effects overcome labor cost supply effects. Otherwise, the income effects would be negative or ambiguous. Technology affects agricultural output positively and prices negatively. International prices, p, may affect agricultural output positively if this is a substitute (for consumers and producers) for the tradable goods, and its effects on agricultural prices would be ambiguous. Otherwise, the output and price effects of changes of p would be ambiguous.

Under the second theoretical interpretation, these equations represent the output and the relative price equations of a non-tradable good in a general equilibrium framework. In this case, p is the exogenous international price of the tradable goods of the economy, y represents a proxy variable of the endowment of capital per head of the economy, T the technology factor of the agricultural sector, and z the economic policy variables and other incidental factors which may affect the agricultural product.

In this second general equilibrium framework, y (as the per capita income or a consequence of economic growth) affects agricultural output positively with ambiguous effects on its associated prices. These latter effects are defined by the difference in the use of the factors of production between the tradable and non-tradable goods and the source of the changes in y. Terms of trade (p) affect agricultural output positively if the income effect derived by p overcomes its supply factor cost effect. Otherwise, its effect on output would be ambiguous. The effect of p on the associated prices is ambiguous. The technology variable (T) affects agricultural output positively and its associated prices negatively.

In both frameworks, external shocks, preferential trade arrangements, and other macroeconomic incidental factors are introduced through z. Variables in z come from the empirical economic growth literature. One author, Edwards (2007), emphasizes the effects of external shocks on economic growth, whereas another, Rajagopal (2006), emphasizes the impact of trade policies and PTA on economic growth. Consequently, external shocks and PTA affects agricultural output and its associated prices through z under both theoretical interpretations. The theoretical framework of the growth effects of external shocks has been developed by many authors, including Calvo (1998), and the growth effects of PTA by Baldwin and Venables (1995) and Seghezza (2003a, 2003 b) among others. Tello (2009b, 2010a) summarizes both sets of models found in the literature. In general, external shocks will affect output negatively and associated prices positively, and the effects of PTAs on output and prices are ambiguous. These latter effects would depend either on the trade creation and diversion effects of PTAs or on the effects of PTAs on the sources of economic growth.

To estimate all these effects, the following two specifications are based upon the differentials of equations [2.1] and [2.2] respectively:

[2.3] $$d\ln y_{at} = \alpha_0 + \alpha_1 . d\ln p_t + \alpha_2 . d\ln y + \alpha_3 . d\ln T_t + \sum_{K=1}^{Nk} \delta_k . X_{kt} + \varepsilon_t ;\ t= 1952\text{-}2007;$$

[2.4] $$d\ln p_{at} = \beta_0 + \beta_1 . d\ln p_t + \beta_2 . d\ln y_t + \beta_3 . d\ln T_t + \sum_{K=1}^{Nk} \theta_k . X_{kt} + \mu_t ;\ t= 1952\text{-}2007;$$

where *d*ln is an operator representing the differential of the natural logarithm[9].

There are three dependent variables used for equation [2.3]. These are $dlny_{at}$, $dlny_{ait}$ and $dlny_{axt}$. These variables correspond to the rate of growth of the per capita agricultural GDP and the internal and export components of GDP respectively. For equation [2.4], six dependent variables are used. The first three dependent variables are $dlnipra_{1t}$, $dlniprai_{1t}$, and $dlniprax_{1t}$.They correspond to the rates of growth of the relative price indices (based on the year 1994) with respect to the consumer price index in period t of the agricultural output and the internal and external components. The next three dependent variables are $dlnipra_{2t}$, $dlniprai_{2t}$, $dlniprax_{2t}$. They correspond to the rates of growth of the relative price indices with respect to the price deflator of the GDP in period t of the agricultural output and the internal and external components.

The set of independent and basic variables used in both specifications are the following:

- $dlnT_t$ is the rate of growth of the terms of trade at period t defined as the export price index (in US dollars, year base of 1994) of goods over the import price (also in US dollars, year base of 1994) index of goods. This variable also represents a source of external shock for the economy and the agricultural sector.
- $dlny_t$ is the rate of growth of the real per capita GDP (based on the year 1994) in period t.
- $dlnyf_t$ is the rate of growth of the estimated trend of the per capita GDP (based on the year 1994) using the Hodrick and Prescott (1997) method with λ=100.

- cylncy$_t$ is the estimated cycle component or the estimated filter of the rate of growth of the per capita GDP (based on the year 1994) using the Hodrick and Prescott (1997) method with λ=100. This and the former variables are used to capture the difference of the effects between the trend and cycle components of the demand factor, yt, on the agricultural output. The results shown in the next section verify the hypothesis that the demand factor affects the agricultural output mainly through the cyclical component of this demand.
- dlnrendt is the rate of growth of the annual average land productivity per hectare in period t.

The set of independent variables X_{kt} is divided into three groups. The first group represents preferential trade arrangements[10]. The second group represents external shocks. The third group is a set of macroeconomic variables related to financial restrictions, real exchange rate instability, the trend or time variable, the phenomenon of *El Niño*, and the degree of openness of the economy representing the degree of liberalization of economic policy.

Preferential trade arrangements implemented in Peru in the period 1970-2000 are represented by two variables. The first is denoted by "A" followed by the acronym of the preferential arrangement. This variable is either 1from the initial year of the implementation of the arrangement up to the end of it, or zero otherwise. The second variable is denoted by "At'" followed by the acronym of the preferential arrangement. This variable is either the value of the "time" variable during the implementation of the arrangement or zero otherwise. The "time" variable is an integer allocated for each year of the estimation period.

The first variable attempts to capture the "temporary" effect of the arrangement on the dependent variable (i.e., it changes the intercept). The second variable attempts to capture the permanent effect of the arrangement on the dependent variables through the change of the coefficient of the time variable. The set of PTAs considered in the estimations are the following:

- CAN is the Andean community. The starting year of the variable ACAN is 1971. In 1993, Peru temporarily withdrew from the agreement till 1997. Therefore, in the period 1993-1997 the value of ACAN is zero.
- CANAR/BR is the Partial Economic Complementation agreement between the Andean Community (excluding Bolivia) and Argentina and Brazil. The initial year of the implementation of the arrangement with Argentina was 2001 and that for Brazil was 2000. To avoid multicolinearity, only one PTA is taken representing both agreements. Therefore, the starting year for CANAR/BR was taken as 2001.
- MEX is the Partial Economic Complementation agreement between Peru and Mexico which started in 1987.
- CHI is the Partial Economic Complementation agreement between Peru and Chile which started in 1998.
- ATPDEA is the Andean Trade Promotion Drug Eradication Act which is a generalized system of preferences granted by the United States to the country members of the Andean Community. These preferences started in 1992 with the Andean Trade Promotion Act, and it was extended in 2002 to the end of 2008. In January of 2009, a free trade agreement between Peru and the United States replaced this ATPDEA.

Peru represents the unilateral preferential trade arrangement which covers the three periods of trade liberalization (and structural reforms) implemented during, 1950-1967; 1980-1982 and 1990-2007.

The second set of variables represents external shocks. Calvo (1998), Milesi-Ferreti and Razin (2000), and Kaminski (2003), among others, have developed a variety of models on crisis and external shocks that may affect the output of an economy. These external shocks may be a sudden stop of the inflows of international capital to an economy, a current account reversal when the deficit of this current account suddenly changes into a surplus for this account, a reduction in foreign exchange capacity of an economy to import goods and services, and terms of trade shocks which is also considered as a basic variable in both specifications. Following the approach of Edwards (2007), these external shocks are incorporated in the output and relative price equations. However, and in contrast with Edward's work, the impact of these external shocks is tested on the rate of growth of the per capita agricultural GDP rather than on the rate of economic growth of the Peruvian economy.

These latter effects have previously been estimated by Tello (2009b). The external shocks variables are the following:

- DSS is a dummy variable representing "Sudden Stops" or a sudden fall of international capital inflows into the Peruvian economy. This variable takes the value of one for six years: 1954, 1976, 1978, 1983, 1984, and 1998 and zero for the rest of the years[11]. In the non-zero years, the fall of the financial account[12] out of the GDP was equal or greater than 4%.
- Dreversal is a dummy variable representing "Current Account Reversals" or a drastic change from a deficit to a surplus of the current account of the balance of payments of Peru. This variable takes the value of one in the following 7 years: 1959, 1968, 1978, 1979, 1983, 1984, and 1989 and zero for the rest of the years[13]. In such years, the reduction of the deficit of the current account relative to the GDP has been at least 4%. This is similar to the result for the sudden stop variable.
- dlncimport is the rate of annual change of the import capacity during period t. This is defined as the real value in American dollars of the imports of goods plus the change in international reserves for the balance of payments. This indicator was suggested by Dancourt, Mendoza, & Vilcapoma (1997) to capture the changes of the terms of trade, the changes in international interest rates, and the degree of the availability of external credit.

The third group of variables represents incidental factors which are standard in economic growth equations (e.g., Barro, 1991; Dinoupolos & Thompson, 2000). The variables are the following:

- Dniño and dtniño represent the potential effects on prices and outputs of the El Niño phenomenon in the years when this event occurred. These were 1982, 1983, 1997, and1998. The Dniño is a dummy variable similar to the "A" variable in the set of preferential trade arrangements and dtniño is equivalent to the variable "At." The first variable captures the temporary effect of the current *El Niño* and the second variable captures the permanent effect on the dependent variable.
- dlncredit is the annual rate of change of the share of domestic credit out of the GDP during period t.
- dlncolt is the annual rate of change of the value of loans set by the private banks during period t. This and the former variables, as supply factors, are expected to affect the output positively and the relative prices negatively.
- dlnAPt is the annual rate of change for the degree of openness of the Peruvian economy and defined as the ratio between the real value of exports plus imports of goods over the real GDP.
- dlnAP't is the same variable as dlnAPt with values only for the three periods of trade liberalization, 1950-1967, 1980-1982, and 1991-2007. For all other years the value is zero. The regression coefficient of this variable measures the differences of the effects on the dependent variable, namely, the changes in economic policy, from an inward-oriented closed policy to an outward-oriented liberal economic policy in the Peruvian economy.
- σ(TCR) is the standard deviation of the rate of change of the monthly bilateral real foreign exchange rate of Peru compared to that of the United States during period t[14].

Except for the variables dlnrendt and dlncolt, the sources of information for the rest of variables were The Central Reserve Bank of Peru (BCRP, 2009) and the National Statistical Institute (INEI, 2009). The source for variable dlncolt was the (Superintendencia de Bancos y Seguros, SBS, 2009) and for the land productivity, the Peruvian Ministry of Agriculture (MINAG, 2009). The consumer price index of the United States was taken from the Bureau of Economic Analysis (BEA, 2009). The annual rate of change of land productivity was obtained as the weighted average of the annual rate of change of land productivity for 55 agricultural products. The weights used for each product were estimated as the average (from period 1950-2007) of the ratio between the real output value of each product, valued according to the farm prices of 1994, divided by the total real output value of the 55 agricultural products. The real agricultural export GDP was estimated by multiplying the real gross output value of 13 agricultural export products (see the list in Table A1), valued according to the farm prices of 1994, by 0.71 (which is the ratio of value added over gross output value of the agricultural sector of the input-output tables of 1994, INEI, 2000).

The agricultural non-export GDP was obtained from the difference between the real agricultural GDP and the estimated agricultural export GDP[15]. The price indices of both components of the agricultural

GDP were obtained by dividing the nominal values of the respective agricultural GDP by the real GDP values. The nominal agricultural export GDP valued in Peruvian soles for year "t" was obtained in two steps: (a) multiplying agricultural exports valued in US dollars of that year by the exchange rate and (b) multiplying this result by the ratio of the nominal agricultural export GDP in Peruvian soles for the year 1994 with the agricultural export value in Peruvian soles of the same year. The nominal agricultural non-export GDP was obtained from the difference between the nominal agricultural GDP and the nominal agricultural export GDP component. Finally, the two relative price indices were obtained by dividing the price indices of both agricultural components first by the consumer price index and then by the GDP deflator index.

Results and Research Hypotheses Drawn from the Estimations

The coefficients of the set of estimations for the rate of growth of the per capita agricultural GDP, its two export and non-export components (i.e. equation [2.3]) and their associated price indicators (i.e. equation [2.4]) are reported in Tables 2 to 4. Each table has 4 columns per dependent variable. The first two columns report the minimum and maximum coefficient values of the set of regressions estimated for the respective dependent variable. The last two columns report the percentage of coefficients with negative and positive signs which have been statistically significant (at most at 10% degrees of significance) out of the total number of coefficients estimated for each independent variable. The standard errors reported (used in all the last squares, LS, estimations) have been estimated using the heteroscedasticity correction (White, 1981). This set of LS regression estimations provides insights on the degree of robustness of the results. The number of regressions estimated is described in each table.

The first group of results comes from the estimated coefficients of the basic variables.

Thus, the numbers in Table 2 show that shocks to the per capita GDP of the economy (represented by the coefficient variable cydlny), regardless of their sources (i.e. demand or supply, and external or internal shocks), may be transmitted to the per capita agricultural GDP, particularly to its non-export (or internal) component. Furthermore, this transmission has been procyclical. This result comes from the fact that the annual rate of growth of the per capita GDP and its cyclical component (cydlnyt) have had positive and statistically significant coefficients in all the estimations implemented in which dlnyat and dlnyait were the dependent variables. Furthermore, the magnitude of the coefficients of dlnyt and cydlnt was very similar. The degree of robustness of the statistical impact of the per capita GDP on the export agricultural GDP component is weaker. Only 50% of the coefficients of dlnyt and cydlnyt were positive and statistically significant.

A second result is that changes of the terms of trade also affect the per capita agricultural GDP; particularly its export GDP component, and that the effects on both are procyclical. A third result is that cycles of the per capita GDP on the economy are transmitted pro-cyclically to the relative prices of the agricultural sector, primarily from the export component. The degree of robustness of the effects of those cycles on the relative prices of the agricultural non-export GDP has been weaker. These three results (which are consistent with the theoretical frameworks described in the previous section) have been reinforced by empirical literature that focuses on the macroeconomic and external shocks of the agricultural sector. This literature is not extensive and most of the literature concentrates its analyses on African countries (e.g., Barros, Spolador, & Bacchi, 2009; Kargbo, 2007; Mkandawire & Soludo, 2003).

A second group of results or hypotheses are derived from estimated coefficients of the PTAs. For these coefficients, most of the statistically significant effects were concentrated on the relative prices of the non-export agricultural GDP component. The effects on the agricultural output were not robust or statistically significant in all the estimations shown in Tables 2 to 4. The PTAs effects on relative price have, in most cases, been temporary for the first year of PTAs implementation; thereafter, the associated prices recovered their original trend. This result comes from the fact that the sign (the positive or negative value) of the temporary effect coefficients (i.e., the "A" variable) are opposite to the sign of the permanent effect coefficient (i.e., the "At" variable). Interestingly, not all arrangements affected the relative prices. Thus, for the relative price indices of the agricultural export GDP component, the arrangements which had statistically significant coefficients were as follows: the CAN agreement

Table 2

Regression Coefficients of the Per Capita Agricultural GDP Equation, [2.3], and Its Relative Prices Indices Equations, [2.4] of Peru: 1952-2007

Depent. Var.	dlnya				dlnipra1				dlnipra2			
Independent Variables	Estimated Coefficients		% of Coef. Statistically. Signif.		Estimated Coefficients		% of Coef. Statistically. Signif.		Estimated Coefficients		% of Coef. Statistically. Signif.	
	Mín.	Máx.	Posit.	Negat.	Mín.	Máx.	Posit.	Negat.	Mín.	Máx.	Posit.	Negat.
1. Basic Variables												
constant	-0.27	0.02	0.0	0.0	-0.03	0.25	0.0	0.0	-0.14	0.34	0.0	0.0
dlnrend	0.51***	0.67***	100.0	0.0	-0.54*	-0.05	0.0	8.3	-0.41	-0.02	0.0	0.0
dlnTIt	0.13*	0.29***	100.0	0.0	-0.64***	-0.19	0.0	50.0	-0.75***	-0.31**	0.0	0.0
dlny	0.89***	1.01***	100.0	0.0	0.94*	1.38***	75.0	0.0	0.51	0.84**	25.0	0.0
dlnyf	-0.39	2.78	0.0	0.0	-0.89	2.30	0.0	0.0	-3.38	2.96	0.0	0.0
cydlny	0.89***	0.99***	100.0	0.0	0.93*	1.37***	75.0	0.0	0.51	0.82	25.0	0.0
2. Preferential Trade Arrangements												
ACAN	-0.05	-0.02	0.0	0.0	-0.04	0.02	0.0	0.0	-0.01	0.06	0.0	0.0
AtCAN	0.00	0.00	0.0	0.0	0.00	0.00	0.0	0.0	0.00	0.00	0.0	0.0
ACanar/br	-0.44	5.65	0.0	0.0	-18.10*	-11.86*	0.0	75.0	-19.10	-13.29	0.0	25.0
AtCanar/br	-0.11	0.01	0.0	0.0	0.24*	0.36*	75.0	0.0	0.27	0.38	25.0	0.0
AChi	-5.45	1.16	0.0	0.0	11.00	17.57*	16.7	0.0	12.15	18.37	0.0	0.0
AtChi	-0.02	0.11	0.0	0.0	-0.36*	-0.22	0.0	16.7	-0.37	-0.24	0.0	0.0
AMex	-0.69	0.89	0.0	0.0	-1.48	1.21	0.0	0.0	-2.37	0.15	0.0	0.0
AtMex	-0.02	0.02	0.0	0.0	-0.03	0.04	0.0	0.0	-0.01	0.06	0.0	0.0
AAtpdea	-0.40	1.02	16.7	0.0	-2.21	0.90	0.0	0.0	-0.41	1.26	0.0	0.0
AtAtpdea	-0.03*	0.01	0.0	33.3	-0.01	0.06	0.0	0.0	-0.02	0.02	0.0	0.0
Aperu	-0.04	0.03	0.0	0.0	-0.05	0.06	0.0	0.0	0.05	0.14	0.0	0.0
AtPeru	0.00	0.00	0.0	0.0	0.00	0.00	0.0	0.0	-0.01	0.00	0.0	0.0
3. External Shocks												
Dreversalt	-0.06***	0.00	0.0	16.7	0.03	0.12	25.0	0.0	0.06	0.13	0.0	0.0
DSSt	-0.02	0.00	0.0	0.0	-0.03	0.01	0.0	0.0	-0.05	-0.03	0.0	0.0
dlncimport	-0.10**	-0.03	0.0	66.7	0.01	0.21**	16.7	0.0	0.02	0.17*	8.3	0.0
4. Control Variables												
dlncredit	0.04	0.07	0.0	0.0	-0.21	0.00	0.0	0.0	-0.12	-0.04	0.0	0.0
dlncol	0.06	0.07*	66.7	0.0	-0.14**	-0.10	0.0	50.0	-0.19**	-0.16*	0.0	100.0
σ(TCR)	-0.32	0.27**	33.3	0.0	-0.91**	-0.23	0.0	33.3	-0.56**	0.08	0.0	16.7
dlnAP	0.15*	0.40***	100.0	0.0	-0.99***	-0.38**	0.0	100.	-1.04***	-0.60***	0.0	100.0
dlnAP´	-0.52**	-0.12	0.0	66.7	-0.25	0.39	0.0	0.0	-0.06	0.38	0.0	0.0
Dniño	-0.30	0.15	0.0	0.0	0.36	0.87**	33.3	0.0	0.40	0.72	0.0	0.0
dtniño	0.00	0.01	0.0	0.0	-0.02**	-0.01	0.0	25.0	-0.02	-0.01	0.0	0.0
time	0.00	0.01	0.0	0.0	-0.01	0.00	0.0	0.0	-0.02	0.00	0.0	0.0
Adjusted R^2	0.77***	0.90***	100.0		0.73***	0.86***	100.0		0.63**	0.72*	100.0	

The number of regressions estimated for equation [2.3] was six and twelve for equation [2.4]. For the equation of associated prices, variables dlny and cdlny were included in four regressions; dlncredit, dlncol and σ(TCR) were included in six regressions and variable dlnyf in eight. For the equation of the per capita agricultural GDP, dlny and cdlny were included in two regressions, variables dlncredit and dlncol in three regressions, and dlnyf in four. The rest of variables were included in all the regressions of each equation. '*' means 10% of level of significance; '**' means 5% and '***' at most 1% level of significance. When the variable dlncredit was included, the period of the regressions was 1961-2006 in all other cases the period of the regressions was 1952-2007.

Table 3
Regression Coefficients of the Per Capita Non-Export Agricultural GDP Equation, [2.3], and Relative Price Indices Equations [2.4] of Peru: 1952-2007

Depent.Var.	dlnya				dlnipra1				dlnipra2			
Independent Variables	Estimated Coefficients		% of Coef. Statistically. Signif.		Estimated Coefficients		% of Coef. Statistically. Signif.		Estimated Coefficients		% of Coef. Statistically. Signif.	
	Mín.	Máx.	Posit.	Negat.	Mín.	Máx.	Posit.	Negat.	Mín.	Máx.	Posit.	Negat.
1. Basic Variables												
constant	-0.38	0.01	0.0	0.0	-0.13	0.58	0.0	0.0	-0.24	0.66	0.0	0.0
dlnrend	0.46*	0.63***	100.0	0.0	-0.63	-0.09	0.0	0.0	-0.49	-0.04	0.0	0.0
dlnTIt	0.12	0.29**	33.3	0.0	-0.79**	-0.31	0.0	50.0	-0.90**	-0.42	0.0	83.3
dlny	0.87***	1.07**v	100.0	0.0	0.26	1.99**	25.0	0.0	-0.18	1.44	0.0	0.0
dlnyf	0.45	4.88	0.0	0.0	-2.47	7.21	0.0	0.0	-4.84	7.93	0.0	0.0
cydlny	0.86***	1.01**	0.0	0.0	0.30	1.92**	25.0	0.0	-0.09	1.36	25.0	0.0
2. Preferential Trade Arrangements												
ACAN	-0.10	-0.06	0.0	0.0	-0.22	-0.04	0.0	0.0	-0.19	-0.02	0.0	0.0
AtCAN	0.00	0.00	0.0	0.0	0.00	0.01	0.0	0.0	0.00	0.01	0.0	0.0
ACanar/br	1.70	8.30	0.0	0.0	-38.29**	-24.86	0.0	25.0	-38.59	-23.60	0.0	25.0
AtCanar/br	-0.17	-0.03	0.0	0.0	0.50	0.77**	25.0	0.0	0.47	0.77*	25.0	0.0
AChi	-8.10	1.15	0.0	0.0	24.39	39r.37*	25.0	0.0	23.27	39.33*	25.0	0.0
AtChi	0.02	0.16	0.0	0.0	-0.80*	-0.49	0.0	25.0	-0.80*	-0.47	0.0	25.0
AMex	-0.20	1.84	0.0	0.0	0.12	4.10	0.0	0.0	-0.02	2.64	0.0	0.0
AtMex	-0.05	0.01	0.0	0.0	-0.10	0.00	0.0	0.0	-0.06	0.00	0.0	0.0
AAtpdea	-1.01	0.89	0.0	0.0	-6.64	0.11	0.0	0.0	-4.76	0.21	0.0	0.0
AtAtpdea	-0.02	0.02	0.0	0.0	0.00	0.17	0.0	0.0	0.00	0.12	0.0	0.0
Aperu	-0.08	0.00	0.0	0.0	-0.16	0.09	0.0	0.0	-0.05	0.15	0.0	0.0
AtPeru	0.00	0.00	0.0	0.0	0.00	0.01	0.0	0.0	-0.01	0.00	0.0	0.0
3. External Shocks												
Dreversalt	-0.07*	0.00	0.0	16.7	0.07	0.22	25.0	0.0	0.08	0.22	0.0	0.0
DSSt	0.00	0.02	0.0	0.0	0.00	0.09	0.0	0.0	-0.04	0.06	0.0	0.0
dlncimport	-0.11**	-0.03	0.0	66.7	-0.04	0.17	0.0	0.0	0.03	0.13	0.0	0.0
4. Control Variables												
dlncredit	0.08	0.11	0.0	0.0	-0.39	-0.02	0.0	0.0	-0.30	-0.06	0.0	0.0
dlncol	0.08*	0.10***	100.0	0.0	-0.02	0.05	0.0	0.0	-0.07	-0.01	0.0	0.0
σ(TCR)	-0.35	0.26	0.0	0.0	-1.65***	-1.22	0.0	83.3	-1.31**	0.85	0.0	33.3
dlnAP	0.15	0.43***	83.3	0.0	-1.39***	-0.50	0.0	750.	-1.44***	-0.72*	0.0	100.0
dlnAP´	-0.53*	-0.12	0.0	66.7	-0.65	0.06	0.0	0.0	-0.43	0.05	0.0	0.0
Dniño	-0.35	0.07	0.0	0.0	0.45	1.39	0.0	0.0	0.39	1.25	0.0	0.0
dtniño	0.00	0.01	0.0	0.0	-0.04	-0.01	0.0	0.0	-0.03	-0.01	0.0	0.0
time	0.00	0.02	0.0	0.0	-0.03	0.00	0.0	0.0	-0.03	0.00	0.0	0.0
Adjusted R^2	0.73***	0.86***	100.0		0.55	0.75**	91.7		0.64		0.0	

The number of regressions estimated for equation [2.3] was six and twelve for equation [2.4]. For the equation of associated prices, variables dlny and cdlny were included in four regressions; dlncredit, dlncol and σ(TCR) were included in six regressions and variable dlnyf in eight. For the equation of the per capita agricultural GDP, dlny and cdlny were included in two regressions, variables dlncredit and dlncol in three regressions, and dlnyf in four. The rest of variables were included in all the regressions of each equation. '*' means 10% of level of significance; '**' means 5% and '***' at most 1% level of significance. When the variable dlncredit was included, the period of the regressions was 1961-2006 in all other cases the period of the regressions was 1952-2007.

Table 4

Regression Coefficients of the Per Capita Export Agricultural GDP Equation, [2.3], and the Relative Price Indices Equations, [2.4] of Peru: 1952-2007

Depent.Var.	dlnya				dlnipra1				dlnipra2			
Independent Variables	Estimated Coefficients		% of Coef. Statistically. Signif.		Estimated Coefficients		% of Coef. Statistically. Signif.		Estimated Coefficients		% of Coef. Statistically. Signif.	
	Mín.	Máx.	Posit.	Negat.	Mín.	Máx.	Posit.	Negat.	Mín.	Máx.	Posit.	Negat.
1. Basic Variables												
constant	-0.14	0.23	0.0	0.0	-1.60	0.08	0.0	0.0	-1.41	-0.05	0.0	16.7
dlnrend	0.92***	1.16***	100.0	0.0	-0.09	0.75	0.0	0.0	-0.05	0.74	0.0	0.0
dlnTIt	0.21	0.35	75.0	0.0	-0.01	0.91*	16.7	00.0	-0.20	0.76	0.0	0.0
dlny	0.47	0.89-	50.0	0.0	4.54**	5.10**	100.0	0.0	4.17**	4.68***	100.0	0.0
dlnyf	-4.44	-2.40	0.0	0.0	-8.71	14.47	0.0	0.0	-7.61	11.56	0.0	0.0
cydlny	0.58	0.90*	50.0	0.0	4.57**	5.00**	100.0	0.0	4.19**	4.62**	100.0	0.0
2. Preferential Trade Arrangements												
ACAN	0.06	0.13	0.0	0.0	0.44	0.72	16.7	0.0	0.48	0.75	33.3	0.0
AtCAN	0.00	0.00	0.0	0.0	-0.03*	-0.02	0.0	50.0	-0.04*	-0.02	0.0	66.7
ACanar/br	-14.50*	-6.41	0.0	37.5	39.16	82.05**	83.3	0.0	42.03*	78.71**	100.0	0.0
AtCanar/br	0.13	0.29*	37.5	0.0	-1.65**	-0.78	0.0	83.3	-1.58**	-0.84*	0.0	100.0
AChi	7.67	16.59*	50.0	0.0	-87.98**	-40.51	0.0	66.7	-84.53**	-43.73*	0.0	100.0
AtChi	-0.34*	-0.16	0.0	50.0	0.82	1.79**	66.7	0.0	0.89*	1.72**	100.0	0.0
AMex	-2.96***	-1.32	0.0	50.0	-13.65***	-4.97	0.0	83.3	-14.0***	-6.57	0.0	83.3
AtMex	0.03	0.07***	50.0	0.0	0.11	0.33***	83.3	0.0	0.15	0.34***	83.3	0.0
AAtpdea	-0.62	0.53	0.0	0.0	10.73	14.38**	66.7	0.0	11.33*	15.01	83.3	66.7
AtAtpdea	-0.01	0.02	0.0	0.0	-0.34**	-0.25	0.0	66.7	-0.36	-0.27	0.0	0.0
Aperu	0.06	0.21**	37.5	0.0	0.03	0.42	0.0	0.0	0.12	0.47	0.0	0.0
AtPeru	-0.01**	0.00	0.0	50.0	-0.03	-0.02	0.0	0.0	-0.03*	-0.02	0.0	0.0
3. External Shocks												
Dreversalt	-0.03	0.01	0.0	0.0	-0.18	0.02	0.0	0.0	-0.15	0.05	0.0	0.0
DSSt	-0.10**	-0.08**	0.0	100.0	-0.17	0.00	0.0	0.0	-0.19	-0.04	0.0	0.0
dlncimport	-0.05	0.01	0.0	0.0	-0.09	0.44*	16.7	0.0	-0.08	0.43*	16.7	0.0
4. Control Variables												
dlncredit	-0.20	-0.18	0.0	0.0	-0.12	-0.02	0.0	0.0	-0.15	-0.05	0.0	0.0
dlncol	-0.08	-0.06	0.0	0.0	-0.23	-0.18	0.0	0.0	-0.27	-0.22	0.0	0.0
σ(TCR)	0.00	0.45	0.0	0.0	0.95	3.64***	66.7	0.0	1.29	3.94***	83.3	0.0
dlnAP	0.08	0.31*	25.0	0.0	-0.38	0.62	0.0	0.0	-0.61	0.39	0.0	0.0
dlnAP´	-0.36	0.14	0.0	0.0	0.39	3.16**	16.7	0.0	0.64	3.13	16.7	0.0
Dniño	0.19	0.81**	25.0	0.0	-1.80	0.74	0.0	0.0	-1.77	0.64	0.0	0.0
dtniño	-0.02**	-0.01	0.0	25.0	0.01	0.07	0.0	0.0	0.01	0.07	0.0	0.0
time	-0.01	0.00	0.0	0.0	0.00	0.07	0.0	0.0	0.00	0.06	0.0	0.0
Adjusted R2	0.80***	0.89***	100.0		0.66**	0.84***	100.0		0.67**	0.84***	100.0	

The number of regressions estimated for equation [2.3] was eight and six for equation [2.4]. For the associated prices equations, variables dlny and cdlny were included in two regressions, variables dlncredit and dlncol in thress regressions, and variable dlnyf in four. For the capita export agriculture GDP equation, variables dlny and cdlny were included in two 2 regressions, variables dlncredit and dlncol in four regression, and dlnyf in four. The rest of variables were included in all the regressions of each equation. '*' means 10% of level of significance; '**' means 5% and '***' at most 1% level of significance. When the variable dlncredit was included, the period of the regressions was 1961-2006 in all other cases the period of the regressions was 1952-2007.

with Argentina and Brazil (with an 83% statistically significant positive coefficient for ACanar/br and a 100% negative coefficient for AtCanar/br), the agreement between Peru and Chile (with an 67% statistically significant negative coefficient for AChi and a 100% positive coefficient for AtChi), the agreement between Peru and Mexico (with an 83% statistically significant negative coefficient for AMex and a 83% positive coefficient for AtMex), the ATPDEA (with an 66,7% statistically significant positive coefficient for AAtpdea and a 83,7% statistically significant negative coefficient for AtAtpdea). It should be noted that the sign differences (positive or negative) of the coefficients among the PTAs is consistent with the theory of PTAs (as summarized in Tello, 2010).

For the relative prices of the agricultural non-export GDP component, the results were much weaker. There were some effects of the agreement between the Andean Community and Brazil and Argentina as well as the agreement between Peru and Chile. These effects in both temporal (A) and permanent (At) variables were the opposites of the ones found for the relative prices of the agricultural export GDP component. However, these results were statistically weak.

A third group of results come from the estimated coefficients of external shocks and the rest of the macroeconomic factors. Thus, current account reversals did not have a statistically significant or robust impact on the output and the relative prices for the agricultural sector during the period 1950-2007. On the other hand, sudden stop shocks and, to a lesser degree the capacity to import, did have a statistically significant impact on the agricultural GDP. They did not have an impact on relative prices, though.

In the case of sudden stops, the impact has been negative and robust only for the export agricultural GDP. In the case of the capacity to import, the statistical results were less robust but there were some negative effects on both export and agricultural non-export GDP.

Finally, from the rest of the independent variables, land productivity, the degree of openness, and to a lesser extent, the loans granted by the private banks had a statistical significance on the agricultural output, its two components and to lesser extent on their relative process indices, although not always with the same degree of robustness. For the remaining variables, either their impact was not robust or was not statistically significant and in many cases, with ambiguous signs for their respective coefficients. Land productivity was the most important variable for the three types of outputs (i.e., total, export, and agricultural non-export GDP). Its effect was positive and statistically significant on all the estimated regressions. These results are consistent with the results found by Tello (2009a), who concluded that for 18 non-tradable agricultural products from the Andean South of Peru, land productivity was the main determinant of the output supply of those products. The impact of land productivity on the relative price indices was less robust and in most of the cases not statistically significant. However, the sign of the coefficients of this variable was negative, particularly for the relative prices of the per capita agricultural GDP and the non-export GDP component. These findings are consistent with the theoretical frameworks of the previous section.

Protectionism or liberal economic policies with the associated impact on the degree of openness of the economy affected the output and the relative prices of the agricultural sector, particularly with the non-export or internal GDP component. Thus, protectionist policies which decreased the degree of openness of the economy, also reduced the rate of growth of the per capita agricultural GDP and its non-export component. The robustness of the impact on the export component was weaker. Liberal policies which increased the degree of openness in the economy and thus increased the rate of growth of the same agricultural output[16] did not have as a strong an effect as expected though. The degree of openness did not statistically affect the per capita agricultural export GDP[17].

The impact of the degree of openness on the relative prices of the agricultural sector, particularly on its non-export component was statistically significant and negative regardless of the market orientation of the economic policy.

The degree of robustness of the impact of loans from the private banks was weaker than the two previous variables. The bank loan impact was mainly on the agricultural non-export GDP. Thus, more loans to the agricultural sector increased the rate of growth of the agricultural GDP, particularly the rate of growth of its non-export output. Loan changes affected the relative prices of the agricultural GDP negatively. These effects were less robust than the respective effects on the agricultural outputs.

The absence of statistical significance on the impact of loans on the associated price indices for both agricultural outputs makes it impossible to identify the source of the negative impact of loans on the associated prices of the total agricultural GDP.

Conclusions

This paper examined the evidence of the effects of (internal and external) shocks and preferential trade arrangements on the per capita agricultural GDP, the two export and non-export GDP components, and the associated price indices.

This examination shows that (internal or external) shocks to the per capita GDP of the Peruvian economy have been transmitted to the agricultural GDP and its export and non-export GDP components in the period 1950-2007. Furthermore, external macroeconomic shocks such as the sudden reduction of the inflow of international capital into the economy have also reduced the rate of growth of the per capita agricultural GDP, mainly through its internal (non-export) component. In the case of terms of trade shocks, their negative impacts have been through a reduction on the rate of growth of the export agricultural component. However, the statistical robustness of the impact of all these shocks on the relative prices indices of the agricultural sector has been weaker, and in general, the coefficients of all these variables were not statistically significant.

Consistent with Tello´s (2009b) results, the set of preferential trade arrangements did not have a statistical impact on the per capita agricultural GDP, particularly on its internal or non-export component[18]. The statistical impact of these arrangements on the export agricultural component was higher, but the impact has generally been temporary and with ambiguous signs. An explanation of the weaker impact of the preferential trade arrangements is that in these arrangements, only ad-valorem tariffs have been reduced and none of the non-tariff barriers have been reduced. According to Tello (2008), these trade restrictions may generate rates of nominal protection as high as 40% for the ad-valorem equivalent rates imposed by the main agricultural export markets of Peru.

The statistical impact of the preferential trade arrangements has been slightly higher on the relative price indices of the agricultural sector, mainly on its export component. This impact was, in most of the cases, temporary and the signs (positive or negative) of this impact depended upon the type of agreement.

The evidence shown in this paper also indicates that the rate of growth of the agricultural GDP and the growth of the prices have responded to liberal and protectionist policies that affected the degree of openness of the Peruvian economy. Thus, a higher degree of openness (through liberal economic policies) has increased the rate of growth of the per capita agricultural GDP, primarily through its internal GDP component. However, the magnitude of these effects has been lower in the periods of trade liberalization than in the protectionist periods of the Peruvian economy. In contrast, the relative price indices of both agricultural outputs in the last three decades have had a decreasing trend regardless of the type of economic policies implemented in Peru.

Finally, the results strongly suggest that one way to avoid the negative impact of external shocks or to obtain sustainable and permanent increases of the agricultural output is through a continuous improvement of the total factor productivity and land productivity in the agricultural sector. Such increases and improvements should not have negative effects upon the relative prices of the agricultural sector.

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Footnotes

1 A preferential trade arrangement is a set of trade instruments that governments use to reduce (partially or totally) trade barriers for goods, services and factors. These arrangements may be of 4 types: unilateral preferential trade arrangement (when an economy reduces trade barriers unilaterally); bilateral or regional preferential trade arrangement (when two or more countries agree to reduce trade barriers within themselves but maintaining trade barriers against non-member countries); the generalized system of preferences (when an economy reduces trade barriers for a country or group of countries unilaterally without reciprocity and maintains trade barriers against the rest of countries); and the multilateral preferential trade arrangement (when the regional arrangement covers all members of the World Trade Organizatio, WTO). As of 2010, the WTO has 153 members.

2 This sector includes Hunting and Forestry.

3 The rate of growth of per capita of all GDP and those of the price indices have been obtained using the differential of natural logarithm operator (dln) applied to each variable.

4 Cycles and trends of outputs and price variables were obtained using the Hodrick-Prescott (1997) filter with the parameter λ=100, which has the role to penalize the variability of the trend components of the variables.

5 Synchronization of any pair of variables is the degree of statistical association between the trends or cycles of these variables. This degree is measured through the Pearson correlation coefficient.

6 In Figure 3, r1 and r2 are the Pearson correlation coefficients between the trends and cycles of both relative prices and the trends and cycles of the per capita GDP rate of growth, and r is the correlation coefficient between the trends and cycles of the relative prices indices.

7 The estimation methodology for both agricultural GDP components and their respective prices is described in the source of Table A1.

8 Subscript '1' means the price relative to the consumer price index and subscript '2' means the price relative to the GDP price deflator.

9 This operator has also been used to transform variables with unit roots to stationary variables.

10 A detailed list of features of the set of preferential trade arrangements considered in this paper is provided by Tello (2010 and 2009a).

11 In 1954 the crisis was originated by a drastic deterioration of the terms of trade in the two previous years. In 1976, 1978, 1983 and 1984 the origin was triggered by the external debt crisis and in 1998 the Asian crisis occured.

12 According to the Central Bank of Reserve of Peru (BCRP, 2009b), the financial account registered the long and short run capital flows between residents of Peru and residents in foreign economies. This account includes flows of foreign direct investment, loans, investment and flows in financial assets of the financial and non-financial system excluding transactions of the Central Bank of Peru. Long run capital flows are presented in two accounts: one from the public sector and the other from the private sector.

13 The current account reversal crisis of 1959 came about with strong terms of trade deterioration for the previous year, 1958. The crisis of 1968 was originated by reductions in the terms of trade and international reserves and foreign exchange rate crises. In 1989 the sources of the crisis were reductions in the terms of trade and international reserves, high inflation rates, unstable foreign exchange rates, and inflation. For the rest of the years, the sources of the current account reversals were the same as the sources of the sudden stops in those years.

14 This real foreign exchange rate is defined as (TCNt).IPC*t/IPCt, where TCNt is the index of the nominal foreign exchange rate, base year of 1994 at period t; IPC*t is the consumer price index of the United States, base year of 1994, at period t, and IPCt is the Peruvian consumer price index, base year 1994 at period t.

15 Seminario and Beltrán (1998) used similar methodology but considered only the three major export agricultural products: coffee, sugar and cotton. Table A1 reports our estimations and those of Seminario and Beltrán (1998).

16 It should be noted that the coefficient of the degree of openness in the liberal period is the sum of the coefficients of variables dlnAP and dlnAP'.

17 The estimations of the export agricultural product included 13 major exports products. The initial year wherein the product was exported for the first time was not included in the calculation. Thus, 9 out of 13 export products were first exported between the years 1991-2007. The newly export agricultural products did not increase the agricultural export share of the total exports given that the three major export products (i.e., coffee, cotton and sugar) were decreasing their share at the same time that the new products were increasing. From 1991 onwards, the agricultural export share of the total Peruvian exports value has been decreasing (Tello, 2008).

18 Similar results were obtained by Tello (2009a) in a product analysis study in 9 regions from the South Andean zone of Peru.

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Appendix

Table A1. *Estimates of Agricultural GDP Peru, 1950-2007*

Year	In millions of Soles of 1994		
	PBI_Agr	PBI_Agr X	PBI_Agr Int
1950	3,119.1	435.4	2,683.8
1951	3,212.6	484.6	2,728.0
1952	3,305.8	542.9	2,762.8
1953	3,381.8	613.1	2,768.7
1954	3,449.3	690.5	2,758.8
1955	3,421.9	695.5	2,726.3
1956	3,257.5	698.6	2,558.9
1957	3,270.6	691.7	2,578.9
1958	3,496.2	774.0	2,722.3
1959	3,667.5	784.1	2,883.4
1960	3,902.3	887.7	3,014.5
1961	4,019.4	921.3	3,098.1
1962	4,115.8	1,007.5	3,108.3
1963	4,177.5	1,003.4	3,174.1
1964	4,382.2	1,023.5	3,358.7
1965	4,469.9	982.8	3,487.1
1966	4,711.3	1,029.1	3,682.3
1967	4,895.1	932.7	3,962.4
1968	4,728.6	949.4	3,779.2
1969	5,040.6	904.7	4,135.9
1970	5,433.8	953.9	4,479.9
1971	5,542.6	991.7	4,550.9
1972	5,409.5	1,001.3	4,408.2
1973	5,431.2	1,021.4	4,409.8
1974	5,632.1	1,070.6	4,561.5
1975	5,630.3	998.3	4,632.0
1976	5,714.6	923.0	4,791.6
1977	5,708.9	968.7	4,740.1
1978	5,623.3	965.0	4,658.3
1979	5,842.0	1,010.7	4,831.2
1980	5,491.9	907.6	4,584.3
1981	6,003.6	906.7	5,096.9
1982	6,124.2	933.4	5,190.8
1983	5,622.9	755.8	4,867.1

→

Year	In millions of Soles of 1994		
	PBI_Agr	PBI_Agr X	PBI_Agr Int
1984	6,131.1	900.3	5,230.8
1985	6,309.3	1,050.1	5,259.2
1986	6,565.2	1,028.7	5,536.5
1987	6,908.9	919.4	5,989.5
1988	7,317.2	1,024.8	6,292.4
1989	7,024.8	1,130.8	5,894.0
1990	6,412.3	962.6	5,449.7
1991	6,671.6	896.4	5,775.2
1992	6,066.3	778.2	5,288.1
1993	6,614.0	773.7	5,840.3
1994	7,487.2	1,002.3	6,484.9
1995	8,201.5	1,140.6	7,060.9
1996	8,630.2	1,269.8	7,360.4
1997	9,099.4	1,227.8	7,871.6
1998	9,145.4	1,111.6	8,033.8
1999	10,069.2	1,330.3	8,738.9
2000	10,729.2	1,445.8	9,283.4
2001	10,796.3	1,490.9	9,305.4
2002	11,445.4	1,609.5	9,835.9
2003	11,795.4	1,642.0	10,153.4
2004	11,629.5	1,715.6	9,913.9
2005	12,259.4	1,606.5	10,652.8
2006	13,286.4	1,984.9	11,301.5
2007	13,722.7	1,958.2	11,764.5

Note. From Seminario and Beltrán (1998), INEI (2007), MINAG (2009). The export component of the agricultural GDP was computed as the sum of the real production value (base year 1994) of a set of 13 agricultural products (i.e., annatto, cotton, cocoa, coffee, sugar cane, onions, asparagus, oranges, mango, dried beans, avocado and grapes) multiplied by the value added-gross output ratio of 0.71o taken from the input output tables for 1994.