Should Mexico Dollarize?

Answering Some Traditional Questions with a Modern Approach

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Should Mexico replace pesos with U.S. dollars? Abandoning an independent currency is an extreme form of currency reform. If Mexico adopts dollars, it very effectively rigidly and credibly fixes its exchange rate to the dollar. What are the gains from permanently fixing the exchange rate?

The traditional approach to fixed versus floating exchange rate questions examines the short run stabilizing properties of each regime. Friedman's (1953) famous argument for floating exchange rates stipulates that in the long run the exchange rate system does not have significant real consequences. His reasoning is that the exchange rate system is ultimately a choice of monetary regimes. In the end, monetary policy does not matter for real quantities, he argues, but in the short run it does. He comments:

> If internal prices were as inflexible as exchange rates, it would make little economic difference whether adjustments were brought about by changes in exchange rates or by equivalent changes in internal prices. But this condition is clearly not fulfilled. The exchange rate is potentially flexible in the absence of administrative action to freeze it. At least in the modern world, internal prices are highly inflexible.

Friedman, of course, makes the case for flexible exchange rates as a vehicle for achieving rapid changes in international relative prices.

Buiter (1999) also contends that the choice of exchange-rate regime is also pertinent only to short-run stabilization questions:

> The theory of optimal currency areas is one of the low points of post-World War II monetary economics. Its key failure is a chronic confusion between transitory nominal rigidities and permanent real rigidities. The result is a greatly overblown account of the power of monetary policy to affect real economic performance, for good or for bad.

While Buiter is overstating the irrelevance of monetary regimes for longer-run economic performance (see, for example, the many important contributions of this conference), examination of the short-run effects of monetary regimes is certainly more squarely in the tradition of modern macroeconomic thinking.

This paper builds a two-country (the U.S. and Mexico) economic model in which agents are forward looking and optimize in an environment of uncertainty, but in which there are short-run nominal price rigidities. The models are extensions of the New Open-Economy Macroeconomic models of Obstfeld and Rogoff (1998, 2000) and Devereux and Engel (1998), but specialized to capture some of the key ingredients of the Mexican economy. Households maximize expected utility over long horizons, and get utility from consumption, leisure and real balances. There are a large number of monopolistic firms in each country. Each firm must set nominal prices for its goods one period in advance. Following Obstfeld and Rogoff (1998), firms set prices optimally to maximize the value of the firm.

One notable shortcoming of the old fixed but adjustable currency peg in Mexico was the risk of occasional large devaluations. That risk may also exist under the current regime of controlled floating exchange rates. The problem is that there are not enough hedging instruments to allow agents to insure fully against these abrupt changes in exchange rates. Their occurrence is infrequent, their timing unpredictable, and the size of the devaluations has been large.

In a world of perfectly flexible prices, a nominal devaluation would not necessarily imply any real changes in wealth. But in the short run with sticky nominal prices, nominal devaluations are inevitably real devaluations. Holders of peso-denominated assets suffer uninsured losses. (Or, as Calvo (1999) emphasizes, peso devaluations have significant impact on Mexicans with dollar liabilities.)

The risk implied by nominal exchange rate fluctuations in a world of less-than-complete asset markets may be much more significant than other types of real risk. Recent studies have found that the gains from international asset trade to hedge against real shocks may be small. For example, Cole and Obstfeld (1991) argue that the terms of trade changes that occur in response to productivity shocks may effectively serve as insurance. A country that experiences a national increase in productivity also will suffer a worsening of its terms of trade. Cole and Obstfeld calibrate an artificial economy and conclude that the terms of trade effect might approximately cancel the initial improvement from the productivity gain.

Cole and Obstfeld use this argument to explain why there is apparently so little international diversification in practice. But it seems likely that individuals would want to diversify the risk of large devaluations. In that case, the problem is the difficulty of constructing enough instruments to hedge against these occasional large changes in exchange rates. It would seem that permanently fixing the nominal exchange rate would eliminate this kind of risk and the problem of incompleteness of financial markets could be sidestepped.

The new open-economy macroeconomics literature has not addressed these issues. In some models (Corsetti and Pesenti (1997), Obstfeld and Rogoff (1998)), the law of one price holds for all goods. Devaluations do not impose any purchasing power risk. Indeed, in the set-up of Obstfeld and Rogoff (1998), because exchange-rate changes immediately cause changes in prices consumers pay, terms of trade fluctuations insure against all real shocks. Just as in the flexible-price model of Cole and Obstfeld (1991), there is no need for formal insurance markets since terms of trade changes effectively completely insure. In practice, however, the law of one price fails in the short run. Nominal exchange rate fluctuations are associated with real exchange rate changes for consumers. However, the model of Devereux and Engel (1998) assumes complete (nominally-denominated) contingent claims. It cannot address the concerns of missing financial markets.

This paper is a first step toward addressing the traditional concerns of macroeconomic stability in fixed versus floating exchange rate regimes, but in a model with limited capital mobility. The model takes into account how fixed exchange rate regimes eliminate the need for insurance against nominal exchange rate shocks that lead to deviations from the law of one price. Indeed, the simple model of this paper constructs an example where, even when there is no trade in assets, markets are essentially complete under fixed exchange rates. That is, under fixed exchange rates there is no need to trade assets internationally to hedge risk. From the reasoning above it might seem obvious that fixed exchange rates could eliminate risk, but the argument is slightly subtler. It is true that the real risk associated with nominal exchange rate changes in a sticky-price world is eliminated with fixed exchange rates. But there are also real productivity shocks and real demand shocks. In a world with sticky prices and fixed exchange rates, the insurance effect of terms of trade changes is absent. But it will be shown that even the risk from those shocks is fully shared under a fixed exchange rate regime.

While fixed exchange rates work to complete financial markets, they are not necessarily optimal. The approach taken here denies the efficacy of short-run adjustments of the nominal exchange rate as a means of changing international relative prices. That is, there is no role for the Friedman effect. As Engel (2000) has argued, in practice nominal prices are sticky in consumers' currencies. Fluctuations of exchange rates do not in the short run change the relative prices that consumers face. Thus, one of the major channels of adjustment that Friedman emphasizes does not work in practice. Section 1 presents some evidence that Mexican peso consumer prices do not respond much in the short run to changes in the peso/dollar exchange rate.

But there is an important "insurance" role for flexible exchange rates. While fixed exchange rates eliminate idiosyncratic risk in the simple model of this paper, they might increase aggregate risk. The problem is that fixed exchange rates lead to perfect correlation of monetary shocks between the countries whose exchange rates are tied. Given that there are important short-run real effects of monetary shocks, there might be an increase in world risk from monetary shocks when exchange rates are permanently fixed. Floating rates might, in essence, allow for lower variance in the world money supply. (Suppose that U.S. and Mexican money shocks have equal variance but are uncorrelated. The variance of the world money supply is the twice the variance of one of the shocks. If the shocks are perfectly correlated the variance of the sum is four times the variance of one of the shocks.)

The advantage of floating exchange rates is that they might reduce aggregate risk. But they may not. Mexican monetary shocks probably have a much higher variance than U.S. money shocks under the fixed but adjustable peg, or under controlled floating. Even if fixed exchange rates lead to perfectly correlated monetary shocks in Mexico and the U.S., they might reduce aggregate risk if there is a sufficient reduction of Mexican monetary variance.

Dollarization might, therefore, eliminate most sources of idiosyncratic uninsured risk, and conceivably could reduce aggregate risk. The basic model is outlined in Section 2, and the implications of the model are teased out in section 3.

Section 4 notes that there is an important source of risk for Mexico that is unlikely to be eliminated by fixed exchange rates. The occasional large swings in the price of Mexico's oil exports are as difficult to insure against as large nominal devaluations. But fixing exchange rates cannot provide insurance against this risk. Indeed floating exchange rates, or an optimally managed float, might provide important protection from this type of risk.

Throughout this study two costs of dollarization are ignored. One is the cost of converting to dollars from pesos. That is a one-time cost that is very difficult to quantify. The fact that conversion is costly, of course, directly means dollarization is less desirable. An important assumption implicit in our models is that agents believe under dollarization that there is no chance for nominal devaluation. A high cost of converting to dollars probably also implies a high cost of reverting back to a peso regime. So the credibility of the system is enhanced by high conversion costs. The second cost is the loss of seignorage. The model assumes that Mexican authorities will share in any seignorage from money creation. This assumption is made for analytical convenience.

1. Empirical Evidence of Local-Currency Pricing

This section follows Engel (1999) in producing measures of the importance of deviations of the law of one price in overall variation of the real exchange rate between Mexico and the United States. The evidence is not direct evidence on nominal price stickiness, but is suggestive of the role of local-currency pricing. Taken in conjunction with Rogers (1999), the evidence is strongly consistent with the hypothesis that prices are set in the short-run in consumers' currencies and real exchange rate variation is due to fluctuating nominal exchange rates on top of sticky nominal prices.

Write the log of consumer prices in Mexico as a weighted average of traded goods and nontraded goods prices:

$$p_t = (1 - b_t) p_t^T + b_t p_t^N \,, \tag{1.1}$$

where p_t equals the log of the consumer price level, p_t^T is the log of traded goods prices, p_t^N is the log of nontraded goods prices, and b_t is the weight on nontraded goods.

Similarly in the U.S.:

$$p_t = (1 - b_t^*) p_t^{*T} + b_t^* p_t^{*N} \tag{1.2}$$

where starred (*) variables represent U.S. values.

Define the real exchange rate as the relative price of Mexican goods:

$$q_t \equiv p_t - s_t - p_t^* \,. \tag{1.3}$$

From equations (1.1)-(1.3), the real exchange rate can be written as:

$$q_t = x_t + y_t \,, \tag{1.4}$$

where

$$x_t \equiv s_t + p_t^{*T} - p_t^T \tag{1.5}$$

$$y_t = b_t^* (p_t^{*N} - p_t^{*T}) - b_t (p_t^N - p_t^T)\,. \tag{1.6}$$

In the model of this paper, all goods are traded. Changes in the real exchange rate come only from movements in x_t – i.e., from deviations from the law of one price. The model focuses on the short-run properties of fixed versus floating exchange rate regimes. (The values of real variables in the long run are unaffected by the choice of exchange-rate regime.) In this section, the question is answered: Are short-run Mexican/U.S. real exchange rate variations primarily coming from deviations from the law of one price?

The alternative possibility is that y_t accounts for much of the short-run variation in real exchange rates. That is the channel implicit in almost all theoretical models of real exchange rate behavior for Latin America, but that channel is missing from the model of this paper. Is it reasonable to exclude short-run changes in y_t in describing short-run real exchange rate behavior?

The statistic j_j measures the fraction of the variance of *j*-month real exchange rate changes that is attributable to the variance of x_t:

$$j_j = \frac{Var(x_{t+j} - x_t)}{Var(q_{t+j} - q_t)}. \tag{1.7}$$

There are other possible ways to decompose the variance of the real exchange rate into a part attributable to x_t and a part attributable to y_t, depending on how the covariance of the two components is treated. This measure tends to understate the importance of the x_t as long as the covariance term is positive (which it is at most short horizons), but any alternative treatment of the covariance has very little effect on the measured relative importance of the x_t component.

Engel (1999) decomposes the mean-squared error of real exchange rate movements rather than the variance. (The difference is that the mean-squared error includes the squared mean change.) In practice, that also makes practically no difference in the calculated share of movement assigned to x_t. Only the variance decomposition is reported here, for convenience.

If the law of one price holds, j_j should be zero at all horizons. Although one would not expect the x_t to be zero literally in all horizons in the data, one expects j_j to be small if the relative price of nontraded goods is the chief mover of the real exchange rate.

Mexican official statistics report a (seasonally unadjusted) series for consumer prices of traded goods. The data was obtained from Datastream, and is monthly from September 1991 – August 1999. For the U.S., the consumer price of "commodities" is used as the price of traded goods. (Consumer prices in the U.S. are split into commodities and services.) The exchange rate is the monthly average market rate. Measures of the overall consumer price indexes are taken from the same sources.

Figure 1 plots j_j for $j = 1,2,...24$. Given that there are only eight years of monthly data, one must treat the estimated longer variances with some skepticism.

The striking thing about Figure 1 is that at all horizons, j_j is quite large. At the 1-month horizon it is greater than 0.99. Even at the six-month horizon, it exceeds 0.96. The smallest value reported is just slightly below 0.89. The values of j_j do decrease as the horizon increases, as one might expect if the importance of deviations from the law of one price diminish over time. But clearly at the horizons relevant for the analysis of this paper, it is deviations from the law of one price that dominate real consumer exchange rates.

An alternative interpretation of these statistics is that the measured price of "traded" consumer goods is actually the price of a basket of goods and services. At the consumer level, prices reflect the marketing and transportation services that bring the good to the consumer. So, the variation in x_t, it might be argued, really reflects variation in the price of these nontraded services relative to the price of the traded commodity.

That is, x_t can be further decomposed into two components in exactly the same way that q_t was:

$$x_t = d_t + u_t . \tag{1.8}$$

Here, d_t represents the (unobserved) true deviation from the law of one price for the traded commodity, and u_t is the relative price of nontraded marketing services to traded commodity price in Mexico relative to the U.S.

Some evidence suggests that this explanation is not the right one. We would like to be able to calculate

$$\tilde{j}_j = \frac{Var(d_{t+j} - d_t)}{Var(q_{t+j} - q_t)}.$$

Assume the true deviations from the law of one price, d_t, are uncorrelated with u_t and y_t. Then,

$$q_j \equiv \frac{\left(Cov(x_{t+j} - x_t, y_{t+j} - y_t)\right)^2}{Var(y_{t+j} - y_t)} = r_j^2 Var(u_{t+j} - u_t).$$

q_j measures the "explained" variance in a regression of $x_{t+j} - x_t$ on $y_{t+j} - y_t$. r_j is the correlation coefficient between $u_{t+j} - u_t$ and $y_{t+j} - y_t$. (The measure of the y_t component is derived from x_t and q_t: $y_t = q_t - x_t$.)

This statistic can be used in two ways to get a sense of how plausible the marketing story is. First, assume $r = 1$, so that the relative price of nontraded marketing services to commodities is perfectly correlated with the general relative price of nontraded goods. Then,

$$\tilde{j}_j = \frac{Var(x_{t+j} - x_t) - q_j}{Var(q_{t+j} - q_t)}.$$

This statistic necessarily attributes less of the variance of the real exchange rate to deviations from the law of one price, compared to j_j plotted in Figure 1. But, it makes little difference. Figure 2 plots $\tilde{j}_j$. In constructing Figure 2, at the first four horizons, q_j is set equal to zero. That is because at those horizons, $Cov(x_{t+j} - x_t, y_{t+j} - y_t)$ is negative. This contradicts the underlying assumption of this exercise (that d_t is uncorrelated with u_t and y_t; and u_t and y_t are perfectly correlated.)

The lesson from Figure 2 is that if the relative price of nontraded marketing services behaves just like the relative price of other nontraded goods, it cannot be a very large component of x_t since $Cov(x_{t+j} - x_t, y_{t+j} - y_t)$ is quite small at all horizons.

Perhaps a fairer test of the marketing hypothesis would be to allow the correlation of u_t and y_t to be less than perfect. That correlation is not easily identified. But, note more generally

$$\tilde{j}_j = \frac{Var(x_{t+j} - x_t) - (q_j / r_j^2)}{Var(q_{t+j} - q_t)}.$$

The value of r_j^2 that makes the share of the variance of true deviations from the law of one price as small as one half can be backed out of this equation for each horizon *j*. Those are plotted in Figure 3. They are all very small. The point is simply that if the explanation for Figure 1 is that "traded" prices measured in x_t contain a large nontraded component from marketing and distribution, that component would have to be pretty much uncorrelated with measured nontraded goods prices. Real exchange rate theories that rely on variation of nontraded marketing prices would need to rely on entirely different sources of shocks than hit measured nontraded goods prices.

It appears more plausible to conclude that the simple interpretation of Figure 1 is the correct one: that most variation in real exchange rates in the short run comes from variation in traded goods prices across locations.

Since Mexican and U.S. consumer price indexes do not weight goods equally, might not the variance of x_t be attributable to terms of trade changes? Evidence from subcategories of products suggest not. Let a_{ht} be the weight of product *h* in the traded goods price index for Mexico, and a_{ht}^* be the weight for the same product in the U.S. price index. Then

$$p_t^T = a_h p_t^h + \sum_{i=1}^k a_i p_t^i \,, \quad i \neq h$$

$$p_t^{*T} = a_h^* p_t^{*h} + \sum_{i=1}^k a_i^* p_t^{*i} \,, \quad i \neq h$$

It follows that

$$x_t = v_t^h + w_t^h \,,$$

where x_t is defined as in equation (1.5), and

$$v_t^h \equiv s_t + p_t^{*h} - p_t^h \,,$$

$$w_t^h \equiv \sum_{i=1}^k a_i^* (p_t^{*i} - p_t^{*h}) - \sum_{i=1}^k a_i (p_t^i - p_t^h) \,.$$

If the law of one price holds for all goods, then $v_t^h = 0$ and

$$w_t^h \equiv \sum_{i=1}^k (a_i^* - a_i)(p_t^i - p_t^h) \,.$$

When the law of one price holds for all goods, changes in the real exchange rate only occur when the relative price of individual traded goods change, and those traded goods have different weights in the U.S. and Mexican price indexes. For example, if food has a higher weight in the Mexican traded consumer price index compared to the U.S., then an increase in the price of food relative to other traded goods will raise the Mexican traded consumer price index relative to that in the U.S.

If the law of one price holds, the statistic $\hat{f}_j^h$, defined by

$$\hat{f}_j^h = \frac{Var(v_{t+j}^h - v_t^h)}{Var(x_{t+j} - x_t)}$$

should be zero at all horizons. Conversely, if the law of one price does not hold, $\hat{f}_j^h$ should be large for many goods.

Figure 4 plots $\hat{f}_j^h$ for $j = 1,2,...24$. The plots are for three categories of goods that are primarily traded: food, household furnishings, and apparel. The data sources and dates are the same as those described above.

The evidence from Figure 4 supports the presumption that movement in x_t in the short run comes from deviations from the law of one price. At all horizons plotted, for all three categories of goods, $\hat{f}_j^h$ is large – not at all close to zero.

Of course, it is possible that at some finer level of disaggregation, there are significant changes in relative traded goods prices within Mexico and the U.S. that are driving movements in $\hat{f}_j^h$. At some level this is tautologically true: goods sold to consumers in Mexico and in U.S. are different goods because the location the good is sold is part of the characteristic of the good. But the statistics presented in Figures 1-4 limit the types of models of real exchange rate behavior one might appeal to if one rejects the interpretation that failures of the law of one price drive the real exchange rate.

Finally, if the law of one price fails, is it because of local-currency pricing? The model in this paper assumes Mexican consumer prices are set in pesos, and American consumer prices are set in dollars, and in the short run those prices are inflexible. Fluctuations in the peso/dollar nominal exchange rate imply failures of the law of one price and real exchange rate fluctuations.

There are two pieces of evidence that appear to support the local-currency-pricing story. First is Rogers's (1999) study of consumer prices in Mexico, the U.S. and Canada. In his study, data on aggregate consumer prices for cities in those three countries is examined. He finds that distance between cities explains much of the variation in relative price levels. That evidence supports the notion that the law of one price fails because of transportation costs and other real factors that drive a wedge between prices in different locations. But, even taking into account distance, relative price levels vary to a much greater degree for city pairs that lie across national borders than for city pairs that lie within a country.[1] This evidence is consistent with the local-currency pricing effect. Indeed, the relative sizes of the U.S./Mexico, U.S./Canada, and Canada/Mexico border effects are nearly identical to the relative sizes of the nominal exchange rate variance for those countries.

Some simple direct evidence comes from examining the correlation of the nominal exchange rate with x_t. Figure 5 plots values of the correlation of $x_{t+j} - x_t$ with $s_{t+j} - s_t$. It shows that at horizons $j = 1,2,...24$, the correlation is greater than 0.75. At shorter horizons, the correlation exceeds 0.90. So, an approximately accurate description of the data is that p_t^T and p_t^{*T} are constant or very slow moving, while s_t varies much more over time.

That does not necessarily imply that nominal prices are sticky, in the sense that they are not responding to forces of supply and demand. Perhaps it is the case that p_t^T and p_t^{*T} are relatively constant over time because monetary policy does a good job in stabilizing nominal prices. Under this theory, movement in x_t really does represent changes in the real forces that segment Mexican and

1 Rogers (1999) thus extends the analysis of Engel and Rogers (1996) to include Mexico, and finds similar results. Note however that Rogers (1999) uses only aggregate consumer prices, while Engel and Rogers (1996) use somewhat disaggregated price indexes.

American markets. But this explanation has a curious implication. Since monetary policy is stabilizing p_t^T and p_t^{*T}, the nominal exchange rate must do all of the adjustment in response to these changes in market segmentation. In short, it is a theory under which nominal exchange rate changes are entirely determined by transportation costs!

The data is consistent with the local-currency pricing model of this paper. Perhaps other models can explain the consumer price data as well, but perforce they would be unusual theories.

2. The Model

The model is a two-country model where explicit account is taken of country size. The two countries in this case are Mexico and the United States. (Mexico's population is indexed by n. Normalize total population to unity, so that U.S. population is $1-n$.) Clearly the U.S. is a much larger country than Mexico, although Mexico is a significant trading partner for the U.S. It is helpful to develop the analysis in a two-country setting to take into account explicitly how monetary policy choices in the U.S. affect the optimality of exchange-rate regimes for Mexico.

The model of this section assumes that all goods produced are final consumer goods. The goods are produced in monopolistically competitive markets. In each country there are a large number of goods produced, each of which is an imperfect substitute for all other goods. Producers must set prices one period in advance. As evidence from the previous section indicates, a reasonable assumption is that producers set prices in consumers' currencies. That is, producers in both Mexico and the U.S. set peso prices for Mexicans and dollar prices for Mexicans. After dollarization occurs, producers can still set different prices for Mexican and American consumers, although the assumptions on preferences will imply that optimally they choose the same prices.

As is well known from the menu-cost literature, the monopolistic assumption has several advantages for motivating sticky-price models in which output is demand-determined in the short run. In the first place, the notion that firms can set prices in itself implies some market power for producers. A producer in competitive markets must take market prices as given and cannot announce a price in advance. But monopolistic producers are able to set prices for their products, and may not change those preset prices in response to supply or demand shocks if there are menu costs and the size of the shocks is sufficiently small. Since producers are monopolists, they set prices above marginal costs. If there is an increase in demand for the product, the producer is willing to increase output to satisfy demand at preset prices as long as the increase in demand does not push into a region where marginal costs exceed the price. So, the monopolistic setting offers a rationale for demand-determined output. This "New Keynesian" approach also offers a rationale for macroeconomic policies that might stimulate output. Because monopolistic producers choose inefficiently low output levels, policies that can increase average output might be desirable.

The extreme assumption is made that there is no capital mobility and the current account is continuously balanced. This assumption both simplifies matters, but also highlights the role of fixed exchange rates in effectively completing financial markets.

Consumers

Consumers in Mexico are assumed to maximize expected utility over an infinite horizon. They get utility from consumption, real money balances and leisure (or, rather, they get disutility from work.) The consumers maximize

$$U_t = E_t\left(\sum_{s=t}^{\infty} b^{s-t} u_s\right), \qquad 0 < b < 1$$

where

$$u_s = \frac{1}{1-r} C_s^{1-r} + c \ln\left(\frac{M_s}{P_s}\right) - hL_s , \qquad r > 0 .$$

C is a consumption index that is a geometric average of home and foreign consumption:

$$C = \frac{C_M^n C_U^{1-n}}{n^n (1-n)^{1-n}} .$$

There are n identical individuals in Mexico, $0 < n < 1$, and $1-n$ identical individuals in the U.S. This is also the measure of goods produced in each country. C_M and C_U are indexes over consumption of goods produced in Mexico and the U.S., respectively:

$$C_M = \left[n^{-1/l} \int_0^n C_M(i)^{l-1/l} \, di \right]^{l/l-1} \qquad C_U = \left[(1-n)^{-1/l} \int_n^1 C_U(i)^{l-1/l} \, di \right]^{l/l-1}$$

There is a constant elasticity of substitution between goods produced within a country, l, which is greater than 1. But, following Corsetti and Pesenti's (1997) innovation to the Obstfeld and Rogoff (1995) framework, this utility function does not impose that the elasticity of substitution between goods produced within a country is the same as consumers' elasticity of substitution for goods produced in different countries. Indeed, it is convenient to assume a unit elasticity of substitution between the home goods and foreign goods indexes.

$\frac{M}{P}$ are peso real balances. It is assumed that before Mexico is dollarized, only pesos are useful in transactions. So, only peso balances yield utility. L is the labor supply of the representative home agent. **(These special assumptions on how money and labor enter the utility function may be generalized in future versions.)**

The price index, P, used to deflate nominal balances is the exact price index associated with the consumption part of the utility function. So, P is defined by

$$P = P_M^n P_U^{1-n} \qquad (2.1)$$

where

$$P_M = \left[\frac{1}{n} \int_0^n P_M(i)^{1-l}\, di \right]^{1/(1-l)} \qquad P_U = \left[\frac{1}{1-n} \int_n^1 P_U(i)^{1-l}\, di \right]^{1/(1-l)}$$

The optimal within-period consumption choices can be summarized by:

$$C_M(i) = \frac{1}{n} \left[\frac{P_M(i)}{P_M} \right]^{-l} C_M \qquad C_U(i) = \frac{1}{1-n} \left[\frac{P_U(i)}{P_U} \right]^{-l} C_U$$

$$P_M C_M = nPC \qquad P_U C_U = (1-n)PC$$

$$\int_0^n P_M(i) C_M(i) di = P_M C_M \qquad \int_n^1 P_U(i) C_U(i) di = P_U C_U$$

Agents can neither borrow nor lend. The budget constraint for the typical Mexican is:

$$P_t C_t + M_t = W_t L_t + p_t + M_{t-1} + T_t \,.$$

Agents are endowed with equal ownership in each of their own country's firms. p_t is the representative agent's share of profits from Mexican firms. T_t are monetary transfers from the government. W_t is the wage rate. Note that it is assumed the Mexican government makes monetary transfers to its residents (even under dollarization.)

The money demand equation for Mexican residents is given by:

$$\frac{M_t}{P_t} = \frac{cC_t^r}{1-d_t} \tag{2.2}$$

where d_t is the inverse of the gross nominal interest rate, given by

$$d_t = E_t\left(b\,\frac{C_{t+1}^{-r} P_t}{C_t^{-r} P_{t+1}} \right). \tag{2.3}$$

The consumption-leisure trade-off is captured by the first-order condition:

$$\frac{W_t}{P_t C_t^r} = h\ . \tag{2.4}$$

U.S. consumers have preferences similar to Mexicans'. They have identical preferences over Mexican and American-produced goods. The functional form in which real balances and labor enter the utility function are the same, but of course Americans have utility over real dollar balances and get disutility from their own labor.

Firms

Firms produce output using labor. The production function for a typical Mexican firm is given by:

$$Y_t = \frac{L_t}{\mathrm{E}_t}, \tag{2.5}$$

where E_t represents a stochastic productivity shock at time *t*. (Note the somewhat nonstandard usage here. E_t is a negative productivity shock, or given the linearity of the production function, a cost shock.) The cases of purely transitory productivity shocks ($E_{t-1}\mathrm{E}_t = 0$) and purely permanent productivity shocks ($E_{t-1}\mathrm{E}_t = \mathrm{E}_{t-1}$) will be analyzed.

The objective of the Mexican firms is to set prices to maximize the expected utility of the firm owners. Mexican firms are owned by Mexican residents. Firms must set prices for period *t* before any information on the stochastic variables – Mexican and American money supply and cost shocks – is known. No state-contingent pricing is allowed. As Obstfeld and Rogoff (1998) show, this problem can be expressed as maximizing the expected discounted value of profits using the consumption discount factor. Given the stationarity of the model, firm *i* in Mexico chooses $P_{Mt}(i)$ (the price Mexicans pay for Mexican goods) and $P^*_{Mt}(i)$ (the dollar price that Americans pay for Mexican goods) to maximize:

$$E_{t-1}\left\{\left(\frac{bC_t^{-r}P_{t-1}}{P_tC_{t-1}^{-r}}\right)\left[P_{Mt}(i)X_{Mt}(i)+S_tP^*_{Mt}(i)X^*_{Mt}(i)-W_t\mathrm{E}_t\left(X_{Mt}(i)+X^*_{Mt}(i)\right)\right]\right\}.$$

In this expression, $X_{Mt}(i) \equiv nC_{Mt}(i)$ represents total sales of the Mexican good to Mexicans, and $X^*_{Mt}(i) \equiv (1-n)C^*_{Mt}(i)$ are total sales of the Mexican good to Americans. The cost function for this firm is $W_t\mathrm{E}_t\left(X_{Mt}(i)+X^*_{Mt}(i)\right)$ given the production function in equation (2.5). It is assumed that the firm hires workers in a competitive labor market and takes nominal wages as given.

The optimal prices are given by[2]:

[2] In deriving these expressions, it is useful to recall that P_t is preset and therefore in the $t-1$ information set.

$$P_{Mt}(i) = \frac{l}{l-1}\frac{E_{t-1}\left(W_t \mathrm{E}_t C_t^{1-r}\right)}{E_{t-1}\left(C_t^{1-r}\right)} \tag{2.6}$$

$$P_{Mt}^{*}(i) = \frac{l}{l-1}\frac{E_{t-1}\left(W_t \mathrm{E}_t C_t^{*} C_t^{-r}\right)}{E_{t-1}\left(S_t C_t^{*} C_t^{-r}\right)}. \tag{2.7}$$

Analogous prices set by American firms are given by:

$$P_{Ut}^{*}(i) = \frac{l}{l-1}\frac{E_{t-1}\left(W_t^{*} \mathrm{E}_t^{*} C_t^{*1-r}\right)}{E_{t-1}\left(C_t^{*1-r}\right)} \tag{2.8}$$

$$P_{Ut}(i) = \frac{l}{l-1}\frac{E_{t-1}\left(W_t^{*} \mathrm{E}_t^{*} C_t C_t^{*-r}\right)}{E_{t-1}\left(S_t^{-1} C_t C_t^{*-r}\right)} \tag{2.9}$$

In these expressions, S_t is the exchange rate expressed as pesos per dollar. Starred (*) variables represent U.S. quantities.

If this were a world of certainty, it is easy to see that in each case, the price charged would be a mark-up over costs. Domestic firms under certainty would charge $\frac{l}{l-1} W_t \mathrm{E}_t$ to domestic consumers and $\frac{l}{l-1}\frac{W_t \mathrm{E}_t}{S_t}$. The law of one price would hold in the absence of uncertainty. Even though firms could discriminate between U.S. and Mexican markets, they would charge the same price because preferences are the same in the two countries.

But, under uncertainty, prices are not simply a markup over expected costs. As Devereux and Engel (1998) emphasize, firm managers optimally take into account the risk aversion of firm owners. In setting prices, they take into account the covariance of profits with the discount factor $\frac{bC_t^{-r}P_{t-1}}{P_t C_{t-1}^{-r}}$. There is a risk premium incorporated in the level of prices to take into account that covariance.

Ex post, the law of one price in general will fail. Producers in each country have set prices in consumers' currencies. As monetary and productivity shocks hit the economy, the ex post exchange rate will vary, leading to ex post deviations from the law of one price.

Equilibrium Relationships

Under the assumption of no capital mobility (with no initial debts), trade must be balanced each period. Americans spend a fraction *n* of their total spending on Mexican goods. So, the typical American spends nP^*C^* dollars on Mexican goods. (Starred (*) variables represent U.S. quantities.) The peso value of those revenues is nSP^*C^*. (The exchange rate, *S*, is expressed as pesos per dollar.) Since there are $1-n$ Americans, the total peso value of exports to America from Mexico is $(1-n)nSP^*C^*$. Similarly, a typical Mexican spends $(1-n)PC$ on American imports, so the total peso value of imports is $(1-n)nPC$. Balanced trade, then, requires:

$$P_t C_t = S_t P_t^* C_t^* \tag{2.10}$$

Equilibrium in the market for Mexican goods requires supply equals demand:

$$\frac{L_t}{\mathrm{E}_t} = n\frac{P_t C_t}{P_{Mt}} + (1-n)\frac{P_t^* C_t^*}{P_{Mt}^*}. \tag{2.11}$$

In the U.S., the equilibrium in goods markets is given by:

$$\frac{L_t^*}{E_t^*} = n\frac{P_t C_t}{P_{Ut}} + (1-n)\frac{P_t^* C_t^*}{P_{Ut}^*}. \tag{2.12}$$

Government

In each country, increases in money supply are transferred directly to residents. So, in Mexico,

$$M_t = M_{t-1} + T_t.$$

A similar condition holds for the U.S.

We will assume that monetary policy in the U.S. is determined independently of any considerations about its exchange rate with Mexico. We will assume that monetary policy might respond to current supply shocks, but there is also a pure noise element:

$$m_t^* - m_{t-1}^* = v_t^* + b_1 e_t + b_2 e_t^*. \tag{2.13}$$

Lower case letters represent the natural log of upper-case letter. (E.g., $m_t = \ln(M_t)$ and $e_t = \ln(E_t)$.)

In Mexico, under floating exchange rates, monetary policy is similar:

$$m_t - m_{t-1} = v_t + a_1 e_t + a_2 e_t^*. \tag{2.14}$$

The *i.i.d.* shock, v_t, represents shocks to the money supply coming from disturbances, for example, in the banking system that the central bank cannot control. The presence of this type of shock is critical to the evaluation of dollarization versus more flexible exchange rate regimes. In this framework, we can allow optimal monetary policy involving optimal choices of the feedback parameters a_1 and a_2.[3] But under our assumptions, monetary policy makers in Mexico cannot eliminate the v_t^* shocks. Only by dollarizing will those money shocks be eliminated.

Under fixed exchange rates, monetary policy must be aimed at keeping the exchange rate steady. In the next section, after solving for the equilibrium exchange rate, the implications for Mexican monetary policy are revealed.

3. Equilibrium under Fixed and Floating Exchange Rates

Fixed Exchange Rates

With the exchange rate fixed at one, producers are essentially setting prices in the same currency for Americans and Mexicans. Given identical preferences, prices charged to each nation will be the same. That is, $P_{Mt}(i) = P_{Mt}^*(i)$, and $P_{Ut}(i) = P_{Ut}^*(i)$. If the law of one price holds for all goods, with identical preferences, purchasing power parity holds: $P_t = P_t^*$. With purchasing power parity, the trade-balance condition (2.10) reduces to:

$$C_t = C_t^*. \tag{3.1}$$

Now note that under the assumptions made here, idiosyncratic risk is completely eliminated with fixed exchange rates! That is, even though no assets are traded, Mexican and American consumption are perfectly. Why does that occur?

[3] This policy function eliminates by assumption time-inconsistent policy actions.

There are two types of shocks in this model. Neither requires asset markets to provide insurance under fixed exchange rates:

1. Monetary shocks. In this model, given that $P_t = P_t^*$ under fixed exchange rates, and $C_t = C_t^*$ from the trade-balance equation. Then from equation (2.3), nominal interest rates must be the same in Mexico and the U.S. It follows from the monetary equilibrium equation (2.2), and the corresponding one for the U.S., that the money supplies must be equal in Mexico and the U.S. That is, fixing exchange rates requires Mexico to perfectly correlate its money supply to the U.S. money supply:

$$M_t = M_t^* . \tag{3.2}$$

(We take the U.S. to be the "leader" – it sets its monetary policy independently of exchange-rate considerations – and Mexico is the "follower".) There are no idiosyncratic monetary shocks, hence no need for capital markets to provide insurance against idiosyncratic shocks.

2. Productivity shocks. There can be transitory or permanent idiosyncratic productivity shocks **(this draft only considers transitory shocks)**, but nonetheless the current account is always balanced and there is no trade in assets. It is helpful to break down the explanation into long-run and short-run effects.

If the shock in period *t* is transitory, and has no effect in period *t* on relative consumption (as we will argue it does not), then it has no further effects in period $t+1$. A permanent productivity shock, say in the U.S., has no effect on relative consumption in period $t+1$ onward for reasons discussed in Cole and Obstfeld (1991). Suppose there is a positive productivity shock in the U.S., which tends to increase U.S. wealth. It also lowers the relative price of U.S. goods, because it lowers the cost of producing those goods. This terms of trade worsening for the U.S. partially offsets the positive wealth effect of the shock for the U.S. It also serves as a positive wealth shock for Mexico.

When utility is Cobb-Douglas, the net effect is that wealth increases equally in the U.S. and Mexico. So the terms of trade change effectively provides insurance even in the absence of asset trade.

How do productivity shocks affect the short run? In the short run, output is demand determined. A positive idiosyncratic productivity shock is accompanied by a decline in hours worked. There is no effect on period *t*'s GDP.

In the case of transitory productivity shocks, lifetime income is therefore unaffected by the productivity shock. Short-run GDP is unchanged, and there is no effect on productivity after period *t*. Since there is no change in income in any period, there is no change in consumption in any period.

If the positive productivity shock is permanent, there is an increase in wealth that is expected to increase consumption in all periods starting in $t+1$. (Consumption in both countries increases equally for the reasons discussed above.) But period *t* consumption is not affected. The reason is that the future increase in consumption, holding money constant, is expected to cause prices to fall. This deflation raises the real interest rate in period *t*. With the given utility function, the increase in the real interest rate just offsets the wealth effect and the net impact on current consumption is zero.

To examine welfare under fixed exchange rates, first take up the case of temporary productivity shocks. From equations (2.13) and (3.2), the logs of both American and Mexican money supplies follow random walks. Assuming normally distributed shocks:

$$E_t\left(\frac{M_t}{M_{t+1}}\right) = m \tag{3.3}$$

where m is related to the variance of the monetary shocks. In this case, equation (2.2) simplifies to

$$C_t^r = (\frac{1-mb}{c})\frac{M_t}{P_t} \qquad (3.4)$$

The implication of this equation – that nominal interest rates are constant in equilibrium – is a well-known consequence of the assumption of real balances entering utility logarithmically.[4] Expected inflation and the real interest rate are not constant in this model, but they always move in opposite directions to render the nominal interest rate constant.

An implication of equations (2.13) and (3.4) is that

$$s_c^2 = \frac{1}{r^2}(s_{v^*}^2 + b_1^2 s_e^2 + b_2^2 s_{e^*}^2)\,. \qquad (3.5)$$

In this equation, $s_c^2 \equiv Var_{t-1}(c_t)$, and like notation applies to the other variance terms. Also

$$s_{ce} = \frac{b_1}{r}s_e^2 \qquad\qquad s_{ce^*} = \frac{b_2}{r}s_{e^*}^2 \qquad (3.6)$$

where $s_{ce} \equiv Cov_{t-1}(c_t, e_t)$ and $s_{ce^*} \equiv Cov_{t-1}(c_t, e_t^*)$.

Taking into account purchasing power parity, and equation (3.1), and using the leisure-consumption relationship given by equation (2.4), optimal prices set by Mexican firms (from equations (2.6) and (2.7)) become:

$$P_{Mt}(i) = P_{Mt}^*(i) = \frac{lh}{l-1}P_t\,\frac{E_{t-1}\left(\mathrm{E}_t C_t\right)}{E_{t-1}\left(C_t^{1-r}\right)}\,. \qquad (3.7)$$

Similarly, optimal prices set by U.S. firms are given by:

$$P_{Ut}(i) = P^{*}_{Ut}(i) = \frac{\lambda\eta}{\lambda - 1} P_t \frac{E_{t-1}\left(\mathrm{E}^{*}_{t} C_t\right)}{E_{t-1}\left(C_t^{1-\rho}\right)}. \tag{3.8}$$

Equation (3.7) shows that all Mexican firms set the same price (for Americans and Mexicans), so $P_{Mt}(i) = P_{Mt}$. Likewise, $P_{Ut}(i) = P_{Ut}$. Equations (3.7) and (3.8), together with the definition of the price index P_t given in equation (2.1) imply

$$E_{t-1}\left(C_t^{1-\rho}\right) = \frac{\lambda\eta}{\lambda - 1}\left(E_{t-1}\left(\mathrm{E}_t C_t\right)\right)^{n}\left(E_{t-1}\left(\mathrm{E}^{*}_{t} C_t\right)\right)^{1-n}. \tag{3.9}$$

The Appendix shows how we can use the above relationships to derive

$$U \propto \left(\frac{1 + \rho(\lambda - 1)}{\lambda(1-\rho)}\right)\left(\frac{\lambda\eta}{\lambda - 1}\right)^{\frac{\rho - 1}{\rho}} \exp\left(\Omega_t^{FIX}\right) \tag{3.10}$$

where

$$\Omega_t^{FIX} \equiv \exp\left[\left(\frac{\rho - 1}{2\rho^{2}}\right)\left(\sigma^{2}_{v^{*}} + (\beta_1^{2} + n\rho + 2n\beta_1)\sigma^{2}_{e} + (\beta_2^{2} + (1-n)\rho - 2(1-n)\beta_2)\sigma^{2}_{e^{*}}\right)\right] \tag{3.11}$$

[4] For example, see discussions in Obstfeld and Rogoff (1996, 1998) and Devereux and Engel (1998).

With the symmetry of the model, utility in the U.S. is also given by equation (3.10). If the U.S. monetary decision makers maximize expected U.S. welfare, the optimal choices of b_1 and b_2 are given by

$$b_1 = -n \qquad\qquad b_2 = -(1-n) \tag{3.12}$$

When Mexico is a small country, $n = 0$, the optimal U.S. monetary policy is to make the U.S. money supply perfectly negatively correlated with U.S. output shocks. This minimizes the price of U.S. goods (see equation (3.8)), thus minimizing the monopoly distortion. As *n* becomes larger, the optimal monetary policy is to offset a weighted average of U.S. and Mexican productivity shocks, so as to keep a weighted average of prices of U.S. goods and Mexican goods low.

Floating Exchange Rates

Under floating exchange rates, equation (2.10) does not imply that consumption in Mexico will equal consumption in the United States. When shocks to money or productivity cause fluctuations in the exchange rate, there are deviations from the law of one price for goods sold in Mexico and the U.S. This implies that purchasing power parity does not hold. In the model of Obstfeld and Rogoff (1998), which has a structure similar to this model, it is assumed the law of one price holds for all goods at all times. That implies purchasing power parity holds continuously, and then home and foreign consumption levels are always equal.

Instead, in this model, the exchange rate is given by:

$$S_t = \frac{P_t C_t}{P_t^* C_t^*} \tag{3.13}$$

Using equation (3.13) and (2.4), equations (2.6) – (2.9) become

$$P_{Mt}(i) = \frac{l h}{l - 1} P_t \frac{E_{t-1}\left(\mathrm{E}_t C_t\right)}{E_{t-1}\left(C_t^{1-r}\right)}. \tag{3.14}$$

$$P_{Mt}^*(i) = \frac{l h}{l - 1} P_t^* \frac{E_{t-1}\left(\mathrm{E}_t C_t^*\right)}{E_{t-1}\left(C_t^{1-r}\right)}. \tag{3.15}$$

$$P_{Ut}^*(i) = \frac{l h}{l - 1} P_t^* \frac{E_{t-1}\left(\mathrm{E}_t^* C_t^*\right)}{E_{t-1}\left(C_t^{*1-r}\right)}. \tag{3.16}$$

$$P_{Ut}(i) = \frac{l}{l - 1} P_t \frac{E_{t-1}\left(\mathrm{E}_t^* C_t\right)}{E_{t-1}\left(C_t^{*1-r}\right)}. \tag{3.17}$$

Since $P_{Mt}(i) = P_{Mt}$ and $P_{Ut}(i) = P_{Ut}$ for all firms, and using the definition of the price index, equation (2.1), we can derive from (3.19) and (3.21):

$$\left(E_{t-1}\left(C_t^{1-r}\right)\right)^n \left(E_{t-1}\left(C_t^{*1-r}\right)\right)^{1-n} = \frac{l h}{l - 1}\left(E_{t-1}\left(\mathrm{E}_t C_t\right)\right)^n \left(E_{t-1}\left(\mathrm{E}_t^* C_t\right)\right)^{1-n} \tag{3.18}$$

Similarly,

$$\left(E_{t-1}\left(C_t^{1-r}\right)\right)^n \left(E_{t-1}\left(C_t^{*1-r}\right)\right)^{1-n} = \frac{l h}{l-1}\left(E_{t-1}\left(\mathrm{E}_t C_t^*\right)\right)^n \left(E_{t-1}\left(\mathrm{E}_t^* C_t^*\right)\right)^{1-n} \qquad (3.19)$$

The Appendix shows the derivation of the following expression for welfare:

$$U \propto \left(\frac{1+r(l-1)}{l(1-r)}\right)\left(\frac{l h}{l-1}\right)^{\frac{r-1}{r}} \exp\left(\Omega_t^{FLEX}\right), \qquad (3.20)$$

where

$$\begin{aligned}\Omega_t^{FLEX} &= \frac{(r-1)^2(1-n)+r-1}{2r^2}s_v^2 - \frac{(r-1)^2(1-n)}{2r^2}s_{v^*}^2 \\ &+\left[\frac{(a_1^2+2a_1 n)((r-1)^2(1-n)+r-1)}{2r^2} - \frac{(b_1^2+2b_1 n)(r-1)^2(1-n)}{2r^2} + \frac{nr(r-1)}{2r^2}\right]s_e^2 \\ &+\left[\frac{(a_2^2+2a_2(1-n))((r-1)^2(1-n)+r-1)}{2r^2} - \frac{(b_2^2+2b_2(1-n))(r-1)^2(1-n)}{2r^2} + \frac{(1-n)r(r-1)}{2r^2}\right]s_{e^*}^2\end{aligned}$$

The optimal monetary policy function for Mexico is independent of policy choices by the U.S. It requires $a_1 = -n$ and $a_2 = -(1-n)$. The intuition for those policy rules is the same as described above for the U.S. under fixed exchange rates. Under floating rates, the optimal choice of monetary policy is the same as under fixed rates, and indeed is unaffected by Mexican monetary policy: $b_1 = -n$ and $b_2 = -(1-n)$.

Fixed vs. Floating: Interpretation

It is helpful to begin with an irrelevance result: If $s_v^2 = s_{v^*}^2$ and if $a_1 = b_1$ and $a_2 = b_2$, then fixed and flexible exchange rates yield the same utility for Mexico. (This can be seen by comparing equation (3.10) to (3.20).) Furthermore, if $a_1 = b_1$ and $a_2 = b_2$ -- as it would if both countries were setting monetary policy optimally in response to supply shocks, or if both countries were ignoring supply shocks in setting monetary policy – then fixed exchange rates are best for Mexico if and only if $s_{v^*}^2 < s_v^2$.

The basic point is that if the money supply process for Mexico is the same under fixed and floating exchange rates, there is no benefit to one regime compared to the other. Intuitively, welfare only depends on the variance of the money supply, and its covariance with supply shocks.

To see why this is true, it is helpful to note, first, that welfare in this model is negatively related to $E\left(C^{1-r}\right)$, assuming the empirically plausible restriction of $r > 1$. That welfare reduces to this simple form can be seen from equation (A.5), which shows that expected employment is positively proportional to $E\left(C^{1-r}\right)$. Since welfare (ignoring the real balances term in the utility function) is given by $\frac{1}{1-r}E\left(C^{1-r}\right) - hE(L)$, it follows that the key is understanding $E\left(C^{1-r}\right)$.

It is helpful to note that under log-normality,

$$E\left(C^{1-r}\right) = (EC)^{1-r} \cdot \exp\left(\frac{r(r-1)}{2} s_c^2\right).$$

Utility increases as expected consumption increases, but falls as the variance of consumption increases. From equation (3.4), given that prices are completely predetermined in the short run and their distribution is independent of the exchange rate regime in the long run, the variance of Mexican consumption depends only on the variance of the Mexican money supply. So, as long as the variance of the money supply is the same under fixed and floating exchange rates, the variance of consumption will be the same.

Monetary policy can also affect the expected level of consumption. From equation (3.4), it is clear that if monetary policy affects the expected real money supply it can change expected consumption. Holding the level of the money supply constant across regimes, the question is how are levels of nominal prices affected by the exchange-rate regime? Intuitively, when expected price levels are higher, there are larger monopoly distortions which implies lower levels of expected consumption.

An examination of equations (3.14) and (3.17) reveal that prices paid by Mexicans are affected by the covariance of productivity shocks with Mexican consumption, and by $E\left(C^{1-r}\right)$ and $E\left(C^{*1-r}\right)$. If $a_1 = b_1$ and $a_2 = b_2$, the covariance of the Mexican consumption with productivity shocks is the same under fixed and floating exchange rates (since the only source of covariation between supply shocks and money comes from monetary policy-makers' response to supply shocks.) Since American prices are affected by the same factors, if there are identical monetary policies in the U.S. and Mexico, $E\left(C^{1-r}\right) = E\left(C^{*1-r}\right)$. So, as long as monetary polices in the U.S. and Mexico are identical, the numerators and denominators of the expressions for Mexican prices in (3.14) and (3.17) will be identical. So, the price levels, and thus the expected consumption levels, are identical under fixed and floating exchange rates if monetary policies are identical.

There are two factors that are conspicuous by their absence in this analysis. First, the traditional role for flexible exchange rates in allowing relative price adjustments that Friedman (1953) stressed does not appear. That is because consumer prices are set in consumers' currencies, and are not affected in the short run by exchange rate changes. In the long run, when prices adjust, the choice of exchange-rate regime is irrelevant.

Second, even though fixed exchange rates eliminate all idiosyncratic risk, they are not necessarily better. Indeed, the variance of consumption in Mexico depends only on the variance of Mexican money supply. The point is rather simple –-fixed exchange rates eliminate all idiosyncratic monetary risk (in this model, where exchange rates are determined only by relative money supplies), but they can increase aggregate monetary risk. Fixed exchange rates imply perfect correlation of Mexican and U.S. money supplies. Under floating exchange rates the independence of the money supplies reduces the variance of world money.

As Frankel (1999) notes, aside from the Friedman-style argument for floating rates, the most common justification is that they allow for independent monetary policy. Although the symmetry of this model eliminates any conflict in monetary goals for the two countries, it is still possible to analyze the potential benefits of independent monetary policy in a limited way. Suppose, for example, that monetary policy in the U.S. is not optimal. For simplicity, take the case in which $b_1 = b_2 = 0$, so U.S. monetary policy-makers do not respond at all to supply shocks in determining the money supply. Then Mexico faces a tradeoff in deciding between fixed versus floating exchange rates. With fixed exchange rates, they inherit some of the stability of the U.S. money supply (if $s_{v^*}^2 < s_v^2$), but they would also inherit the U.S.'s non-optimal response to productivity shocks.

If Mexico responds to productivity shocks optimally under floating exchange rates, while the U.S. makes no response, floating rates are better than fixed rates (comparing (3.14) to (3.17)) if and only if:

$$s_v^2 - s_{v^*}^2 < n^2 s_e^2 + (1-n)^2 s_{e^*}^2 . \qquad (3.21)$$

The interpretation of this condition is obvious. The remarkable thing about this inequality is its simplicity, and that it does not depend on any of the parameters of the utility function or the production function.

How does capital mobility affect the fixed versus floating exchange rate decision? One might expect that floating exchange rates are more likely to be preferred under perfect capital mobility. The argument would be that, first, welfare under fixed exchange rates does not depend on the degree of capital mobility. We have seen that (in this model) fixing exchange rates leads to complete risk-sharing, even in the absence of asset trade. Then, since one expects freer asset trade to improve welfare, one might conclude that welfare is higher under floating exchange rates with capital mobility than without. So, one might conclude that the conditions for preferring floating exchange rates under capital mobility are weaker than under no capital mobility.

We shall see that this is not true. As Betts and Devereux (2000) demonstrate, if agents can trade a complete set of nominal contingent claims, then:

$$\frac{C_t^{-r}}{P_t} = \frac{C_t^{*-r}}{S_t P_t^*}.$$

This relationship has the interpretation that the marginal value of a peso on consumption in Mexico, $\frac{C_t^{-r}}{P_t}$ equals the marginal value of a peso on consumption in the U.S., $\frac{C_t^{*-r}}{S_t P_t^*}$. The contingent contracts are written in nominal terms, so that Mexicans must still pay Mexican prices for all goods (and Americans must pay U.S. prices.) That is, the contracts do not allow agents to avoid the goods-market segmentation that leads to deviations from the law of one price.

This relationship does not insure perfect correlation of consumption in the U.S. and Mexico. Intuitively, when prices are relatively cheap in Mexico compared to the U.S., optimal contracts would have Americans transferring wealth to Mexicans (ceteris paribus.) So, consumption is relatively higher in Mexico when prices there are low.

Assuming the monetary supply functions given in equations (2.13) and (2.14), welfare in the case of perfect capital mobility is given by:

$$U = \left(\frac{l - 1}{l h} \right)^{1-r \big/ r} \left[\left(\frac{1}{1-r} - \frac{n(l-1)}{l} \right) \exp(H) - \frac{(1-n)(l-1)}{l} \exp(H^{*}) \right],$$

where

$$H = \frac{r - 1}{2r^{2}} \left\{ s_{v}^{2} + (a_{1}^{2} + 2na_{1} + nr) s_{e}^{2} + (a_{2}^{2} + 2(1-n)a_{2} + (1-n)r) s_{e^{*}}^{2} \right\},$$

and

$$H^{*} = \frac{r - 1}{2r^{2}} \left\{ s_{v^{*}}^{2} + (b_{1}^{2} + 2nb_{1} + nr) s_{e}^{2} + (b_{2}^{2} + 2(1-n)b_{2} + (1-n)r) s_{e^{*}}^{2} \right\}.$$

In general, welfare is not higher with perfect capital mobility than with no capital mobility. This is a world of the second best. Because there are existing distortions in the economy, adding new markets does not necessarily increase welfare. This economy suffers from three distortions: monopoly pricing, price-stickiness and segmented markets. It is the combination of the latter two distortions that lead to the result that welfare may be lower under perfect capital mobility. If there are no deviations from the law of one price, in this model agents would have no desire to trade assets. This is true if the law of one price holds because prices are perfectly flexible, because in that case the model reduces to the one of Cole and Obstfeld (1991) where no asset trade is needed to achieve complete risk sharing. It is also true if prices are sticky, but set in the producer’s currency. In that case, given the identical preferences, firms set the same price for Mexicans and Americans so the law of one price holds. The model then reduces to that of Obstfeld and Rogoff (1998) where again no asset trade is needed to achieve perfect risk sharing.

The monopoly distortion, per se, is not the reason why perfect capital mobility may lower welfare. As monopoly power disappears ($l \to \infty$), the difference between welfare under perfect capital mobility and under no capital mobility does not go to zero.

Suppose, for example, that Mexicans set monetary policy optimally under perfect capital mobility, and Americans do not respond at all to supply shocks ($b_1 = b_2 = 0$) in setting the money supply. Then welfare under no capital mobility is higher than welfare under perfect capital mobility precisely when equation (3.21) is satisfied.

This implies that the conditions for floating rates to be preferred to fixed rates are the same under perfect capital mobility and no capital mobility. That is, if condition (3.21) is satisfied

$$U(FIX) < U(PKM) < U(NKM)$$

where PKM refers to "perfect capital mobility" and NKM means "no capital mobility." If (3.21) is reversed, then

$$U(NKM) < U(PKM) < U(FIX).$$

Government Spending Shocks

In the analysis above, shocks emanated from monetary sources or the real supply side. Much of the traditional discussion on fixed versus flexible exchange rates is centered on the ability of each system to insulate a country from monetary shocks and real demand shocks. This section demonstrates that the analysis undertaken above is not dependent on the absence of real demand shocks.

Assume that the Mexican government imposes lump-sum taxes, and purchases goods produced in Mexico, while the U.S. government follows an analogous fiscal policy in the U.S. This description of fiscal policy is different from the typical fiscal policy in the new open-economy macroeconomics.[5] The typical assumption is that there is no bias in government spending – that government spends on domestic and foreign goods in the same ratio as consumers. So, it is usually assumed that the gross amount of government spending is set exogenously, but that government must pay market prices for goods (and has an insignificant influence on market prices) and it chooses the composition of goods purchases to maximize a period utility function identical to consumers'.

Here, government also chooses total spending exogenously and must pay market prices, which it takes as given. But, government only gets utility from goods produced in its own country. So, the utility function for the Mexican government is

$$G_M = \left[n^{-1/l} \int_0^n G_M(i)^{l-1/l} \, di \right]^{l/l-1},$$

where $G_M(i)$ is the quantity purchased of the *i*th good (per capita). Similarly, the utility function for the U.S. government is

[5] See, for example, Obstfeld and Rogoff (1995, 1996). Fiscal policy here is more like in Corsetti and Pesenti (1997).

$$G_U = \left[(1-n)^{-1/l} \int_n^1 G_U(i)^{l-1/l} \, di \right]^{l/l-1}.$$

The exogenous total amount of government spending in each country is a random variable. The mean value of government spending is tied to the level of spending by private consumers. This assumption is introduced mainly as a matter of mathematical convenience, but is similar to assumptions made in growth models to insure that government spending converges to a constant fraction of economic activity:

$$G_{Mt} = (\Gamma_t - 1)C_{Mt},$$

$$G_{Ut} = (\Gamma_t^* - 1)C_{Ut}^*.$$

Γ_t and Γ_t^* are *i.i.d.* random variables, with means Γ and Γ^* respectively. **(This version only considers transitory fiscal shocks.)**

Total spending per capita in Mexico on Mexican goods is $G_{Mt} + C_{Mt} = \Gamma_t C_{Mt}$. To keep things simple, in this section it is assumed there are no productivity shocks. The typical Mexican firm chooses $P_{Mt}(i)$ and $P_{Mt}^*(i)$ to maximize:

$$E_{t-1}\left\{ \left(\frac{bC_t^{-r} P_{t-1}}{P_t C_{t-1}^{-r}} \right) \left[P_{Mt}(i) X_{Mt}(i) + S_t P_{Mt}^*(i) X_{Mt}^*(i) - W_t \mathrm{E}_t \left(X_{Mt}(i) + X_{Mt}^*(i) \right) \right] \right\},$$

where

$$X_{Mt}(i)=\left(\frac{P_{Mt}(i)}{P_{Mt}}\right)^{-l}C_{Mt}\Gamma_t=\left(\frac{P_{Mt}(i)}{P_{Mt}}\right)^{-l}\frac{nP_tC_t\Gamma_t}{P_{Mt}}$$

$$X^*_{Mt}(i)=\frac{1-n}{n}\left(\frac{P^*_{Mt}(i)}{P^*_{Mt}}\right)^{-l}C^*_{Mt}=\left(\frac{P^*_{Mt}(i)}{P^*_{Mt}}\right)^{-l}\frac{(1-n)P^*_tC^*_t}{P^*_{Mt}}.$$

Optimal prices are given by:

$$P_{Mt}(i)=\frac{l}{l-1}\frac{E_{t-1}\left(W_t\Gamma_tC_t^{1-r}\right)}{E_{t-1}\left(C_t^{1-r}\Gamma_t\right)}$$

$$P^*_{Mt}(i)=\frac{l}{l-1}\frac{E_{t-1}\left(W_tC^*_tC_t^{-r}\right)}{E_{t-1}\left(S_tC^*_tC_t^{-r}\right)}.$$

Analogous prices set by American firms are given by:

$$P^*_{Ut}(i)=\frac{l}{l-1}\frac{E_{t-1}\left(W^*_t\Gamma^*_tC_t^{*1-r}\right)}{E_{t-1}\left(C_t^{*1-r}\Gamma^*_t\right)}$$

$$P_{Ut}(i)=\frac{l}{l-1}\frac{E_{t-1}\left(W^*_tC_tC_t^{*-r}\right)}{E_{t-1}\left(S_t^{-1}C_tC_t^{*-r}\right)}$$

The first-order conditions for consumers described in section 2 are unaffected by the lump-sum tax imposed on them.

For simplicity, assume that under floating exchange rates, money supplies in each country are simple random walks:

$$m_t^* - m_{t-1}^* = v_t^* .$$

$$m_t - m_{t-1} = v_t .$$

Under that assumption, as in previous sections, consumption in each country can be written simply as a function of real money supplies:

$$c_t = \frac{1}{r}(m_t - p_t) + \frac{1}{r}\ln\left(\frac{1-mb}{c}\right),$$

$$c_t^* = \frac{1}{r}(m_t^* - p_t^*) + \frac{1}{r}\ln\left(\frac{1-m^*b}{c}\right).$$

Since p_t and p_t^* are in the time $t-1$ information set, c_t (c_t^*) is perfectly contemporaneously correlated with m_t (m_t^*). This implies consumption in each country is uncorrelated with the shocks to government spending.

The equation for trade balance in this model is still given by (2.10). That is because no government spending in either country falls on imported goods. The total peso value of exports to America from Mexico is $(1-n)nSP^{*}C^{*}$ and the total peso value of imports is $(1-n)nPC$.

The Appendix shows how the pricing equations with fiscal shocks reduce to equations that are identical to ones without fiscal shocks (noting that eliminated productivity shocks have been eliminated for simplification.) The derivation of expected utility from consumption is unaltered from the model without fiscal shocks, so:

$$\frac{1}{1-r}E_{t-1}C_t^{1-r} = \left(\frac{1}{(1-r)}\right)\left(\frac{lh}{l-1}\right)^{\frac{r-1}{r}}\exp\left[\left(\frac{r-1}{2r^2}\right)(((r-1)^2(1-n)+r-1)s_v^2-(r-1)^2(1-n)s_{v^*}^2\right]. \qquad (3.22)$$

Welfare from consumption is unaffected by government spending.

Expected leisure is reduced by an increase in government spending. The Appendix shows:

$$E_{t-1}(L_t)=\left(\frac{l-1}{lh}\right)[E_{t-1}(C_t^{1-r})+n\Gamma]. \qquad (3.23)$$

So, the only welfare effect of government spending shocks is a reduction in leisure (an increase in work effort).

There is no effect of fiscal shocks on the welfare comparison of fixed versus floating exchange rates. Welfare under fixed exchange rates with government spending is affected in precisely the same way as under floating exchange rates: expected work effort is increased by $\left(\frac{l-1}{lh}\right)n\Gamma$. **(When**

monetary policy responds optimally to fiscal shocks under floating rates, the condition for favoring floating rates will be affected. That will be in the next revision.)

Transitory government spending shocks are met by an increase in output in the country where the government spends. There are two offsetting effects on welfare. The increase in output pushes the economy toward its efficient level of production. That increases welfare, and accords with the traditional Keynesian view of the benefits of government spending. But agents are taxed to pay for the spending (and receive no utility directly from the goods purchased by government.) Agents increase their work effort in response to the taxes. With the preferences assumed here, work effort increases exactly to offset the loss in wealth from taxes, so consumption levels are unchanged. But, since leisure declines, there is a negative effect on welfare. The welfare effect, $-\left(\frac{l-1}{l}\right)n\Gamma$ is smaller the larger the monopoly distortion, but it is always a net loss.

The traditional Friedman-style case for floating exchange rates has no merit in this model, because prices are set in consumers' currencies. The evidence presented in section 1 supports this presumption for Mexico. Friedman argues that changes in relative demand will lead to quick changes in relative prices when the nominal exchange rate changes. But under local-currency pricing, the prices consumers face are unaffected by exchange rate changes.

4. Conclusions

The very stylized models presented here are not able to produce definitive answers on the dollarization question. But they do throw some light on some old presumptions in the fixed vs. flexible exchange rate debate. There are three points worth reemphasizing:

1) When there is local-currency pricing, floating exchange rates do not play a role in speeding adjustment of relative prices in response to aggregate demand or productivity shocks. Prices that consumers face are not affected by exchange rate fluctuations in the short run. In the long run, when prices can adjust, the choice of exchange-rate regime is irrelevant.

2) If capital markets are not complete, there can be incomplete insurance against idiosyncratic monetary shocks. In one sense, fixed exchange rates might eliminate that problem, because they may eliminate idiosyncratic monetary shocks. (In the example models of this paper, exchange rates are determined purely by money suppies in the short run.) But fixed exchange rates do not eliminate risk in the same way that complete financial markets do. Fixing exchange rates also alters the nature of the underlying risk. Fixed exchange rates may increase global monetary risk by increasing the correlation of money supplies internationally.

3) A natural presumption might be that opening capital markets increases welfare. So, welfare with floating exchange rates and perfect capital mobility might be greater than welfare under floating exchange rates and no capital mobility. Since fixed exchange rates effectively complete markets, one might have further presumed that the conditions favoring floating exchange rates are stronger under perfect mobility than under no capital mobility. But the simple model presented here shows that opening capital markets may not increase overall welfare. It may magnify existing distortions – particularly distortions arising from deviations from the law of one price. In fact in the model of this paper, the condition for preferring floating to fixed rates is not affected by perfect vs. no capital mobility.

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Appendix

First, this appendix derives expressions for s_c^2, $s_{c^*}^2$, s_{ce}, s_{ce^*}, s_{c^*e}, and $s_{c^*e^*}$.

Taking longs of equation (3.4) and combining with equation (2.14):

$$c_t - c_{t-1} = \frac{1}{r} v_t + \frac{a_1}{r} e_t + \frac{a_2}{r} e_t^* - \frac{1}{r}(p_t - p_{t-1}) \qquad \text{(A.1)}$$

Recalling that prices are predetermined, it is easy to use (A.1) to derive the following conditional variances and covariances:

$$s_c^2 = \frac{1}{r^2} s_v^2 + \frac{a_1^2}{r^2} s_e^2 + \frac{a_2^2}{r^2} s_{e^*}^2$$

$$s_{ce} = \frac{a_1}{r} s_e^2$$

$$s_{ce^*} = \frac{a_2}{r} s_{e^*}^2$$

Likewise, for the U.S. variables:

$$s_{c^*}^2 = \frac{1}{r^2} s_{v^*}^2 + \frac{b_1^2}{r^2} s_e^2 + \frac{b_2^2}{r^2} s_{e^*}^2$$

$$s_{c^*e} = \frac{b_1}{r} s_e^2$$

$$s_{c^*e^*} = \frac{b_2}{r} s_{e^*}^2$$

Fixed Exchange Rates

Using the log-normality assumption and exploiting equations (3.5) and (3.6), we have:

$$\begin{aligned} E_{t-1}(c_t) = {} & \frac{1}{r}\ln\left(\frac{l-1}{lh}\right) + \left(\frac{r-2}{2r^2}\right)s_{v^*}^2 + \left(\frac{(r-2)b_1^2 - nr - 2nb_1}{2r^2}\right)s_e^2 \\ & + \left(\frac{(r-2)b_2^2 - (1-n)r - 2(1-n)b_2}{2r^2}\right)s_{e^*}^2 \end{aligned} \qquad \text{(A.2)}$$

We can use the fact that

$$\frac{1}{1-r}E_{t-1}C_t^{1-r} = \frac{1}{1-r}\exp\left((1-r)E_{t-1}(c_t) + \frac{(1-r)^2}{2}s_c^2\right), \qquad \text{(A.3)}$$

and equations (3.5) and (A.2) to derive:

$$\frac{1}{1-r}E_{t-1}(C_t^{1-r}) = \frac{1}{1-r}\left(\frac{lh}{l-1}\right)^{\frac{r-1}{r}} \exp\left(\Omega_t^{FIX}\right) \qquad \text{(A.4)}$$

where

$$\Omega_t^{FIX} \equiv \exp\left[\left(\frac{r-1}{2r^2}\right)\left(s_{v^*}^2 + (b_1^2 + nr + 2nb_1)s_e^2 + (b_2^2 + (1-n)r - 2(1-n)b_2)s_{e^*}^2\right)\right].$$

Taking expectations of equation (2.11),

$$E_{t-1}(L_t) = n\frac{P_t E_{t-1}(C_t \mathrm{E}_t)}{P_{Mt}} + (1-n)\frac{P_t^* E_{t-1}(C_t^* \mathrm{E}_t)}{P_{Mt}^*}.$$

But using equation (2.6),

$$E_{t-1}(L_t) = \left(\frac{l-1}{lh}\right)E_{t-1}(C_t^{1-r}). \qquad \text{(A.5)}$$

In evaluating welfare, the direct effects of real balances on welfare are ignored as is typical in this literature (see, for example, Obstfeld and Rogoff (1995).) That is, it is assumed that c is very small. Given the stationarity of the equilibrium, utility is proportional to (from equations (A.4) and (A.5)):

$$\frac{1}{1-r}E_{t-1}(C_t^{1-r}) - hE_{t-1}(L_t) = \left(\frac{1+r(l-1)}{l(1-r)}\right)\left(\frac{lh}{l-1}\right)^{\frac{r-1}{r}}\exp\left(\Omega_t^{FIX}\right). \qquad \text{(A.6)}$$

When U.S. monetary policy is set optimally, the expression for utility simplifies to:

$$\left(\frac{1+r(l-1)}{l(1-r)}\right)\left(\frac{lh}{l-1}\right)^{\frac{r-1}{r}}\exp\left[\left(\frac{r-1}{2r^2}\right)\left(s_{v^*}^2 + n(r-n)s_e^2 + (1-n)(r-(1-n))s_{e^*}^2\right)\right] \qquad \text{(A.7)}$$

If monetary policy does not respond at all to supply shocks, so $b_1 = b_2 = 0$, utility is given by:

$$\left(\frac{1+r(l-1)}{l(1-r)}\right)\left(\frac{lh}{l-1}\right)^{\frac{r-1}{r}} \exp\left[\left(\frac{r-1}{2r^2}\right)(s_{v^*}^2 + nrs_e^2 + (1-n)rs_{e^*}^2)\right]. \qquad \text{(A.8)}$$

Floating Exchange Rates

Using the fact that all variables are log-normally distributed, with a fair amount of tedious algebra in the case of purely transitory productivity shocks, equations (3.18) and (3.19) can be solved:

$$\begin{aligned} E_{t-1}c_t = \frac{1}{r}\ln\left(\frac{l-1}{lh}\right) - \left(\frac{1+n(1-r)}{2}\right)s_c^2 - \left(\frac{(1-n)(1-r)}{2}\right)s_{c^*}^2 - \frac{n}{2r}s_e^2 - \frac{(1-n)}{2r}s_{e^*}^2 \\ + \left(\frac{n((1-n)(1-r)-1)}{r}\right)s_{ce} + \left(\frac{(1-n)((1-n)(1-r)-1)}{r}\right)s_{ce^*} \\ - \left(\frac{n(1-n)(1-r)}{r}\right)s_{c^*e} - \left(\frac{(1-n)^2(1-r)}{r}\right)s_{c^*e^*} \end{aligned} \qquad \text{(A.9)}$$

Using the values of these variances and covariances as solved from the Appendix, and using equations (A.3) and (A.9):

$$\frac{1}{1-r}E_{t-1}C_t^{1-r} = \frac{1}{1-r}\left(\frac{lh}{l-1}\right)^{\frac{r-1}{r}} \exp\left(\Omega_t^{FLEX}\right),$$

where

$$\Omega_t^{FLEX} = \frac{(r-1)^2(1-n)+r-1}{2r^2} s_v^2 - \frac{(r-1)^2(1-n)}{2r^2} s_{v^*}^2$$
$$+\left[\frac{(a_1^2+2a_1 n)((r-1)^2(1-n)+r-1)}{2r^2} - \frac{(b_1^2+2b_1 n)(r-1)^2(1-n)}{2r^2} + \frac{nr(r-1)}{2r^2}\right] s_e^2$$
$$+\left[\frac{(a_2^2+2a_2(1-n))((r-1)^2(1-n)+r-1)}{2r^2} - \frac{(b_2^2+2b_2(1-n))(r-1)^2(1-n)}{2r^2} + \frac{(1-n)r(r-1)}{2r^2}\right] s_{e^*}^2$$

Equation (A.5) holds in the flexible-exchange rate solution of this model also, so we can express welfare as:

$$\frac{1}{1-r} E_{t-1}(C_t^{1-r}) - hE_{t-1}(L_t) = \left(\frac{1+r(l-1)}{l(1-r)}\right)\left(\frac{lh}{l-1}\right)^{\frac{r-1}{r}} \exp\left(\Omega_t^{FLEX}\right) \qquad \text{(A.10)}$$

If policy is set optimally in both countries, $a_1 = b_1 = -n$ and $a_2 = b_2 = -(1-n)$, and utility is given by:

$$\left(\frac{1+r(l-1)}{l(1-r)}\right)\left(\frac{lh}{l-1}\right)^{\frac{r-1}{r}} \times$$
$$\exp\left[\left(\frac{r-1}{2r^2}\right)(((r-1)(1-n)+1)s_v^2 - (r-1)(1-n)s_{v^*}^2 + n(r-n)s_e^2 + (1-n)(r-(1-n))s_{e^*}^2)\right] \qquad \text{(A.11)}$$

If policy does not react at all to supply shocks, utility is given by:

$$\left(\frac{1+r(l-1)}{l(1-r)}\right)\left(\frac{lh}{l-1}\right)^{\frac{r-1}{r}}\times$$
$$\exp\left[\left(\frac{r-1}{2r^2}\right)\left(((r-1)(1-n)+1)s_v^2-(r-1)(1-n)s_{v^*}^2+nrs_e^2+(1-n)rs_{e^*}^2\right)\right] \quad \text{(A.12)}$$

Fiscal Shocks

Using the trade balance relationship, the leisure-consumption tradeoff and the money demand equations, prices for each good can be written as:

$$P_{Mt}(i)=\frac{lh}{l-1}P_t\frac{E_{t-1}(C_t)}{E_{t-1}\left(C_t^{1-r}\right)}.$$

$$P_{Mt}^*(i)=\frac{lh}{l-1}P_t^*\frac{E_{t-1}\left(C_t^*\right)}{E_{t-1}\left(C_t^{1-r}\right)}.$$

$$P_{Ut}^*(i)=\frac{lh}{l-1}P_t^*\frac{E_{t-1}\left(C_t^*\right)}{E_{t-1}\left(C_t^{*1-r}\right)}.$$

$$P_{Ut}(i)=\frac{l}{l-1}P_t\frac{E_{t-1}(C_t)}{E_{t-1}\left(C_t^{*1-r}\right)}.$$

Following steps similar to those above derives the expression for expected utility from consumption in the text, equation (3.22).

Since $Y_t = L_t$, expected leisure is given by:

$$E_{t-1}(L_t) = n\frac{P_t E_{t-1}(C_t \Gamma_t)}{P_{Mt}} + (1-n)\frac{P_t^* E_{t-1}(C_t^*)}{P_{Mt}^*}.$$

Using the equations for equilibrium prices, and using the independence of government spending shocks and the levels of consumption, equation (3.23) can be derived.

Figure 1

Variance Decomposition of Mexican-U.S. Real Exchange Rate Changes (September 1991 - August 1999)

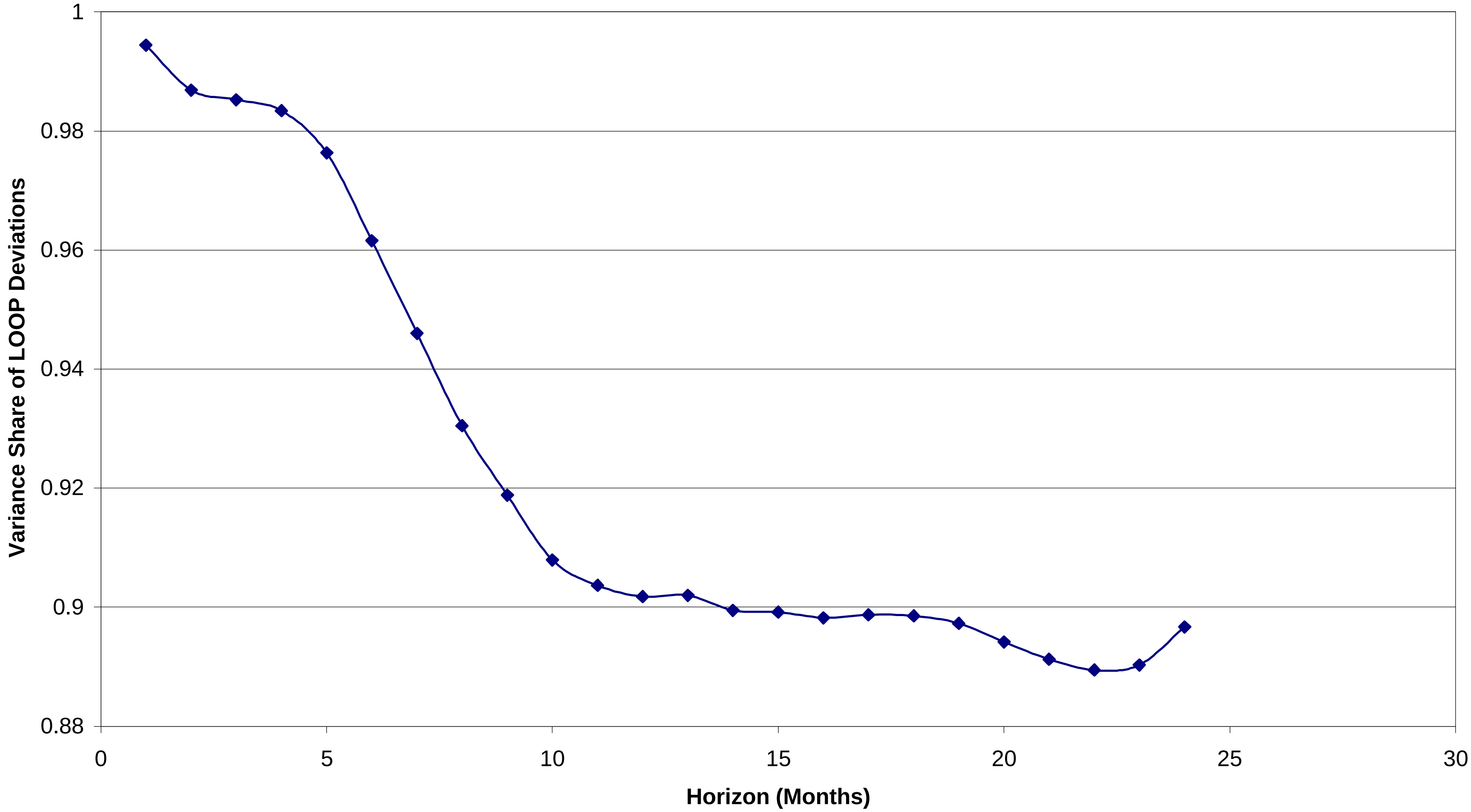

Figure 2
Variance Decomposition Allowing for Marketing Effect

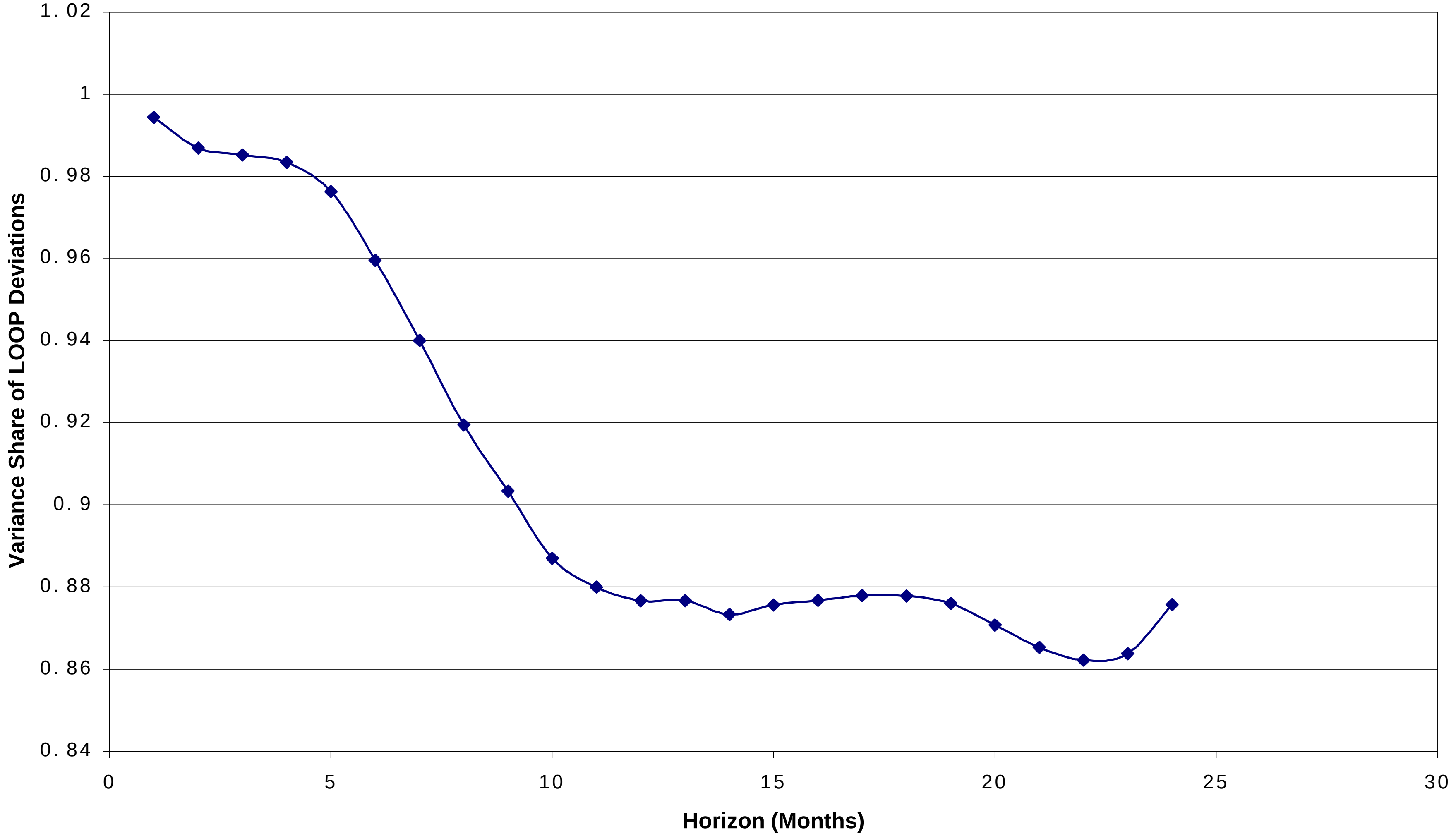

Figure 3
Implied Squared Correlation Coefficients

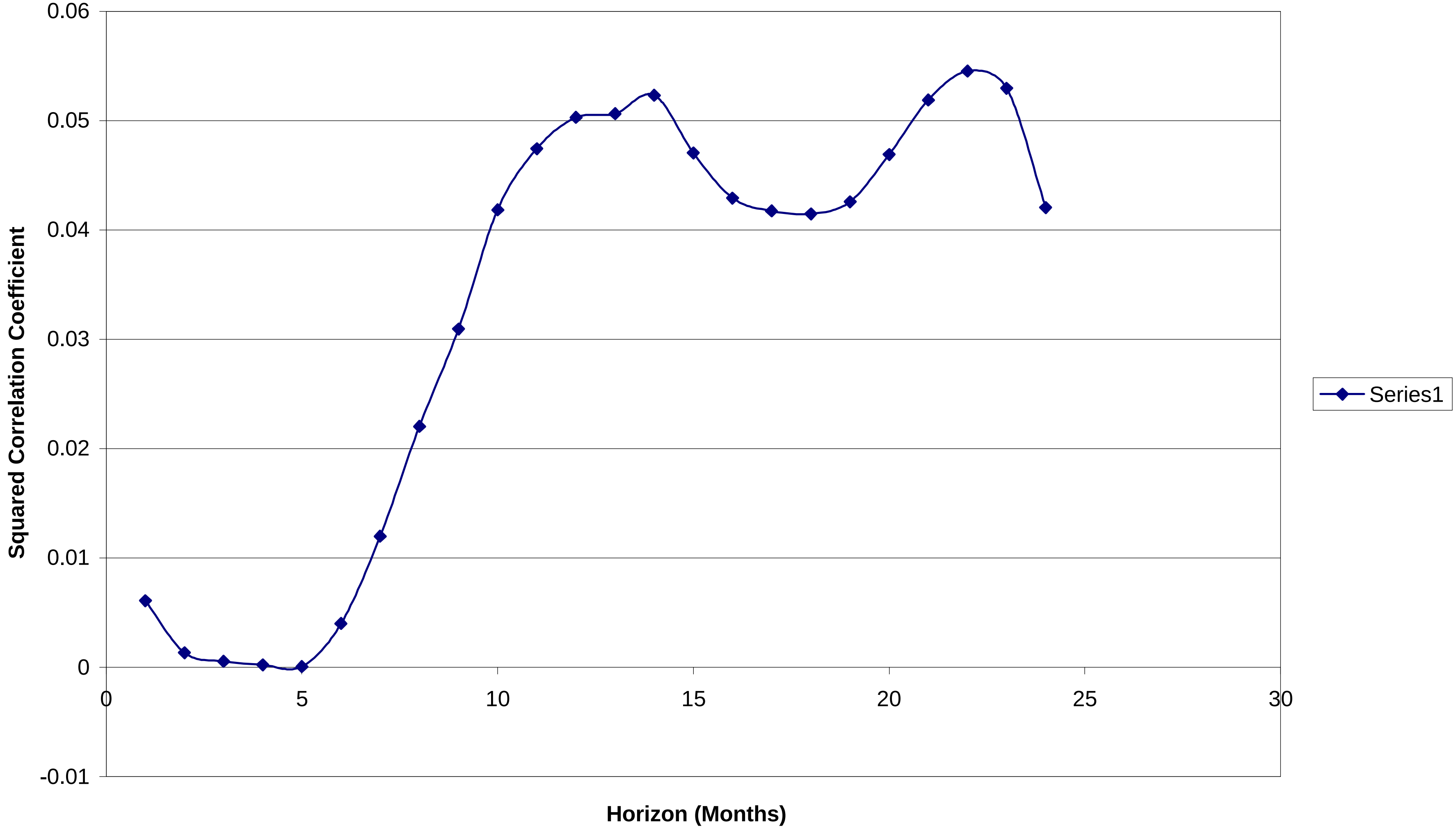

Figure 4
Variance Shares of Tradable Goods

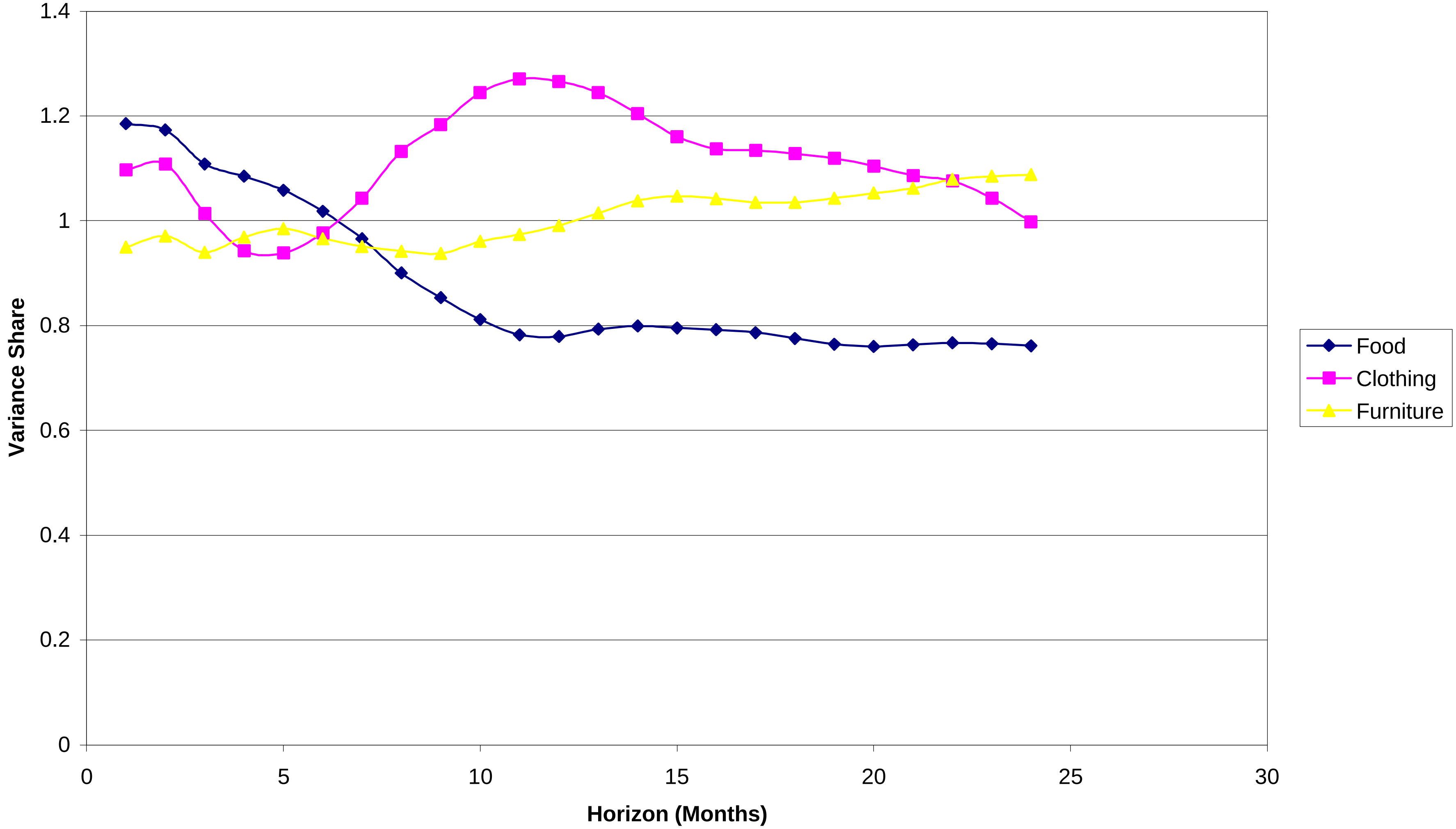

Figure 5
Correlation of Nominal Peso/Dollar Exchange Rate and Relative Traded Goods Prices