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FLOATING EXCHANGE RATES IN PERU, 1950-54

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ABSTRACT

I test three potentially complementary models in an effort to capture the fundamentals that underlaid the market's determination of Peru's floating exchange rate through the period 1950-54: the first is an expectational purchasing power parity (PPP) model which maintains that asset market forces were driving the exchange rate to its perceived PPP level; the second is a flexible-price monetary model; and the third is a model along the lines described by Tsiang (1957) which emphasizes world prices for Peruvian exports as a fundamental determinant. I find that the expectational PPP model not only dominates the others, but also fits quite well.

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Floating Exchange Rates in Peru, 1950-54

1. Introduction

In November 1949, the Peruvian government adopted a system of floating exchange rates that remained in force through 1954. The duration of the episode coupled with its rich context of macro policy and world events make it a valuable opportunity for analyzing the behavior of floating rate systems in developing countries. Though a number of issues are worthy of attention, the analysis below focuses on the following question: what fundamentals underlaid the market's determination of the exchange rate? For instance, is the monetary approach so often applied to industrialized countries' floating rate experience the best approach in the less-developed Peruvian case? An alternative model suggests that it is not.

The Peruvian episode has certainly not gone without interpretation. Tsiang (1957) and Schott (1959) provide earlier, more qualitative analyses. It is not until much later that Edwards (1983) provides the first, and to my knowledge only, econometric appraisal of events. He uses a short-run monetary model and concludes that, "the results obtained are quite satisfactory, indicating that the monetary view of exchange rate determination provides a useful benchmark for analyzing the behavior of floating exchange rates in developing countries." In contrast, Tsiang (1957) suggests a very different view that emphasizes world prices for Peruvian export goods as a fundamental determinant. He asserts in his first paragraph:

> From the outbreak of the [Korean] war to the end of 1952, when export prices were very favorable, the exchange rates were remarkably stable, despite considerable monetary expansion. In 1953, however, the certificate rate depreciated by 28 percent, because world market prices of

Peruvian exports fell sharply while domestic costs and prices continued to rise on account of internal inflation.

Below, I propose a model that admits the dollar price of exports as a proximate determinant of the exchange rate. I then test this "Tsiang model" against some competing alternatives.

The principal alternative model against which I test both the Tsiang and the monetary models is an expectational purchasing power parity (PPP) model, where expectational refers to the use of the expected price level as measured by a projection on the previous period's information set. This model is, in fact, a very sensible point of departure given that PPP provides the basis of the monetary model. I find that, contrary to the very poor performance of PPP models for the industrial countries since generalized floating in 1973 [Frenkel (1981)], the expectational PPP model provides a very good description of the floating rate's behavior in Peru, better than both the Tsiang model or the short–run monetary model. This is true despite the fact that inflation over the period was never greater than 10 percent per year. Moreover, because PPP is embedded in the specification of the monetary model, our results militate against the use of a conventional money market representation of the price level for the Peruvian episode.

Before considering the models in more detail, a brief description of the Peruvian setting is in order. The economic and institutional characteristics at the time were similar to those in most developing countries: exports depended heavily on a small number of commodities, the domestic capital market was repressed, and there were no organized forward markets for the Peruvian sol. In August 1948 an important structural shift occurred—a military coup from the right—that ushered in a period of economic liberalization and orthodoxy that extended beyond the end of the floating rate regime. Only a year after the coup, the government adopted the

new exchange rate system which established two different floating rates: the certificate rate for trade transactions and the so-called draft rate for financial transactions. The supply side of the certificate market was established through a 100% surrender requirement for exporters. The demand side of the certificate market was limited to imports and certain types of invisible and capital transactions.[1] Both the demand and supply side of the draft market were unfettered. Although it was known that, from time to time, the central bank intervened in order to "smooth out short-term fluctuations in the certificate rate," policy makers claimed that no attempt was made during this period to prevent its long-term adjustments.[2] The draft market, which is the one I analyze here, was free of any intervention. (One of the principal reasons for setting up a dual rate and constraining the supply and demand sides of the certificate market was insulation of trade transactions from potential "destabilizing" speculation. Tsiang (1957) treats this in detail and concludes that on balance speculative capital movements were not destabilizing.) Not surprisingly, the two floating rates tended to move in tandem; the difference between them seldom exceeded 2 percent, with the certificate rate always below the draft rate since draft market access was unrestricted. Also of particular relevance for the issues at hand is the fact that the policy shift of November 1949 eliminated virtually all trade and capital movement restrictions. Thus, individuals and firms had a great deal of freedom to exploit available opportunities in the foreign exchange market. Tsiang, for example, repeatedly emphasizes the role of foreign direct investors—the flow was substantial through

[1] The types of payment eligible for, and usually permitted in, the certificate market included freight and transit expenses, interest payments and dividends on foreign capital, royalties, agents' commissions, repayments of commercial debts, payments for insurance related to merchandise trade, remuneration of foreign technicians, etc. [Tsiang (1957) page 452.]

[2] Tsiang (1957) page 449. For more detail on the relationship between the certificate and draft markets see Tsiang pages 453–457.

this period—in the process of exchange rate determination.

The paper is organized as follows: section 2 characterizes the determination of the exchange rate in the draft market; section 3 presents the competing models; section 4 presents the various regression results; section 5 addresses the viability of the flexible rate regime; and section 6 concludes.

2. Determination in the Draft Market

The first issue that needs to be addressed is whether Peru's exchange rate can appropriately be referred to as "floating" through this period. This was certainly the view of previous authors [Tsiang (1957), Schott (1959), and Edwards (1983)]. Nevertheless, since there is some evidence of occasional intervention in the certificate market, and since the two markets were linked together in various ways, the question deserves further attention. Figure 1 illustrates the behavior of the log of the draft rate over the 5 year period. First of all, it looks like a floating rate. Though it remains fairly stable into 1953, it does bounce around. The relatively sharp depreciation that began in mid-1953 extended over a period of 8 months, a very unlikely span of time had it been a "devaluation" implemented by the central bank. Moreover, as Tsiang points out, the outstanding amount of import credits received from foreign suppliers continued to increase in 1953, which indicates that importers as a whole did not attempt to reduce significantly their future foreign exchange commitments because of expected depreciation.

More directly relevant, however, is actual Central Bank intervention. Judging from the paths of foreign exchange reserves and monetary gold, there appear to have been 3 bouts of intervention over the period: March 1951, January–June 1953, and August–December 1954. As Tsiang points out, there appears to be little evidence of any intervention in 1950 or 1952: net compensatory financing of the balance of

payments is zero in both years.[3] In 1951, on the other hand, the Central Bank absorbed $9.5 million in reserves in order to stabilize the certificate rate, with the great bulk of the action occurring in March of that year. Three relevant questions arise: (i) Why did they do it? (ii) Is $9.5 a large amount? and (iii) Does this necessarily do violence to the draft market? In answering the first, and probably most important of the three, notice that the Central Bank absorbed reserves, i.e., was keeping the sol from appreciating in the certificate market. This stabilization effort was probably necessary precisely because of the artificial structure imposed by the dual rate system. In March of 1951 the price index for Peru's export goods jumped by 29%. Since export proceeds had a 100% surrender requirement to the certificate market, and since the demand side of the certificate market was restricted, a captive excess supply might easily have developed in that market. The intervention was an effort to mop up this artificial excess supply to stabilize the rate. This interpretation is supported by the fact that once the absorption of reserves was curtailed, the rate did not appreciate, which one would have expected if the Central Bank had truly been fighting fundamentals; in fact, both the certificate and draft rates depreciated over the remaining nine months of that year. This view is also supported by the fact that the surrender requirement was adjusted downward in late March and returned to 100% approximately 2 months later in order to drain certificate market supply into the draft market.[4]

Is $9.5 million a large amount relative to the size of the certificate market? In 1951 exports totaled $248 million. Thus, the absorption of reserves over the year represents less than 5% of the surrendered proceeds (even after taking into account

[3] In 1950 a $3.0 million decrease in reserves is matched by a $3.0 million dollar increase in monetary gold; in 1952 a $3.1 million decrease in reserves is matched by a $3.1 million increase in liabilities to the IMF [Tsiang (1957) page 455].

[4] Tsiang (1957) footnote 3, page 451.

the surrender requirement adjustment). To be sure, the requisite size of effective intervention is a much disputed issue; nonetheless, in light of the apparent purpose of the intervention, the magnitude of its effect on the fundamentals is not likely to have been large.

Finally, with respect to the 1951 intervention, or any intervention for that matter, one would like to know to what degree its effects might spill over into the draft market. As already noted, the two rates did remain close together over the five year period. Tsiang points out potential arbitrage operations that would tend to bring the two rates together (e.g., direct investors selling dollars in the draft market and using the proceeds in the certificate market for needed imports). However, this convergence does not imply that the draft market moves to the level of the certificate market. With respect to the arbitrage mechanisms to which Tsiang refers, the question of which market is the tail and which the dog is largely determined by size. Without any measure of volume on the draft market this cannot readily be determined. The key point, however, is that pollution in the certificate market does not necessarily translate into pollution in the draft market.

Next I consider the second bout of intervention, which occurred in the first half of 1953; "during the latter half of the year the authorities seem to have given up major attempts to intervene and to have resigned themselves to letting the rate find its own level" (Tsiang page 466). In early 1953 Peru suffered from unfavorable terms of trade together with rising inflation (particularly in May). The certificate rate depreciated, but seemingly not as rapidly as fundamental forces would have had it. Net sales were some $12.5 million over the first 6 months. Over this period, the central bank clearly slowed adjustment, allowing full adjustment to occur later in the year. Thus, through the first six months the exchange rate path was not as steeply upward sloped as it would have been in an unfettered market.

The last of the intervention bouts occurred over the last months of 1954.

Hence, it was not the cause of the sharp appreciation of the sol early in that year. In February 1954, the President of Peru announced a stabilization program that included a reduction of government expenditures to the level of current receipts and the checking of bank credit expansion. The intervention of that year was manifested as an absorption of reserves in the amount of $6.6 million. This support of the dollar in the face of an appreciating sol occurred over the last months of 1954, and as with the first bout of intervention in 1951, is probably most accurately attributed to the artificial structure of the dual rate system and the mopping up of captive excess supply.

A final point and some key additional evidence on the matter of intervention remain. One should keep in mind that the exchange rate literature commonly refers to and econometrically analyzes floating rates that are in reality dirty floats. While the Peruvian experience was not spotless, neither were the major dollar rates over most of the post–1973 period. In the end, only the intervention in the first half of 1953 appears to have had any appreciable effect. And even in that case, the intervention appears to have moderated adjustment to changing fundamentals, rather than preventing it. As a final piece of evidence, when the level of Central Bank reserves (foreign exchange plus gold) is included in the preferred model of the spot rate its coefficient is insignificant (see footnote 11).

Before moving on to the models it is worth addressing whether the rates in the two markets were competitively determined, or close to it. First, I consider the certificate market. One might argue that export revenue is concentrated in relatively few hands, affording the supply side of the certificate market significant market power. However, this neglects the fact that export proceeds were necessarily surrendered to the Central Bank for certificates that remained valid for a short time (15 days over most of the 1950–1954 period), after which they had to be sold to the Central Bank at the current certificate rate less 2 percent. This is not a

prescription for market power. On the demand side of the certificate market there is a more legitimate argument that market power existed since a substantial portion of Peru's trade was handled by a single bank at the time. This would suggest that the sol was systematically overvalued in the certificate market. Tsiang, in his analysis for the IMF shortly after the floating rate experience, makes no mention of this. To the extent that is was true, however, as long as the degree of market power did not vary much over the period my econometric results should not be substantively affected.

Finally, the draft market accommodated a variety of different sources and uses of dollar foreign exchange. Not all of these were capital account transactions, however, since most transactions tied to invisibles trade were shunted into this market. Nevertheless, Tsiang repeatedly refers to substantial activity in the draft market associated with moving into and out of dollars in response to speculative forces. For example, in reference to the substantial direct investment from multinationals at the time, Tsiang emphasizes the opportunity "to sell part of their foreign exchange funds on the draft market and use the sol proceeds to buy certificates for their imports of equipment and materials rather than use their foreign exchange resources directly on such imports." Later, he states that "the fact that in 1954, the year of recovery and stabilization of the sol, the outflow of private short–term capital recovered its former strength and rose to more than double that of the preceding year seems to indicate the cessation of speculative sales of foreign exchange and possibly some repurchases by speculators when the expected recovery of the sol was realized." Hence, Tsiang's description of the episode, far and away the most comprehensive, is supportive of the conception that asset market forces were playing the central role in determining the sol.

3. The Models

My point of departure, purchasing power parity, is motivated by the central importance of the real exchange rate in outward–directed developing countries. In its absolute version PPP theory states that the equilibrium rate between two currencies equals the ratio of the two price levels. Though it is well established that PPP models provide a very poor description of the industrial countries' floating rate experience since 1973, the case of Peru is different in two key respects: (1) Peru is not an industrialized country and (2) economists and market analysts in the 1950's and 1960's were far more accepting of the idea that real exchange rates would remain constant or nearly constant in the context of a freely–floating exchange rate. Among other reasons, the first difference is important because speculators realize that pronounced deviations from PPP are likely to be much less sustainable for developing countries, both because of international borrowing constraints and because pronounced deviations are likely to induce abandonment of floating rate experiments with a concomitant policy–induced adjustment of the rate back toward the PPP level. The second difference is important in that, as a result, we would expect speculators in the 1950's to have put a much higher weight on a PPP model of exchange rate fundamentals than today's speculators do.

Indeed, supporters of flexible exchange rates at this time generally expected exchange rates to follow PPP. Theoretically, this would be the likely outcome if any one of the following three conditions are met. First, PPP would prevail if differing rates of inflation were the only source of shocks to the balance of payments. Second, if shocks from other sources are present, PPP would prevail if import and export

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[5] Indicative of the era, Friedman's (1953) classic defense of floating rates made strongly the argument that exchange rates would follow PPP since speculators would force the market toward its long–run equilibrium, and further suggesting that it was far easier to allow exchange rates to adjust to differing rates of inflation than vice–versa.

demand elasticities were so high that adjustment would require only very small exchange rate changes. And third, PPP would prevail if domestic wages and prices were completely flexible because any shock to the exchange rate would first produce a change in the price of tradables and than rapid and parallel changes in wages and all other prices in the economy, assuming an accommodative monetary policy. Clearly, the first condition is unlikely to be met in any real world economy. However, even if the second and third conditions are only true over the longer run, PPP might be saved as a description of short-run behavior if rational speculators conclude that the long-run exchange rate path is determined by relative price levels, and trade accordingly. That is, it is possible that asset market forces would drive the exchange rate to the perceived PPP level.

An Expectational Purchasing Power Parity Model

First, I consider a model which allows short-run deviations from PPP:[6]

$$s_t = E[p_t | \Omega_{t-1}] - E[p_t^* | \Omega_{t-1}] + \gamma d_{t-1} + \epsilon_t \qquad (1)$$

where

s_t = log of the spot draft exchange rate (soles/dollar)

p_t, p_t^* = log of Peruvian and US price levels, respectively

[6] One might ask whether the direction of "causality" from prices to the exchange rate is consistent with the data. Frenkel (1978) investigates the same question regarding the industrialized countries' floating rates in the 1920's. His Sims (1972) test for Granger causality yields evidence that, in fact, the proper specification for the countries he considers should have exchange rates on the right hand side. He then goes on to estimate price equations. For the peruvian episode, however, results of Sims tests between the nominal exchange rate and the peruvian price indices yield no evidence that the exchange rate Granger causes prices but prices do not Granger cause the exchange rate: the null hypothesis of econometric exogeneity can not be rejected in either direction.

$E[.| \Omega_{t-1}]$ = expectation conditional (linearly) on information at time t–1

d_t = deviations from PPP in period t, where $0 \leq \gamma < 1$

ϵ_t = white noise random disturbance

Equation (1) postulates that deviations from PPP can be represented as a stationary first–order autoregressive process. That is, even though there are short–run deviations from PPP, in the long–run these deviations tend to disappear. The speed at which deviations from PPP are eliminated depends on the value of γ. Because I make use of a linear projection onto the previous period's information set (Two–Stage Least–Squares) rather than using the contemporaneous price levels, potential joint endogeneity will not threaten the consistency of the parameter estimates. Additionally, though the presence of a unit root cannot be rejected for the nominal exchange rate and price level series, the null hypothesis of non–cointegration between the variables of this model can be rejected at the 1 percent level,[7] implying that conventional parameter estimation will be consistent in this setting. I return to the issue of cointegration below.

The Short–Run Monetary Model

I now consider the short–run monetary model employed by Edwards (1983). In essence, the model begins with the PPP relation above, and then substitutes in expressions for the determination of the price level in the money markets:

[7] I tested both of the Peruvian price level series and the nominal exchange rate series using Dickey–Fuller and Phillips tests (including normalized bias versions) and only for the CPI was there any evidence of stationarity, and even in this case the results were mixed. See Schwert (1987) for a description of these tests. Similar results for the U.S. price level have been established elsewhere.

$$d_t \equiv s_t - p_t + p_t^* = \gamma d_{t-1} + \epsilon_t \text{ with } 0 \leq \gamma < 1 \tag{2}$$

$$(M_t - p_t)^d = ay_t - bi_t \; ; \; (M_t^* - p_t^*)^d = ay_t^* - bi_t^* \tag{3}$$

$$m_t - m_{t-1} = \theta(m_t^d - m_{t-1}) \; ; \; m_t^* - m_{t-1}^* = \theta(m_t^{*d} - m_{t-1}^*) \tag{4}$$

where

M_t, M_t^* = log of domestic and foreign nominal money stock

m_t, m_t^* = log of domestic and foreign real money stock

y_t, y_t^* = log of domestic and foreign real income

i_t, i_t^* = domestic and foreign nominal interest rates

The model also includes the simplifying assumption that the coefficients a, b, and θ are equal across the two countries.[8] Equation (3) presents the demand for money functions in the domestic and foreign countries. The assumption of slow adjustment in the money markets is captured in equation (4), where θ is the speed of adjustment.

The equilibrium price levels at home and abroad can be found by replacing m_t^d and m_t^{*d} [eq. (3)] into the partial adjustment equation (4). The resulting expressions for p_t and p_t^* can then be used in (2) to find the following equation for the equilibrium exchange rate in the short-run:

$$s_t = (M_t - M_t^*) - \left[\frac{\theta a}{1-(1-\theta)L}\right](y_t - y_t^*) + \left[\frac{\theta b}{1-(1-\theta)L}\right](i_t - i_t^*) + \gamma d_{t-1} + \epsilon_t \tag{5}$$

where L is the lag operator.

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[8] This assumption follows Edwards (1983); I relax it in estimation.

Equation (5) suggests that in the short-run the log of the exchange rate is related with a unitary coefficient to the difference in the log of the nominal money stocks at home and abroad, and that current and lagged values of y, y*, i, and i* affect the current value of the exchange rate. The presence of lagged y, y*, i, and i* and of γd_{t-1} are the main differences between the short-run formulation of exchange rate determination presented in (5) and the most simple versions of the monetary approach. As may be seen, the coefficients of current and lagged values of y_t, y^*_t, i_t, and i^*_t are related to the parameters of the money demand equations and to the speed of adjustment coefficient θ. If, for example, it only takes one period for the money markets to clear (i.e., θ=1), then the coefficients of the income and interest rate terms will be equal to their respective coefficients in the money demand equations.

The Tsiang Model

The views expressed by Tsiang (1957) suggest an alternative model that emphasizes the role of world prices for Peruvian exports as a proximate determinant of the exchange rate. On page 460 he asserts that:

> On the assumption that no very great changes in the volume of exports are required to keep the balance of payments in equilibrium, the sol price of dollars . . . could be expected to tend to adapt itself to the changes in the domestic cost of producing a dollar's worth of exports.

Citing only annual figures, he demonstrates a rough correspondence between the certificate rate and the estimated average cost of a dollar's worth of exports

measured as the ratio of the Peruvian cost of living to unit export prices in dollars.[9] This is the extent to which Tsiang might be said to have modeled the exchange rate in his analysis. For an econometric test of the role of export prices, one possible specification of Tsiang's view includes the Peruvian price level and dollar export prices as the proximate determinants of the spot rate within the asset market, with the PPP adjustment term of the previous model to assure appropriate long-run behavior:

$$s_t = \beta_o + \beta_1 E[p_t | \Omega_{t-1}] + \beta_2 E[DPE_t | \Omega_{t-1}] + \gamma d_{t-1} + \epsilon_t \qquad 0<\gamma<1 \qquad (6)$$

where DPE equals the log of the dollar price of exports and the predicted sign of the coefficient β_2 is negative. Though this is perhaps the most direct representation of Tsiang's view, it is certainly not the only way in which export prices might enter. I investigate this further below.

4. Results Over The Full Sample

I begin with estimation of the expectational PPP model described in equation (1). The period of estimation runs from January, 1950 through December, 1954 (monthly). Data sources are provided in the Appendix and correspond to those used by Edwards (1983). Table 1 presents the results using 2SLS (constants not reported):[10]

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[9] Use of the CPI or WPI in determining the cost of exports is surely a rough proxy for exports originating in the provinces as both of these (IFS) indices apply to Lima. Nonetheless, given Tsiang's application of them in the shaping of his thinking, together with the lack of practical alternatives, I choose to stay with these measures.

[10] The instruments are a constant, a time trend, and the first two lags of: the price levels, the money supply differential, the interest rate differential, and the index of dollar export prices.

Table 1

Results for Expectational Purchasing Power Parity Model

$$s_t = \beta_0 + \beta_1 E_{t-1}[p_t] + \beta_2 E_{t-1}[p_t^*] + \beta_3 d_{t-1}$$

	β_1	β_2	β_3	R^2	DW	Q
CPI	1.06 (0.07)	-1.08 (0.18)	0.86 (0.07)	0.94	1.51	0.64
WPI	1.01 (0.04)	-1.06 (0.12)	0.82 (0.06)	0.92	1.55	0.42

Conventional standard errors in parentheses.

These equations fit well, particularly in light of the dismal performance of PPP models for the industrial countries since generalized floating. All of the price level coefficients are very close to their predicted values; the coefficient on d_{t-1} is positive and less than one; and the adjusted R^2's are high. Additionally, there is no conclusive evidence of autocorrelation from either the Durbin–Watson statistics or the Ljung–Box Q–statistics (marginal significance levels). Breaking the sample in half and testing the null of stable coefficients produced a marginal significance level of 0.56 for the CPI equation and 0.26 for the WPI equation. Finally, testing for cointegration using an Augmented Dickey–Fuller test (2 lags) on the residual series produced a rejection of the null of non–cointegration at the 1 percent level in both cases, indicating that the OLS parameter estimates are consistent even though the equation is in levels. Hence, all told, the data provide considerable support for the model.[11]

[11] To investigate further the potential importance of intervention I included the level of Central Bank reserves in the expectational PPP equation. The coefficient was insignificant in both equations. The reserves series included foreign exchange and gold from International Financial Statistics, corrected for the $10 million International Petroleum Company loan extended in

I turn now to the results for the monetary model. In effect, the monetary model simply couples PPP with a money market description of price level determination, as laid out in equations (2) through (4). Although Edwards (1983) estimates this same model, his estimation begins with July, 1951, a full eighteen months into the floating rate period—a length of time that corresponds to his choice of lag length. In so doing, he neglects nearly a third of the available monthly data. Moreover, it is this third which captures the United States' deepest involvement in the Korean War, the influence of which is highlighted by Tsiang (1957) for reasons quite apart from purely monetary considerations. There is no mention of this sampling choice in Edwards' paper. One might argue that it would be inappropriate to use data for the lagged regressors from a period in which a different exchange rate system is operative. However, in the monetary model the lagged regressors are only relevant insofar as they describe the current price level within the money market. The exchange rate is then determined by substituting these price level determinants into the PPP relationship. Since his model of the money market is independent of the exchange rate, there is little reason to exclude such a large portion of the available data. At the very least, it leaves some important questions unanswered.

Table 2 presents the OLS results for two alternative specifications of the monetary model, where the reported standard errors are computed using Hansen's (1982) consistent covariance matrix. Edward's partial adjustment model appears first and includes the 18–month lags of the real income and interest differentials.[12]

October, 1983 [See Tsiang (1983), page 455].

[12] The data are the same as those used by Edwards as verified by replication of his results. He uses consumer price indices to calculate d_t. When extending his eighteen month lag from the beginning of the five–year period it becomes necessary to use a different source for the real income series since the one he uses does not include the 1948–49 period. I use nominal GNP figures deflated by the consumer price index for the period 1948:7–1949:12.

The second model could be referred to as a long-run or complete adjustment formulation in which lagged values of income and interest rate differentials do not appear. (This is not strictly the long-run formulation of the monetary model in that it still admits transitory deviations from PPP.) In terms of Edwards' model this corresponds to a money market that fully adjusts every period; i.e., the value of θ is one in equation (4).

Table 2

Results for Monetary Models Over the Full Sample

$$s_t = \beta_0 + \beta_1(M_t - M_t^*) + \beta_2\Sigma(y_{t-j} - y_{t-j}^*) + \beta_3\Sigma(i_{t-j} - i_{t-j}^*) + \beta_4 d_{t-1}$$

	β_1	β_2	β_3	β_4	R^2	DW
Partial Adjustment	0.32 (0.05)	0.07 (0.49)	0.13 (0.10)	0.21 (0.15)	0.89	0.49
Complete Adjustment	0.31 (0.05)	0.46 (0.23)	0.07 (0.02)	0.47 (0.20)	0.88	0.69

Corrected standard errors in parentheses.

Perhaps the most striking feature of the results is the fact that the coefficient on the log money stock differential is very significantly different from its predicted value of one. This alone is damaging evidence against the monetary formulations. In the partial adjustment model, the remaining three coefficients are insignificant. In the complete adjustment model, all of the coefficients are significant; but one of them, that for the log income differential, has the wrong sign.[13] And in addition to the

[13] In the monetary model higher (relative) income is associated with a lower (relative) price level other things equal, in order to clear the money market, and this implies a lower exchange rate.

above deficiencies, the dismal Durbin–Watson statistics indicate the likelihood of omitted variables, non–cointegration, or both. (Though non–cointegration is rejected at the 5 percent level for the complete adjustment equation, it cannot be rejected at the 5 percent level for the partial adjustment equation.) In sum, the models are a relatively poor description of the full five–year floating rate period.

In an effort to determine why the monetary representation of the price levels breaks down, I re–estimate the two different formulations of the monetary model treating the foreign (US) price level as exogenous. In effect, this specification relaxes the assumptions used by Edwards that all money market coefficients are equal across the two countries and that both money markets can be described by a partial adjustment process (extending over 18 months). The second of these appears particularly suspect: while partial adjustment in the less institutionally–developed Peru seems quite reasonable, money market adjustment in the US extending over so long a period is far less justifiable. With this more robust specification, p_t^* is included as a separate regressor and the money supply, real income, and interest rate terms in the equation now reflect only the conditions in the Peruvian money market. Table 3 presents the OLS results. In both equations, p_t^* is the US consumer price index.

The US price level is very significant in both equations but its magnitude is much less than the theoretical value of negative one, significantly so in the complete adjustment equation with no real income or interest rate lags included. The coefficients on the log money supply are still significantly less than one and the coefficients on the log real income have the wrong sign. In addition, the very low Durbin–Watson statistics continue to indicate the likelihood of omitted variables,

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A positive coefficient β_2 is consistent with the story that higher income increases absorption and therefore demand for foreign exchange, pushing its price up.

non–cointegration, or both. In short, these monetary specifications are not supported by the data.

Table 3

Results for Monetary Models with US Price Level Treated as Exogenous

$$s_t = \beta_0 + \beta_1 M_t + \beta_2 \Sigma y_{t-j} + \beta_3 \Sigma i_{t-j} + \beta_4 d_{t-1} + \beta_5 p^*_t$$

	β_1	β_2	β_3	β_4	β_5	R^2	DW
Partial Adj.	0.21 (0.09)	0.57 (0.43)	0.16 (0.07)	0.44 (0.10)	–1.80 (0.50)	0.95	1.19
Complete Adj.	0.37 (0.10)	0.98 (0.19)	0.05 (0.01)	0.63 (0.09)	–1.88 (0.41)	0.93	1.03

Corrected standard errors in parentheses.

One valid consideration vis–a–vis the relatively poor results for the monetary model is the adequacy of the measured opportunity cost of money. The estimation above uses the same variables Edwards uses, which includes the yield on long–term Peruvian bonds as the interest rate. Yet, this is arguably not a very good reflection of market rates or opportunity cost. Table 4 presents the OLS results for the same specification in Table 3 except that the CPI inflation rate is used as the opportunity cost of money, where the inflation rate in period t is measured as the annualized rate over the previous 6 months:

Table 4

Monetary Models with Inflation as Opportunity Cost of Holding Money

$$s_t = \beta_0 + \beta_1 M_t + \beta_2 \Sigma y_{t-j} + \beta_3 \Sigma i_{t-j} + \beta_4 d_{t-1} + \beta_5 p^*_t$$

	β_1	β_2	β_3	β_4	β_5	$\bar{R}^2$	DW
Partial Adj.	0.28 (0.09)	1.65 (0.20)	0.018 (0.003)	0.52 (0.07)	−1.21 (0.35)	0.97	1.93
Complete Adj.	0.48 (0.12)	0.95 (0.31)	0.0003 (0.001)	0.73 (0.13)	−2.10 (0.54)	0.90	0.72

Corrected standard errors in parentheses.

The complete adjustment specification suffers from the same shortcomings it suffered from in Table 3. The partial adjustment results, on the other hand, show some improvement. The coefficient on the US price level is now close to its predicted value and the Durbin–Watson statistic no longer indicates autocorrelation. (Additionally, non–cointegration can now be rejected at the 1 percent level.) Nevertheless, the coefficient on the log income differential still has the wrong sign and is significant, and the money stock coefficient remains far below one. Hence, though this measure of the opportunity cost of holding money helps, the predictions of the monetary formulation remain strongly rejected by the data. In the end, the principal problem appears to be the velocity reductions in the early part of the sample as manifested by money stock coefficients systematically less than one (together with the fact that Edwards finds a coefficient close to one over the latter two–thirds of the sample).[14] This type of velocity shift is at least

[14] Perhaps a more direct indicator of where the monetary approach breaks down, a 2SLS regression of the Peruvian price level (CPI) on the other money market determinants yields a

consistent with the view that the substantial policy–regime shift in the direction of liberalization that occurred in 1949 and 1950 increased the public's willingness to hold domestic money, other money market parameters equal.

I turn now to the results for the Tsiang model described in equation (6). Again, the linchpin of his view is that the dollar price of Peruvian exports was a fundamental determinant of the exchange (certificate) rate. Table 5 presents the 2SLS results using the Peruvian consumer price index and wholesale price index. Recall that the variable DPE denotes the log of the dollar price of exports:[15]

Table 5

Results for Tsiang Model

$$s_t = \beta_0 + \beta_1 E_{t-1}[p_t] + \beta_2 E_{t-1}[DPE_t] + \beta_3 d_{t-1}$$

	β_1	β_2	β_3	$\bar{R}^2$	DW
CPI	0.69 (0.05)	–0.11 (0.03)	0.99 (0.08)	0.93	1.22
WPI	0.89 (0.06)	–0.27 (0.05)	0.85 (0.09)	0.91	1.06

Corrected standard errors in parentheses.

These results for the Tsiang model are mixed. Though the coefficients appear

coefficient of 0.20 with a standard error of 0.11.

[15] As noted in the data appendix, the dollar export price index I use is built from the sol export price index in International Financial Statistics deflated by the current draft exchange rate. I attempted to improve the fit of the Tsiang model by constructing four different export price indices from US wholesale prices in the Survey of Current Business; the results, however, were not substantively different from those reported above.

well–determined with the appropriate sign and the adjusted R^2's are only slightly lower than those for the expectational PPP model, the Durbin–Watson statistics continue to indicate autocorrelation, which in this case is more likely due to omitted variables since non–cointegration is rejected at the 5 percent level for both equations.

In an effort to compare more formally the Tsiang model with the non–nested alternative of the expectational PPP model I effect two different tests. First, I use the J–test of Davidson and Mackinnon (1981) to determine whether the fitted values of the (log) exchange rate from the Tsiang model are significant when included as a regressor in the expectational PPP equation. I find that the fitted values are insignificant, which supports the dominance of the expectational PPP model. Second, to distinguish further the role of export prices, I estimate the expectational PPP model with the dollar–price–of–exports included as an explanatory variable. Is there information in the export price variable that is not captured by the PPP specification? Of course, a negative answer to this question does not imply that the variable is unimportant in exchange rate determination. Rather, this result would suggest that to the extent there is a role, it is being summarized by the price level.[16] Table 6 presents the 2SLS results:

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[16] The feedback of traded goods prices onto the general price level is a significant issue in itself. A plot of the relative price of traded and non–traded goods, where the traded goods price is calculated as an equal weighted average of import and export prices, demonstrates that disturbances are both large and persistent (deviations of 10% to 40% from the initial value through approximately three–fifths of the sample). This would not have been the case had Peru's internal price structure been characterized by considerable flexibility. Perhaps more important, this has a key implication regarding interpretation of the empirical success of the expectational PPP model. In effect, it undercuts the interpretation that PPP is a good model because shocks to the exchange rate, whatever the source, are being transmitted quickly and widely into the domestic price structure, rather than the opposite story (effected through the asset markets) being more nearly the truth.

Table 6

Results for Expectational PPP Model With Dollar Export Prices

$$s_t = \beta_0 + \beta_1 E_{t-1}[p_t] + \beta_2 E_{t-1}[p_t^*] + \beta_3 d_{t-1} + \beta_4 E_{t-1}[DPE_t]$$

	β_1	β_2	β_3	β_4	R^2	DW	Q
CPI	1.10	-1.19	0.85	0.02	0.93	1.50	0.54
	(0.10)	(0.27)	(0.07)	(0.04)			
WPI	0.99	-0.85	0.81	-0.07	0.93	1.54	0.36
	(0.04)	(0.21)	(0.06)	(0.06)			

Conventional standard errors in parentheses.

In both equations the dollar-price-of-exports variable is insignificant. Moreover, none of the price level coefficients is significantly different from its predicted value, although the US WPI coefficient does come down. Hence, the results provide no evidence that export prices deserve to be included independently in the specification, further supporting the dominance of the expectational PPP model.

5. The Exchange Rate Regime in Perspective

To put the exchange rate regime in perspective I consider three additional issues: (1) Was the exchange rate more volatile than the dollar has been post Bretton Woods? (2) Why did policy shift back toward fixing the rate? and (3) What are the implications for the choice of exchange regimes?

A comparison of the volatility of the sol/dollar rate with that of the post Bretton Woods dollar rates against other industrialized countries demonstrates that in fact the sol/dollar rate was considerably more stable, even when the dollar volatility of the 1980's is omitted. The mean squared change of the log of the nominal sol/dollar rate (annual basis) was 0.006. The same statistic for the

dollar/DM rate from 1973 to 1980 was 0.011, and that for the dollar/yen rate was 0.019. Hence, strictly in volatility terms, the floating rate experiment appears to have been quite successful. This certainly jibes with Tsiang's conclusion that there did not appear to be any "destabilizing speculation" over the period. Moreover, this is true in spite of the fact that the mean squared change (annual basis) in the log of dollar export prices was 0.064 from 1950 to 1954.

In the face of seemingly exemplary performance, why was the flexible rate regime abandoned? The policies implemented by the Odria regime (1948–1956) after the coup in 1948 were quite strongly oriented toward laissez–faire and export–led growth. On the import side, quantitative restrictions were removed and a list of prohibited imports was soon abolished. Yet, in Peru as well as most of the other Latin American countries, by the mid–50's a disenchantment with export–led growth and export dependence began to set in, and import substitution strategies became increasingly popular. To quote from Thorp and Bertram (1978, p. 262):

> A turning point for industrialization can thus be identified in the last year or so [1955] of the Odria government, as a new generation of manufacturing ventures came on to the scene ... The new firms of the 1950's ... represented the first steps in a diversion of elite interest away from export activities and toward non–export sectors, including manufacturing.

The authors also go on to point out that disenchantment with export dependence "was also induced by the experience of price instability in foreign markets in 1953–54." This was also the period of relative exchange rate volatility. In the end, the movement toward import substitution became increasingly incompatible with the complete liberalization of the import side and foreign exchange market. It

should be noted, however, that the flexible rate regime was not abandoned with a bang, but rather with a whimper, in the sense that the Central Bank simply began to intervene in the certificate market near the end of 1954 in order to keep it fixed at 19.0 soles/dollar; the exchange rate system did not come crashing down.

The main implications for the choice of exchange rate regimes are two. First, any choice of exchange rate system must necessarily fit into an existing institutional structure and coexist with a general policy orientation. This idea is not new but deserves emphasis. The Peruvian government, in most all respects, seems to have created an environment in which a floating rate system could operate effectively, with relative stability. Both capital and goods were free to flow in response to relatively unfettered market forces. The vital importance of the former with respect to stability is highlighted in the literature [e.g., see Branson and Katseli–Papaefstratiou (1981)]. However, the extreme economic liberalism that characterized the government's orientation is not so common, nor is it welcome in much of the developing world for reasons such as inequitable distribution, foreign domination, etc.. Differences in orientation, producing differences in policy objectives, might very well compromise the potential stability of a floating rate. Capital controls, a la Branson–Katseli–Papaefstratiou are a prime example. The point is, going part of the way may be worse than not going at all.

Second, in order to consider floating rates in the current developing country context it is important to ask whether or not the market-perceived model of fundamentals might have changed over the last three decades. I make the point in section 3 that because the thinking in the 1950's was far more accepting of the idea that real exchange rates would remain constant or nearly so under floating rates, we would expect speculators to have put a much higher weight on a PPP model of fundamentals than they would today. Indeed, experience since 1973 has taught that real exchange rates are not even close to remaining constant in the face of floating

rates, at least for the industrial countries. Ceteris paribus, it stands to reason that other driving forces would most likely be afforded more weight in today's asset markets.

6. Conclusions

In my efforts to model the fundamentals which underlaid the market's determination of Peru's floating exchange rate I find that not only are the predictions of the expectational purchasing power parity model borne out in the data, but it also fits quite well. Even though the monetary models begin with the assumption that PPP holds, their substitution of the price levels with their money market determinants is soundly rejected by the data when estimated over the whole floating rate period, largely due to the substantial decrease in velocity occurring early in the sample. Turning to the third of the three models, with respect to the emphasis that Tsiang (1957) puts on the dollar price of Peru's exports in the determination of the exchange rate, it appears as though any role for export prices is adequately summarized by more general price indexes.

DATA APPENDIX

Peru

Money Supply: Seasonally adjusted M1. The unadjusted figures are from Boletin del Banco de la Reserva del Peru.

Interest Rate: Yield on long-term government bonds from International Financial Statistics.

Price Indices: CPI is from Boletin del Banco de la Reserva del Peru. Wholesale and export goods price indices are from International Financial Statistics.

Exchange Rate: The end of period draft rate in the free market from Pick's Currency Yearbook.

Real Income: Constructed interpolating annual data on real GNP from Cuentas Nacionales del Peru.

U.S.

Money Supply: Seasonally adjusted M1 from Supplement to Banking and Monetary Statistics (US Board of Governors of the Federal Reserve System, 1962).

Interest Rate: Yield on long-term government bonds from Supplement to Banking and Monetary Statistics.

Price Indices: CPI from Survey of Current Business. WPI from International Financial Statistics.

Real Income: Seasonally adjusted index of industrial production from Survey of Current Business.

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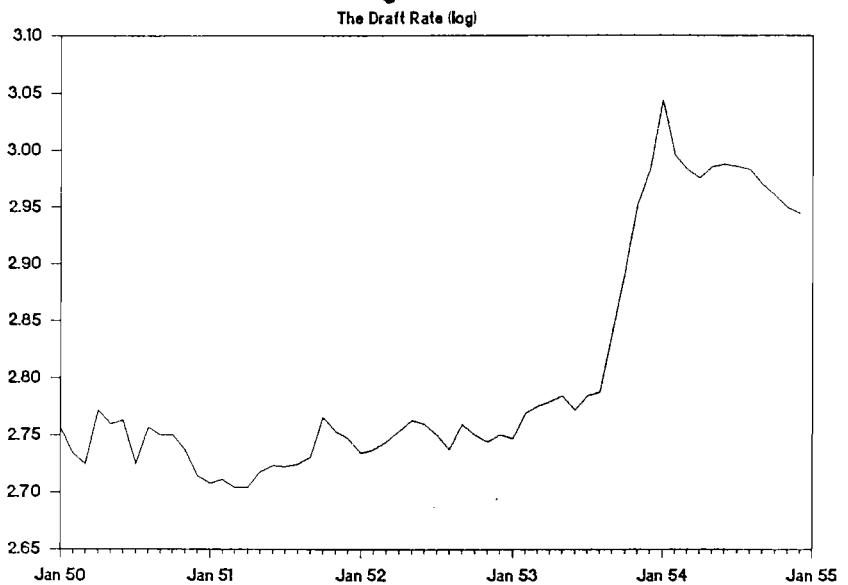
Figure 1


The Draft Rate (log)
3.10
3.05
3.00
2.95
2.90
2.85
2.80
2.75
2.70
2.65
Jan 50
Jan 51
Jan 52
Jan 53
Jan 54
Jan 55