NOTES

*The Real Exchange Rate of the Mexican Peso, 1762-1812: A Research Note and Estimates**

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Several years ago, I argued that international trade caused the demise of Mexico's obrajes in the eighteenth century [Richard Salvucci 1987: 135-169. The Mexican translation is Richard Salvucci 1992: 203-250]. I based this conclusion on three considerations. First, the capitalization of the woollen industry, as measured by the number of operating obrajes, fell during the eighteenth century. Second, economic theory emphasizes the substitution effect in the law of demand. Abundant anecdotal evidence identified British cottons as substitutes for Mexican woollens in the later eighteenth century. Third, an ordinary least squares regression that linked Mexican woollen production to Mexican silver and shipments of British cottons to the Caribbean produced a reasonably complete model. As silver production rose, more British cottons were shipped to Jamaica, there was widespread smuggling, and Mexican woollen output fell. In short, a model based on the substitution effect was consistent with historical experience. [See Richard Salvucci 1987: 221-222 for the relevant regressions]

This model seems correct. But I have recently identified another trade-related variable that perhaps played an even more important role in the demise of the obrajes: the real exchange rate of the Mexican peso. Here I wish to examine the real exchange rate of the peso, and to measure its contribution to the demise of the woollen industry in the eighteenth century.

Indeed, I here contend that the Mexican peso was significantly overvalued in the later eighteenth century, and that overvaluation contributed to the decline of the Mexican woollen industry. In the future, I will explore the question for the early nineteenth century as well. Historians have assumed that Mexican capital flight in the 1820s was the result of political instability. Economists

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suggest that capital flight is generally evidence of overvaluation [Maddison 1991: 35]. Overvaluation may explain the balance of payments problems that Mexico experienced in the 1820s, and consequently, the macroeconomic stagnation that ensued.

The economic intuition behind the relationship between the exchange rate and the collapse of woollen production in Mexico is as follows. At a constant price, the purchasing power of silver varied inversely with an index of import prices. Of course, the price of silver fluctuated in response to supply and demand. So the purchasing power of silver reflected both its own price and the price of imports. That is, an index of the purchasing power of silver consists of an index of the price of silver divided by an index of the price of imports. In other words,

$$\pi_{\text{TOT SILVER}} = (\pi_{\text{SILVER}} / \pi_{\text{IMPORTS}})$$

where Π is an index of the net barter terms of trade (TOT), i.e., the price of silver in terms of imports, and the πs are price indices of silver and imports. The idea is quite simple. The terms of trade at which silver exchanges are important.

Yet things are a bit more complicated than this. Silver could purchase imports or home products. In other words, when Mexican silver purchased imports, the buyer implicitly made a dual calculation. Assuming the substitutability of home and foreign goods, the buyer's decision depended on their relative prices. Was the purchasing power of silver greater at home or abroad? What was cheaper: a domestic good, or an import?

According to the law of one price, identical goods exchanged within a market must trade at the same (equilibrium) price, assuming no cost of transportation. This implies that internationally traded goods must have the same price everywhere (making allowances for non-zero costs of transportation, search, barriers to trade, and so forth), or the law of one price is violated. In other words, an exchange rate is said to be at «parity» if it equalizes the price of tradable goods in the international market. If the exchange rate diverges from parity, so too will the prices of tradable goods, at least over the period in which arbitrage occurs. If a currency is «overvalued», it purchases more abroad than at home. If "undervalued", it purchases less abroad than at home. If the Mexican peso is overvalued, imports look cheap to Mexican demanders, and foreign price levels seem low. By the same token, Mexican exports will look expensive to foreign demanders, and the Mexican price level will seem high.

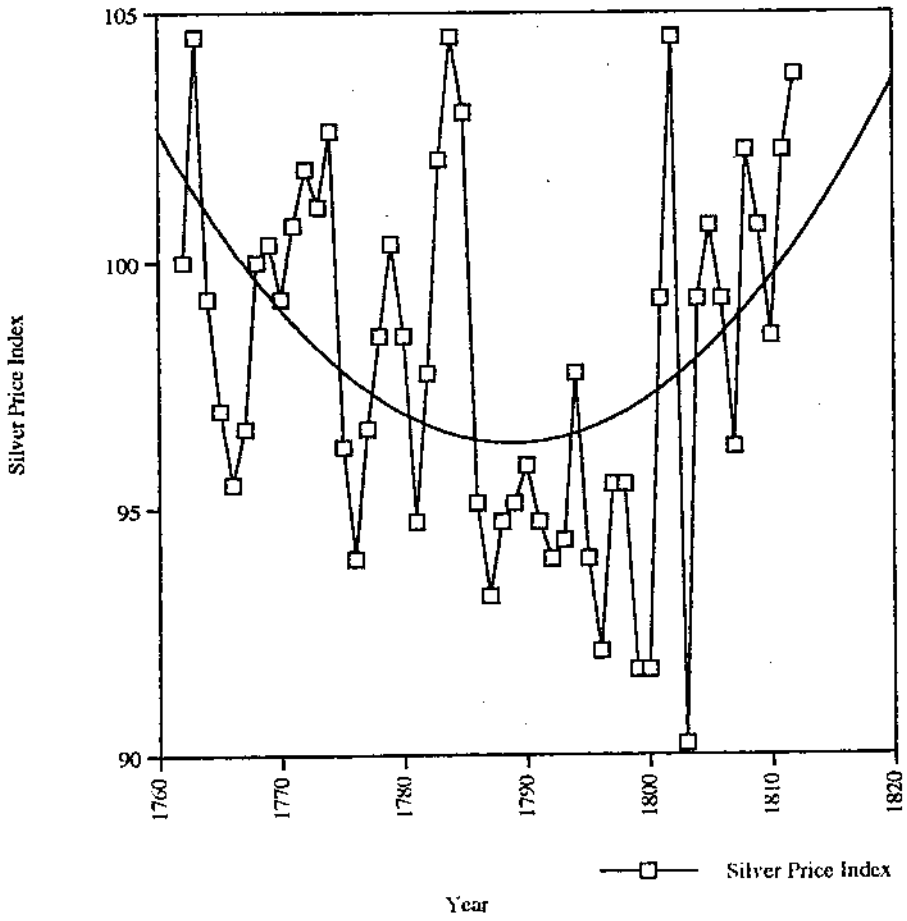
How do we measure the real exchange rate of the Mexican peso?

Consider first the nominal exchange rate of the peso. Under a specie standard, the value of a currency is defined by its weight in precious metal. The Mexican peso was defined by its weight in silver, which changed from time to time during the colonial period. In the eighteenth century, after the devaluation of 1728, the Mexican peso was defined as 24.82 grams of silver. After 1777, its silver content was reduced once more to 24.44 grams. [Torres Gaytán 1981:

30-31]. [1] The value of silver on the international market varied according to supply and demand, and these variations affected the exchange rate of silver. For our purposes, we may define the London price of standard silver in pounds sterling as an estimator of the peso-sterling exchange rate. [2] Between 1762 and 1801, this price was remarkably stable. Figure One provides visual confirmation. There was a downward trend in silver prices between 1762 and 1802, but it was a mild decline in trend values of no more than 6.9 percent (i.e., from 102 to 095) according to an ordinary least squares line fitted to the index numbers displayed here. [3] Prices increased once more after 1802 (the nonlinear trend line fitted to the index numbers in Figure One merely illustrates the

FIGURE ONE

Index of London Price of Standard Silver, 1762-1812



change) and largely reversed the tendency of the preceding decades by 1812. Since the Mexican output of silver grew by 53 percent between 1761-1780 and 1781-1800, the stability of international silver prices implies a considerable increase in demand. (INEGI 1985: 2, 437)

But what of the real purchasing power of the peso? A peso could purchase foreign goods, British for example, or home goods. The real purchasing power of the peso must be measured in terms of both home and foreign goods. If the purchasing power of silver abroad rose more rapidly than its purchasing power in Mexico, the result was a real appreciation of the peso - it bought more abroad than at home. If the purchasing power of the peso rises more at home than abroad, the result is a real depreciation. This, in effect, is what variations in the real exchange rate measure.

To estimate changes in the real purchasing power of the peso in trade, then, we require three indices: an index of silver prices; an index of Mexican prices; and an index of foreign prices. For the later eighteenth century, we employ Great Britain as a proxy for Mexico's «foreign» trade partner, a plausible simplification in view of the growing share of British cottons in Mexico's foreign trade. Silver prices are easily found. A price index for Mexico exists as well. The period we select is 1762 through 1812, roughly the period from the Seven Years' War to the Insurgency. To measure the real exchange rate of the peso, we must compute the following index

$$\hat{\Pi} = (\pi_{\text{silver in £}}) * (\pi_{\text{Mexico}}/\pi_{\text{Great Britain}})$$

where $\hat{\Pi}$ is an estimator of the real exchange rate, and the πs are the relevant price indices. [4] To see how the index functions, consider the following example. Suppose the nominal exchange rate (i.e. the price of (Mexican) silver in pounds sterling) remains unchanged at its base period value (i.e., 100) over a given period of time. Suppose further that Mexican prices rise relative to British prices. The resulting index number will rise above 100, i.e., the ratio of Mexican to British prices will exceed unity, which is then multiplied by 100. Thus a number over 100 indicates that the purchasing power of the peso is greater

[1] In the United States in the early nineteenth century, Mexican «dollars» were all approximately worth one dollar, i.e., in 1830, the «old square Mexican dollar» at 101.306 cents; «Mexican dollar with globes (1746)» at 101.656 cents; and «Dollar, late coinage» at 99.905 cents. See United States 1830: 135.

[2] The actual rate could vary somewhat given the costs of obtaining and transporting silver, i.e., within limits set by the specie import and export points. For simplicity's sake, we ignore this complication.

[3] The fitted trend line has the equation
Silver Index = $-.161$Year + 385.539 ($r^2=.29$)

[4] The formula is a variant of the identity given by Krugman and Obstfeld 1991: 381.

abroad than at home, i.e., overvaluation. Conversely, a number under 100 indicates that the purchasing power of the peso is greater at home than abroad, i.e., undervaluation. An index of 100 may be interpreted as parity.[5]

The next step is to find data that can be used to perform the relevant computations. For the price of silver in pounds sterling, I utilize Report from the Secretary of the Treasury Respecting the Relative Value of Gold and Silver (1830), United States, 21st Congress, 1st session, Table EE, giving the London market price of standard silver, i.e., 92.5 percent fine. The Mexican price level is more difficult. Historians have generally used an index of maize prices as a proxy, if only because nothing else is available. I follow established practice, and use Richard Garner's maize price index, shifting the base period to 1762-1772 [Garner 1990, 78-81]. Using this index creates what is effectively a volatile index of wage goods, and almost surely overestimates both the level and variation of a true cost-of-living index. Yet we have no other alternative open to us. The foreign price index is a British cost-of-living index, the Phelps Brown-Hopkins index, again with the base shifted to 1762-1772 [McCusker 1992: 342-344]. The choice of Britain as Mexico's «foreign» index component simply reflects the increasing importance that Britain was acquiring in Mexico's external trade. Its percentage share probably peaked in the 1820s and 1830s. Figure Two displays the results graphically, and Table one supplies the numbers. For the sake of simplicity, I also display the results by decades in Table Two using a median average value with 1762-69 representing parity.
The results of the exercise are quite revealing. If we recall that index numbers above 100 represent overvaluation, and those below 100 undervaluation, our calculations suggest that between 1762 and 1813, the peso was overvalued for a total of 29 years, or for nearly 60 percent of the period. [In Figure Two, points over the solid line drawn at 100 represent overvaluation. Points below the line represent undervaluation. The solid line at 100 represents parity]. If we take the 1760s as parity (i.e., the base period) in the 1770s, the real exchange rate appreciated by an estimated 50 percent. In the 1780s, it rose still more. It was only in the 1790s and after that the peso returned to levels closer to parity. Small wonder that British goods proved increasingly attractive to Mexican consumers, or that contraband in the Caribbean grew to epidemic proportions. Mexican industries that competed directly with imports became less competitive as the real exchange rate of the peso rose.

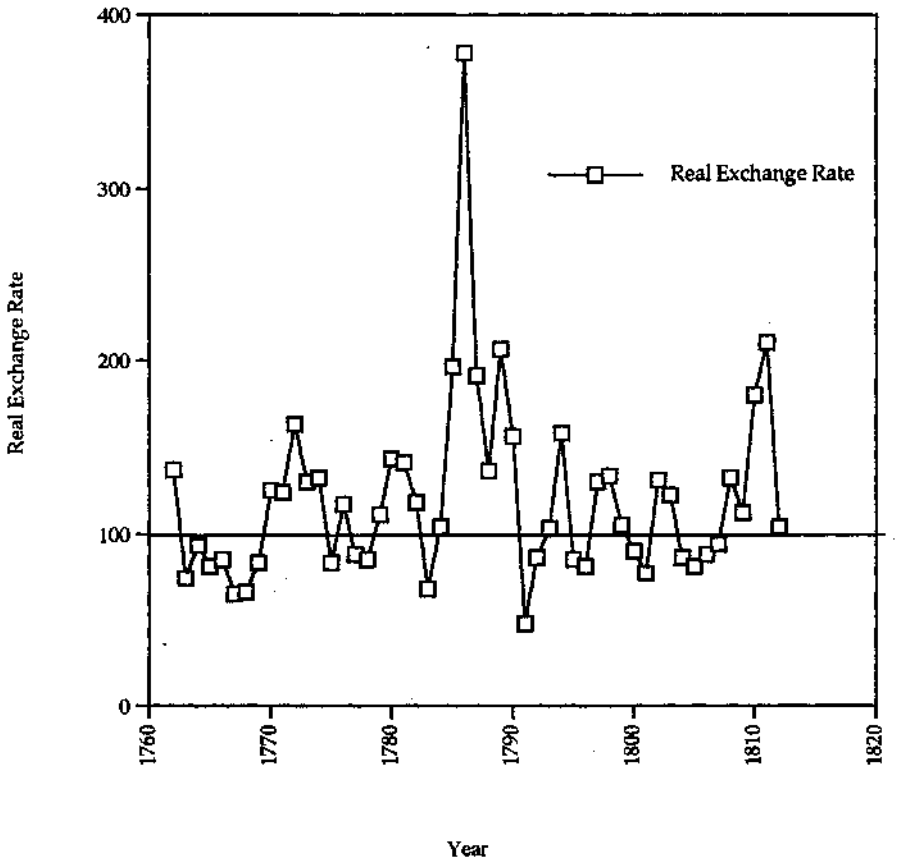
[5] Define the purchasing power parity exchange rate as the ratio of home to foreign price levels. At parity, the foreign price of the home currency must be the inverse of the exchange rate. See Krugman and Obstfeld 1991: 381. Obviously, we assume parity in the base period, and meagure deviations from it. The level of the calculations is therefore less important than their trend. Strictly speaking, the evidence suggests a substantial appreciation of the real exchange rate of the peso.

TABLE ONE

Year	(A) Mexico Prices	(B) UK Prices	(C) Silver Index	[(A)/(B)](C) Real Exchange
1762	118	86	100	137
1763	62	89	105	74
1764	90	97	100	93
1765	84	100	97	81
1766	90	101	96	85
1767	72	107	97	65
1768	70	106	100	66
1769	80	97	101	83
1770	121	97	100	125
1771	129	105	101	124
1772	185	116	102	163
1773	148	116	102	130
1774	150	117	103	132
1775	94	110	97	83
1776	134	108	94	117
1777	97	107	97	88
1778	96	112	99	85
1779	112	102	101	111
1780	142	99	99	143
1781	152	103	95	141
1782	126	105	98	118
1783	78	118	103	68
1784	117	118	105	104
1785	215	114	103	196
1786	450	114	96	378
1787	230	113	94	191
1788	168	117	95	136
1789	250	116	96	206
1790	191	118	96	156
1791	59	118	95	48
1792	109	120	94	86
1793	134	123	95	103
1794	213	132	98	158
1795	133	148	94	85
1796	137	157	93	81
1797	192	141	96	130
1798	192	138	96	133
1799	178	155	92	105
1800	207	212	92	90
1801	183	237	100	77
1802	228	182	105	131
1803	231	172	91	122
1804	153	177	100	86
1805	165	206	101	81
1806	175	197	100	88
1807	187	193	97	94
1808	257	200	103	132
1809	242	219	101	112
1810	410	226	99	180
1811	450	220	103	210
1812	247	249	104	104
1813	322	255	98	124

FIGURE TWO

Estimated Real Exchange Rate of the Peso, 1762-1813



Since no one has ever suggested that the Mexican peso was overvalued in the late eighteenth century, we may ask if something other than our calculations supports the hypothesis. There are a few tantalizing clues. In the late eighteenth century, the complaints of royal officials who came out to Mexico, and were shocked by the cost of living there are well established [Linda K. Salvucci 1983: 250; and Arnold 1988: 101-102]. Equally suggestive is Guy Thomson's discussion [Thomson 1989: 221] of the «peculiarities» of Mexico's economy in the early nineteenth century. Thomson cites an anonymous Mexican essayist of 1836 who argued that the Mexican price level was three times higher than the

price level of other, non-mining nations. In other words, silver mining itself inflated the Mexican price level.

Perhaps the most striking test we can offer incorporates the real exchange rate itself. Thomson [1986: 184] calculated entries of Puebla cloth to Mexico City customs between 1785 and 1812. If a rise in the real exchange rate tended to depress domestic production by inducing a greater substitution of foreign (i.e., British) goods, variations in the real exchange rate should explain variations in the delivery, and hence production, of domestic cloth in Mexico's largest market. To test this hypothesis, I regressed the logarithm of the estimated real exchange rate against the logarithm of deliveries of domestic cloth made in Puebla to Mexico City customs between 1785 and 1812 (lagged one year, to allow for delayed adjustments to changes in the real exchange rate). I included an independent dummy variable to account for the many war-induced interruptions of international trade that occurred during the period. The results are intriguing:

$$\text{LN (PUEBLA CLOTH}_{(t+1)}) = 6373.93 - 6.07\ \text{LN (REAL EXCHANGE RATE}^{*}_{(t)}) + 908.34\ \text{WAR}^{*}_{(t+1)}$$

$$(-2.16) \qquad (2.36)$$

$\bar{R}^2 = .37$	* coefficient significant at 90 percent level
$F = 6.94$	t-statistics in parentheses
SEE = 848.87	N = 21

The independent variables are both significant at the 90 percent level, and both have the expected sign. As the real exchange rate rises, deliveries of Puebla cloth to Mexico City fall; when warfare intervenes and trade with Europe is disturbed, the proxy for Puebla production rises. Variations in the real exchange rate and the existence of a state of war account for 37 percent of the variation in the deliveries of Puebla cloth to Mexico City after adjusting for degrees of freedom. The probability-value of the F-ratio (prob>.006) indicates both variables explain the behaviour of domestic cloth deliveries.

It is now clear why the Mexican economy was quite prone to international shocks in the late colonial period. A strong demand for silver driven by the expanding international economy maintained the world price of silver, increasing Mexican production notwithstanding. The nominal exchange rate was thus sustained. The high costs associated with silver mining inevitably drove up the real exchange rate of the peso. Moreover, the ability of the Mexican economy to generate large amounts of foreign exchange by exporting silver led to overvaluation as well, since the supply of foreign exchange could grow much

more rapidly than demand. In the late eighteenth century, these forces were fully operative, and eroded the competitivenes of domestic Mexican industry. A cresting wave of imports thus ensued, producing widepread complaints about smuggling and foreign competition. [6]

If the peso remained overvalued after independence, we may have a better explanation for the dimensions of Mexican capital flight in the 1820s. The seeming inability of across-the-board tariffs and prohibitions to stem the flow of imports in the 1820s and 1830s also makes more sense. Such actions raise domestic costs, and could contribute to further appreciation of the exchange rate. Hence the apparently self-defeating nature of Mexican commercial policy in the 1820s. All these questions will require far more detailed explanation if the economic crisis that attended Latin American independence is to be properly understood. But for now, the hypothesis that the Mexican peso was seriously overvalued in the late eighteenth century warrants consideration.

TABLE TWO

ESTIMATED REAL EXCHANGE RATE OF THE PESO, BY DECADES. MEDIAN AVERAGE VALUES

1762-69	100
1770-79	148
1780-89	174
1790-99	127
1800-09	112

[6] There is another way of viewing the situation. The Mexican production of silver grew faster than the domestic production of other goods and services. Therefore the Mexican price level tended to rise. But the international price of silver - the nominal exchange rate - was constant. With a constant rate of exchange and increasing domestic inflation, the peso became overvalued. Mexican competitiveness therefore declined. I am grateful to Jorge González for this observation.

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