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NOMINAL AND REAL EXCHANGE RATES AND PURCHASING POWER PARITY DURING THE GUATEMALAN FLOAT, 1897-1922

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From around 1897 until 1924 the Guatemalan peso was a fiat currency whose exchange value floated against the U.S. dollar. The behavior of the nominal exchange rate is consistent with purchasing power parity. The hypothesis that the elasticities of the exchange rate with respect to the domestic money supply and foreign price level are +1 and −1 cannot be rejected. The exchange rate, money supply and foreign price level each appear to follow a random walk with drift but are cointegrated, implying a stationary real exchange rate. The behavior of the real exchange rate is consistent with fundamentals. Terms of trade improvements and years of good coffee harvests are associated with real appreciation. The WWI period, which likely diminished or reversed long term capital inflows, is associated with real depreciation.

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1. INTRODUCTION

This paper analyzes nominal and real exchange rate behavior during an episode of floating that has largely gone unexamined. From the late 1890s until the mid 1920s the Guatemalan peso was a fiat currency whose exchange value floated against the regionally dominant international money, the US gold dollar. The peso/dollar float is unusual not only because it occurs during an era that comprises part of the heyday of the classic gold standard, but also because it is a rare case of a sustained float in what would today be described as a small, open LDC.

The behavior of the exchange rate is consistent with combined monetary and purchasing power parity (PPP) theories. The hypothesis that the elasticity of the exchange rate with respect to the domestic money stock is one and that the elasticity with respect to the foreign price level is minus one cannot be rejected. The exchange rate, domestic money stock and foreign price level each individually appear to follow a random walk with drift. These series are cointegrated, however, implying a stationary real exchange rate. Stationarity of the real exchange rate can be attributed to the stationary behavior of its fundamental determinants, the terms of trade and the volume of the predominant export, coffee. Terms of trade improvements and years of good coffee harvest are associated with real peso appreciation. The effect of capital flows on the exchange rate could not be directly examined for lack of data, but the World War I period, which likely diminished new investment inflows as well as causing some foreign disinvestment, is associated with real peso depreciation that cannot be accounted for by the other fundamentals.

The rest of the paper is organized as follows. Part two is a brief historical background. Part three reviews the theory to be tested as well as the methodological approach. Empirical results are presented in part four, and part five concludes the paper.

2. HISTORICAL BACKGROUND

Guatemala's Liberal Revolution of 1871 ushered in economic policies that welcomed foreign investment, encouraged specialization and trade, and made Guatemala into a classic mono-crop, export economy. From the mid 1870s to the mid 1890s the volume of coffee exports nearly quadrupled.[1] Export agriculture, dominated by coffee, accounts for some twenty two percent of GDP in the early 1920s, the first years for which estimates of GDP are available.[2] Guatemala was on a silver standard throughout most of the nineteenth century.[3] When the United States was also on the gold standard, the peso/dollar exchange rate was a reflection of the silver price of gold. The first banknotes to circulate in Guatemala were those of the short-lived (1874-76) *Banco Nacional de Guatemala*, a public institution founded from the proceeds of the Liberal confiscation of Church property.[4] The first charters to private banks with authority to issue silver-backed peso banknotes were granted in 1877.

Beginning in the mid-1890s, government expenditure was increasingly financed through loans from these banks. As government debt rather than metal came to back a growing circulation of banknotes, silver convertibility was suspended. Under an 1898 agreement between the government and the banks, banks would not be required to redeem their notes for silver until the government had repaid its debt to the banks. The agreement also created a Banking Committee which "functioned merely as a

[1] Based on data from Jones (1966, p. 210), the five year averages of coffee exports for the years 1873-77 and 1893-97 are, respectively, 8,840 and 33,400 (English) tons.

[2] The figure is calculated from the data presented in Bulmer-Thomas (1987, pp. 308-316).

[3] The basic reference for the monetary history of nineteenth and early twentieth century Guatemala is contained in a chapter of *Central American Currency and Finance* by Young (1925) on which this section is based.

[4] Prior to the Liberal period, the Catholic Church was the major financial institution and "loaned out money, at about six percent interest, usually on mortgages against farms (Young, (1925, p. 25))."

government institution to issue paper money" that was "purely fiduciary" and "not redeemable in coin (Young (1925, p. 31))." Peso-denominated metal coin disappeared from circulation leaving the national currency to consist of paper pesos. The exchange value of the peso against the gold dollar would henceforth be determined by what amounted to a pure float.

The reign of General Manuel Estrada Cabrera, who was president from 1898 to 1920, coincides with most of the period of floating. Estrada Cabrerea recognized the benefits of seignorage and continued to borrow from rather than to repay the banks. Some borrowing took the form of loans to cronies who had only to present a letter of recommendation to a bank from *el presidente*. Young noted that "Cabrera did not evince much enthusiasm for (currency) reform since the *billete* (paper currency) system was lucrative to himself and to a large number of his friends (p. 55)." The overthrow of Estrada Cabrera in 1920 led eventually to the currency reform of 1924 which laid the basis for monetary stability that has largely endured to the present.

The growing stock of paper pesos in circulation was associated with peso depreciation *vis à vis* the gold dollar. Between 1897 and 1922 the money stock increased at an average annual rate of fourteen per cent and the peso price of the dollar at a rate of twelve per cent. The exchange rate was two pesos per dollar in 1897 but stood at around sixty at the time of the 1924 currency reform. Unfortunately, there is no data series for domestic inflation during this period. Contemporary observers, however, noted that "prices of commodities have risen as the paper circulation has increased" and that "accompanying the fall in the gold value of the peso has gone a rise in domestic prices and wages, necessitating constant readjustments (Young (1925, p. 38))."

3. NOMINAL AND REAL EXCHANGE RATES AND PPP

A. PPP and the Real Exchange Rate

Define the real exchange rate, R, as $R = EP^* / P$, where the exchange rate, E, is the domestic currency price of foreign currency (pesos per dollar), P^* is a measure of the foreign (U.S.) price level, and P is a measure of the domestic (Guatemalan) price level. Real depreciation (appreciation) in this paper will refer to an increase (decrease) in R. Letting lowercase letters denote logarithms and rearranging gives

$$e = r + p - p^* . \qquad (1)$$

Absolute PPP holds that R is unity, so that r is zero. Relative PPP holds that R is some non-unitary constant, so that the change in r is zero. In either case, the exchange rate is a purely nominal variable. *Ceteris paribus*, the (log) exchange rate is proportional to the (log) domestic price level, with factor of proportionality equal to one, and inversely proportional to the (log) foreign price level, with factor of proportionality minus one. If the real exchange rate is not constant, however, then exchange rate changes can reflect both real and nominal influences.

To discuss real exchange rate changes requires being more specific about the price indexes represented by P and P^*, with different real exchange rate concepts arising from different choices of price index (see Harberger (1986) and Edwards (1989)). One approach is to define the real exchange rate as the ratio of foreign and home consumer price indexes (CPI) expressed in a common currency. If the purchasing power of a national currency is best measured by the reciprocal of a country's CPI, and if one wants to test whether the purchasing powers of national currencies are equalized internationally, then this is a logical choice for defining the real exchange rate. With nontraded goods in the CPI, however, absolute PPP need not hold even if the law of one price holds for all traded goods. Even relative PPP need not hold if the relative price of nontraded goods to traded goods evolves differently in the home and foreign country, the Balassa-Samuelson effect (Balassa (1964) and Samuelson (1964)). Alternatively, Williamson (1994) argues that "since the nominal exchange rate is the relative price of two national monies, the real exchange rate must be the relative price of two national outputs (p. 14)." This leads to defining the real exchange rate as the ratio of foreign and home GDP deflators expressed in a common currency. With heterogeneous national outputs, this real exchange rate has a terms of trade dimension, and there is no reason to expect it to be constant.

This paper will use the ratio of GDP deflators expressed in a common currency, but in a "dependent economy" setting where the small home country exports a single primary commodity and imports a broad range of tradable goods produced only in the foreign country. Each country also produces its own nontradables. Let the foreign GDP deflator be $P^* = (P_M^*)^{a^*}(P_N^*)^{1-a^*}$ where P_M^* is the price (index) of foreign-produced tradable goods, which are all importables from the home country's perspective, P_N^* is the price (index) of foreign nontraded goods, and a^* is the weight of tradables in the overall index. The home country's GDP deflator is $P = (EP_X^*)^a (P_N)^{1-a}$ where P_X^* is the foreign currency ("world market") price of the export good, P_N is the price (index) of home nontraded goods, and a is the weight of the export good in the overall index. The small home country's terms of trade is $T = P_X^* / P_M^*$, and its relative price of nontraded to imported tradable goods is $\Omega = P_N / P_M$. Similarly, let $\Omega^* = P_N^* / P_M^*$ for the foreign country. Making these substitutions into (1) and assuming the law of one price holds for all traded goods, the real exchange rate can be rewritten as $R = (\Omega^*)^{1-a^*} / (T)^a (\Omega)^{1-a}$.

In logarithmic form this becomes

$$r = (1-a^*)w^* - at - (1-a)w \,. \tag{2}$$

The real exchange rate is thus a function of the terms of trade, t, and the relative price of nontraded goods, w. Neary (1988) shows in a real model that a terms of trade improvement (an increase in t) for a small country can, in general, be presumed to cause "real appreciation" in the sense of an increase in the relative price of nontraded to traded goods (an increase in w). Edwards (1986) reaches similar conclusions in a macro/monetary model. If t and w move together in this fashion, then a terms of trade improvement implies real appreciation as defined here, that is, a decrease in r. Having introduced PPP and precisely defined the real exchange rate and its relation to the terms of trade and the relative price of nontraded goods, empirical issues in testing PPP are considered.

B. Empirical Tests of PPP

Upon adding time subscripts, Equation (2) becomes

$$e_t = r_t + p_t - p_t^* . \tag{3}$$

A traditional approach to testing PPP (Frenkel (1978, 1981)) is to estimate the following equation by ordinary least squares (OLS)

$$e_t = b_0 + b_1 p_t + b_2 p_t^* + u_t . \tag{4}$$

Comparing (4) to (3), PPP implies that $b_1 = -b_2 = 1$. Absolute PPP adds the additional coefficient restriction, $b_0 = 0$.

There are at least two criticisms of this approach. If the time series for the price levels and the exchange rate are nonstationary, then, unless the variables are cointegrated, (4) represents a case of spurious regression (see Granger and Newbold (1974), Phillips (1986), Engle and Granger (1987)). Even with cointegration, standard t and F tests applied to coefficient estimates may not be appropriate. Also, the real exchange rate, r_t, has been omitted from (4). If the real exchange rate is not constant, and if real exchange rate changes, now subsumed in u_t, are correlated with price level changes, there is omitted variable bias. A theoretical justification for omitting r_t from (4) is provided by the classical dichotomy - changes in relative prices (in this case, the real exchange rate) should be independent of general price level changes.

In light of evidence that the real exchange rate not only fails to be constant but may display random walk behavior, recent research into PPP has examined the real exchange rate for stationarity to determine if there is a long-run, time-invariant mean around which its fluctuations are anchored (see Boucher Breuer (1994)). Researchers have examined data for industrialized countries in the post-Bretton Woods period (Abuaf and Jorion (1990), Cheung and Lai (1993)), the experience with floating in the 1920s (Taylor and McMahon (1988), Ardeni and Lubian (1989)), the Canadian float of the 1950s (Choudry *et al.* (1991)), Latin American and other high inflation countries (McNown and Wallace (1989), Liu (1993)), the gold standard era (Diebold *et al*. (1991)) and periods with regime changes (Flynn and Boucher (1993), Grilli and Kaminsky (1991)). Results have been mixed in terms of support for PPP.

One approach is to apply unit-root tests to the real exchange rate series, $r_t = e_t - p_t + p_t^*$, in which the traditional PPP restriction, $b_1 = -b_2 = 1$, is imposed rather than tested. An alternative is to test whether the exchange rate, domestic price level and foreign price level are cointegrated. A simple test for cointegration is to estimate (4) by OLS and apply a test for stationarity to the residual series, $\hat{u}_t$, which is interpreted as reflecting movements in the real exchange rate. If (4) is, indeed, such a cointegrating regression, then a long-run, equilibrium relationship exists among the nominal variables, e_t, p_t and p_t^*. However, the estimated cointegrating vector, $(1,\ b_0,\ b_1,\ b_2)'$, need not satisfy the coefficient restriction of traditional PPP, $b_1 = -b_2 = 1$, and some researchers claim support for PPP, in the looser sense of cointegration, without testing this hypothesis.

As it stands, (4) cannot be estimated for the period in question as there is no available time series for the Guatemalan price level. To overcome this data deficiency, PPP is imbedded in a simple, small country monetary model of exchange rate determination (see, for example, Frenkel (1978)). A justification for this is that the monetary model has been found to provide a good fit to the Guatemalan data for the post-WWII, fixed exchange rate period (Blejer (1982)). Consider the money market equilibrium condition, $M = kPY$, where M is the money stock, P is the GDP deflator, Y is real GDP, and k is a constant. Using the real exchange rate, $R = EP^* / P$, to substitute for P, taking logarithms, and moving e to the left side yields

$$e_t = -\log k + \{m_t - p_t^*\} + \{r_t - y_t\}. \tag{5}$$

The brackets distinguish nominal from real variables. According to the classical dichotomy, the vector of nominal variables, $(e_t,\ m_t,\ p_t^*)'$, should in some sense "move together over time" (be cointegrated) and also be independent of the vector of real variables, $(r_t,\ y_t)'$. This justifies dropping the real variables in (5), just as the real exchange rate was dropped in moving from (3) to (4) above, to give

$$e_t = b_0 + b_1 m_t + b_2 p_t^* + u_t. \tag{6}$$

Equation (6) is similar to (4) except that the (log) price level, p_t, is replaced by the (log) money stock, m_t, to which, *ceteris paribus*, it is assumed to be proportional. Just as in (4), PPP implies that $b_1 = -b_2 = 1$.

4. EMPIRICAL ANALYSIS

This section establishes that each variable in (6) individually appears to follow a random walk with drift. If PPP is to hold in any sense, then the variables in (6) must be cointegrated. A residual-based test for cointegration is applied to (6) with positive results. Given evidence of cointegration, the regression is nonspurious, and valid, though nonstandard, inference about the cointegrating vector, $(1,\ b_0,\ \ b_1,\ \ b_2)'$, is performed to test the coefficient restriction of traditional PPP. The hypothesis that $b_1 = -b_2 = 1$ can be accepted. The (stationary) real exchange rate series, $r_t = e_t - m_t + p_t^*$, is then analyzed to find that terms of trade improvements are associated with real appreciation.

Table 1 presents the results of a battery of unit root tests applied to the logarithms of the money stock (m_t), exchange rate (e_t), coffee exports (x_t), U.S. GNP deflator (p_t^*) and terms of trade (t_t)[5]. A visual inspection of the series for m_t, e_t, x_t and p_t^* suggests a definite upward trend, which is not the case for t_t. For the first four series, therefore, stationarity around a deterministic trend is entertained as the alternative to a unit root, while for the terms of trade the alternative is stationarity around a constant mean. Dickey-Fuller t and F tests, and augmented Dickey-Fuller and Phillips-Perron tests all give consistent results (Dickey and Fuller (1979), Phillips and Perron (1988)).[6] The null hypothesis of a unit root cannot be rejected for the money stock, exchange rate and U.S. GNP deflator. Each series individually appears to follow a

[5] Young (1925) contains annual time series for: the average peso/dollar exchange rate; the nominal value of peso banknotes in circulation; Guatemalan coffee exports. The U.S. GNP deflator and U.S. BLS wholesale price index are from ***Historical Statistics of the United States***, U.S. Department of Commerce. The British Department of Overseas Trade (1922) reports that in 1921 coffee exports accounted for seventy seven percent of total export value. For selected years between 1913 and 1921, imports from the US as a percent of total import value ranged from 51 to 73 per cent. A reasonable measure of Guatemala' s terms of trade, T, is thus the ratio of the price of coffee to the U.S. WPI. Coffee prices within Guatemala at the time were quoted on a U.S. gold dollar basis and were geared to the price on the New York coffee exchange (Kemmerer (1919)). The annual series for coffee prices on the New York coffee exchange are from Ukers (1933).

Bulmer-Thomas (1987) contains national income and product accounts and balance of payments accounts for Guatemala beginning in 1920 from which the share in GDP of export agriculture for the early 1920s is calculated.

[6] Only one lag was found to be needed in the augmented Dickey-Fuller and Phillips-Perron tests. Coefficients on additional lagged first differences in the augmented Dickey-Fuller regressions, to which standard t-tests can legitimately be applied, are in general not significantly different from zero. The adequacy of a single lag to account for serial correlation is no doubt due to the low frequency, annual nature of the data. As for using annual data, with a resulting small number of observations in many cases, such as this one, Shiller and Perron (1985) point out that the power of unit roots tests depends more on the span of the data, the number of years, that on the number of observations.

random walk with positive drift. The unit root hypothesis is rejected for exports and the terms of trade. Coffee exports appear to be stationary around a trend annual growth rate of about one per cent. The terms of trade appears to be a stationary series.

Table 1. Unit Root Tests

Estimated regression: $y_t = a + r y_{t-1} + dt + u_t$

True process under $H_0 : y_t = a + y_{t-1} + u_t$

5% Critical Value to test $r = 1$ (Cols. 1-3): -3.60[1)]

5% Critical Value to test $r = 1$ and $d = 0$ (Col. 4): 7.24[2)]

Series	(1) Dickey-Fuller *t* test	(2) Augmented Dickey-Fuller *t* test	(3) Phillips-Perron Z_t test	(4) Dickey-Fuller *F* test
m_t	−2.15	−2.73	−2.34	2.52
e_t	−2.24	−2.80	−2.45	3.04
p_t^*	−1.68	−2.42	−1.96	1.71
x_t	−8.06	−4.42	−8.61	32.22

Estimated regression: $y_t = a + r y_{t-1} + u_t$

True process under $H_0 : y_t = y_{t-1} + u_t$

5% Critical Value to test $r = 1 : -3.00$[3)]

Series	(1) Dickey-Fuller *t* test	(2) Augmented Dickey-Fuller *t* test	(3) Phillips-Perron Z_t test
t_t	−3.59	−3.90	−3.73

Notes: [1)] From Table B.6, Case 4 (Hamilton (1994, p. 763)). [2)] From Table B.7, Case 4 (Hamilton (1994, p. 764)). [3)] From Table B.6, Case 2 (Hamilton (1994, p. 763)).

Given these results, Equation (6) is subject to the criticism of spurious regression unless the variables are cointegrated. A residual-based approach is used to test for cointegration (Engle and Granger (1987), Phillips and Ouliaris (1990), Hansen (1992)). (6) is first estimated by OLS. The residual series, $\hat{u}_t$, is then tested for a unit root by applying OLS to the following residual autoregression[7]

$$\hat{u}_t = z\Delta\hat{u}_{t-1} + r\hat{u}_{t-1} + e_t \,. \tag{7}$$

[7] The presence of the lagged first difference term, $\Delta\hat{u}_{t-1}$, corrects for serial correlation in the disturbance.

The absence of a unit root in (7), or $r < 1$, is evidence against the null hypothesis of no cointegration. The standard OLS t statistic, $(\hat{r}-1)/\hat{s}_{\hat{r}}$, is compared to the appropriate (nonstandard) lower-tailed critical value which, at a five percent significance level, is -3.80.[8] The estimated cointegrating regression, (6), and residual autoregression, (7), are presented in Table 2. $(\hat{r}-1)/\hat{s}_{\hat{r}}$ is -5.107, so the null hypothesis of no cointegration, or a unit root in the residual series, is rejected.

Table 2. OLS Estimates of (6) and (7)

	Coefficient	Standard Error
Equation (6)		
Intercept	−5.675	.50
m_t	1.025	.097
p_t^*	−.856	.310
Standard Error of Estimate	.221	
R^2	.935	
Durbin Watson	1.652	
F Statistic		
$H_0: b_1 = -b_2 = 1$	1.233	
$T = 26$ (1897-1922)		
Equation (7)		
$\Delta\hat{u}_{t-1}$	.412	.186
$\hat{u}_{t-1}$	−.246	.244
t Statistic		
$H_0: r < 1$	−5.107	

Not only is there evidence that the exchange rate, money stock and foreign price level are cointegrated, but the estimates of the coefficients on m_t and p_t^*, 1.03 and -.86 are quite close to the traditional PPP predictions of +1 and –1. If standard inference could be applied to (6) to test the hypothesis that $b_1 = -b_2 = 1$, it would be accepted at any conventional significance level. In general, however, even though the regression in (6) is nonspurious due to cointegration, the sampling distributions of estimators are nonstandard. The approach undertaken here to perform generally valid inference is to apply a correction to the standard F statistic using the procedure recommended by Phillips and Loretan (1991) and Stock and Watson (1993).

[8] The critical value is from Table B.9, Case 3 of Hamilton (1994, p. 766).

Leads and lags of first differences of right hand side variables are added to (6) to give

$$e_t = b_0 + b_1 m_t + b_2 p_t^* + \sum_{s=-p}^{p} g_s \Delta m_{t-s} + \sum_{s=-p}^{p} h_s \Delta p_{t-s}^* + u_t \ . \tag{8}$$

where the sum, in general, is over $s = (-p,\ p)$.

This equation is estimated by OLS. To perform inference on the b s, the standard F statistic is multiplied by $(s_e \backslash l)^2$. This transformed F statistic can be compared to a critical value from the appropriate standard F distribution. s_e is the standard error of estimate from (8), and $l = s_u \backslash (1 - \hat{f}_1 - \ldots - \hat{f}_p)$. s_u is the standard error of estimate and the $\hat{f}$ s are the estimated coefficients from the following autoregression involving the residuals from (8)

$$\hat{u}_t = j_1 \hat{u}_{t-1} + j_2 \hat{u}_{t-2} + \ldots + j_p \hat{u}_{t-p} + \text{residual.}$$

The estimates are presented in Table 3. The standard F statistic to test $b_1 = -b_2 = 1$ is .8406, $(s_e \backslash l)^2 = 1.267$, and the transformed F statistic is thus 1.065. This is less than the five per cent F critical value of 3.74, so the hypothesis, $b_1 = -b_2 = 1$, is accepted.

Table 3. OLS Estimates of (8) and Residual Autoregression

	Coefficient	Standard Error
Equation (8)		
Intercept	−5.76	.88
m_t	1.24	.23
p_t^*	−1.57	.79
Δm_{t+1}	1.39	.58
Δm_t	−.14	.35
Δm_{t-1}	−.15	.36
Δp_{t+1}^*	.20	.81
Δp_t^*	.29	.82
Δp_{t-1}^*	1.19	1.75
Standard Error of Estimate, s_e	.1954	
F Statistic		
$H_0 : b_1 = -b_2 = 1$	.8406	

Table 3. (Continued)

	Coefficient	Standard Error
Residual Autoregression		
$\hat{u}_{t-1}$	.68	.21
$\hat{u}_{t-2}$	−.44	.21
Standard Error of Estimate, s_u	.1319	
$l = s_u \setminus (1 - j_1 - j_2)$	.1736	

To conclude, the nominal variables, e_t, m_t and p_t^*, are not only cointegrated, but the estimated cointegrating vector is such that the hypothesis of traditional PPP, $b_1 = -b_2 = 1$, cannot be rejected. The real exchange rate, though not constant, is stationary.

The concluding section examines the relation between the (stationary) real exchange rate and "fundamentals". The PPP coefficient restriction, $b_1 = -b_2 = 1$, is imposed on (6) and the OLS residuals, or (log) real exchange rate, are obtained, i.e., $r_t = e_t - b_0 - m_t + p_t^*$, where b_0 is the restricted estimate of b_0. The resulting (log) real exchange rate series is regressed on the following "fundamentals": the (log) terms of trade; (log) coffee exports; and a dummy variable, D_W, for the WWI years,

$$r_t = g_1 t_t + g_2 x_t + g_3 D_W + u_t . \tag{9}$$

All of the right hand side variables in (9) can reasonably be taken as exogenous, and, based on above results, all of the variables can be taken to be stationary. While coffee was big in Guatemala, Guatemala was small in the world coffee market. For the period 1910-1914, Guatemalan coffee production accounted for 3.8% of world production (Ukers (1922, p. 294)). Hence, t can reasonably be taken as exogenous from the perspective of the Guatemalan economy. Guatemalan coffee was grown almost exclusively for export, so in any given year coffee exports amounted to whatever was harvested. Since coffee is a permanent tree crop, in a given year the harvest depends on the predetermined stock of coffee trees plus the weather and other such exogenous factors. While x_t is stationary around a trend, the trend growth is less than one per cent and large year to year fluctuations overwhelm the upward trend over the years in question. Standard assumptions can therefore be made about the disturbance, u_t, and standard inference performed. The estimated equation is presented in Table 4. Each estimated coefficient is significantly different from zero at conventional significance levels.

Table 4. OLS Estimate of (9)

	Coefficient	Standard Error	*t*-ratio
t_t	−.394	.117	−3.368
x_t	−.132	.038	−3.474
D_w	.234	.093	2.516
Standard Error of Estimate	.169		
R^2	.469		
Durbin Watson	2.186		
$T = 26$ (1897-1922)			

Consistent with the previous discussion in part III, terms of trade improvements are associated with real appreciation. $\hat{g}_1$, the estimated elasticity of the real exchange rate with respect to the terms of trade, is −.394. From Equation (3) in part III, the direct effect of the (log) terms of trade on the (log) real exchange rate is $\partial r / \partial t = -a$, where a is the share of the export good in GDP. As noted earlier, export agriculture, dominated by coffee, accounted for some twenty two per cent of GDP. The fact that the point estimate −.394, overestimates (in absolute value) $-a$ is what one would expect from a consideration of the effect of omitted variable bias. The relative price of nontraded to traded goods, w, is both affected by the terms of trade and, in turn, affects the real exchange rate, but, for lack of data, is omitted from (9). If, as theory suggests, w is correlated positively with t and negatively with r, then the coefficient on t in (9) should overestimate the "true" parameter, $\partial r / \partial t = -a$, when w is omitted. This is in fact what occurs.

The rationale for including physical coffee exports in (10) is a "payments flows", or balance of payments, view of exchange rate determination (see Mussa (1984) and Harberger (1986)). The importance of underlying flow supply and demand for goods in explaining exchange rate fluctuations was stressed at the time by Young (1925) who noted that "since the currency of Guatemala cannot be shipped out of the country in payment of international balances, exchange rates fluctuate erratically with the demand and supply of (gold dollar) drafts (and) the supply ... comes almost entirely from coffee shipments (pp. 42-43)." From a "payments flows" perspective, years of above average coffee exports, associated with good harvests, should be associated with an increased "supply" of foreign exchange and (real) peso appreciation. This is supported by the negative coefficient on (log) exports in (9).

Finally, the WWI period is associated, on average, with a twenty three per cent real depreciation ($\hat{g}_3 = .234$). This cannot be explained by adverse effects of the war on exports and the terms of trade. Not only are these variables already included in (9), but, more importantly, the evidence indicates that there were no adverse effects.[9] What did occur during WWI was a significant reduction in foreign ownership of Guatemalan coffee plantations, and real depreciation could be explained in terms of the associated capital outflows.

Much of the productive capacity in the coffee sector in the latter nineteenth century occurred as a result of long term foreign investment, and, among the foreigners who invested in coffee plantations, Germans were predominant.[10] International capital mobility often went hand in hand with capitalist mobility, as Germans acquired land and took up residence in the country, although often continuing to be nationals of their country of origin. As a reflection of the importance of the German connection, prior to WWI more Guatemalan coffee was exported to Germany than to any other single country. While Guatemala did not immediately declare war on Germany at the outbreak of WWI, Guatemala's foreign policy followed that of the U.S., and war was eventually declared. At that time the property of any remaining German (enemy) nationals in Guatemala was expropriated. The WWI period, then, unlike the previous decades, was likely to have been associated with diminished new capital inflows and even a net reduction in foreign holdings of real assets in Guatemala, or capital outflows, which is consistent with the observed real depreciation.

5. CONCLUSIONS

A contemporary Guatemalan observer referred to the country's experience with a fiat currency and floating exchange rate as one of "economic disequilibrium" (de Leon (1922)) due to excessive money creation, currency depreciation and inflation. While the situation contrasted with the general monetary stability associated with the gold standard era, it was one in which the exchange rate, far from being in "disequilibrium", appears to behave consistently with the predictions of theory. The traditional PPP hypothesis that the (log) exchange rate is proportional to the (log) domestic money supply and inversely proportional to the (log) foreign price level, with factors of proportionality +1 and −1, cannot be rejected. While the exchange rate, money supply and foreign price level each individually appear to follow a random walk with drift, they are cointegrated, implying a stationary real exchange rate. Stationarity of the real exchange rate can be attributed to the stationary behavior of the terms of trade and coffee exports, its fundamental determinants. The residual real exchange rate series is related to these fundamentals as theory would suggest. Terms of trade improvements are associated with real

[9] In a regression of the (log) terms of trade on a constant and a dummy variable for WWI, the coefficient on the dummy variable is not significantly different from zero. In a regression of (log) coffee exports on a constant, a time trend and a WWI dummy variable, a similar result obtains.

[10] The development of the coffee industry is described by Jones (1966).

appreciation, as are good harvest years. The WWI period, which likely saw at least a diminution if not a reversal of capital inflows, is associated with real depreciation.

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