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Steven C. Trost
Oberlin College

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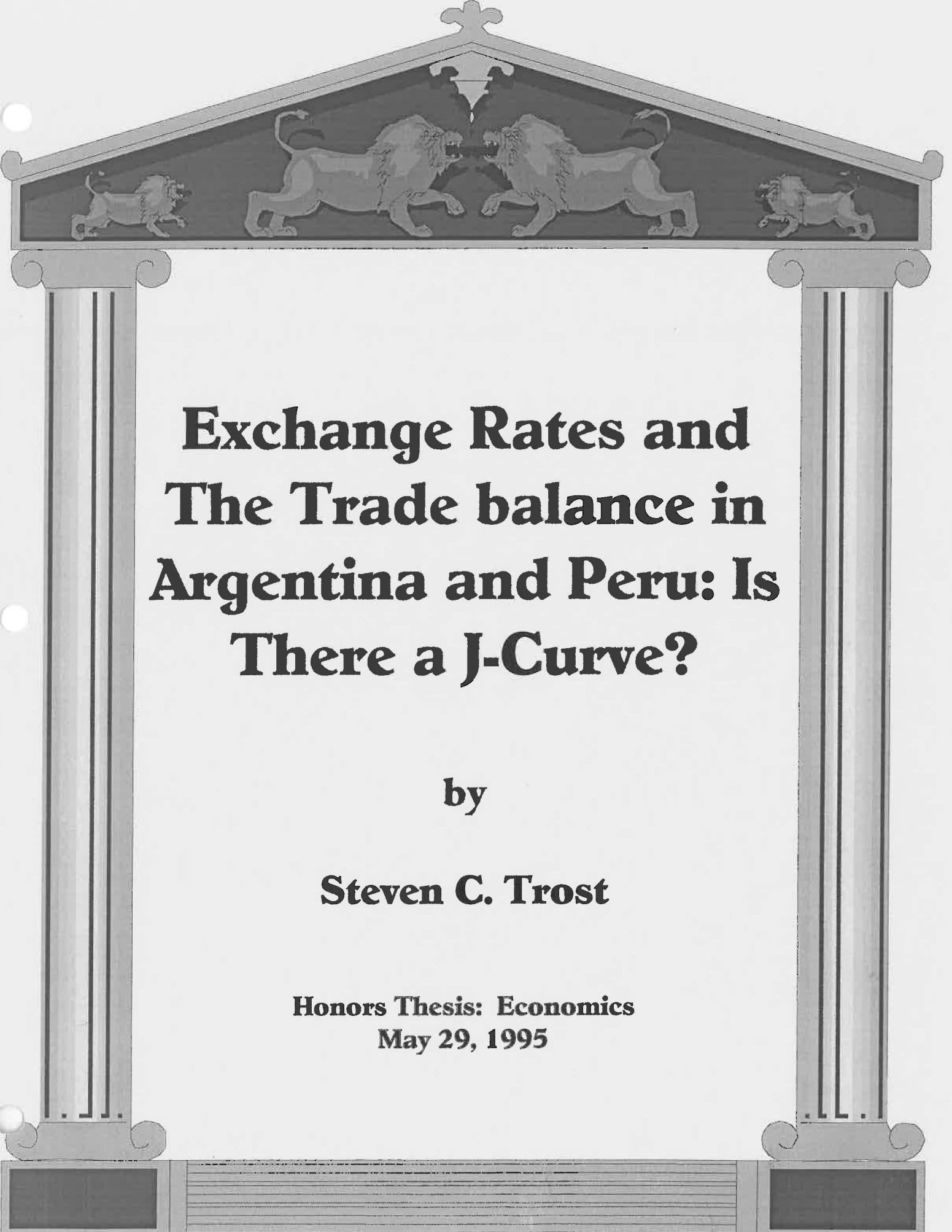


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**Exchange Rates and
The Trade balance in
Argentina and Peru: Is
There a J-Curve?**

by

Steven C. Trost

**Honors Thesis: Economics
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Honors- Final Revised Version

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I: Introduction

As a result of the debt crisis of the early 1980s, many Latin American countries have been forced to find new ways to obtain the foreign exchange necessary to import needed consumer goods and producer inputs as well as to service the sizable debts they have accrued. Mexico's default on its foreign debt had precipitated a decline in the availability of international loans to the region. As Mexico's default in 1982 demonstrated, the risk inherent in lending to highly-indebted countries in the eighties was great. As a result, such loans became unprofitable for private lenders and politically unacceptable for foreign governments. One way for these high-risk countries to get needed foreign exchange is through an improvement of their balance of trade. By reducing imports and increasing exports, these countries can increase their net inflow of foreign exchange. This foreign currency can then be used to service the debt and import needed goods and materials.

With this goal in mind, one of the most important tools available to these countries is a devaluation of their domestic currencies against the major trading currencies, such as the dollar or the yen. In theory, a depreciation of the domestic currency will both increase exports and decrease imports. Exports priced in the domestic currency will become cheaper to buyers holding foreign currency since, by the definition of a devaluation, their unit of foreign currency can now buy more units of the domestic currency. With more domestic currency the foreigner will be able to buy more goods from the domestic country. As prices fall demand should rise. Assuming foreign import demand elasticities of greater than one - not an unreasonable assumption - total revenue for exports will rise. On the import side, as the domestic currency loses its value against foreign currency, one unit of domestic currency will buy less units of the foreign currency. Relative to domestic goods, imported goods priced in foreign currency become more expensive in terms of the domestic currency. Prices for imports rise and the demand for imports falls along with the total amount spent on imports (once again assuming price elasticities for imports to be greater than one).¹ When both the import and the export effects of a depreciation are added together, the expected result is a significant improvement in the devaluing country's balance of trade. Khan and Knight (1988) point out that despite efforts during the 1980s to boost exports and improve the trade balance through tools such as exchange rate devaluation, many developing countries were unsuccessful in obtaining the needed international reserves.² The authors go on to

¹ Such a policy may seem somewhat inconsistent considering that one of the goals of increasing the inflow of foreign currency is to be able to afford certain critical imports. Many countries have used a system of differentiated exchange rates that makes possible the importation of certain goods at a more advantageous appreciated exchange rate. Without such a system, it has sometimes been argued that a devaluation can actually have a negative effect on exports because of a rise in price of imported inputs used in producing those exports. (see Khan and Knight (1988).

² Mohsin S. Khan and Malcolm D. Knight, "Import Compression and Export Performance in Developing Countries," Review of Economics and Statistics (May, 1988) 315.

state that such countries went on to enact policies of active import compression to improve the trade balance. Export promotion through devaluation had not worked. Why had the devaluations not worked? One possible reason is the existence of a J-curve relationship between the exchange rate and the trade balance. Such a relationship is explained below.

When used as a tool toward the goal of improving the country's balance of trade, the result expected by the policy makers responsible for the devaluation is as discussed above. There is, however, another result that could follow. It has been postulated, and indeed empirically shown, that there are cases for which a depreciation of the currency can actually lead to a deterioration of the balance of trade in the short-run. For the fast-paced economies of Latin America, the short-run is crucial. The argument for such a scenario is as follows: As the currency devalues, imports become more expensive in terms of the local currency (this should happen no matter what). Instead of imports falling, however, the level of imports stays fairly constant. This result can be attributed to one or both of two factors. First, contracts outstanding at the time of the depreciation can cause stickiness in the volume of imports. Second, and more importantly, the price elasticity of demand for imports could be low. A low elasticity could cause considerable lags in the importers' response to higher prices. As prices rise, the fall in demand does not keep pace. With prices (in terms of domestic currency) higher, and without a significant fall in quantity imported, the result may be increased expenditure on imports. An analogous situation can also be found on the export side. It is possible that due to low price elasticities of demand for imports on the part of the foreign countries, a fall in the relative price of exports from the devaluing country could have little or no short-term effect on the level of exports flowing out of that country. With less money (in terms of foreign currency) received for each unit exported and little or no rise in the quantity exported, total export revenues will fall. With import expenditures rising and export revenues falling, the obvious result is a deterioration in the balance of trade.

This deterioration, however, is usually only a short-term condition. While the short-run price elasticities may be low, they are not zero. Eventually demand for exports will rise and demand for imports will fall. In the long run the balance of trade should improve. The short-term deterioration of the balance of trade followed by a longer-term improvement caused by a depreciation, gives the curve that traces out the relationship between exchange rates and the trade balance over time a J shape. For this reason, such a phenomenon is known as the J-curve. For policy makers in Latin America, it is the short-term deterioration, and whether it exists or not, that should be of concern.

Is the J-curve really a problem for Latin American countries which have, more often than not, a fixed rather than a floating exchange rate? In his text The International Economy, Peter Kenen states that,

This J-curve effect poses no serious problem when a government devalues a pegged exchange rate, provided the government has enough reserves to finance the temporary deterioration of the current-account balance. It does pose a problem for the functioning of a flexible exchange rate. If the current account gets worse when the domestic currency depreciates, the currency may go on depreciating under the pressure of excess supply in the foreign exchange market. The market may be unstable.³

Because of this widely-held assumption, most studies of the J-curve phenomenon have focused on countries with floating exchange rates. Why look at Latin America? According to Mr. Kenen, by pegging their exchange rates, most Latin American countries avoid the negative effects of the J-curve. There are two reasons why this phenomenon can be costly to Latin America. The first is one that was mentioned in Kenen's quotation above. It has to do with having sufficient reserves to finance the fall in the balance of trade. Latin American nations do not, as a rule, have any sizable surplus of foreign exchange. The huge debt payments see to that. With few excess reserves, the fall in the trade balance will leave these countries even more unable to import important commodities and inputs. Then why should countries devalue at all? The logic here is that any short-run reduction of reserves caused by a devaluation will be more than made up for by the reserves gained through a long-term improvement in the trade balance. This leads us to the second reason why a J-curve in the exchange rate - trade balance relationship can be costly in Latin America. To be blunt, in Latin America, at least over the past ten or so years, the phrase "long-term" has meant very little. This is due to the frequent bouts of hyperinflation that have plagued Latin America mercilessly for the past decade and a half. With prices rising as quickly as they do in Latin America, it is quite conceivable that by the time the balance of trade would have turned up due to the depreciation, the exchange rate could have already appreciated back to or even beyond its original level due to the rising prices.⁴

In this paper, I test whether quarterly data either supports or disproves the existence of such a J-curve in two Latin American countries -- Argentina and Peru. The time periods studied will be: for Peru, 1979 quarter 1 to 1991 quarter 2 and for Argentina, 1977 quarter 1 to 1990 quarter 4⁵. Before completing the empirical part of this paper, I expected to find, if any, only a

³ Peter Kenen, The International Economy, New York: The Cambridge University Press, 1994, 355.

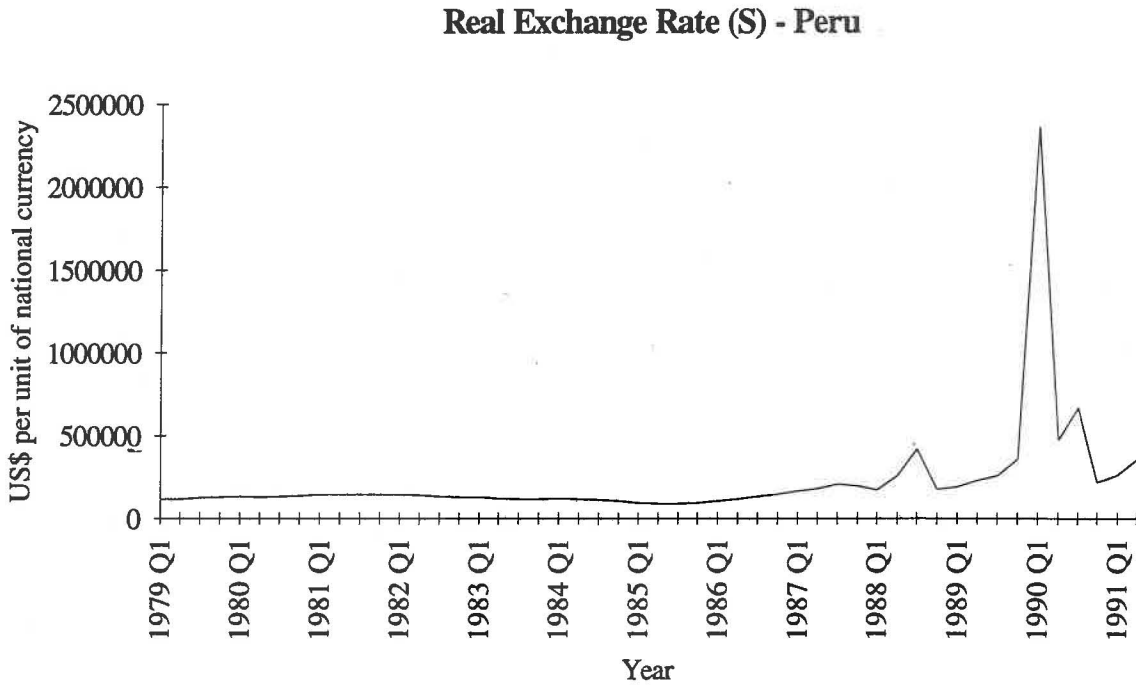
⁴ This scenario is made even more likely by the fact that rising prices of imports caused by the devaluation can be spread through the entire economy to spur inflation. For example, if a manufacturer of bulldozers has to import now more costly parts for his product, he will, in turn, raise the price of his bulldozers. The contractor, facing the cost of more expensive bulldozers, will raise his contracting fees. The construction company, confronted with higher contracting costs will raise its fees. And so on and so forth.

⁵ I am looking only at Argentina and Peru for no other reason than that they are the only Latin American countries with sufficient and available quarterly data (for a discussion of the data, see appendix 1).

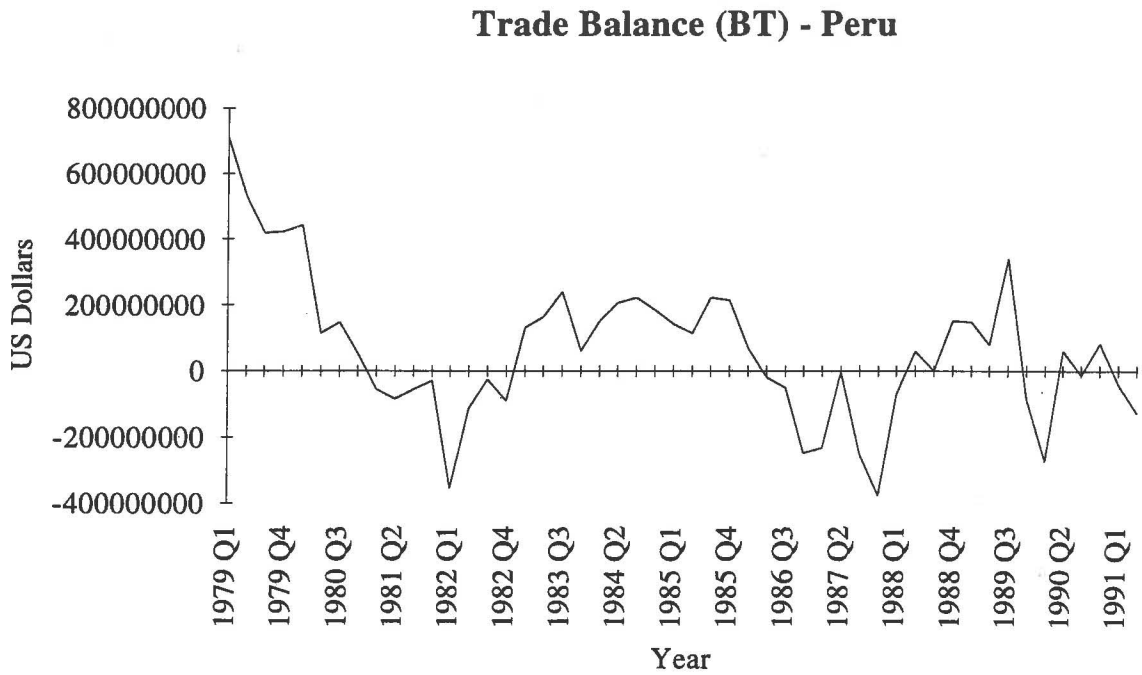
short deterioration in the trade balance following a depreciation of the real exchange rate in these two countries. With prices as well as other economic indicators changing daily, the reaction times of economic actors who deal with Latin America, whether from the inside or the outside, have grown ever shorter. Many contracts are short-term or are indexed so the real terms of the contract will not change as the nominal indicators do. Short reaction times should mean that the import/export market will adjust quickly to any change in the real exchange rate or other indicators. Contracts will be renegotiated quickly because of their short-term nature. This quick adjustment is not only important for the first possible cause of a J-curve, namely stickiness caused by contracts outstanding, but could also lead to a prediction about the second factor involved, that of trade elasticities. Quick renegotiations of contracts as well as a general attitude among actors that are expectant of quick changes would seem to favor a high elasticity of demand. For example if a foreign importer suddenly sees the price of imports from Peru go down, she may be more anxious to take advantage of this fall in price than if the imports were from a more stable economy. Since in the Peruvian economy, things are likely to change quickly, the foreign importer will want to take advantage of the low prices before they are eradicated by, for example, a sudden rise in inflation in Peru. Because of this expectedly short duration of a J-curve, should one exist, I define a significant J-curve as anything longer than two quarters. In other words, if the trade balance does not start to improve before the second lagged quarter after the depreciation (after the quarter of the depreciation and the first lagged quarter), a J-curve exists. Any deterioration shorter than two quarters can be interpreted only as the result of the impossibility of instantaneous reactions on the part of the actors. While this may be a brief J-curve by any standards, I think this definition is appropriate for a study of Latin American countries.

Figure 1 - Real Exchange Rates and Trade Balances in Peru and Argentina.

a)



b)



c)



d)



Results of econometric tests for Argentina show an immediate decline in the balance of trade in the quarter of the depreciation followed by two quarters of improvement. While the trade balance does deteriorate, it is for less than one quarter. Results for Peru are similar. The

unstructured lag model shows an immediate decline in the trade balance the quarter of the depretiation followed by three quarters of improvement. Such short deteriorations seen in both countries are consistent with expected reaction and renegotiation times. They do not constitute J-curves. When a polynomial distributed lag (PDL) structure is imposed on the lagged real exchange rates for both countries, results are similar to results obtained without the constraint on the lagged variables.. There is no evidence of a significantly long J-curve in either country.

Section two of this paper gives a brief explanation of my choice to use the relatively unavailable quarterly data rather than more readily accessible annual data.

In the third section I take a brief look at other work done in the area of the J-curve. I also discuss work dealing with determinants of trade and the effects of devaluations and other exchange rate changes on the trade balance. While the literature on the J-curve in developing countries is scarce, there is an abundance of literature from related areas that can be helpful to this study.

Section four introduces the model that is used to determine the relationship between changes in the exchange rate and the balance of trade.

The fifth section provides a presentation and discussion of the results obtained from the model presented in section four.

The final section summarizes the results and draws possible conclusions about any policy implications that these results may have.

II: The Sample Why Quarterly Data?

Most of the previous studies of trade patterns and exchange rates in Latin America look at annual data which is available in abundance for almost all countries. Such data can be useful for many purposes. For this study, however, annual data may prove too coarse. As discussed above, I expect the negative section of any J-curve for the two countries studied to have relatively short durations, perhaps less than one year. To try to detect a phenomenon that has a short duration with yearly data could lead to inaccurate results, especially if the hook lasts less than a year. A full year of deterioration in the trade balance could be costly to any economy. A study using annual data would not even detect such a deterioration. The superiority of quarterly data is evidenced by the fact that almost all studies in the area of trade or exchange rates for developed countries use quarterly data when it is available.⁶

⁶ See, for example, Norland (1989), and Rose and Yellen (1989) among others.

I would have liked to have included more countries in my sample but the data simply is not available for any Latin American countries but Peru and Argentina.

It should be pointed out that due to the nature of the data involved, the exchange rate will be the foreign currency price of one unit of the domestic currency rather than the usual domestic currency price of foreign currency.

(See Appendix 1 for more information on the data used.)

III: What Others Have Done

A search for a J-curve relationship between a devaluation of the real exchange rate and the balance of trade falls under the broader category of literature on the determinants of trade. Literature in this category focuses on finding the causes of changes in the balance of trade. One of the most widely studied possible causes of such changes in the trade balance are changes in the real or nominal exchange rate. Due to the widely debated notion that a devaluation or depreciation of the real exchange rate will lead to an improvement of the trade balance, such episodes have become a popular topic of research. As a result, while there may be a relative paucity of literature looking specifically for a J-curve effect, and even a greater scarcity of papers looking for a J-curve in developing countries, there are many articles that look at the effects of devaluations or exchange rate changes in general on trade in developed as well as developing countries.

These articles can be divided into three categories - 1) econometric time series analysis, 2) statistical study of stylized facts, and 3) cross-sectional econometric analysis of devaluation episodes. Each category is characterized by a different method used to determine the effects of an exchange rate devaluation on the balance of trade. Below are brief explanation of what each method entails and summaries of studies that use each technique.

1-Econometric Time-Series Analysis

In the articles utilizing this method, the authors simply use econometric analysis of time-series data on the trade balance, the real exchange rate and other variables that may help determine the balance of trade to estimate the effect of any change in the real exchange rate on the balance of trade. More generally, this method is used to find the determinants of the balance of trade, one of which is the real exchange rate.

Andrew Rose and Janet Yellen's paper (1989), "Is There a J-curve?,"⁷ falls under this category. Rose and Yellen try to find evidence of a J-curve in quarterly U.S. data spanning the period from 1960, quarter 1 to 1985, quarter 4. They look at bilateral data with the United States' six major trading partners. The equation,

$$BT_t = BT_t(Y_t, Y_t^*, S_t, S_{t-1}, \dots, S_{t-N})$$

where BT = balance of trade, Y = domestic GDP, Y^* = foreign GDP, S = the real exchange rate, and N is the maximum number of lags included.

was estimated directly using the Instrumental Variables (IV) method (since S and Y are endogenous and therefore possibly correlated with the error term). Investment, government spending and the money supply were used as instruments.

The model was estimated separately with lags in the real exchange rate of 0, 4, 8 and 12 quarters. No formal lag structure was imposed.

All the variables were first-differenced. This treatment was needed because of positive results of a Dickey-Fuller test for the existence of unit roots in, or non-stationarity of the data. Normally when looking for relationships between changes in two variables, the data is logged rather than first differenced. Logging tends to retain the shape of the series better than first-differencing. First-differencing was used here because of negative values in some of the series, most notable the trade balance. Either treatment also reduces multicollinearity in the model.

The results of this estimation not only do not support the existence of a J-curve but actually support the hypothesis that movements in the real exchange rate have no effect on the U.S. trade balance. These results were shown to be robust with respect to almost every aspect of the model and estimation technique chosen.

Most other papers falling under this first category deal with imports and exports separately. For example, Dennis Warner and Mordechai Kreinen use this method in their 1983 paper, "Determinants of International Trade Flows."⁸ They examine quarterly data from 19 developed countries from 1957 to 1980. Although they do not test specifically for the existence of a J-curve, the technique used and results obtained are relevant to this paper. On the import side, for the fixed exchange rate period from 1957 to 1971, they use the equation,

$$\ln M_t = \beta_0 + \beta_1 \ln Y_t + \beta_2 \ln P_t + \beta_3 \ln PM_t$$

⁷ Andrew Rose and Janet Yellen, "Is There a J-curve?," Journal of Monetary Economics, July, 1989, 53-66.

⁸ Dennis Warner and Mordechai Kreinen, "Determinants of International Trade Flows." Review of Economics and Statistics, Feb., 1983, 96-104.

where M = imports, Y = domestic GDP, P = the domestic CPI, and PM = the price of imports in foreign currency.

For the floating exchange rate years from 1972 to 1980, they simply add the current and four quarter lags of the nominal exchange rate (NER) to the equation used for the fixed rate period.

A polynomial distributed lag is imposed on the four lagged nominal exchange rate variables for the floating exchange rate years. The model was estimated using the instrumental variables technique due to the same simultaneity problem dealt with in Rose and Yellen's paper.

The results show that the current and lagged exchange rates do have a significant impact on import levels for several of the countries. The lagged coefficients form sort of a bell shape for the U.S., United Kingdom, France and Canada. While it is not shown to reduce the level of imports, a depreciation of the exchange rate is shown to lead to a fall in import growth rates. The most powerful effect is shown to occur in the second or third quarter after the change. Results from other countries were similar but less significant.

On the export side only the period of floating exchange rates was examined. The estimated equation is,

$$\ln X_t = \alpha_0 + \alpha_1 \ln Y_{Wt} + \alpha_2 \ln P_x^{DC} + \alpha_3 \ln E_t + \alpha_4 \ln E_t^e + \alpha_5 \ln P_{COMP}^{FC}$$

where X = exports deflated by their unit value, Y_w = the weighted average GDP of 23 major trading partners, P_x^{DC} = the export unit value index of the domestic country, E = a weighted effective exchange rate index, E^e = the expected change in E ,⁹ and P_{COMP}^{FC} = a weighted average export price for 64 competing countries.

No lags of the exchange rate are included in the export equation.

Results show that changes in the exchange rate have a powerful effect on the rate of export growth for most countries. As the exchange rate depreciates, exports rise as expected. Overall, the balance of trade is shown to react as expected for a good number of the countries. A depreciation leads to an improvement in the trade balance and an appreciation leads to a deterioration of the trade balance. In several of the countries studied, the trade balance initially deteriorates for one or two quarters following a depreciation before improving in the longer-run.

⁹ $E^e = [0.7(\ln E_t - \ln E_{t-1}) + 0.3(\ln E_{t-1} - \ln E_{t-2})]$. According to Warner and Kreinen, this variable is borrowed directly from Wilson and Takacs (1980).

A similar model was used by Marcus Norland in his 1989 paper, "Japanese Trade Elasticities and the J-curve"¹⁰. Norland looks at quarterly Japanese data from 1970, quarter one to 1985, quarter 4. Instead of looking at only two equations as Warner and Kreinen do, Norland looks at three equations, one for imports, one for the supply of exports and one for the demand for exports. Among other things, Norland was interested in finding the lags involved in the relationship between changes in relative prices of traded and domestic goods and the trade balance represented by the three equations. Since changes in such relative prices are brought about, in large part, by changes in the real exchange rate, what Norland is actually interested in is the exchange rate - trade balance relationship.

Results of Norland's work show that there are considerable lags in the exchange rate - trade balance relationship for each of the three equations. Export demand shows a 4.60 quarter average lag with respect to relative prices while export supply shows only a 2.66 quarter average lag. Imports show a much longer average lag in the relative prices - trade balance relationship of 9.34 quarters. Saying that there is a lag of n quarters is equivalent to saying that the negative hook of the J-curve is n quarters long. When dealing with the total trade balance in Japan, Norland estimates a lag of approximately 7 quarters for a change in relative prices to impact on the trade balance.

2 - Stylized Facts

In his paper, "Devaluation, External Balance, and Macroeconomic Performance,"¹¹ Steven Kamin points out that for some purposes, time series analysis (method 1 above) is not appropriate. According to Kamin and others, the study of the effects of a devaluation on the balance of trade or on any other variable, especially in developing countries, is one such purpose. Kamin cites three reasons for this inappropriateness:

- (1) Time series analysis does not tell us what has happened historically during and after devaluation episodes. Looking at all changes in the real exchange rate may not accurately show what has happened during past devaluations.
- (2) Devaluations (at least the policy induced ones) are often associated with other stabilization-aimed policies. The presence of other such policies such as the liberalization of trade or a control on the money supply make these devaluations noticeably different than other exchange rate changes.

¹⁰ Marcus Norland, "Japanese Trade Elasticities and the J-curve." Review of Economics and Statistics. Feb., 1989, 175-179.

¹¹ Steven Kamin, , "Devaluation, External Balance, and Macroeconomic Performance." Princeton Studies in International Finance, no.62, Aug., 1988, 1-54.

(3) Without knowledge of the appropriate lag length involved in the exchange rate-trade balance relationship, it is difficult to get a useful estimate. A misspecification of the lag length can cause the estimate to have a high variance or can lead to biasedness of the results.¹²

In order to deal with these problems, many authors choose to develop a set of stylized facts. Such a method involves collecting data for particular indicators for the period surrounding a devaluation. Such statistics are then compared, using statistical tests, to the corresponding statistics for a sample group of other devaluation episodes.

These comparisons along with personal knowledge of special circumstances and factors that could not be put into an estimable equation should provide information on changes in certain indicators that either are a cause of or a result of the devaluation.

Kamin creates a set of such stylized facts for 50 to 90 devaluation episodes (depending on the indicator studied) that took place in developing countries.¹³ He looks at the period from three years before to four years after the devaluation.

Results relevant to our study show that the trade balance normally improves for one to two years following the devaluation and then deteriorates quickly for the next two years. At first glance, it appears that in the long run (four years, by Kamin's definition) the deterioration often seems to be worse than it would have been had it stayed at the rate of deterioration that was experienced before the devaluation. Kamin shows, however, through comparison to other non-devaluing countries, that this may be due to a general deterioration of trade balances for many developing countries rather than to the devaluation itself.

After looking at the trade balance, Kamin also evaluates the effect of a devaluation on imports and exports separately. While imports grow throughout the sample, they grow at a slower rate the year before and the year after the devaluation. About one year after the devaluation, import levels start to rise quickly. Export growth rises significantly during the first and second years after the devaluation then slows a little. Due to this fast export growth and slower import growth, that balance of trade generally improves during the two years following the devaluation.

In chapters six and seven of his book, Real Exchange Rates, Devaluation, and Adjustment,¹⁴ Sebastian Edwards also uses this method. Edwards looks at stylized facts for 39 devaluation episodes that took place in developing countries between 1962 and 1982. He examines the performance of several key indicators after each devaluation. One of the key indicators studied is the current account. In one section, using annual data, Edwards tries to

¹² Kamin (1988) 3.

¹³ Kamin (1988).

¹⁴ Sebastian Edwards, Real Exchange Rates, Devaluation, and Adjustment. Cambridge, Mass.: The MIT Press, 1989.

determine the effect of a nominal exchange rate devaluation on the current account to GDP ratio of the devaluing country.¹⁵

Results of that particular study show that the current account normally deteriorates during the year of the devaluation and often during the following year as well. After this initial fall, however, the current account usually shows significant improvement.¹⁶

Stylized facts also have another noteworthy use. Authors will often look at a set of stylized facts dealing with some economic phenomena to determine what economic factors are likely to be important in the cause or effect of the phenomenon studied. With this knowledge in hand, the authors can form a model that incorporates the important factors.

3 - Cross-Sectional Econometric Testing of Devaluation Episodes

The third, and perhaps least popular method is sort of a combination of the first two methods. It involves using econometric analysis to look at a cross-section of individual devaluation episodes. The idea is to see how the economies react to a devaluation. Regressions can be run on a sufficient number of devaluation episodes to determine the effect the devaluation had on different economic indicators including the trade balance. This method is considered by its proponents to be more direct than the first method since it looks exclusively at devaluation episodes and their effects on the trade balance. One major reason that this method is not more widely used lies in the difficulty of obtaining needed data on a sufficient number of devaluation episodes. The availability of data is especially limiting when developing countries are studied.

In his paper, "Devaluation, External Balance, and Macroeconomic Performance", Steven Kamin uses such a technique and compares the result to a group of stylized facts that he compiled.¹⁷ Kamin runs cross-section regressions to determine the causes of changes in import and export growth rates for six years surrounding the devaluation episode. Exports were regressed on the real exchange rate and the reserves to import ratio. Imports were regressed on export growth, GDP growth, the real exchange rate and the reserves to imports ratio. Kamin splits the time period up into three sections and runs regressions for each. The three sections are, (1) the two years before the devaluation, (2) the year of the devaluation, and (3) the three years after the devaluation. In his study he uses annual data from 57 devaluation episodes.

¹⁵ Edwards (1989) 279.

¹⁶ In Edward's study, he also determines whether several policy-induced devaluations were successful or not. In his view, a successful devaluation occurs when, three years after the devaluation, the real exchange rate is still depreciated in comparison to the pre-devaluation level. Devaluations in Peru in 1975 and in Argentina in 1970 both fall into the "unsuccessful" category. This result gives testimony to the notion that any devaluation in these two countries will be eroded quickly by, among other things, high inflation.

¹⁷ Kamin (1988) 35.

The results of these regressions, which, incidentally, Kamin admits are crude and should not be fully trusted (he is not a proponent of the technique), reveal no real relationship between the exchange rate and the rate of import growth in any of the three periods. A significant relationship is found between exchange rates and the growth of exports in the period before the devaluation and in the three years following the devaluation but not in the year of the devaluation itself. Results of the regressions also show the effect of the lagged reserves-imports ratio to be highly significant and positive for the import equation. A result suggesting that imports are constrained by the supply of international reserves.¹⁸

The three techniques for determining the effect of a devaluation or depreciation on the trade balance all have their strengths and weaknesses. The time series analysis method remains the most popular technique despite certain strong assumptions that must be made in order for it to be used.¹⁹ The collection and analysis of stylized facts is becoming more popular due to its intuitive appeal. If one wants to find out what happens after a devaluation, then one should look at what has happened after past devaluations. The third method, as stated above, is not widely used due to the paucity of data.

IV: The Model - Theoretical and Empirical

As discussed in the previous section, there are three ways to approach the problem of how the trade balance will react to a devaluation of the domestic currency. This paper uses the first method listed, namely a time-series analysis of how the trade balance reacts to changes in other real variables. Exchange rates are generally thought to be one of the prime determinants of changes in the balance of trade (although some, such as Rose and Yellen (1989), have found otherwise).

There are two ways to look at the balance of trade. Many studies look at imports and exports separately. In the simplest case, imports are thought to depend on domestic income, the current real exchange rate, and past values of the real exchange rate. The higher the domestic income the higher is the demand for all goods including imports. The higher the exchange rate (in the not so conventional terms of foreign currency per unit of domestic currency) the higher the demand for imports due to lower prices relative to domestic goods. The lagged real exchange rates are included because of delays in the reaction time of importers to changes in the real exchange rate. For the countries included in this study, it is not unreasonable to think that a lack of available foreign exchange may constrain the value of goods and services that can be

¹⁸ Kamin (1988) 36.

¹⁹ Such assumptions are discussed below.

imported.²⁰ To reflect this possibility, the lagged reserve-import ratio should also be included in the model for imports.²¹ A low value of this ratio, especially a value of less than 1, may signify a relative shortage of reserves that could work to constrain the country's ability to import.

$$(1) \quad M_t = M_t(Y_t, S_t, S_{t-1}, \dots, S_{t-N}, RIR_{t-1})$$

where M = real imports, Y = real domestic GDP, S = the real exchange rate, RIR is the reserve-import ratio, and N is the maximum number of lags.

Similarly, the level of exports, again in the simplest case, is thought to be dependent on foreign income and the current and lagged real exchange rates.²² The more money foreigners have, the more they will want to import. The lower the exchange rate, the cheaper the exports are relative to the foreign goods and the higher the demand for those exports. Once again, lags are included because of the possibility of slow reactions on the part of the foreign importer.

$$(2) \quad X_t = X_t(Y_t^*, S_t, S_{t-1}, \dots, S_{t-N})$$

where X = real exports and Y^* = real foreign GDP.

A regression can be run on a equation form of (1) and (2) separately and the implications for the overall balance of trade can be gleaned from the results. Such a technique is useful if one wants to find the separate effects that a devaluation may have on imports and exports.

A second way to approach the problem is simply to look at the balance of trade itself rather than imports and exports separately. It logically follows from combining equations (1) and (2) that the balance of trade, in the simple case, should depend on foreign and domestic income, current and lagged values of the real exchange rate, and the lagged reserve-import ratio.

$$(3) \quad BT_t = BT_t(Y_t, Y_t^*, S_t, S_{t-1}, \dots, S_{t-N}, RIR_{t-1})$$

where BT = the real balance of trade and a * signifies a foreign variable.

Other variables can, and most likely should be added. This paper will look only at equation (3) with the addition of the lagged reserves to lagged imports ratio to the left hand side for both

²⁰ "There is considerable evidence available that many developing countries' capability to import is constrained by the stock of real international reserves." (Khan and Knight (1988), 318)

²¹ The lagged ratio is included instead of the current ratio since the current ratio will be endogenous to the model.

²² Khan and Knight (1988) suggest adding some measure of imported inputs to this model. As such imports go down, the supply of exports will fall due to a fall in the inputs needed to make those exports. I agree with the logic here and think that such a variable should be added. I do not add such a variable because of the lack of available data on imported inputs in the two countries sampled.

countries and the addition of two other variables to be discussed later in the case of Peru. The choice to use equation (3) is motivated by my interest in the trade balance rather than in imports and exports. For my purposes, equation (3) is more direct. For equation (3), the expected signs of the coefficients of each variable are as follows:

- Domestic income (Y) should have a negative coefficient. A rise in domestic income should lead to a rise in demand for all goods including imports. A rise in imports, other things equal will lead to a fall in the trade balance.
- Foreign income (Y^*) should have a positive coefficient. A rise in income abroad should lead to a rise in demand for exports from the domestic economy. A rise in exports, other things equal, will improve the trade balance.
- The lagged reserve-import ratio (RIR_{t-1}) should have a negative coefficient. A low RIR value could mean that the ability to import is constrained. This may mean that imports will go down and the trade balance will improve, *ceteris paribus*. The sign of the coefficient here is rather ambiguous though. If reserves do not constrain imports, they may have no effect on the trade balance whatsoever. In such a case, the coefficients may be either positive or negative and should be insignificant. This is one area where any ambiguity may be cleared up by estimating import and export equations separately. It is possible that while reserves do constrain imports for a certain country, such an effect may not show up in a trade balance equation. Since reserves act mostly on imports, such an impact may show up more clearly in an import equation.
- The sign of the coefficients for the real exchange rates (S) are what we are interested in discovering. They do not have any expected sign. Under the J-curve hypothesis, the first few lags should be positive while the later coefficients turn negative. Whether or not the J-curve hypothesis holds, it can be expected that the current real exchange rate would have a positive coefficient. Due to the fact that reaction times on the part of the actors is not zero, a depreciation, or a fall in S should hurt the trade balance in the quarter of the depreciation.

To use equation (3) to determine the effect of devaluations on the balance of trade requires two rather strong assumptions. First, it must be assumed that the trade balance reacts similarly, but in opposite directions to a devaluation (depreciation) and a revaluation (appreciation) of the real exchange rate. What the three equations look at is the effect of any movement in the real exchange rate on the trade balance. If we find that a J-curve does exist for depreciations, it also must be true that a revaluation will lead to a short-term improvement in the balance of trade followed by a longer-term deterioration, forming a sort of inverse J-curve. I believe this to be a reasonable assumption.

The second, and considerably stronger, assumption that we must make is that the source of the change in the exchange rate is irrelevant to its effect on the balance of trade. Under a fixed

nominal exchange rate regime, a change in the real exchange rate can have two sources. The authorities can devalue or revalue the nominal exchange rate or there can be a change in the relative price levels (in domestic currencies) between the domestic economy and the rest of the world. Either event will lead to a change in the real exchange rate.

Under a floating exchange rate system, there are many other factors that could affect the real exchange rate. By definition only changes in the nominal exchange rate or the relative price levels can cause changes in the real exchange rate. But while under a fixed rate system, only the government can change the nominal rate, under a floating regime, almost anything can and does effect the nominal exchange rate. Just a few possible examples include foreign and domestic interest rates, investment levels, stock market activity and political changes. Another factor that could affect the nominal exchange rate under a floating regime is the balance of trade. The nature of this relationship and the implications of possible endogeneity of the exchange rate in equation (3) will be discussed below. Foreign and domestic price levels are treated as exogenous variables. The causes of changes in the price levels will not be discussed here.

In Argentina and Peru, during the period focused on, the exchange rates were either fixed, crawling peg, or some sort of controlled or managed float.²³ In effect, we will be dealing with all possible causes for changes in the real exchange rate. In order to use the results to make predictions about the response of the trade balance to a policy-induced devaluation (it is such devaluations that are our main concern here), we must assume that the relationship between such devaluations and the balance of trade is, more or less, the same as the relationship between any change in the real exchange rate, no matter what the cause of the change, and the balance of trade. One may argue that actors will react more strongly to a policy-induced change in the real exchange rate than to a similar change caused by a change in the relative price levels between two countries.²⁴ A policy-related change can signal the direction in which the government wants to go. It can predict further, long-term changes in exchange rate policy. A simple change in relative price levels has only short-term implications and as such will not hold as much importance for the actors. For the purposes of this paper, I will assume that actors are only acting in the short term and do not differentiate between different sources of real exchange rate changes.

²³ Philip B. Cowitt, *World Currency Yearbook, 1988-89*. New York: International Currency Analysis, Inc., 1991, 218-220, 359-361.

²⁴ See, for example, Khan and Knight (1988), 316.

The Endogeneity Problem - S and YD

To determine the exact characteristics of the relationship outlined in equation (3), my initial impulse would be to run an Ordinary Least Squares (OLS) regression, with the assumption that the relationship is linear, on the equation,

$$(4) \text{BT}_t = \delta_0 + \delta_1 Y_t + \delta_2 Y_t^* + \delta_3 \text{RIR}_{t-1} + \delta_4 S_t + \delta_5 S_{t-1} + \dots + \delta_{N+3} S_{t-N} + \mu_t$$

where the subscript t-n represents the current time period t minus n quarters, N is the number of exchange rate lags included, and μ is an error term.

But, as pointed out above, in a floating or controlled floating regime, the current real exchange rate may depend on current balance of trade causing an OLS estimation to be biased and inconsistent due to the fact that S and Y are endogenous and may be correlated with the error term, μ . The logic behind second half of the S→BT→S relationship is simple. As the balance of trade improves, more foreign currency is available in the domestic economy. A rise in supply will force the domestic currency price of foreign currency down. The inverse is true for a deterioration in the trade balance. The current real exchange rate may also depend on previous values for the balance of trade but this poses no real problem as far as an estimation is concerned. From the definition of GDP²⁵, it is clear that domestic income, or Y (which is just GDP in 1985 prices) will also depend on the trade balance. I will first deal with the two way relationship between the real exchange rate and the trade balance. Then I will go on to look at domestic income's relationship to the trade balance.

The Real Exchange Rate

To deal with the two-way relationship between the exchange rate and the balance of trade, we must look at the model as structural equations model with two equations,

$$(3a) \quad \text{BT}_t = \text{BT}_t(Y_t, Y_t^*, S_t, S_{t-1}, \dots, S_{t-N}, \text{RIR}_{t-1}) \quad \text{and}$$

$$(5) \quad S_t = S_t(\text{BT}_t, \dots(\text{other variables}))$$

with the 'other variables' yet to be determined.

²⁵ GDP = C+I+G+BT, where G is government spending minus taxes and BT is exports minus imports.

The first equation (3a) is simply equation (3). The second equation, (5), is used to analyze the determinants of a change in the real exchange rate.

In order to estimate such a system, it is necessary to determine the causes of the changes in the real exchange rate in terms of variables to be included in equation (5). As discussed above, under a floating or flexible exchange rate regime, many factors can influence the real exchange rate. Due to the complicated nature of these relationships, however, I will do what is often done when modeling exchange rate changes. That is, I will ignore most possible causes and treat foreign and domestic interest rates, along with the current balance of trade as the only determinants of the exchange rate. This is another gross simplification of the truth but it has been shown to work just about as well as anything else. So if the exchange rate is flexible, equation (5) may look something like this:

$$(5a) \quad S_t = S_t(r_t, r_t^*, BT_t)$$

where r is the interest rate.

If the exchange rate is fixed, or even the least bit controlled by the government, other factors come in to play.

To assume that a decision on the part of the government to change the nominal exchange rate is purely exogenous to our model seems foolish. Certain factors must make the authorities believe that a change is warranted or necessary. These decisions are not completely random. For example, in the early eighties in Peru and Chile, the ministry of finance based the magnitude of the monthly devaluation of the exchange rate on the rate of inflation during the previous month.²⁶ Another example can be seen in the fact that during the debt crisis of the early eighties, insufficient amounts of foreign exchange prompted many Latin American countries to devalue the local currency. So inflation and international reserves are two more variables that may effect the government's decision to devalue and thus may effect the real exchange rate. Both variables are included in the model. Instead of just adding foreign reserves to the model, I included the lagged ratio of reserves to imports (RIR). The choice of this variable is explained as follows: If the government sees that during any quarter, the country is importing at a level that may put a strain on the amount of international exchange that the country has on reserve, that government should react. The government will try to ease the pressure placed on reserves. It is very likely that any action will include either limits on imports, such as tariffs or quotas, or a devaluation of the nominal exchange rate. Due to the time needed to measure or collect the data involved in any government policy decision, it might be expected that the government's decision and thus the real

²⁶ Cowitt (1991) 261, 360.

rate change may not take place immediately but rather with a lag of one period for all variables. Although the relationships here are not so clear as the relationships involved in a floating system, they do exist and should not be ignored. Under a fixed or controlled exchange rate regime, equation (5) may look something like this,

$$(5b) \quad S_t = S_t(RIR_{t-1}, BT_{t-1}, \Delta P_{t-1})$$

where RIR = the reserve to import ratio and ΔP = the rate of inflation.

It is also possible, and indeed likely, that authorities base their decisions to change the exchange rate on the values of these variables from even earlier periods. For this paper, however, I will stick to the assumption that changes are only based on the data from the previous period.

For the most part, the countries in this study did not subscribe to a purely fixed or a purely floating exchange rate during the time period studied. More commonly they operated under a dirty or managed float or a kind of crawling peg exchange rate.²⁷ Under each of these systems, both market and policy oriented factors can effect the real exchange rate. Because of this mixture, a truly representative equation for exchange rate determination would be a combination of equations (5a) and (5b) and would look like this,

$$(5c) \quad S_t = S_t(BT_t, BT_{t-1}, r_t, r_t^*, RIR_{t-1}, \Delta P_{t-1})$$

There is a good chance that the determinants of changes in the real exchange rate differ under different exchange rate regimes. If this is true, even more versions of equation (5) would be needed to differentiate between the regimes. For this paper, I will assume that equation (5c) applies to all types of exchange rate regimes.

Now we have a system of equations made up of equations (3) and (5c),

$$(3) \quad BT_t = BT_t(Y_t, Y_t^*, S_t, S_{t-1}, \dots, S_{t-N}, RIR_{t-1})$$

$$(5c) \quad S_t = S_t(BT_t, BT_{t-1}, r_t, r_t^*, RIR_{t-1}, \Delta P_{t-1})$$

Domestic Income

Our goal here, as above with the real exchange rate, is to find a list of exogenous variables, or instruments, on which we can regress Y to obtain fitted estimates of Y . These

²⁷ Cowitt (1991) 261, 360.

estimated Y_t s will not be correlated with the error term in equation 3 as the real Y_t s would be. The estimated values will then be used to replace Y values in the original equation for the trade balance (eq. 3)

Such exogenous variables can be obtained by looking at the definitional equation of GDP or domestic income,

$$(6) \quad Y_t = \text{GDP}_t = C_t + I_t + G_t + \text{BT}_t$$

where C = consumption and $C_t = C_t(Y_t)^{28}$. C is endogenous to our model for Y .

I = investment and $I_t = I_t^D + I_t^F$, where I^D is domestic investment and I^F is foreign investment. I is exogenous to our model for Y .

G = government expenditure minus tax revenues or the negative of the government deficit or surplus. $G_t = G_t(G_t)$ and is exogenous to our model, and

$\text{BT} = \text{exports minus imports}$. $\text{BT}_t = \text{BT}_t(Y_t, Y_t^*, S_t, S_{t-1}, \dots, S_{t-N}, \text{RIR}_{t-1})$.

In addition to these variables, the money supply divided by the consumer price level (M/CPI) will also have an effect on domestic income. The higher the ratio of money supply to CPI, the higher the country's income, assuming the velocity of money is constant. I assume the reader has a basic understanding of the above stated relationships and will not give the logic behind them here. From the above equations, I pull out all the exogenous variables plus the trade balance and regress Y on them to obtain my estimate for Y . G is exogenous by definition and will be included. Here investment (I) is treated as exogenous and should be included. (Due to a lack of data pertaining to domestic investment, I will instead include only foreign direct investment (FDI).) Because the money supply adjusted by the CPI (M/CPI) may not be exogenous, I will include a one quarter lag of the money supply - CPI ratio as an instrument for money. So we have,

$$(7) \quad Y_t = Y_t(G_t, \text{FDI}_t, (M/\text{CPI})_{t-1}, \text{BT}_t)$$

Now we have a system of three equations that looks like this,

$$(3) \quad \text{BT}_t = \text{BT}_t(Y_t, Y_t^*, S_t, S_{t-1}, \dots, S_{t-N}, \text{RIR}_{t-1})$$

$$(5c) \quad S_t = S_t(\text{BT}_t, \text{BT}_{t-1}, r_t, r_t^*, \text{RIR}_{t-1}, \Delta P_{t-1})$$

$$(7) \quad Y_t = Y_t(G_t, \text{FDI}_t, (M/\text{CPI})_{t-1}, \text{BT}_t)$$

²⁸ For this paper, I am assuming that consumption patterns are only based on current income and not on past or expected future income as is commonly thought to be the case.

This system of equations is estimated using a two-stage least squares (2SLS) method with all exogenous variables as instruments. What this means is that both S and Y will be regressed on all of the exogenous variables in the system. Here all variables except S, Y, and BT are exogenous. Without getting into the messy algebra, it should be noted that since all exogenous variables are used as instruments, an instrumental variables (IV) method will produce the same results as a two-stage least squares estimation of the system. The first stage equations of a 2SLS process would look like this,

$$(8) \quad S = \alpha_0 + \alpha_1 Y_t^* + \alpha_2 RIR_{t-1} + \alpha_3 FDI_t + \alpha_4 M_{t-1} + \alpha_5 G_t + \alpha_6 r_t + \alpha_7 r_t^* + \alpha_8 \Delta P_t + \alpha_9 BT_{t-1} + \alpha_{10} S_{t-1} + \alpha_{11} S_{t-2} + \dots + \alpha_{10+N-1} S_{t-N} + v_1.$$

and,

$$(9) \quad Y = \beta_0 + \beta_1 Y_t^* + \beta_2 RIR_{t-1} + \beta_3 FDI_t + \beta_4 M_{t-1} + \beta_5 G_t + \beta_6 r_t + \beta_7 r_t^* + \beta_8 \Delta P_t + \beta_9 BT_{t-1} + \beta_{10} S_{t-1} + \beta_{11} S_{t-2} + \dots + \beta_{10+N-1} S_{t-N} + v_2.$$

where N is the appropriate number of lags and v_1 and v_2 are error terms.

The results of these estimations are used to calculate a fitted series for both S and Y, let's call them S^{\wedge} and Y^{\wedge} . These predicted series should not be correlated with the error term like the actual series for the real exchange rate and domestic income may be, and should be highly correlated with the actual values for S and Y. These fitted series are then be put back into equation 3, replacing the original S and Y and equation 3 is estimated using ordinary least squares (OLS).

The results of this estimation should show the relationship (if one exists) between the real exchange rate and the trade balance. From these results it should be possible to tell whether a J-curve exists, and if not, what the true relationship between the real exchange rate and the trade balance is. Using my notation for the real exchange rate (the foreign currency price of domestic currency) a J-curve exists if the coefficients for the exchange rates start out positive for the current and first few lags and then turn negative for the remaining lags. So it is actually an upside down J-curve.

The Selection of an Appropriate Lag Length

It is important in any study where lags are involved to choose the number of lags that will provide the best results. Lagged variables act like any other variables. Too few lags could lead to omitted variable bias while too many could lead to inefficiency due to an unnecessarily high

variance. Several tests have been devised for determining the appropriate lag length. The test that I use is Akaike's (1973) information criterion, or AIC. The test is as follows,

$$(10) \quad AIC(q) = \ln(e'e/T) + 2q/T.$$

where $e'e$ is the residual sum of squares, q is the number of lags and T is the sample size. The appropriate lag length will be the lag length that achieves the minimum value in this equation. I chose this test because it is simple and makes straight-forward, intuitive sense. The first term rewards for a better fit reflected in the residual sum of squares while the second term punishes for loss of degrees of freedom.²⁹ To make the test simpler, as well as to avoid using too many lags, I set the maximum number of lags at 12.

Due to the simultaneous nature of my model, I have a choice of performing the lag length tests on the first stage or the second stage results. I choose to run the lag length tests on the first-stage results for both S and Y. In addition to simply being more convenient, this method also makes intuitive sense. If the current real exchange rate or the domestic income is affected by the trade balance and the trade balance is affected by the n^{th} lag of the real exchange rate, then the current real exchange rate or the current domestic income should also be affected by the n^{th} lag of the real exchange rate. This relationship should be reflected in the lag length tests performed on the first stage results. Where the best lag length was different for S than for Y, I ran the second stage of equations with both number of lags and any amount of lags in between the two. I then ran the AIC test on the results from these second-stage equations and chose the best one.

Results from these tests for Peru show an appropriate lag length of 6 lags for the S equation and an appropriate length of 7 lags for the Y equation. Tests run on the second stage regressions show that 6 lags is preferable to 7. Results for Argentina show that for the S equation, 9 lags are optimal while for the Y equation, 11 lags are optimal. The second stage equation was run with 9, 10, and 11 lags. The AIC test was run on the results and 9 lags proved to be the best choice.

The Imposition of a Lag Structure

In many papers that look at the behavior of several lags of a variable, some kind of structure is imposed on the lags. This is done for several reasons. First, because imposing a structure reduces the degrees of freedom used up by the lagged terms, such an imposition is often useful in a study that uses a relatively small sample. Second, sometimes the unconstrained results

²⁹ William H. Greene, *Econometric Analysis*. New York: Macmillan, 1993, 515.

are difficult to interpret. By constraining or controlling the results in some way, they can be easier to interpret. For example, a series of jigs and jags could be smoothed into a well behaved curve by the imposition of some sort of lag structure. While I see the merit and the necessity of the first reason, I question the validity of the second. Reducing degrees of freedom used up by the model can lead to a better fit and overall more reliable results. To try to push and fit the results into something that is 'nice', however seems to simply be a way to make the results fit a predetermined hypothesis on how they should look.

I do experiment with the imposition of a lag structure but only to see if there is any improvement in the overall results of the regression due to the imposition. Where constrained and unconstrained results dealing with the S coefficients differ greatly, I question the validity of the imposition of a lag structure. Where the results are similar, I see it as a reaffirmation that the results are, at least in some sense, robust.

The lag structure that I impose is a polynomial distributed lag structure or PDL. In simple terms, what such a structure does is to constrain the coefficients of the lagged variables to sit on a polynomial of specified degree. The whole concept of a PDL is based on the Weierstrass approximation theorem.³⁰ What this theorem says is that any function continuous on a closed interval can be approximated on the entire interval by a polynomial of sufficient degree. The goal of imposing a PDL is to obtain as good of a fit as possible while using as few degrees as possible. I use a variation of the Almon lag that was developed by Cooper (1972).³¹ In a basic Almon lag, the number lagged terms to be estimated is reduced to the degree of the polynomial plus one. For example, the imposition of a third degree PDL on an equation with nine lags would reduce the number of terms to be estimated from nine to four. Thus creating five more degrees of freedom. This is done by replacing the nine lagged terms with four new terms. The four new terms are each linear combinations of the nine lagged terms. After coefficients are estimated for the four new regressors, the coefficients for the actual lagged values can be determined from the linear combinations of the four lagged terms. While Cooper's method is more advanced than the basic Almon method, it follows a similar principal. Due to the complex nature of Cooper's method, it will not be explained here.

After some experimentation, I noticed that including the current estimate of the real exchange rate in the lag structure changed the shape of the graph of the S coefficients considerably. When excluding the current estimated S coefficient, the graph of the constrained and unconstrained coefficients look more similar. This is especially true in the case of Argentina.

³⁰ J. Johnston, Econometric Methods, Third Edition. London: McGraw-Hill Book Company, 1991, 353.

³¹ To be honest, the reason I am using Cooper's method is because it is part of the TSP computer program that I used. TSP uses Cooper's method rather than a basic Almon lag because the Almon lag has been shown to be, "numerically unstable," (Bronwyn H. Hall, TSP User's Guide, Version 4.2. Palo Alto, CA: TSP International, 1991, 34-37.

Inclusion of the current S coefficient alters the look of the entire curve. Due to this discovery, I exclude the current real exchange rate from the lag structure. So what I have is an unconstrained current S coefficient followed by a PDL that contains the lagged real exchange rates. While this method may seem unorthodox, I believe it provides us with a structured lag model that more closely resembles the truth.

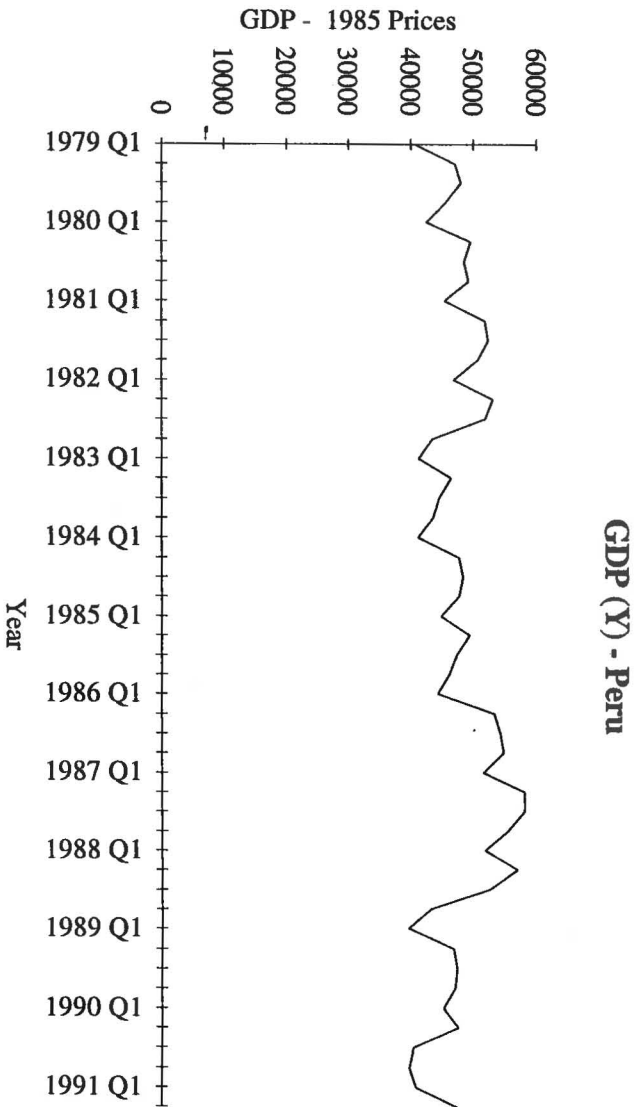
Treatment of the Data

Due to the time series nature of the data, it is advisable to test the data for unit roots or non-stationarity. A basic Dickey-Fuller test for unit roots is run on the three endogenous variables, BT, S and YD, for both countries (see figures 1 and 2 for graphs of the series). The Dickey-Fuller test simply regresses the current value of an indicator on its first-lagged value. If the t-statistic of the lagged variable is greater than the appropriate value on a Dickey-Fuller table (the value depends on the sample size) then the series does not contain unit roots and is stationary. If some sort of upward or downward drift is suspected in the series, a constant is added to the regression to pick up that drift. If it is suspected that the drift is caused by a time trend in the series, a time term is also added to the regression.³² Despite the addition of extra variables such as the constant or time-trend term, the t-statistic of the lagged variable remains the only important statistic. Here the equation is estimated both with and without the constant drift term. While there is no theoretical basis for suspecting a drift in any of the series, a quick glance at the real exchange rate for Peru gives some cause for suspicion. In many countries GDP is often thought to be time-trend stationary (i.e. stationary around a line that rises with time). This is not a problem in many Latin American countries in the eighties because of the inconsistent rise and fall pattern that GDP exhibits. Again, a look at a graph of GDP in the countries studied should provide ample evidence of this. Results of the test run on levels of the data are given in table 1 and are discussed below.

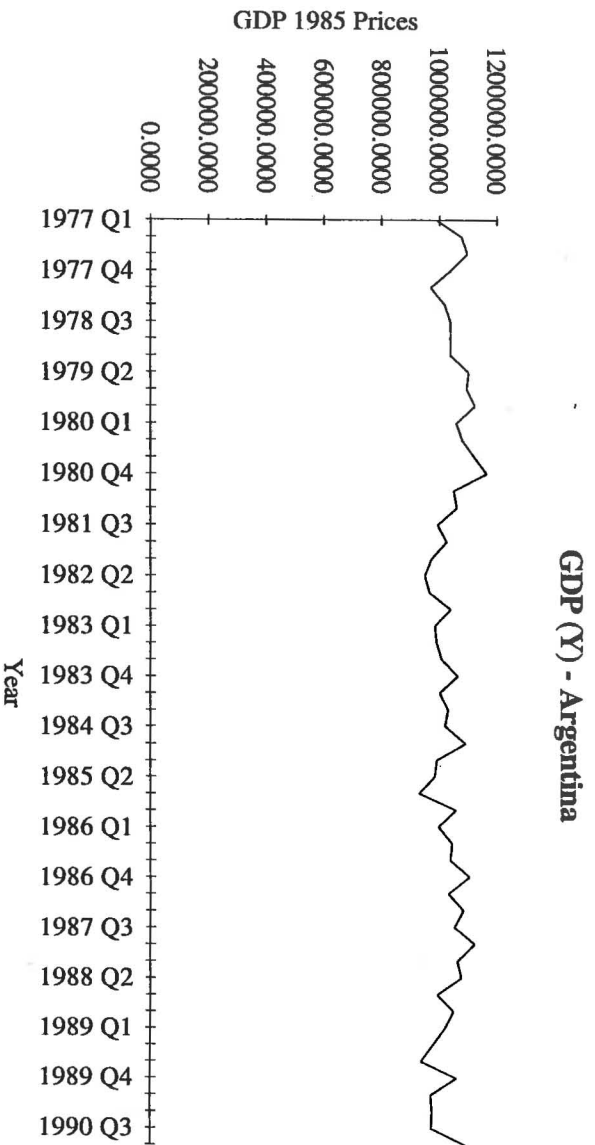
³² James D. Hamilton, Time Series Analysis. Princeton: Princeton University Press, 1994, 501-502.

Figure 2 - Domestic Income in Peru and Argentina.

a)



b)



According to the results of the test, there is no sign of non-stationarity in the levels for any of the variables when the constant is not included. Since the leveled variables for Argentina, both with and without the constant term added are fine, I use those in the model. Peru's exchange rate with the constant term added, while still passing the Dickey-Fuller test at the 1% significance level does not reject the hypothesis of unit roots as strongly as the other variables tested. Despite this result, I also use levels of the data for Peru. There are two reasons for believing that using levels here will not bias the results. First, there is no theoretical reason for the real exchange rate series to be non-stationary. Second, I ran the Dickey-Fuller test on Peru's real exchange rate series without the large spike that can be seen in figure 1. I simply replaced the anomalous value with the average of the values immediately before and immediately after the value in question. Test results showed no sign of non-stationarity of the adjusted series evidenced by a much higher t-statistic in the model with or without the constant term (see "Adjusted S" results in table 1). So what we have here is one point causing the entire series to appear slightly non-stationary. Even though this point is included in the data, it should be obvious that the majority of the series exhibits a stationary pattern. While this technique has been criticized for having limited power,³³ the results obtained are consistent with economic theory and with the behavior of the series evident in figures 1 and 2.

Table 2 — Results of Dickey-Fuller Tests for Unit Roots.

Variable Tested	Lagged Variable (BT _{t-1} , S _{t-1} , Y _{t-1})	Constant Term (If added)	Variable Tested	Lagged Variable (BT _{t-1} , S _{t-1} , Y _{t-1})	Constant Term (If added)
Peru	Coefficient (t-statistic)	Coefficient (t-statistic)	Argentina	Coefficient (t-statistic)	Coefficient (t-statistic)
BT	.813635 (10.0423) [†]		BT	.883818 (13.9739) [†]	
BT with constant	.542103 (4.74535) [†]	.209344E+09 (3.15805)	BT with constant	.703176 (7.27207) [†]	.235262E+09 (2.65164)
S	.535161 (5.01874) [†]		S	.978155 (47.3308) [†]	
S with constant	.266091 (2.18430) [†]	161427 (3.68347)	S with constant	.889559 (17.6268) [†]	2951.71 (1.91737)
Y	.99772 (83.7106) [†]		Y	1.00065 (139.246) [†]	
Y with constant	.610242 (5.65405) [†]	18617 (3.60848)	Y with constant	.397240 (3.28543) [†]	623130 (4.99683)
Adjusted S	.942843 (16.3585) [†]				

³³ See, for example, Robert S. Pindyck and Daniel L. Rubinfeld, *Econometric Models and Economic Forecasts*. New York: McGraw-Hill, Inc., 1991. 462.

Adjusted S with constant	.721314 (6.90966) [†]	54622.5 (2.49313)			
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[†] - Significant at the 1% level.

V: The Results First Stage Results

The first stage results are important for two reasons. First, as discussed above, the first stage results are used to determine the appropriate lag length. Second, the estimates that are produced have an effect on the second stage results. A strong correlation between estimated and real Ss and Ys is a must if the second stage is to produce credible results. Other test statistics such as F-statistics, t-statistics, and the Durbin-Watson test are also important because they reflect the structural integrity of the model.

While there were some problems with all of the first stage results, I believe that they are credible and the estimates generated can be used for the second stage. The most notable problems come in the form of low t-statistics for individual variables and several cases of coefficients being the opposite sign than expected. F-tests run on the entire regression show that the regression is significant for all first stage equations. Durbin-Watson statistics were well within their proper range in all cases except the S equation for Peru. Here a Cochrane-Orcutt transformation was performed on the data and the resulting regression results showed no sign of serial or autocorrelation at the 5% significance level. Perhaps the most important and most encouraging result is the high correlations between the estimated and real S series (see table 3). While correlations were not quite as good for the Y estimates, there are still strong enough to trust the estimates as instruments. A strong correlation shows that the first stage regression is doing its primary job which is to generate good estimates for the instrumented variables. Regardless of what the other statistics look like, as long as they are reasonable, this correlation can make or break the effectiveness of the estimation.

Table 3 - Correlations between estimated and actual S and Y.

Variable	Correlation Coefficients for Peru	Correlation Coefficients for Argentina
Real Exchange Rate (S)	.97679	.98354
Domestic Income (Y)	.81345	.78611

Second Stage Results

Argentina

Results for Argentina show an immediate decline in the balance of trade in the quarter of the depretiation followed by about two quarters of improvement. After these two quarters of improvement in the trade balance, the coefficients become positive again for two quarters, signifying a resumed decline in the trade balance. Following these two quarters, the coefficients for S oscillate relatively closely about zero, perhaps signifying a return to the long run trade balance. (???) While the trade balance does initially deteriorate, it is for less than one quarter. Such a short deterioration is consistent with expected reaction and renegotiation times. It does not constitute a J-curve. The rather large positive coefficient at the third lagged S signifying a deterioration of the trade balance and the large negative coefficient at the fifth lagged S signifying a considerable improvement in the trade balance are rather surprising but since they are not individually significant, they should not be much of a worry. Due to the fast-paced nature of the Argentine economy during the eighties, it would be my guess that the first three observations are of the most importance. Three quarters is plenty of time for a depretiation to be eroded by inflation in such an inflation-ridden economy. If this is the case, then why did I include a full 9 quarters of lagged real exchange rates in the model? The answer to this is simple. According to the AIC tests performed on the first and second stage results, 9 quarters was the optimal lag length. But just because 9 quarters are included in the model does not mean that all 9 are necessarily important in determining whether a J-curve exists. So to briefly summarize, a depretiation in of the Argentine currency should lead to a deterioration of the trade balance during the quarter of the depretiation. This initial deterioration will be followed by approximately two quarters of improvement in the trade balance after which the trade balance will return to its pre-depretiation pattern.

The imposition of a third degree polynomial distributed lag structure does not change the results much in the case of Argentina. As can be seen in figure 3 a. and b., the graphs of the S coefficients for the two models look fairly similar. The only notable difference is that the constrained coefficients show less movement around the x-axis following the first three observations. This is consistent with my belief that the first three observations of the real exchange rate are of primary importance. The similarity of the results of the two models also works to strengthen the validity of those results.

It should be noted that in both the PDL constrained and unconstrained models, while not all of the individual S or lagged S coefficients are significant according to the t-statistic, the real exchange rates as a group are highly significant. This result was obtained from F-tests comparing

the model with current and lagged S's to the model without the real exchange rates. This is true for Peru as well.

Another important result can be obtained from the total effect of all the real exchange rates - both current and lagged. This statistic is calculated as the sum of all of the coefficients for the S's. For Argentina this statistic is positive but relatively small for the unconstrained model but negative and larger for the model with a PDL imposed. A positive value indicates that over the entire lag length, the depreciation led to an overall fall in the trade balance. A negative value indicates an overall rise in the trade balance. While the results for Argentina may appear ambiguous, I think it is sensible to look exclusively at the unconstrained model. Due to the fact that the current real exchange rate is not included in the PDL, its coefficient tends to be large relative to the other coefficients. This result could cause the sum to be inaccurate. The fact that the statistic is small and positive for Argentina shows that a depreciation of the real exchange rate will cause the trade balance to decline slightly over the period of nine lags.

The other variables included in the model act more or less as expected. Coefficients on domestic and foreign income are both the correct sign and are both significant. The coefficient on the lagged reserve-import ratio is not the expected sign but is also not significant. This would seem to indicate that Argentina's ability to import is not constrained by a shortage of international reserves.³⁴ The signs of the coefficients and significance levels of Y, Y*, lagged RIR, and the constant term do not change noticeably with the imposition of the PDL.

As a whole, the regression results look pretty good for both the PDL-constrained and unconstrained model. The F-statistics show that both regressions are significant at the 1% level. The Durbin-Watson statistics show no sign of autocorrelation. The only worrisome statistics are the R-squared values. At right around 0.6, the R-squared statistics indicate that neither model does a very good job of explaining changes in the trade balance. The low R-squared values might be caused by government action and intervention in the import/export market that is not picked up in the model. Such government actions may not be explained by real indicators that are included in the model. Other possible explanations come from changes in trade patterns associated with changing political regimes or the announcement of new national or international policy. Such factors are very difficult to include in a model. It is also very hard to decide what should be included and what should not be. Instead of making a series of arbitrary decisions, I decided to look at the model without any such political factors included.

³⁴ This is one area where it would help to separate exports and imports. It is possible that the lagged RIR does have an impact on imports but we just can't see it by looking at the results for the trade balance.

Table 4— Results of the second stage regressions with and without PDLs

Variable or Test Statistic	Peru - no lag structure.	Peru - with PDL	Argentina - no lag structure	Argentina - with PDL
	Coefficient (t-statistic)	Coefficient (t-statistic)	Coefficient (t-statistic)	Coefficient (t-statistic)
Constant (C)	0.311799E+10 (1.30899)	0.390709E+10 (2.07894)*	0.151223E+11 (3.86909) [†]	0.103223E+11 (3.53717) [†]
Domestic Income (Y [^])	4909.72 (0.141165)	-10135.0 (-0.542317)	-15887.5 (-4.69346) [†]	-11924.5 (-4.63234) [†]
Foreign Income Index (Y*)	----	----	0.199436E+08 (2.10312)*	0.264594E+08 (3.00362) [†]
Industrial Production Index (IPI)	-0.300119E+08 (-2.06267)*	-0.273036E+08 (-2.12470)*	----	----
Lagged Reserve-Import Ratio (RIR _{t-1})	-0.997567E+08 (-1.20934)	-0.125949E+09 (-1.98802)	0.262933E+08 (0.294091)	0.711458E+08 (0.873310)
World Price of Oil (POIL)	-0.601075E+07 (-0.421502)	-0.581957E+07 (-0.418940)	----	----
El Nino Dummy Variable (D)	-0.397815E+09 (-1.90961)	-0.418486E+09 (-2.07459)*	----	----
Real Exchange Rates (S)				
S _t	80.0953 (0.132984)	368.422 (1.73853)	74431.5 (2.38154)*	50108.1 (1.96326)
S _{t-1}	-51.3218 (-0.253375)	-86.8725 (-0.478795)	-52003.7 (-1.63854)	-39930.7 (-2.04884)*
S _{t-2}	-81.4121 (-0.286837)	-233.354 (-1.24388)	-24355.3 (-0.923001)	-7950.63 (-1.07458)
S _{t-3}	-74.7423 (-0.381143)	31.6004 (0.232977)	34849.9 (1.35724)	5782.69 (0.815385)
S _{t-4}	354.625 (1.69147)	352.571 (2.01300)	8155.58 (0.337442)	6737.13 (1.10793)
S _{t-5}	179.019 (0.417975)	374.135 (2.80218) [†]	-29911.0 (-1.12749)	380.558 (0.106883)
S _{t-6}	2261.32 (0.436354)	-259.126 (-0.315474)	-12726.0 (-0.482859)	-7819.17 (-1.64544)
S _{t-7}	----	----	-1925.45 (-0.072022)	-12394.2 (-1.92661)
S _{t-8}	----	----	9383.72 (0.350625)	-7876.65 (-1.86384)
S _{t-9}	----	----	-5525.14 (-0.358470)	11201.3 (1.23884)
Total Effect of Current Plus Lagged S's (Sum of all S _{t-i})	2667.58	547.38	374.11	-1761.57
F-statistic	2.29615*	2.78483 [†]	5.49775 [†]	8.53665 [†]

Variable or Test Statistic	Peru - no lag structure.	Peru - with PDL	Argentina - no lag structure	Argentina - with PDL
Durbin-Watson statistic	1.43493	1.47611	1.85099	1.66600
R ²	.426835	.416590	.629861	.592344

* - Significant at the 5% level. † - Significant at the 1% level.

Peru

Before I discuss the movement of the S coefficients, I need to talk about a few alterations I make to the Peruvian model. Results of the regression of the basic model with no lag structure are discouraging in a few ways. First of all, several key variables have coefficients that are either insignificant or do not take on the right sign. Domestic income is both the wrong sign and insignificant. Foreign income is more worrisome in that it is also the wrong sign but was significant. In addition, the F-statistic shows the model not to be significant at the 5% level and the R-squared statistic is abysmal. In an effort to figure out the causes of and possible remedies to these problems, I augment and change the model. First I replace the foreign income index (Y*) with an industrial production index (IPI) from the industrialized countries. I make this switch because Peru's exports consist mainly of minerals³⁵. It seems logical that as industrial production abroad grows, demand for mineral inputs would rise. A rise in demand for minerals may have more of an impact on Peru's exports than a rise in the demand for finished products or foodstuffs that a simple rise in foreign income might bring about. While this substitution does not change the sign of the variable, it does improve the F-statistic of the regression to the point where it is significant at 5%. An alternative explanation for the negative sign of the foreign income (or industrial production index) could possibly be found in some variable that just happens to act to offset the expected effects of a rise or fall in foreign income or industrial production. For example, while a rise in industrial production abroad would normally lead to an improvement in Peru's trade balance through a rise in exports, a fall in the world price of oil at the same time could actually cause export revenues to fall. Unless the price of oil was included in the model, such a scenario may make it appear as if a rise in industrial production abroad actually led to a fall in Peru's export revenues. Since Peru is an oil exporter, and since the price of oil did drop considerably in the eighties, this scenario is not so inconceivable. To check for such an effect, I include the price of oil in the model for Peru.³⁶ I also include a dummy variable that represents the

³⁵ All information on imports and exports of individual products or groups of projects are taken from the IMF publications *International Financial Statistics* or *Direction of Trade Statistics*, various issues.

³⁶ A consistent index for the world price of oil was only available on a yearly basis. To include this variable, I simply put the same price for every quarter of each year. While such a technique might not pick up all the finer changes in the price of oil, the major changes that do get measured should be sufficient to determine whether a relationship exists between the trade balance and the price of oil.

extended stay of the warm tropical winds known as El Nino. During 1983 and 1984, El Nino forced the anchovy population that normally lives near the coast of Peru far out to sea. Peru exports a large amount of anchovies. This sharp decline of the accessible anchovy population greatly curtailed anchovy exports and had an effect on the overall balance of trade. To include this factor in my model, I set the dummy variable equal to zero for all quarters except 1983, quarter 2 to 1984, quarter 1 when El Nino was affecting the anchovy population causing exports of anchovies to be considerably lower than their normal level.³⁷ During these quarters the dummy variable equaled 1.³⁸

The addition of these variables does not have the hoped-for effect on the results of the regression. While the R-squared and F-statistics both go up, the coefficient for the industrial production index remain negative and significant and the domestic income coefficient remain positive and insignificant. Both added variables, the world price of oil and the dummy variable, have the expected sign but neither is significant (although the El Nino dummy variable is close). For the model with no PDL constraint, the reserve-import ratio is negative but insignificant.

The imposition of a polynomial distributed lag (PDL) structure improves things somewhat in the case of Peru. While domestic income is still insignificant, at least it shows the expected sign. With the PDL, the lagged reserves-import ratio is almost significant at the 5% level and is negative. This result suggests that imports may be limited by a shortage of international reserves.³⁹ The El Nino dummy variable also shows a significant negative coefficient, signifying that the fall in the supply of anchovies in 1983 and 1984 did have a significant impact on the trade balance.

The unconstrained real exchange rate or S coefficients show a pattern similar to Argentina's for the first few quarters. The trade balance shows a slight deterioration in the quarter of the depreciation. Again, as stated for Argentina's results, a one quarter deterioration can be expected due to reaction and renegotiation times and does not constitute a J-curve. This initial fall in the trade balance is followed by three quarters of slight improvement. After the first four quarters, the trade balance seems to deteriorate with an exceptionally high positive coefficient at the 6th lagged quarter, signifying a sizable decline in the trade balance. As I argued for the results for Argentina, it is my belief that only the first few observations are important. The results I consider important are the initial deterioration of the trade balance and the three quarters of improvement. The validity of the result for the sixth lag of S is also put into question by the huge standard errors that go off of the graph in figure 3 (c). (To make the movements of the S

³⁷ All statistics on the export of oil and anchovies is taken from the IFS books and disk.

³⁸ A dummy variable was included instead of simply including exports of anchovies because there was no available series on anchovy exports for the entire time period studied.

³⁹ Again, to come to any certain conclusion on this result, it would be necessary to separate imports and exports.

coefficients in the first 5 lagged quarters easier to see, I have included figure 3 (d) which leaves the sixth lagged S coefficient and its standard errors off of the graph.)

When a polynomial distributed lag (PDL) structure is imposed, the S coefficients show a similar but slightly more exaggerated pattern for the first few quarters. Again, the trade balance deteriorates during the quarter of the depretiation. With the PDL imposed, the ensuing improvement in the trade balance only lasts two quarters with a slightly positive coefficient at the third lag of S. While I believe those are the most important, in terms of this study, of the results, the high t-statistics for the fourth and fifth lagged real exchange rates suggest that the trade balance normally deteriorates during the fourth and fifth quarter following a depretiation. This unexplainable result is supported by a relatively high t-statistic for the fourth lagged S in the unconstrained results. One conceivable explanation for this result is that severe inflation caused by the depretiation or other concurrent policies could have eroded the real exchange rate to a point where the initial depretiation actually hurt the trade balance in the long run through a sizable rise in the price of exports and a large fall in the price of imports.⁴⁰ Again, the large standard errors associated with the sixth lag, along with the radical change of direction between the constrained and unconstrained sixth lag, place doubt on the validity of that result.

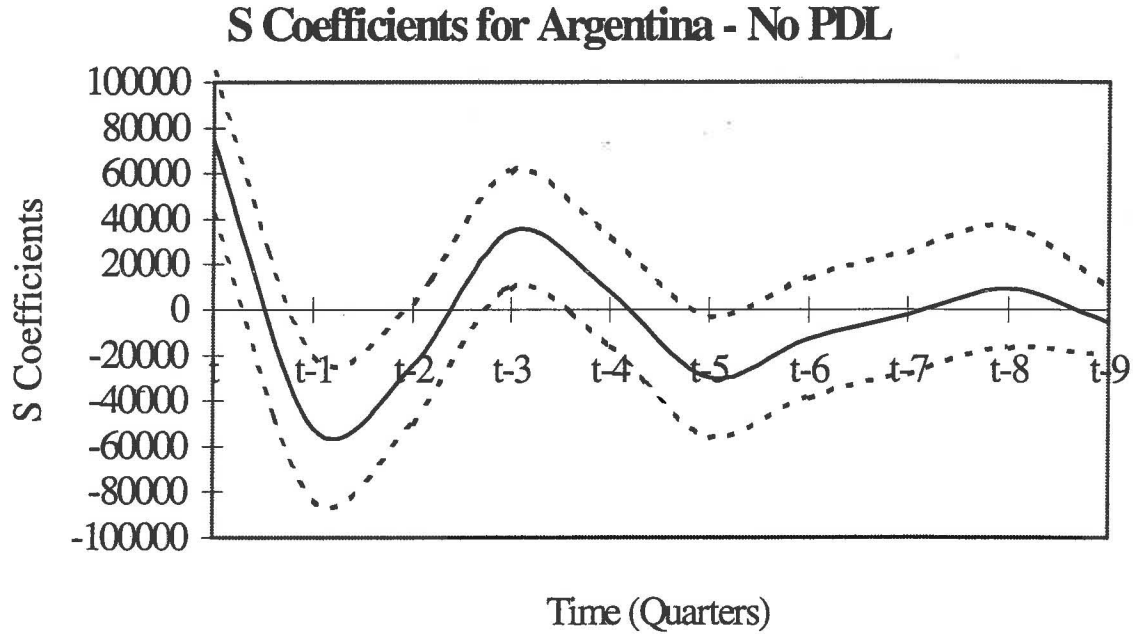
The sum of the S coefficients for Peru shows a relatively large positive value for both the lag-constrained and unconstrained models. This result indicates, rather strongly, that a depreciation of the real exchange rate will lead to a fall in the trade balance over the entire lag period, *ceteris paribus*. Regardless of whether a J-curve exists, this result indicates that depreciations may be more harm than help to the trade balance in the longer run.

Test statistics and other regression results for Peru show a weaker performance than in the case of Argentina. F-statistics for both models, while significant at the 5% level for the unconstrained model and at the 1% level for the PDL-constrained model, are still fairly low. Durbin-Watson values for both models show no sign of autocorrelation. The R-squared values for Peru are even worse than those for Argentina, hovering just above the 0.4 level. This is especially troubling, particularly when extra variables were added above and beyond the basic model. Once again, as I did with Argentina, I will place partial blame for such a low R-squared on unpredictable government actions and hard to model public reactions to national and international changes. Of course not all the blame lies there. I am sure the model is not perfect and should be further augmented and altered if it is to be used for more refined purposes. I believe, however, that this model serves the purposes of this study well.

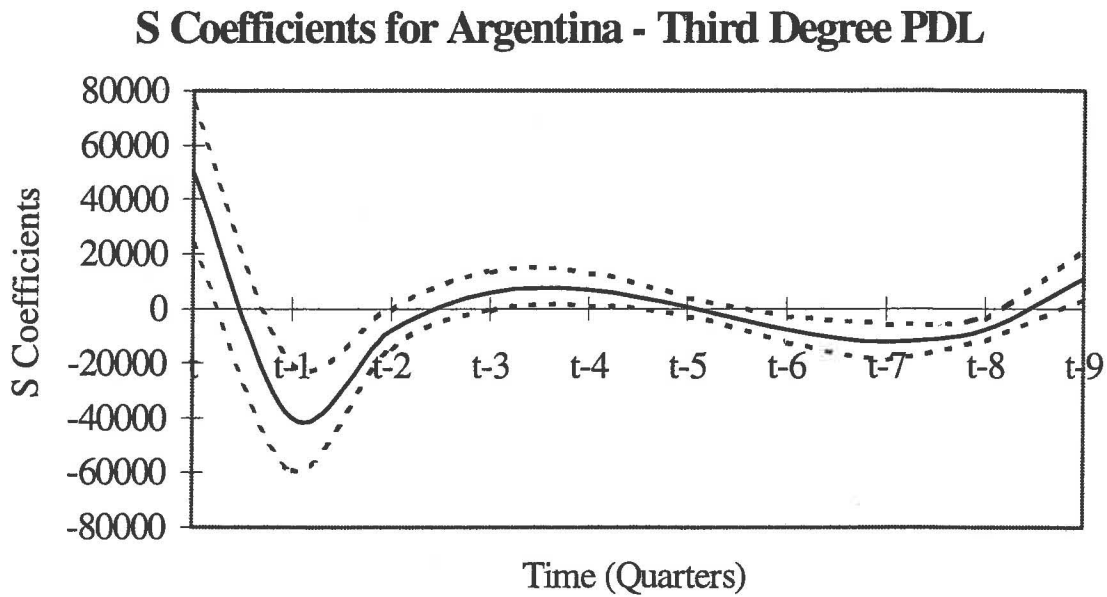
⁴⁰ It is not uncommon for severe inflation to crop up several quarters after a Latin American stabilization plan is enacted. Such a plan usually includes a policy-induced nominal devaluation.

Figure 3 - Real Exchange Rate (S) Coefficients for Argentina and Peru with and without PDLs.
 (Standard errors are represented by dotted lines.)

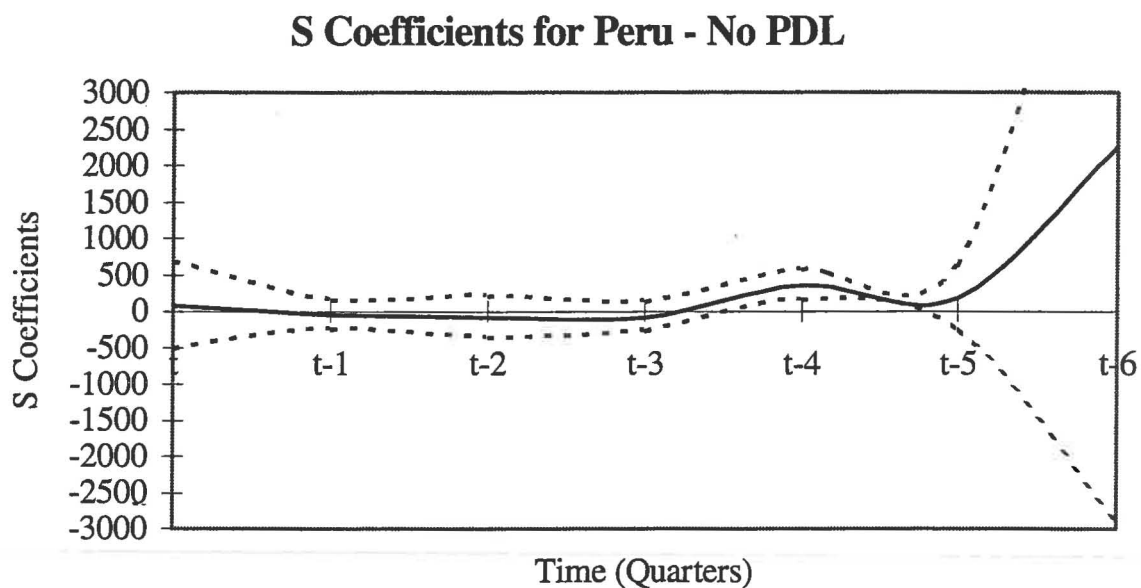
a)



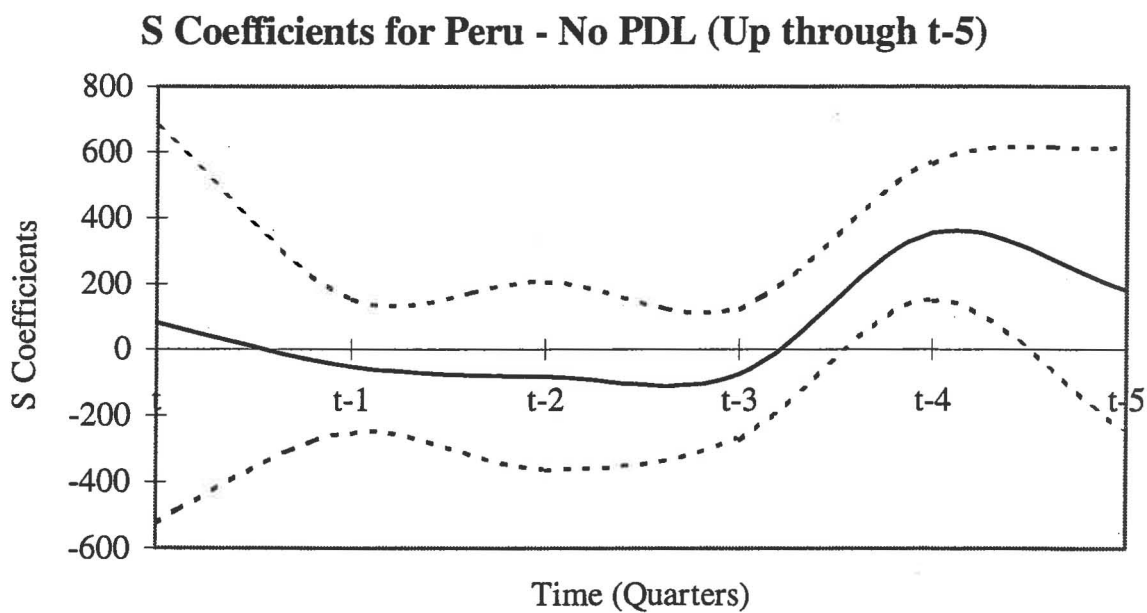
b)



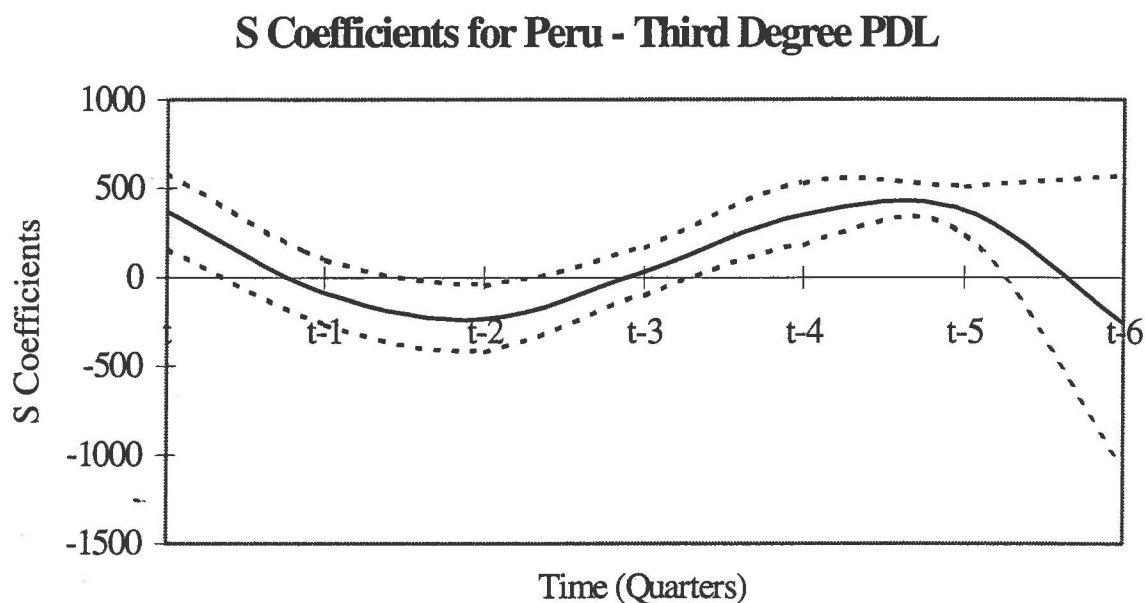
c)



d)



e)



VI: Conclusion

The results of this study provide evidence against the existence of an extended J-curve in the relationship between the real exchange rate and the trade balance in either Argentina or Peru. According to the results, the trade balance does deteriorate during the quarter of the depreciation. This deterioration, however, is short enough to be explained by the time it takes actors to react to any changes in the market and either renegotiate contracts or make new purchases or sales. Such a short deterioration can be expected in all cases of depreciation and does not constitute a J-curve. This result is very useful to policymakers in these two countries. According to the results of this model, a policy-induced depreciation of the real exchange rate (a devaluation of the nominal exchange rate that causes a real depreciation), will not cause a prolonged initial deterioration of the trade balance.

While a J-curve may not exist in Argentina and Peru, there are other results from this study that should concern policy makers in these two countries just as much as the existence of a J-curve. First, according to the results, a depreciation of the real exchange rate in either Argentina or Peru leads to an improvement of the trade balance that lasts approximately two quarters. Two quarters of improvement is a scant reward for the potential cost of a policy devaluation. Devaluations are not popular in Latin America. It is commonly acknowledged that through rising import prices, devaluations contribute to inflation that spreads quickly throughout the economy. Argentines and Peruvians are already overwhelmed by recurrent hyperinflation. They do not

need or want more. Depreciations, whether of the policy brand or not, have been known to hurt industry through rising prices of imported machinery and inputs. The results of such phenomena are dissatisfied consumers and disgruntled businessmen. Such are the ingredients for political instability. Devaluations become even less popular when their benefits are reaped for a mere six months.

If the benefits do last for only six months, the need for another devaluation may come just that much sooner. Frequent devaluations are also a bad idea. First of all several devaluations in a relatively short time will just work to compound the problems discussed above. Consumers will soon become disheartened by the ridiculous number of zeros on the price tags. (That is assuming that the depreciation does indeed cause inflation.) In response, store owners will opt to price their wares in dollars -- an action that is the first step towards an economy in which the domestic currency is virtually useless. Investors and businessmen will also try to hoard as many dollars as possible. If they don't have dollars, purchasing imported inputs will become prohibitively expensive and investment will grind to a halt. In addition to all of this, devaluations may simply cease to be at all effective as a tool towards improving the trade balance. Foreign purchasers, who will eventually grow to expect further devaluations, will not react quickly to any single depreciation. Instead they will wait to see if the exchange rate will depreciate even more, making the imported goods they seek even cheaper in terms of their currency. Under such a scenario, a policy-induced devaluation will not have the desired effect of improving the trade balance.

Another important result is indicated in the statistic measuring the sum of the S coefficients. Positive statistics for both countries indicate that over the appropriate lag length a depreciation is more likely to hurt the trade balance than to help it. This result casts even more doubt on the usefulness of devaluation as a policy tool.

The results of this paper indicate that the governments of Argentina and Peru should carefully consider their options when trying to improve their trade balance. It is not clear that the most obvious option - a devaluation - will provide the quick fix that it is often expected to. Other options that should be considered are to act through the money supply, the real interest rate, or possibly even tariffs or quotas. While every option has its drawbacks, such problems should be weighed with the effectiveness of the option.

To briefly summarize, while policy makers in Peru and Argentina need not worry about a J-curve type relationship between the real exchange rate and the trade balance, they should be concerned about the relatively short duration of any positive influence a devaluation may have on the trade balance as well as the longer-term negative effect that may be brought about by a devaluation.

Appendix 1: The Data.

All statistics were taken from the IMF's International Financial Statistics Disk or Books. The trade balance (BT) is equal to exports (IFS disk #21370..DZF for Argentina and #29370..DZF for Peru) minus imports (IFS disk #21371..DZF for Argentina and #29371..DZF for Peru).

The real exchange rate (S) is computed using the purchasing power parity method. The nominal exchange rate of U.S. dollars per unit of national currency (IFS disk #...) is multiplied by the ratio of the domestic CPI (IFS disk #...) over the U.S. CPI.

$$S = \text{NER}(\text{CPI}/\text{CPI}^*)$$

where NER = the nominal exchange rate and CPI = the consumer price index.

Domestic income (Y) is equal to GDP in 1985 prices and is taken directly from the IFS disk (#21399B.PZF for Argentina and #29399B.PZF for Peru).

Foreign income (Y*) is a trade-weighted index of the GDPs (in 1985 prices) of the six countries that comprise of the top 5 trading partners for Argentina (The U.S., Japan, Germany, Italy, and The United Kingdom) and the top 5 trading partners for Peru (The U.S., Japan, Germany, Italy, and The Netherlands), for which data on quarterly GDP is available. Weights are determined by the approximate amount of total trade (exports + imports) in 1985. Trade statistics are taken from the 1993 Direction of Trade Statistics Yearbook published by the IMF.

The Industrial Production Index is taken Directly from the IFS disk (#.....)

The inflation rate (ΔP) is calculated from the Consumer Price Index (CPI) for each country, using the formula, $\Delta P = (\text{CPI}_t - \text{CPI}_{t-1})/\text{CPI}_{t-1}$. Where the CPI is taken directly from the IFS disk, (#... for Argentina and #.....for Peru)

The money supply is an index taken directly from the IFS disk, (# 21334..IZF for Argentina, and #29334..IZF for Peru). To get M/CPI, this index is simply divided by the CPI.

Foreign direct investment (FDI) is taken directly from the IFS disk, (#21377BADZF for Argentina and #29377BADZF for Peru).

The government deficit or surplus (G) is taken directly from the IFS disk, (#21380..ZF for Argentina and #29380..ZF for Peru).

The reserve-import ratio (RIR) used in the first stage equation for S is, in the case of Argentina, the supply of foreign exchange, (IFS disk #.....) divided by imports lagged one quarter, and in the case of Peru, total reserves (IFS disk #293.1LDZF) divided by imports lagged one quarter. **WHY**

The reserve-import ratio used in the second stage equation

The domestic interest rate (r) is, for Argentina, the deposit rate taken directly from the IFS disk, (#21360L..ZF), and for Peru, the discount rate given on the IFS disk, (#29360...ZF).

The foreign interest rate (r*) is the U.S. discount rate taken from the IFS disk, (#11160...ZF).

The world price of oil (POIL) is taken from the 1993 IFS yearbook (line.....)

The dummy variable (D) used for Peru is equal to zero for all periods except the period from 1983, quarter 2 to 1984, quarter 1, when it is equal to one.

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