Export-led Stagnation in Paraguay: A Time Series Approach.

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I. Introduction.

The purpose of this paper is to examine the influence of changing agricultural structure on the overall macroeconomic performance for Paraguay. Conventional neoclassical economic wisdom argues that macroeconomic performance is maximized when markets encourage countries to structure their exports according to the principle of comparative advantage. The alleged benefits of trade specialization are considered particularly important for small countries with narrow resource bases that are unable to efficiently meet their varied consumption needs.

In the 1980s and 1990s this conventional market wisdom was given a fillip by the comparative economic performances of the Latin American countries and the East Asian countries. Whereas Latin America was mired in stagnation during the lost decade of the 1980s, East Asia was being propelled by export led growth. Many commentators argue that the differences in economic performance can be traced to the willingness of the East Asian countries to abandon import substitution industrialization (ISI) in favor of export promotion industrialization.[1]

Paraguay is somewhat atypical among Latin American countries in that it never pursued the ISI model as did most other countries in the region. Rather, the Paraguayan economy has always been and continues to be dedicated to the production of primary goods and mostly agricultural output. An important exception to this tendency involved the construction during the 1970s and 1980s of what was then the world's largest hydro-electric facility at Itaipu. The dam was a bi-national project undertaken in cooperation with Brazil. In fact, the developmental benefits have largely been limited to Brazil. Paraguay lacks the transmission capacity to absorb only a very small portion of the wattage generated by the facility. The major impacts of the dam on the Paraguayan economy were short-term boosts to its national accounts and financial balances and the stimulus to short term employment in the construction industry.

While agriculture has remained the dominant sector in the Paraguayan economy throughout the twentieth century and into the twenty-first century, there have been substantial shifts in the structural composition within the sector over the past forty or more years. In particular, over time Paraguayan agriculture has become much more externally oriented. This is true in a dual sense. First, an increasing proportion of output has consisted in production for foreign markets. An especially important change has involved the expansion of the soybean economy. Soybeans are an industrial commodity produced mostly as animal feed and for processing to manufacture oils. Second, along with the expansion in the soybean economy, there has occurred a dramatic increase in foreign participation in the agricultural sector. Brazilian investment has led the way for the infusion of foreign capital and this flow has been accompanied by others from North America, Europe, and Asia.

These structural changes have also implied a third type that relates to the factor proportions characteristic of Paraguayan production. Industrial agriculture is typified by highly concentrated landholdings as well as capital intensive methods. As a direct consequence of the globalization of Paraguay's agriculture in the manner just described, there has also occurred a displacement of small producers who lack capital, land title, credit, and technical expertise with which to compete with the larger, well-capitalized, and increasingly foreign, growers. The larger farms are not able to absorb the now landless labor force that is then forced into the urban labor market where they are confronted with under-employment or outright unemployment. Because the new agriculture is so externally oriented, it provides few linkages to the rest of the economy, especially the secondary manufacturing sector, that might otherwise be a source of employment opportunities for the expanding urban labor force.

It should be clear that the brief picture of Paraguayan economic development painted here is at strong variance with that provided by the standard export-led growth argument rooted in neo-classical orthodoxy. By contrast the export-led *stagnation* thesis is a staple of the dependency theory of the 1970s and 1980s. Jaffee (1985) among others has examined the link between export dependence and economic growth in a cross-national empirical assessment and found that the negative impact of dependency is more likely when dependence involves commodity concentration, foreign capital penetration, and raw materials specialization. These are precisely the conditions that we argue characterize the role played by soybeans in the Paraguayan economy though we focus attention on the first of these.

In the sections to follow we shall provide empirical evidence to support the export-led stagnation thesis. The evidence consists of results of modern time series analyses of relevant data for the Paraguayan economy between the years 1961 and 2003 or 2007 depending on the particular series involved.

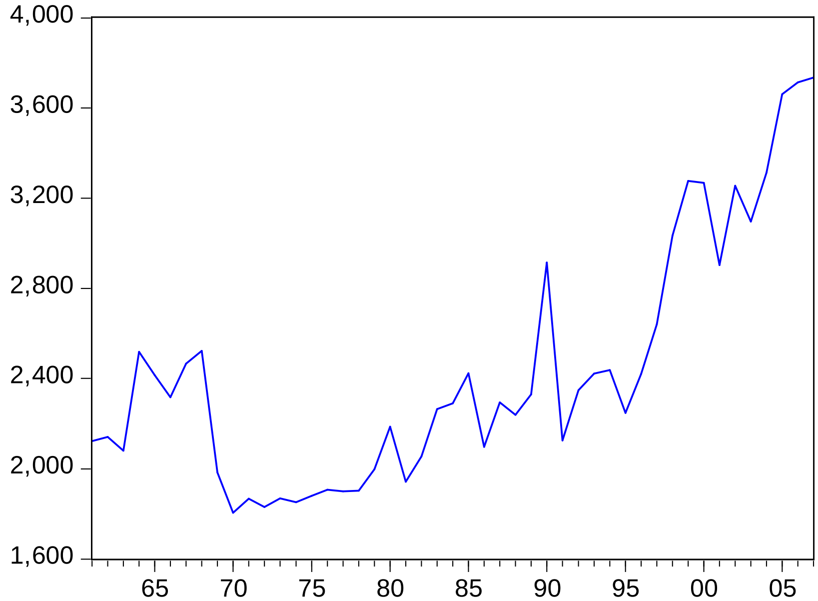
II. Agricultural commodity concentration.

Commodity concentration can be measured in a variety of ways. Typical measures involve concentration ratios calculated as the proportion of total sectoral output accounted for by the largest one, two or three commodities in physical terms. Alternatively, similar analogous measures may be calculated on the basis of area cultivated. The latter measure may be preferred inasmuch as physical outputs of different commodities may themselves be incommensurable.

An alternative to commodity concentration ratios involves the calculation of the agricultural Herfindal ratio. This is calculated as the sum of squared percentage shares of all commodities produced or sold. The Herfindal index (HI) is typically applied as a measure of industrial concentration in antitrust cases. It takes a maximum possible value for the case of single firm monopoly wherein HI = 10,000. An industry is considered moderately concentrated when HI > 1,800 and lightly concentrated when HI < 1,000. The latter case would obtain, for example, in an industry of composed of 10 equally sized firms.

Figure 1 below shows the evolution of the Herfindal Index for Paraguayan agriculture (based on area cultivated) for the period 1961-2007.

Figure 1: Herfindal index of agricultural commodities, 1961-2007.

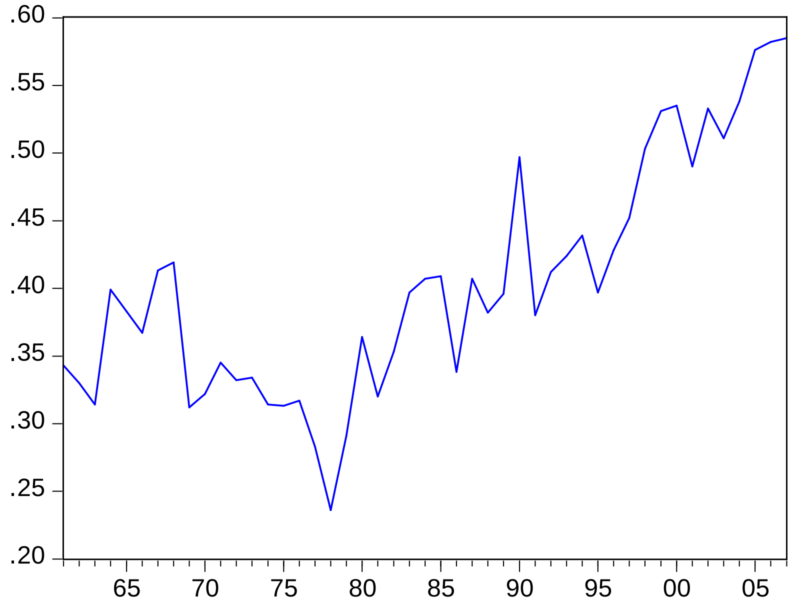


As the figure demonstrates agricultural concentration was relatively high in the beginning of the period and is followed by a substantial decline in 1970 where it remains relatively low before showing a marked increasing tendency beginning in 1980. In the 1960s corn was the dominant crop followed by cassava and cotton. Corn is important as both a food and feed crop while cassava, known as manioc in Paraguay, is a low cost food staple good. Cotton is significant in terms of its productive factor requirements. It does not lend itself to mechanical harvest as readily as either corn or soybeans and is therefore favored by smaller producers. The growth of the cotton economy was therefore an important source of employment to the rural labor force in the 1970s. Between 1972 and 1988 area dedicated to cotton production expanded from 57 thousand hectares to 403 thousand hectares in 1989—an increase of over 600 percent. Following the 1989 growing season the cotton sector went bust and has never recovered to its previous high level.

In the period between 1970 and 1978, when Paraguay followed a relatively diversified pattern of crop production, land area dedicated to rice, sugar, beans, soybeans and wheat all increased in absolute and relative terms while corn and cassava played relatively smaller roles.

The dominance of soybeans begins in 1979 when it constituted around 24 percent of total hectares planted in temporary crops. As can be appreciated from Figure 2 below, the take-off in the soybean economy occurs in the 1980s, suffers some instability in the early to mid 1990s before resuming its upward march after 1995. The behavior of soybeans clearly accounts for the rise of commodity concentration as revealed in the rising HI values in Figure 1.

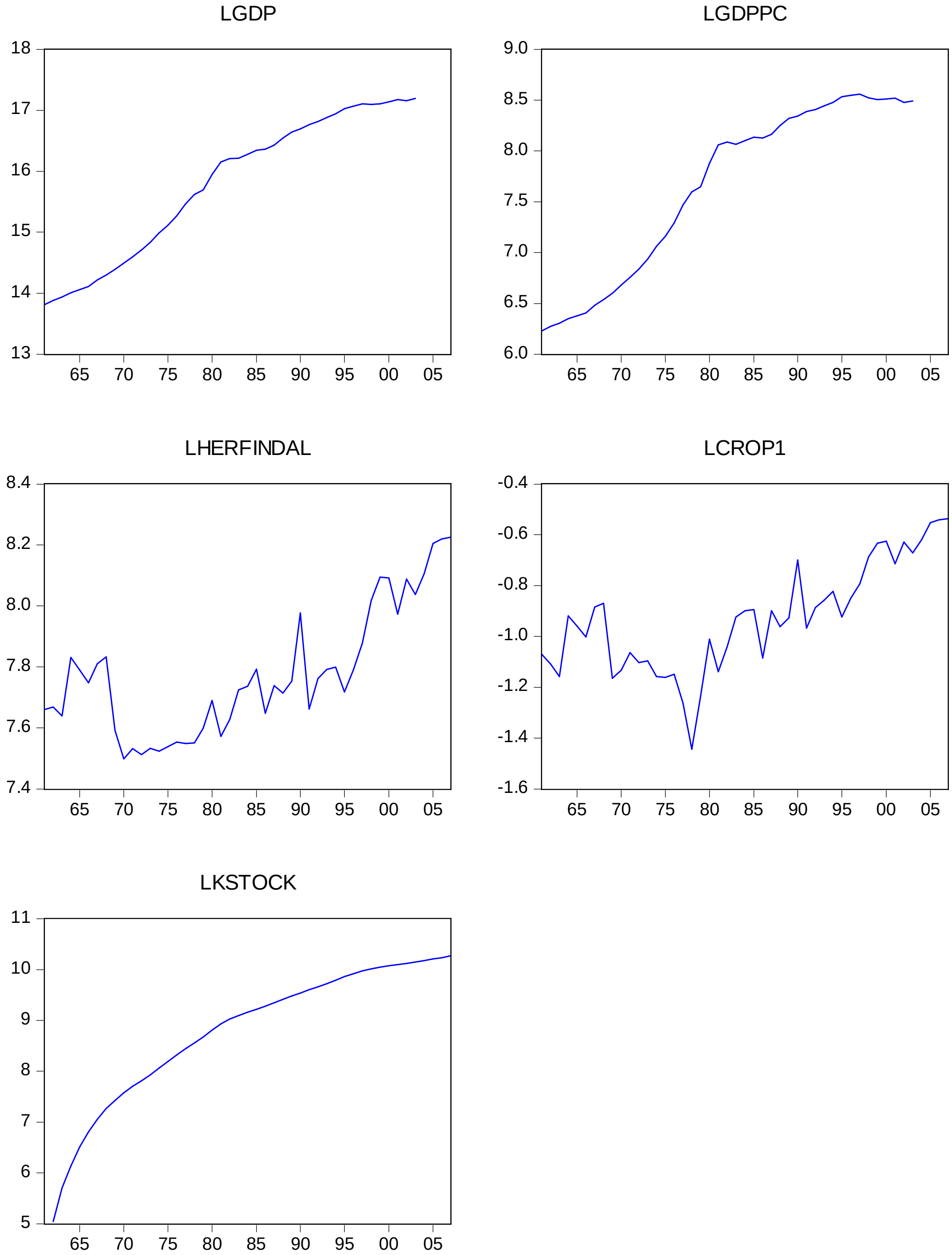
Figure 2: One crop concentration ratio, 1961-2007



III. Agricultural concentration and economic performance.

In this section we wish to examine the relationship between commodity concentration and Paraguay's macroeconomic performance as a test of the export-led growth hypothesis. Towards this end we shall examine empirically the link between our measures of commodity concentration and gross domestic product (GDP). We shall also include in our model some additional relevant variables that might account for the behavior of GDP over time including growth in the capital stock.[2] The series are shown graphically in the following Figure 3 where all variables have been expressed in natural log form.

Figure 3: Time paths of GDP, GDP per capita, Commodity Concentration and Capital Stock.



For the series LGDP and LGDPPC (gross domestic product per capita) it is notable that growth appears to be fairly exponential until around 1980 after which there occurs a deceleration in the growth rate. The year 1980 also appears significant in the series that represent agricultural commodity concentration (LCROP1 and LHERFINDAL) when each of these measures appear to experience definite upward movements. This visual evidence is provocative and provides the basis for our empirical investigation.[3]

It is well known that the stationarity characteristics of time series data have important implications for the validity of standard regression results (Granger and Newbold 1974). Spurious regression occurs when least squares estimates are shown to have small standard errors, large t-statistics, and models indicate large coefficients of multiple determination (R^2.) The presence of unit roots can invalidate these results by rendering the least squares estimates inconsistent and their economic interpretation meaningless (Enders 2004, p.171-174.)[4] The test for the stationarity of a time series involves identifying the presence of a unit root. Standard procedures for checking for the presence of unit roots are provided by the augmented Dicky-Fuller (1979) (ADF) and Phillips-Peron (1988) (PP) tests. Results for tests on our variables of interest are given in the following Table 1.[5]

Table 1: Unit root test results for gross domestic product (GDP); GDP per capita (GDPPC); agricultural commodity concentration (HERFINDAL), (CROP1); and capital stock (KSTOCK).

	$T_{T(ADF)}$	$T_{\mu(ADF)}$	$T_{(ADF)}$	$T_{T(PP)}$	$T_{\mu(PP)}$	$T_{(PP)}$
LGDPPC	-0.30	-2.01	.064	.16	-1.76	2.96
LGDP	-1.07	-1.77	0.85	0.20	-1.80	4.65
LHERFINDAL	-2.33	-0.25	1.09	-2.15	-0.61	1.20
LCROP1	-3.07	-1.49	-0.97	-2.96	-1.03	-1.11
LKSTOCK	-0.55	-2.77	4.40	-7.43	-8.21	2.44
DLGDPPC	-3.52	-1.38	-1.06	-3.55	-2.99	-1.84
DLGDP	-3.56	-1.38	-0.86	-3.59	-3.07	-1.43
DLHERFINDAL	-8.85	-8.72	-8.63	-10.36	-8.94	-8.66
DLCROP1	-7.48	-8.68	-8.65	-9.91	-9.44	-9.17
DKSTOCK	-13.42	-12.28	-9.97	-13.54	-10.63	-7.38
5% critical value	-3.52	-2.94	-1.95	-3.52	-2.93	-1.95

The results in Table 1 suggests that for most of the variables of interest we cannot reject the hypothesis of a unit root when the variable is given in level form, but that stationarity is achieved for all first differenced versions of each variable under the specifications that include an intercept term and time trend (T_T).

An important exception to the above concerns our variable for capital stock expressed in log level form (LKSTOCK). Here we can see that for certain specifications of the ADF test the results do not reject the hypothesis of a unit root, but that for one specification of the ADF test, and for all three specifications of the Phillips-Peron test, the results indicate that the series is stationary. To resolve the ambiguity we test the series once more making use of the Kwiatkowski, Phillips, Schmidt and Shin (2003) (KPSS) test. The KPSS test differs from the ADF and PP tests in that it posits a null hypothesis that the series is stationary. For the LKSTOCK series the KPSS test statistic is found to be 0.837 which exceeds the asymptotic critical value at both the 5 and 1 percent levels, (.463 and .739, respectively.) On the basis of this test then we reject the null hypothesis that the series is stationary and conclude in favor of the alternative that it contains a unit root.[6] As is true for the other series under examination, the results in Table 1 indicate that the capital stock series is stationary in first difference form (DKSTOCK.)

In order to examine the nature of the relationship in more detail we next specify a test of Granger (1969) causality. The Granger causality test seeks to determine if the lagged values of one series helps to improve the forecasting performance of another series. For our system of three series the test takes the following form:

$$LGDPPC = \alpha + \beta LHERFINDAL_{-1} + \delta LKSTOCK_{-1} + \varepsilon_t \qquad (1)$$

$$LHERFINDAL = \gamma + \sigma LGDPPC_{-1} + \varphi LIKSTOCK_{1} + é_t \qquad (2)$$

$$LKSTOCK = \rho + \mu LGDPPC_{-1} + \rho LHERFINDAL_{-1} + \mu_t \qquad (3),$$

where ε_t, $é_t$, and μ_t are identical and independently distributed disturbance terms. The variables in the above equations are specified in levels rather than differences on the assumption that the system constitutes a cointegrated system of order one.[7] As Enders (2004) points differencing the variables would discard information contained in the cointegrating relationship and render the resultant estimates and test statistics non-representative of the true underlying long run relationship. Results of the Granger causality test are given in Table 2.

Table 2: Granger causality test results for GDP, HERFINDAL, and KSTOCK

Null hypothesis	F-Statistic	Probability
LHERFINDAL does not Granger cause LGDPPC	12.52	0.001
LGDPPC does not Granger cause LHERFINDAL	3.19	0.08
LKSTOCK does not Granger cause LGDPPC	4.33	0.04
LGDPPC does not Granger cause LKSTOCK	125.88	$1.E^{-13}$
LKSTOCK does not Granger cause LHERFINDAL	2.01	0.16
LHERFINDAL does not Granger cause LKSTOCK	9.65	0.001

The results of the Granger causality test suggest a causal relationship runs from agricultural commodity concentration (LHERFINDAL) to the level of GDP per capita (LGDPPC), but that the reverse causality, from GDP per capita to commodity concentration does not hold at the .05 level of statistical significance. The results also strongly suggest a dual causal relationship between investment (LKSTOCK) and GDP per capita. Finally, there appears to be a significant causal relationship running from commodity concentration to capital formation.

When GDP per capita is substituted by GDP the Granger causality test results are given as follows in Table 3.

Table 3: Further Granger causality test results with GDP.

Null hypothesis	F-statistic	Probability
LHERFINDAL does not Granger cause LGDP	11.92	.001
LGDP does not Granger cause LHERFINDAL	3.55	0.067
LKSTOCK does not Granger cause LGDP	9.50	0.004
LGDP does not Granger cause LKSTOCK	310.36	$7.E^{-20}$

As in the previous Table 3 the results shown in Table 4 indicate a causal relation running from agricultural commodity concentration to GDP, but not the other way around, significant at a .05 level of significance. Also as before there is evidence of a mutually causal relationship between GDP growth and growth in the capital stock.

When our measure for commodity concentration, the agricultural Herfindal index, is replaced by the alternative measure of the one-crop concentration ratio, much the same results (not shown) for the Granger causality test are obtained. In this case there is evidence of mutual causation running between commodity concentration and growth of GDP per capita as well as between capital stock growth and GDP per capita. Similarly, mutual causation at the .05 significance level is found between (one crop) commodity concentration and GDP.

The evidence provided by the Granger causality results are useful though limited inasmuch as they suggest the likelihood of interdependence without suggesting anything about the direction of causality (positive or negative) or the magnitudes of the relevant coefficients. To gain more insight into these questions requires a model. Given the presence of unit roots in our series a modeling approach is provided by Engle and Granger (1987) called cointegration modeling. The presence of unit roots does not necessarily preclude the possibility that a long term equilibrium relationship exists among our variables.[8] Engle and Granger note that a linear combination of non-stationary variables may itself be stationary. If this is the case the non-stationary series composing the linear combination are said to be cointegrated. It is useful that our variables in first difference form (at least in the indicated specifications T_T and T_μ) are shown to be stationary since the Engle-Granger method requires that the variables be integrated of the same order. Table 1 results suggest that each variable contains a single unit root, i.e. is integrated of order one.

Table 4 presents cointegration test results employing the Johansen (1988) method and reported test statistics with critical values for the Trace and Max-Eigen value tests.[9]

Table 4: Johansen Cointegration Test Results for LGDPPC, LHERFINDAL, and LKSTOCK.

Number of cointegrating Equations under the null hypothesis	Trace stat./Critical value	Max-Eigen/Critical value
None *	36.54 / 29.80	24.09 / 21.13
At most 1	12.45 / 15.49	11.91 / 14.26
At most 2	0.53 / 3.84	0.534 / 3.84

* indicates rejection of the null hypothesis at the 5% significance level.

The results from Table 4 provide support for the presence of a long run equilibrium relationship among and between our variables. The Trace and Max-Eigen tests suggest the presence of a single cointegrating vector among the variables thus suggesting a long run equilibrium relationship.

When LGDPPC is replaced by LGDP in the cointegrating model the results are as follows:

Table 5: Johansen Cointegration Test Results for LGDP, LHERFINDAL, and LKSTOCK.

Number of cointegrating Equations under the null hypothesis	Trace stat./Critical value	Max-Eigen/Critical value
None *	43.15 / 29.80	26.87 / 21.13
At most 1 *	16.27 / 15.49	12.64 / 14.26
At most 2	3.63 / 3.84	3.63 / 3.841

* indicates rejection of the null hypothesis at the .05 level.

The results for Table 3 are somewhat ambiguous indicating two cointegrating equations according to the Trace test and a single cointegrating equation according to the

Max-Eigen value test. When the Herfindal measure of agricultural concentration (LHERFINDAL) is replaced by our alternative one-crop commodity concentration ratio (LCROP1) in the cointegrating model, the results are almost identical to those presented in Tables 4 and 5. In the vector error correction analysis that follows the underlying assumption is that the endogenous variables are linked to one another in a single cointegration relationship. With that in mind we shall confine our attention to GDP per capita (LGDPPC) as the relevant measure of national welfare rather than GDP where this first order cointegrating relationship is empirically established. On theoretical grounds this choice also seems preferable since, potentially, social welfare is a function of the size of the national product as well as of the size of population.[10]

IV. Vector error correction and short run dynamics.

When a system of variables is known to be cointegrated the dynamics of the system may be investigated by the method of vector error correction (VEC) modeling (Engle and Granger 1987.) A VEC model is a modified vector autoregression (VAR) model that includes the residuals of the equation that establishes the set of variables as cointegrated. A VEC model involving two endogenous variables (x and y) may be represented as follows:

$$\Delta y_t = a_{10} + \alpha_y(x_{t-1} - \beta y_{t-1}) + \Sigma a_{11}(i)\, \Delta y_{t-i} + \Sigma a_{12}(i)\, \Delta x_{t-i} + \varepsilon_{yt} \qquad (4)$$

$$\Delta x_t = a_{20} + \alpha_x(y_{t-1} - \beta x_{t-1}) + \Sigma a_{21}(i)\, \Delta x_{t-I} + \Sigma a_{22}(i)\, \Delta y_{t-I} + \varepsilon_{xt} \qquad (5)$$

The terms in parentheses on the right-hand side equations (1) and (2) represent the (lagged) error correction terms and ε represents white noise errors. The lagged values of the dependent variable in each equation identify the model as a modified VAR. In long run equilibrium the error correction terms are zero. When y and x deviate from zero then these terms are non-zero and the adjustment parameters (α_y and α_x) indicate the speed of adjustment that restores equilibrium.

When the model given in the above equations (1) and (2) is applied to our cointegrated set of variables (LGDPPC, LHERFINDAL, LKSTOCK) the following results are obtained. The normalized cointegration equation (6) is given as follows with t-statistics in parentheses,

$$\underset{}{1.000\text{LGDPPC}(-1)} - 13.443\,\text{C} + \underset{(5.646)}{2.010\,\text{LHERFINDAL}(-1)} - \underset{(-12.270)}{1.199\,\text{LKSTOCK}(-1)} \qquad (6)$$

The signs attached to LHERFINDAL and LKSTOCK are interpreted as suggesting an inverse relationship between agricultural commodity concentration and growth in per capita output while that attached to LKSTOCK suggests a direct relationship between growth in the capital stock and GDP growth. The t-statistics for each of the variables indicate significance at .05. This cointegration equation captures the residuals from the long run equilibrium relation and is included in the VAR model to yield our VEC model whose results are presented in Table 6.[11]

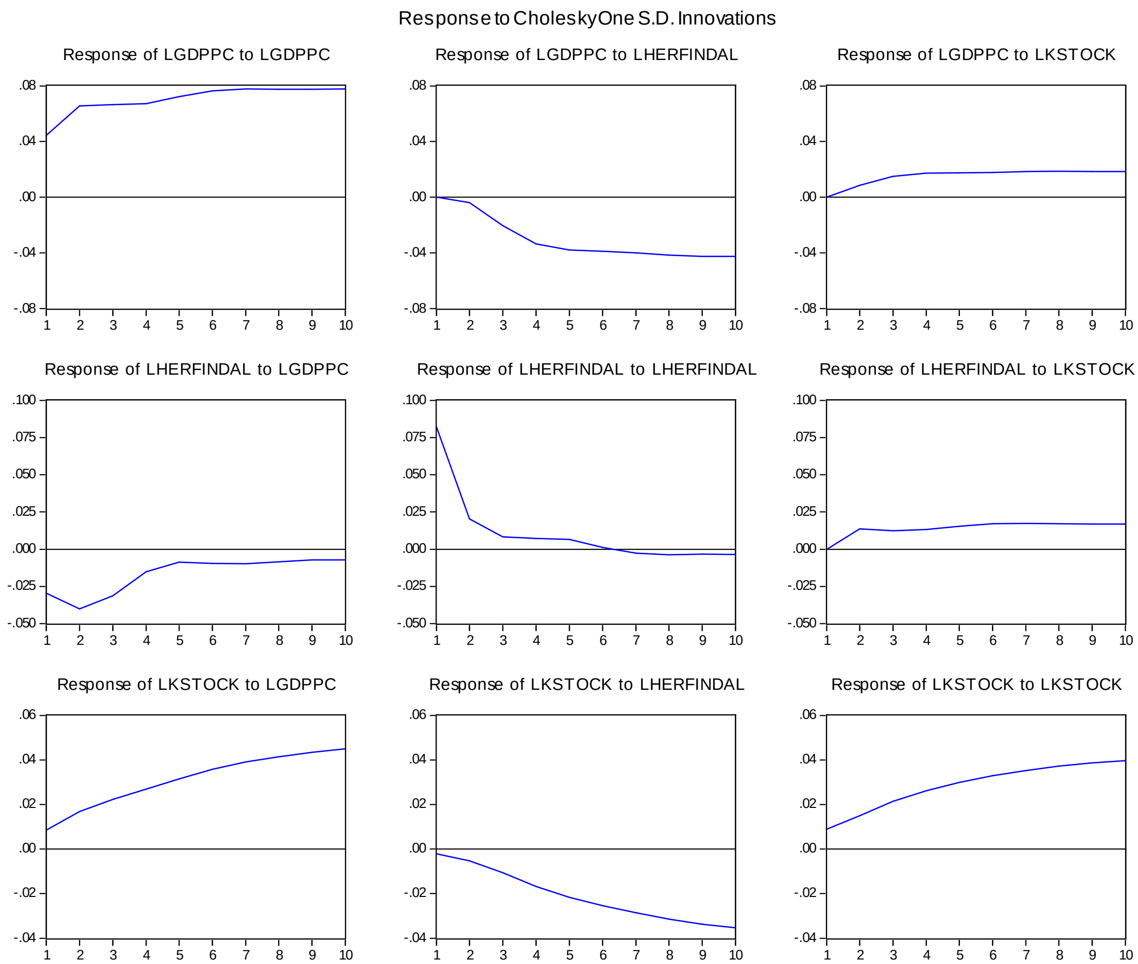
Table 6: Vector Error Correction regression results.

Variable	D(LDGPPC)	D(HERFINDAL)	D(LKSTOCK)
CointEquation	-0.093 (-1.91)	-0.325 (-3.396)	-0.026 (-1.882)
Constant	0.005 (0.17)	-0.159 (-2.54)	0.006 (0.67)
D(LGDPPC)(-1)	0.370 (1.95)	-0.678 (-1.83)	0.072 (1.35)
D(LGDPPC)(-2)	-0.281 (-1.57)	-0.055 (-0.157)	-0.079 (-1.56)
D(HERFINDAL)(-1)	0.174 (1.95)	-0.028 (-0.16)	0.034 (1.36)
D(HERFINDAL)(-2)	0.021 (0.26)	0.036 (0.22)	0.008 (0.37)
D(KSTOCK)(-1)	0.845 (1.64)	1.146 (1.13)	0.647 (4.47)
D(KSTOCK)(-2)	-0.276 (-0.76)	0.471 (0.65)	0.207 (2.02)
DU80	-0.044 (-2.19)	0.037 (0.94)	-0.008 (-1.41)
Adjusted R^2	0.444	0.244	0.972

Concentrating attention on the first row of Table 6 we note that of the three speed of adjustment coefficients in the system the largest (and most statistically significant) is the one related to agricultural commodity concentration (D(Herfindal)). This result suggests that this variable has a particularly important role to play in achieving the long run equilibrium relationship among these three variables. The lack of statistically significant results on the lagged endogenous regressors suggests that adjustment in the system is not a matter of short run dynamics, though an exception may apply to the capital stock adjustment equation.[12]

As an additional experiment to examine the dynamic characteristics of our system impulse response functions are estimated based on a Choleski Decomposition of variance and its associated concept of impulse response function. Each of these is based on an orthogonalized innovation of each endogenous variable in the system to assess its impact on the other variables in the system. The figure below presents diagrams of the impulse response functions. Inspection of these provides another means by which to assess the qualitative character of the dynamical relationship among and between the variables.

Figure 4: Impulse response functions of a single standard deviation of a Cholesky variance decomposition.



The most interesting plots in the above figure concern the impact of agricultural commodity concentration. The plot that illustrates the impact of commodity concentration on GDP per capita (Response of LGDPPC to LHERFINDAL) indicates that increasing concentration has a rather dramatic immediate and negative effect on the growth of output per capita after which it levels off. The effect of commodity concentration on capital formation (Response of LKSTOCK to LHERFINDAL) is equally dramatic and negative though the impact is more gradual. GDP per capita growth responds to capital formation in the direct manner that we would expect from theory. A comparison of this plot (Response of LGDPPC to LKSTOCK) to that for commodity concentration, however, suggests the greater impact provided by the latter variable.

A quantitative representation of the variance decomposition is provided by Table 7.

Table 7: Variance decomposition results.

Variance Decomposition of LGDPPC: Period	S.E.	LGDPPC	LHERFINDAL	LKSTOCK
1	0.044397	100.0000	0.000000	0.000000
2	0.079581	98.61140	0.234704	1.153898
3	0.106772	93.59034	3.812769	2.596894
4	0.131633	87.59273	8.990427	3.416847
5	0.155816	83.95261	12.36060	3.686787
6	0.178709	82.11864	14.08834	3.793021
7	0.199757	80.83731	15.28138	3.881312
8	0.219058	79.72937	16.32107	3.949558
9	0.236963	78.84751	17.16775	3.984741
10	0.253712	78.20683	17.79622	3.996947
Variance Decomposition of LHERFINDAL: Period	S.E.	LGDPPC	LHERFINDAL	LKSTOCK
1	0.087291	11.48700	88.51300	0.000000
2	0.099181	25.29141	72.79288	1.915706
3	0.105090	31.43839	65.46625	3.095366
4	0.107245	32.18592	63.31859	4.495497
5	0.108890	31.88379	61.77229	6.343918
6	0.110645	31.61884	59.84021	8.540954
7	0.112473	31.36923	57.97046	10.66032
8	0.114146	31.01078	56.38795	12.60127
9	0.115692	30.59085	54.98150	14.42765
10	0.117219	30.18124	53.65451	16.16425
Variance Decomposition of LKSTOCK: Period	S.E.	LGDPPC	LHERFINDAL	LKSTOCK
1	0.012472	45.63219	3.019378	51.34843
2	0.026249	51.07162	4.717856	44.21053
3	0.041878	48.42298	8.250403	43.32662
4	0.058674	45.72109	12.34618	41.93274
5	0.076162	44.30728	15.39384	40.29888
6	0.093852	43.70578	17.48217	38.81205
7	0.111354	43.34342	19.03558	37.62100
8	0.128428	43.03050	20.29805	36.67146
9	0.144943	42.77296	21.33258	35.89446
10	0.160829	42.58226	22.16736	35.25038

Cholesky Ordering: LGDPPC LHERFINDAL LKSTOCK[13]

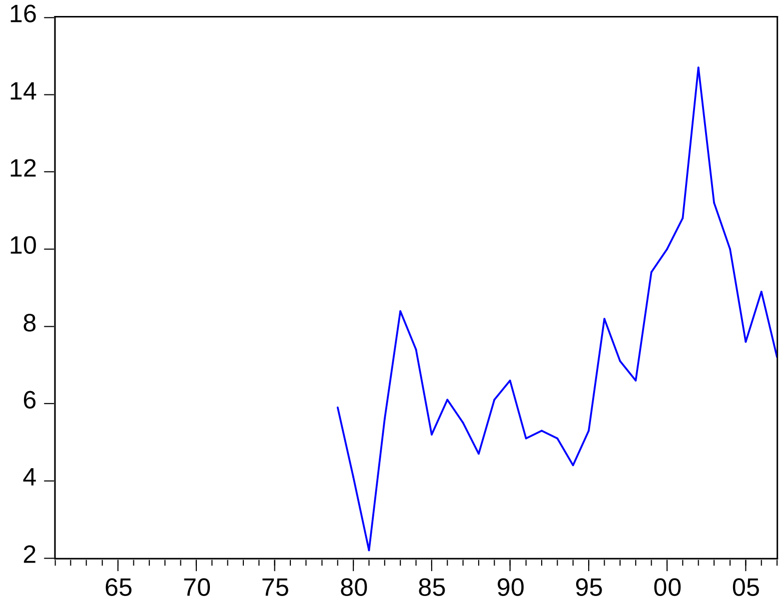
The cell values for columns 3-5 in Table 7 indicate the percentage share of the variance in the variable indicated at the head of column 1 by the corresponding variable designated at the head of columns 3-5, respectively. The table shows then that the variation in GDP per capita (the top panel of Table 7) is largely explained in terms of its own innovations in the first period after the innovation, but that innovations in both commodity concentration and capital formation begin to make significant contributions thereafter and together these innovations amount to around 22 percent of the variance by period ten. The contribution of commodity concentration (LHERFINDAL) is particularly strong amounting to nearly 18 percent of the variation in GDP per capita by the end of the ten-period timeframe.

As the lowest of the three panels in Table 5 also indicates, innovations in commodity concentration play an increasingly substantial role in the variation in capital formation. While GDP plays a larger role as we might expect, there is only a slight change (decrease) in its relative importance in the forecast period following the innovation. These results suggest then a dual role played by commodity concentration in the behavior of GDP per capita. One line is direct and the other indirect via its influence on the rate of capital formation.

V. Commodity concentration and urban unemployment.

As a final area of empirical interest we examine the relationship between agricultural commodity concentration and urban sector unemployment. Unfortunately data for the latter variable are much less abundant than for the other series we have examined in this paper. A continuous series on the urban unemployment rate only begins in 1979. A sample size of 29 observations is not considered adequate for most of the methods we have employed in the analysis to this point. Nonetheless it might be at least suggestive to examine the available data and its relationship to our main variable of interest—agricultural commodity concentration. The time path of the (log) urban unemployment rate is given in the following figure.

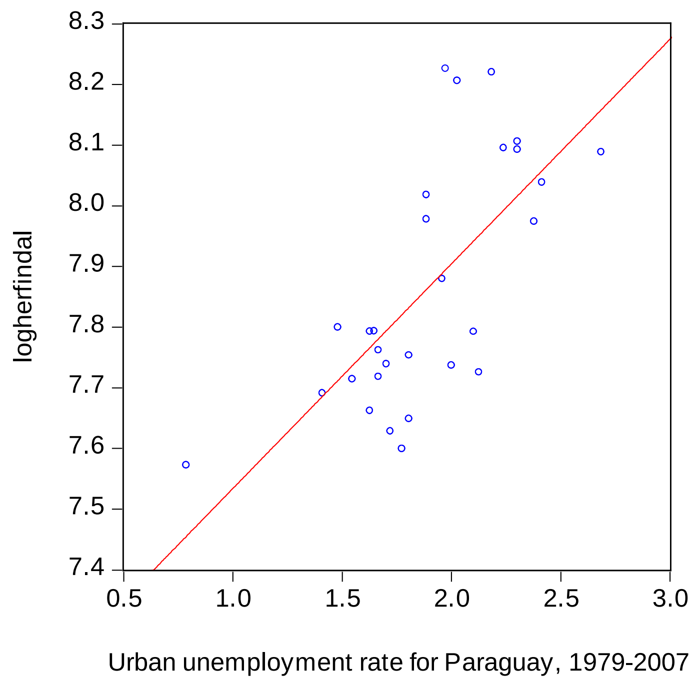
Figure 5: Urban open unemployment, 1979-2007



As can be seen in the figure the urban unemployment rate is subject to both substantial cyclical as well as trend instability. Since the mid 1990s there has been a noticeable upward trend in urban unemployment. Reports from the country indicate that this is in part a result of rural sector labor displacement that has accompanied the trend toward export-oriented commodity concentration, especially related to the expansion in soybean production. The calculated correlation coefficient between log of the unemployment rate (LUNEMPLOY) and the log value for commodity concentration (LHERFINDAL) is .69, a highly statistically significant result.

A scatter plot of the variables shown in Figure 6 below provides visual evidence of a relationship between the variables. A least squares regression line is included in the diagram.

Figure 6: Scatter plot of LHERFINDAL and LUNEMPLOY with least squares line.



A test of Granger causality in the manner as described earlier by equations (1)-(3) gives the following results in Table 8.

Table 8: Granger causality results for commodity concentration (LHERFINDAL) and urban unemployment (LUNEMPLOY).

Null hypothesis	F-Statistic	Probability
LHERFINDAL does not Granger cause LUNEMPLOY	3.93	0.03
LUNEMPLOY does not Granger LHERFINDAL	1.34	0.28

The results suggest one-way causation running from export commodity concentration to unemployment.

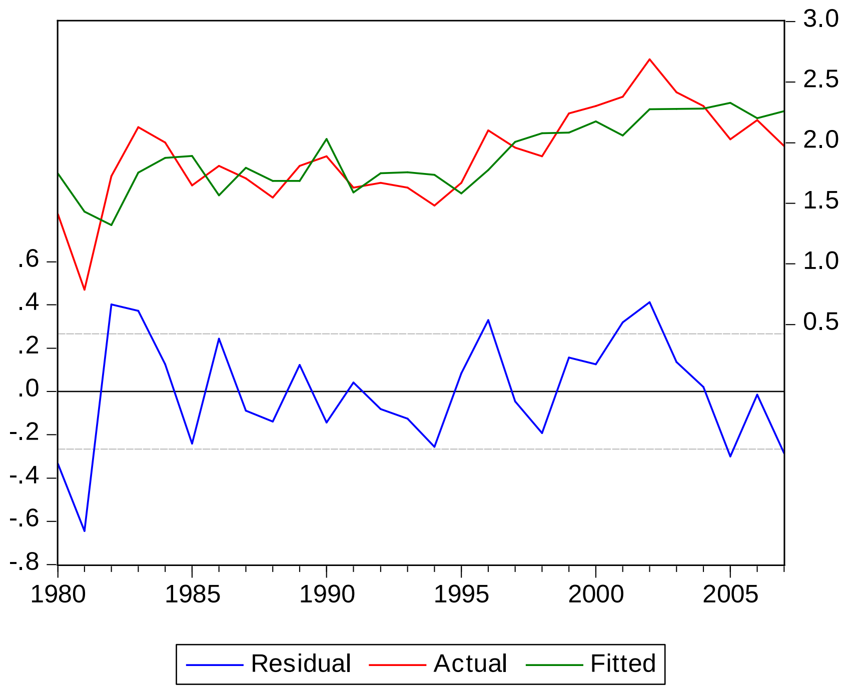
A simple first degree auto regression (AR) model (equation 7) of the type suggested by the above figure yields the following results:

$$\text{LUNEMPLOY} = -7.44 + 1.18\ \text{LHERFINDAL} + 0.36\ \text{LUNEMPLOY}_{-1} \quad (7)$$
$$(-2.49)^{*} \qquad (3.11)^{**} \qquad (1.83)$$

*, ** indicate statistical significance at .05 and .01 respectively. Adj. R^2 = .51, F-stat. = 15.33, Durbin-Watson stat.= 1.58.

Figure 7 shows how well the predicted model conforms to the actual time series behavior of the unemployment rate. While the Durbin-Watson statistic is s little low to provide strong confidence in the absence of serial autocorrelation of the error term, the plot of the residuals also shown in figure 7 appear to indicate a fairly strong tendency for the residuals to revert to zero.

Figure 7: Plots of fitted model, actual data, and residuals derived from auto regression model (equation 7.)



Together with the positive correlation coefficient we have some evidence that the changing structure of Paraguayan agriculture is linked to a growing urban unemployment problem. To be sure, more data and a more fully developed structural model are required to provide a firmer basis for this admittedly impressionistic evidence.

VI. Summary and conclusions.

The time series analysis carried out in this paper provides convincing evidence of a long run equilibrium relationship among growth in GDP per capita (a measure of social welfare), the growth in the capital stock, and the increasing tendency over time for the structure of agricultural production to become more concentrated in a small number of cash crops destined primarily for export. Moreover, examination of the causal interactions of these variables strongly suggests that the tendency for increasing agricultural commodity concentration has a depressing influence both on the rate of capital formation and the growth of GDP per capita. The interesting finding then is that agricultural commodity concentration potentially has both direct and indirect dampening effects on Paraguayan economic growth with the indirect effects operating through the growth of the capital stock. There is also some tentative evidence that agricultural commodity concentration in Paraguay may be linked to a tendency for rural-urban labor migration and the recently observed rise in open urban unemployment. Taken together these findings cast doubt on the neoclassical conventional wisdom that production specialization based on static comparative advantage and export-led growth provides a path to welfare improvement. In the case of Paraguay the externally driven agricultural expansion might more appropriately be termed 'export-led stagnation' rather than 'export-led growth.'

The development policy implications of this analysis are clear. A simple reliance on market forces alone will not be sufficient to stimulate sustained economic growth that is capable of increasing social equity. Policies must pursue means to provide linkages between the growing agricultural sector and the economy-at-large, particularly in ways that promote the creation of jobs. To some extent this means greater diversity of production within agriculture, but it may also mean moving the established lines of agricultural production into higher stages of value added production. It isn't sufficient for Paraguay, for example, to produce raw unprocessed soybeans for export. For soybeans to play a dynamic role in the Paraguayan economy ways must be found to promote soybean processing and the development of industries that can make profitable use of these processed products. Only in this way can the sector promote employment creation to substitute for the jobs lost when soy production displaces more labor absorbing lines of agricultural production.

Notes

1. For a representative discussion see Taylor 1998. More recently Herzer and Nowak-Lehnmann D. (2006), making use of the same type of time series estimation methods employed in this paper, have noted the beneficial impact on Chilean economic growth that can be traced to export diversification.

2. Capital stock is estimated by the perpetual inventory method from data provided by the International Monetary Fund's *Yearbook of Financial Statistics*. Data are in real terms with nominal values adjusted by the producer price index. Variable definitions and sources are provided in Appendix I. Appendix II provides the actual (log transformed) data series used in the analysis.

3. To be sure booming agriculture was not the only sector that has explanatory power in describing the behavior of growth of GDP in Paraguay. As noted earlier the construction sector, especially that part of it related to the Itaipu dam, played an important role in the 1970s. The peak activity related to this construction, both in terms of investment flows and employment, occurred in 1978. The economic impacts for Paraguay were essentially limited to the period 1974 when the project began and the early 1980s when construction was completed.

4. The presence of unit roots in time series is not necessarily fatal to the validity of least squares estimators as will be seen below in the case of so-called co-integrated series. This, however, is a special case requiring that specific conditions be met.

5. The 'L' prefix indicates a variable expressed in natural log (level) form. The 'D' prefix indicates the first difference of the variable also expressed in natural log form. All econometrics were performed in EViews 6.1 Optimal lag lengths (not shown) for unit root tests were chosen according to the AIC criterion.

6. The KPSS test results are sensitive to the specification of exogenous parameters in the regression equation. The reported specification included a constant but no trend parameter. When the equation is re-specified to include a trend term the KPSS statistic is increased providing stronger evidence against the null hypothesis. Results are also found to be insensitive to the choice of the estimate of the residual spectrum at frequency zero.

7. This assumption will be explored further below.

8. The use of the term "equilibrium" is to be understood in the econometric sense rather than in the standard economic sense as the limit to an adjustment process. Econometric equilibrium suggests a long term tendency for variables to jointly respond to some common stochastic trend. This *may* be the result of a causal

relationship among and between the variables but does *not* guarantee the existence of such a relationship.

9. The cointegrating equation was estimated under the assumption of a single period lag. The choice of lag specification was made following the AIC and SBC tests for lag length.

10. Of course GDP per capita by itself tells us nothing regarding the distribution of income which is itself potentially related to social welfare.

11. Several variants of the VEC model were examined that modified the choice of lag length (for 1 and 3 years) for the endogenous variables without any changes in the qualitative results.

12. The VEC model includes a dummy variable (DU80) to represent a shift in the trend behavior of LGDPPC. DU80 takes a value of one after 1979 and is zero otherwise. The choice of 1980 as the structural break point was determined endogenously by the Quant-Andrews breakpoint test as described in Andrews (1993). As noted earlier visual inspection of the time path of LGDPPC in Figure 3 also suggests the presence of an inflection point around 1980.

13. The results of the variance decomposition and impulse response functions may be sensitive to the ordering of the variables. With this in mind the exercise was repeated with a re-ordering of the variables. No significant changes occurred in the results.

Appendix I: Data definitions and sources.

HERFINDAL, Herfindal index calculated by the authors as area (hectares) planted in eleven major commodity crops. *Statistical Yearbook for Latin America and the Caribbean*, (various issues), United Nations Economic Commission for Latin America and the Caribbean, Santiago, Chile.

CROP1, Ratio of single largest commodity planted to total hectares planted of eleven major commodity crops. *Statistical Yearbook for Latin America and the Caribbean*, (various issues), United Nations Economic Commission for Latin America and the Caribbean, Santiago, Chile.

GDPPC, Real gross domestic product per capita. Penn World Tables 6.1.

GDP, Real gross domestic product. Obtained by multiplying GDPPC by population. Penn World Tables 6.1

KSTOCK, Real capital stock calculated by the authors according to the perpetual inventory method with data from *International Financial Statistics Yearbook*, (various issues), International Monetary Fund, Washington, D.C. Nominal values were adjusted by the producer price index.

UNEMPLOY, Urban unemployment rate. Data refer to the capital city of Asunción. Data are obtained at CEPALSTAT website whose address is http://www.eclac.org/estadisticas/default.asp?idioma=IN

Appendix II: Data series used in the analysis.

obs	LGDPPC	LGDP	LKSTOCK	LHERFINDAL	LCROP1	LUNEMP
1961	6.229851	13.81004	NA	7.660585	-1.070025	NA
1962	6.274931	13.88082	5.043425	7.669028	-1.108663	NA
1963	6.306367	13.93780	5.703782	7.640123	-1.158362	NA
1964	6.348597	14.00541	6.133398	7.831220	-0.918794	NA
1965	6.376710	14.05919	6.511745	7.789869	-0.959720	NA
1966	6.404517	14.11338	6.806829	7.748029	-1.002393	NA
1967	6.482893	14.21833	7.057898	7.810353	-0.884308	NA
1968	6.537387	14.29913	7.262629	7.833204	-0.869884	NA
1969	6.599585	14.38780	7.421776	7.592366	-1.164752	NA
1970	6.681206	14.49601	7.574558	7.498316	-1.133204	NA
1971	6.756211	14.59810	7.704812	7.532088	-1.064211	NA
1972	6.838116	14.70675	7.810758	7.512618	-1.102620	NA
1973	6.936382	14.83442	7.928766	7.533159	-1.096614	NA
1974	7.062097	14.98978	8.061802	7.523481	-1.158362	NA
1975	7.160349	15.11542	8.190909	7.539027	-1.161552	NA
1976	7.291241	15.27024	8.321665	7.553811	-1.148854	NA
1977	7.467445	15.46847	8.440312	7.549083	-1.262308	NA
1978	7.597010	15.62023	8.559294	7.551187	-1.443923	NA
1979	7.646602	15.69187	8.673513	7.599401	-1.234432	1.774952
1980	7.878087	15.94680	8.805525	7.690286	-1.010601	1.410987
1981	8.059238	16.15362	8.933400	7.571988	-1.139434	0.788457
1982	8.087908	16.20939	9.030256	7.627544	-1.041287	1.722767
1983	8.063888	16.21378	9.096275	7.724888	-0.923819	2.128232
1984	8.100386	16.27902	9.160625	7.736307	-0.898942	2.001480
1985	8.135367	16.34277	9.217515	7.793174	-0.894040	1.648659
1986	8.127859	16.36428	9.278466	7.648263	-1.084709	1.808289
1987	8.163628	16.42902	9.344172	7.738488	-0.898942	1.704748
1988	8.249078	16.54313	9.410174	7.713785	-0.962335	1.547563
1989	8.320828	16.64371	9.481969	7.753194	-0.926341	1.808289
1990	8.343951	16.69533	9.536257	7.977282	-0.699165	1.887070
1991	8.386394	16.76639	9.603598	7.661998	-0.967584	1.629241
1992	8.407492	16.81576	9.660141	7.761319	-0.886732	1.667707
1993	8.443691	16.88011	9.721966	7.791936	-0.858022	1.629241
1994	8.477277	16.94191	9.789142	7.798933	-0.823256	1.481605
1995	8.533011	17.02550	9.858542	7.717796	-0.923819	1.667707
1996	8.547965	17.06815	9.917095	7.791523	-0.848632	2.104134
1997	8.557675	17.10520	9.975064	7.878913	-0.794073	1.960095
1998	8.521777	17.09648	10.01127	8.017637	-0.687165	1.887070
1999	8.505972	17.10751	10.04368	8.094684	-0.632993	2.240710
2000	8.510251	17.13827	10.07099	8.091933	-0.625489	2.302585
2001	8.519211	17.17338	10.09807	7.973500	-0.713350	2.379546
2002	8.478024	17.15802	10.12154	8.087948	-0.629234	2.687847
2003	8.490794	17.19646	10.14690	8.037866	-0.671386	2.415914
2004	NA	NA	10.17550	8.105609	-0.619897	2.302585
2005	NA	NA	10.20485	8.205492	-0.551648	2.028148
2006	NA	NA	10.23459	8.219595	-0.541285	2.186051
2007	NA	NA	10.26671	8.225503	-0.536143	1.974081

NA indicates “not available.”

References

Andrews, Donald W.K. 1993. "Tests for parameter instability and structural change with unknown change point," *Econometrica*, 61(4):821-856.

Dickey, D.A. and W.A. Fuller. 1979. "Distributions of the estimators for autoregressive time series with a unit root," *Journal of the American Statistical Association*, 75:427-61.

Dickey, D.A. and W.A. Fuller. 1981. "Likelihood ratio statistics for autoregressive time series with a unit root," *Econometrica*, 49:47-74.

Enders, Walter. 2004. *Applied Econometric Time Series, Second Edition.* Wiley: Hoboken, NJ

Engle, Robert F. and C.W.J. Granger. 1987. "Co-integration and error correction: Representation, estimation, and testing," *Econometrica*, 55:251-276.

Granger, C. W. J. 1969. "Investigating causal relations by econometric models and cross-spectral methods," *Econometrica*, 37:424-438.

Granger, Clive and Paul Newbold. 1974. "Spurious regression in econometrics," *Econometrica*, 2:111-120.

Herzer, Dierk and Felicitas Nowak-Lehnmann D. 2006. "What does export diversification do for growth? An econometric analysis," *Applied Economics*, 38:1825-1838.

Jaffee, David. 1985. "Export dependence and economic growth: A reformulation and respecification," *Social Forces*, 64, no.1(September):102-118.

Johansen, Soren. 1998. "Statistical analysis of cointegrating vectors," *Journal of Economic Dynamics and Control*, 12(July-September):231-54.

Kwiatkowski, Denis, Peter C.B. Phillips, Peter Schmidt, and Yongcheol Shin. 2003. "Testing the null hypothesis of stationarity against the alternative of a unit root," *Journal of Econometrics*, 115:53-74.

Phillips, P.C.B. and P. Peron. 1988. "Testing for a unit root in time series regression," *Biometrica*, 75:335-346.

Taylor, Alan. 1998. "On the costs of inward-looking development: Price distortions, growth and divergence in Latin America," *The Journal of Economic History*, 58, no.1(March):1-28.