The Effects of a Depreciation of the Peso on Cross Border Retail Sales in San Diego and Imperial Counties

June 8, 1999

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ABSTRACT: Changes in taxable sales in San Diego and Imperial counties are correlated with fluctuations in the value of the peso. An empirical model is used to specify and estimate the relationship between fluctuations in the value of the peso and total taxable sales. Regression results show that an unanticipated ten percent decline in the value of the peso depresses total taxable sales by approximately one percent in San Diego county and 2.22 percent in Imperial county. During periods of high peso volatility, expectations of future depreciations can offset much of this effect, however, and lead to increased purchases. The paper also shows that the effects of the peso depreciation vary by retail sector and region. The largest relative effects are in the auto and automotive products sector in San Diego and the apparel sector in Imperial county.

1. Introduction

On July 21, 1998, the Mexican peso was valued at 8.8 to the dollar. By September 10, its value had fallen to 10.63 to the dollar. Pressure on the peso was part of a larger set of international financial problems set in motion by the Asian financial crisis that began in July, 1997. Currency depreciations hit many newly industrializing nations as international investors sold off large parts of their emerging market portfolios in order to reduce their exposure to financial market volatility. One side effect of the depreciations was that many countries, including Mexico, came under much closer international scrutiny of their national financial systems and their regulatory oversight.

It is not surprising that in the wake of the depreciation of the peso and other emerging market currencies, the focus of attention was on the national and international implications of volatility in currency and financial markets. Exchange rate crises have macroeconomic implications that literally span the globe. Contagion from the Asian crisis threatened to halt economic growth in Latin America and raise the level of dissatisfaction with the market reforms of the 1980s and 1990s. In Russia, the economy began to collapse during the summer of 1998, leading to a growth in poverty and widespread disillusionment with the transition process. In the U.S. and Europe, fears of recession increased through the summer and fall of 1998 as export markets disappeared and trade deficits ballooned. The threats were serious enough for the IMF to try to prevent a crisis in Brazil through a pre-emptive loan package and for the G-7 to call for a reorganization of the "architecture" of the international financial system.

As with previous threats to the global economy, the enormity of the potential national and international problems led analysts to ignore the secondary and tertiary effects of the crisis which tend to be local in nature. By definition, local effects are less severe than national and international macroeconomic effects. Hence, in general, they tend to be less noted and less studied. Nevertheless, along the U.S.-Mexico border zone where different national currencies are widely circulated and where U.S. and Mexican citizens mix together in business, social, and family circles, local effects of a currency crisis can be deeply felt. One of the more noticeable local effects in the counties and cities along the U.S.-Mexico border is the impact of the peso's depreciation on cross border purchases by Mexican citizens. Depending on locale, cross border purchases range from important to absolutely essential (San Diego Chamber of Commerce, 1979; Patrick and Renforth, 1996; Prock, 1983; San Diego Dialogue, 1994; San Diego Dialogue, et. al., 1998). Clark (1994) hypothesized that these effects are inversely related to the distance to the border and the relative size of the U.S. border city. Patrick and Renforth (1996) empirically confirmed these patterns for a sample of four Texas border cities.

The focus of this analysis is not on the size of the cross border market, but rather on the effects of a decline in the value of the peso. The analysis is confined to San Diego and Imperial counties, the two largest cross border markets in the California-Baja California border zone. The characteristics of these two cross-border shopping districts are very distinct. San Diego is the largest city on the U.S.-Mexican border, a fact which dilutes the relative significance of cross-border shopping by comparison to Imperial county or other metropolitan areas along the border. Nevertheless, as will be shown, cross border shopping in San Diego county by residents of Mexico is significant in absolute

terms and a sizable depreciation of the peso, such as the one experienced during the fall of 1998, can be expected to have an effect on taxable sales which is sizable in dollar terms. By comparison, the impact of the depreciation on taxable sales in Imperial county is large, both as a share of overall taxable sales and in absolute dollar amounts. The larger relative effect in Imperial county is due to the fact that the county is small (about one-twentieth the size of San Diego) and its twin city, Mexicali, is relatively large.

The next section reviews some previous estimates of the amount of cross border shopping in the San Diego and Imperial regions. This is followed by a review of the impact of previous episodes in which the peso lost a significant amount of its value, in particular during 1982 and 1983. The literature review and discussion of previous studies is followed in section three by the development of a demand equation for total taxable sales. The equation is then used to estimate the impact of a decline in the value of the peso on total taxable sales, total retail sales, and several sub-components of retail sales. Estimation of the impact is complicated by the fact that a change in the value of the peso will also change expectations about its future value which, in turn, alters consumption behavior. In the development of the equation, I argue that changes in expectations may partially or even totally offset the effects of actual changes in the peso's present value. Model estimation confirms this view and makes it necessary to control for expectations when estimating the impacts of a depreciation in the peso. The estimated impacts are both statistically significant and economically important.

2. Size and relative importance of the cross border shopping market

Two recent surveys (San Diego Dialogue, 1994; and San Diego Dialogue, et. al., 1998) show that a significant amount of northbound border crossing in both San Diego

and Imperial counties is motivated by the desire to make purchases in the United States. The Dialogue's 1992 survey of border crossers in San Diego estimated that there were five to six million northbound crossing per month, with one crossing defined as one person, on foot or in a vehicle so that two people in a car were defined as two crossings. They estimated that the total number of crossings represented about 521,000 unique individuals. A follow-up survey in Imperial county in 1998 estimated that there were 2.9 million northbound crossers in March of 1998, representing 700,000 individuals.

In both cases, shopping was the single most important reason for crossing the border. The San Diego study estimated that 1.4 million northbound crossings (per month) were for the primary purpose of shopping, and about one million of those trips were solely for the purpose of shopping. In the Imperial county survey, 34 percent of the border crossers interviewed gave shopping as their primary reason for crossing. Implicitly, this means that there around 986,000 crossings per month for the primary purpose of shopping.

While crossings in San Diego county are more numerous, they are less important in relative terms. This follows from the fact that the 1.4 million crossings per month were equal to a little more than half (53 percent) of the county population, whereas in Imperial county the monthly crossings of 986,000 are equal to nearly seven times the size of the population (California Department of Finance, 1998a, 1998b). From this it follows that a change in the value of the peso is likely to have a larger relative impact in Imperial county than it has in San Diego county.

Total annual expenditures in the United States by these two groups are uncertain, although there are a few estimates. The 1992 Dialogue survey of the San Diego area

border estimated annual expenditures by northbound border crossers at around $2.8 billion dollars, not all of which was captured by San Diego since some border crossers had Los Angeles and other cities as their final U.S. destination. Of the $2.8 billion, an estimated $1.5 billion per year was spent in San Diego county on items that are subject to sales taxes. In Imperial county, an estimated $70 million was spent on taxable items during the month of March, 1998. If there are no seasonal effects (an unlikely assumption) and if March can be taken as representative of an average month, the Imperial county figure equals $840 million per year. Considering the relative sizes of Tijuana and Mexicali, this is not an unreasonable number ($1.5 billion versus $840 million) although the survey of northbound crossers in Imperial county does not give any idea about how much of this expenditure escapes into San Diego, Los Angeles, or other regions.

Ultimately, there is no way to judge the accuracy of these expenditure estimates. At first glance, the Imperial county figure in particular seems too high, or at least in further need of clarification. Taxable sales to Mexican citizens of $70 million during March of 1998 implies that quarterly sales would have been somewhere near $210 million (3x70). The California State Board of Equalization's preliminary estimate of taxable sales in Imperial county during the first quarter of 1998 is 268 million (California State Board of Equalization, 1998). This implies that Mexican citizens are responsible for 78 percent of the county's sales. While the number may be accurate, it seems too large.[1]

[1] It should be noted that the $70 million does not take into account the share of expenditures that are made on the U.S. side but outside Imperial County. This could reduce the figure substantially.

Looking at San Diego county during the year of the border crossing survey (1992), total taxable sales were $21.4 billion. Therefore, the estimate of $1.5 billion in sales to Mexican citizens represents 7.1 percent of total taxable sales in the county. It is possible to compare the San Diego number to an estimate that was made nearly 20 years ago by the Economic Research Bureau of the San Diego Chamber of Commerce (1979). In its 1978 survey, the Chamber tried to estimate the percentage of all taxable sales in San Diego county that were made to Mexican citizens. The Chamber's methodology was to conduct spot surveys of eleven county shopping districts. In 1978, they estimated that Mexican citizens accounted for 7.5 percent of total taxable sales in the San Diego county, a figure that is remarkably close to the 7.1 percent estimate of 1992. For the most current year of data, 1997, the total value of taxable sales in the county was approximately $28 billion so that seven percent would be nearly $2 billion. The 1978 Chamber of Commerce survey also confirmed the pattern that the relative importance of cross border shopping tapers off with distance from the border. Merchants made 80.9 percent of their sales in San Ysidro to Mexican citizens, 23.5 percent in Chula Vista, 9.5 percent in Mission Valley, and 0.5 percent in Escondido (San Diego Chamber of Commerce, 1979).

3. Previous estimates of the impact of a peso devaluation

Given the relative number of northbound cross border shoppers, important changes in the Mexican economy such as a peso devaluation or a strong economic expansion are likely to have a significant impact on retail sales in San Diego. This fact has been noted, but never analyzed. For example, the *Economic Bulletin* of the San Diego Chamber of Commerce noted that in both 1982 and 1983 the visitor industry was affected by the slowdown in border crossings brought on by the large devaluations of the

peso in February and August of 1982. While the visitor industry rebounded with the end of the U.S. recession in 1983, the Chamber noted that 1983 was a second year of decline in border crossings because the "erosion of the currency during 1983 made visiting the U.S. much more expensive and served to deter many Mexican visitors." While the focus of the Chamber's comments were on the visitor industry, what was true for Mexican tourists must have been equally true for shoppers.

To date, most studies of the impacts of a peso decline on cross border shopping have focused on Texas-Mexico border. Patrick and Renforth (1996) used a survey of 374 retailers in Brownsville, McAllen, Laredo, El Paso to estimate that retail sales to Mexican citizens comprise somewhere between 20 and 50 percent of total retail sales. In addition, they found that sales vary by city, by proximity to the border, by retailer, and by shopping district. More importantly for the purposes of this paper, Patrick and Renforth estimate that the nearly 50 percent decline in the value of the peso between December, 1994, and the middle of 1995 resulted in an average fall in retail sales in the four cities of 41.8 percent. The largest effects were in retail outlets classified as sellers of general merchandise, jewelry, and clothing. In addition, the effects varied by city, with larger cities and cities farther from the border experiencing a smaller effect.

Prior to the study by Patrick and Renforth, analysis of the 1982-1983 devaluation found significant impacts in Texas border cities. Diehl (1983) estimates that sales fell 80 to 90 percent in some individual stores, while Prock (1983) notes that border cities experienced a sharp drop in sales taxes in 1983: Laredo was down 45.47 percent; Brownsville and McAllen both dropped 36 percent; and El Paso fell 8.2 percent. According to Prock, the impact of the peso devaluation on Texas border cities was greater

than the impact of the U.S. recession of 1981-1982. Prock also argues that the severest impacts were the result of the exchange controls that were enacted in Mexico. The controls made it more difficult for Mexican citizens to take money out of Mexico and had significant harmful effects on banking, construction, and real estate along the border. In addition, dollar denominated bank accounts in Mexico were converted to pesos at an unfavorable exchange rate that reduced the real wealth of Mexican citizens and caused a decline in cross border shopping.

4. The county-level demand for goods and services

County-wide taxable sales can be modeled within a simple demand equation. Let nominal demand be a function of nominal income and prices:

$$Q^d = f(Y,P).$$

This says that the quantity of goods and services demanded depends on incomes and prices. In the estimations that follow, prices are assumed to be exogenous to San Diego and Imperial counties. This follows from the fact that they are relatively small regions within the national market and that it is consequently not unreasonable to assume that they are price takers.

Note, however, that regional income has two components, U.S. and Mexican. Given that there is a significant amount of cross border shopping, changes in either the dollar value of the peso or in Mexican incomes will have a significant impact on retail activity in San Diego and Imperial counties. The importance of these impacts depends on several factors: (1) the size of the change in the value of the peso; (2) the size of changes in real Mexican incomes; (3) the amount of cross border shopping; (4) the speed at which

changes in the value of the peso are passed through into higher prices in Mexico; and (5) the general economic environment in Mexico accompanying the changes.

A decline in Mexican incomes can affect retail sales in U.S. border areas for exactly the same reasons as a decline in U.S. incomes. The relative importance of impacts that are initiated by changing Mexican incomes depends in part on the third factor, the amount of cross border shopping. There is no reason to believe that this is a constant, however, and increases in incomes south of the border could easily generate relatively more border crossing. This probably occurred during the expansion of credit in Mexico from the early 1990s until the crisis of 1994, while the opposite effect of less border crossing and lower incomes happened during the crises of 1982-1983 and 1994-1995. Income is not the only factor influencing cross border shopping, however, and from the perspective of a Mexican shopper, a fall in the value of the peso is equivalent to a uniform increase in the prices of U.S. goods. Each dollar costs more pesos, so even if U.S. prices are constant, each peso buys less across the border. Consequently, the direct effect of a fall in the value of the peso is a decline in the purchase of U.S. goods by Mexican citizens.

Assuming that real Mexican income and the value of the peso are likely to have significant effects on the dollar value of sales in U.S. border cities, it is reasonable to rewrite the demand curve as

$$Q^d = f(Y_U, P_U, Y_M, e),$$

where the subscript U refers to the U.S., M is Mexico, and e is the nominal exchange rate.

Assuming a Cobb-Douglas form for the demand equation gives

$$Q^d = \beta_0 Y_U^{\beta_1} P_U^{\beta_2} Y_M^{\beta_3} e^{\beta_4} \varepsilon,$$

where ε is a random error term. Taking logs and letting lower case letters stand for the natural logarithm of a variable, the equation becomes

$$q^d = \beta^* + \beta_1 y_u + \beta_2 p_u + \beta_3 y_m + \beta_4 e + \varepsilon^*$$

where $\beta^* = \ln(\beta_0)$ and $\varepsilon^* = \ln(\varepsilon)$.

The coefficient on *e* is expected to be positive, implying that a peso appreciation (rise in *e*) will have a positive effect on the purchasing power of Mexican incomes and will increase retail sales in San Diego and Imperial counties. A depreciation would have a symmetrical and opposite effect. This is not the end of the story, however, and these direct effects may be offset by three interrelated factors. First, a significant but unknown share of the border economy is already dollarized, so that changes in the value of the peso are less influential than they would be if all citizens of Mexico earned income in pesos instead of dollars, or if they held all their wealth in pesos instead of a combination of dollars and pesos. Dollar denominated bank accounts in Mexico, U.S. bank accounts held by Mexican citizens, and the requirements of Mexican landlords and producers that payments be made in dollars are all relatively common strategies for coping with the uncertainties of a highly variable peso (Cano and Cappi, 1998). Much of the recent discussion of a single currency for the NAFTA countries is directed at the issue of eliminating the uncertainties associated with a variable peso and the need to carry out transactions in two currencies.

Second, the direct effects of a depreciation of the peso on retail sales in San Diego is partially mitigated by the fairly quick feedback from a peso decline to an increase in prices in Mexico. (See the Appendix where this issue is explained in greater detail.)

That is, while the costs of Mexican goods and services may fall below the costs of U.S. substitutes after an episode of depreciation, there is a relatively quick response in Mexico that begins to raise prices there. Mexican importers of U.S. goods must pay higher prices in pesos and they pass along the price increases to their customers. The rise in the price of imports has an effect on domestic producers in Mexico since it reduces the competitive pressures they face and allows them to follow suit in raising prices. Pressures on employers to raise wages may also develop since a significant share of the consumption bundle of Mexican workers is comprised of foreign goods. The net result is that Mexican prices rise. The actual relationship between the exchange rate and prices in Mexico is given in Table 1 where a ten percent depreciation in the value of the peso leads to nearly an eight percent increase in prices after 3 quarters.

A third factor that mitigates the effects of a peso depreciation is that the periods of most rapid depreciation are also periods of high variability in the rate of change of the peso. For example, in the dataset used in this paper, the rate of change in the peso is calculated on a quarterly basis for the period from 1980:2 to 1997:3. During this span, there are two periods of relatively high rates of peso depreciation. The first lasts from the fourth quarter of 1981 through the first quarter of 1988, and the second is from the fourth quarter of 1994 through the fourth quarter of 1995. Table 2 shows the average rate of change in value of the peso during these two periods, along with its standard deviation, and compares them to the other years of the sample.

The first of the two periods of high volatility and rapid depreciation make up 26 of the 70 quarters between 1980:2 and 1997:3. Between 1981:4 and 1988:1, Mexico experienced the collapse of oil prices, the rise of international interest rates, the onset of a

world-wide recession, and the worst effects of the debt crisis. In the second period of high volatility and rapid depreciation, the country experienced a collapse in the value of the peso, an IMF bailout, ongoing structural adjustments brought on by the implementation of NAFTA, an ongoing rebellion in the state of Chiapas, and a deep year-long recession. A rapid deterioration in the value of the peso discourages purchases of U.S. made goods, but the expectation of future depreciation has the opposite effect. If the peso price of an import from the U.S. is likely to be higher next month, then it pays to buy now rather than wait. High volatility reinforces the uncertainty and adds to the desirability of current purchases over waiting until next period.

Table 3 sums up the described effects. Given that current expectations of the future exchange rate are likely to influence purchases by Mexican shoppers, it is necessary to include a measure for expectations in the model.[2] Taking this observation into account, the final version of estimated equation is:

$$q^d = \beta^* + \beta_1 y_u + \beta_2 p_u + \beta_3 y_m + \beta_4 e + \beta_5 e^f + \varepsilon^*$$

where e^f is the expected future value of the peso, and ε is a random error term which is assumed to have an independent, normal distribution with zero mean and a constant variance.

5. Estimates of the Impact of a Peso Devaluation

The data used to estimate the above equation are quarterly observations from 1980 to the third quarter of 1997. The left hand side variable is taxable sales in San Diego or Imperial County and the data are drawn from the California State Board of Equalization.

[2] Note too, that expectations should also influence the value of purchaes by U.S. shoppers in Mexico. This is an area in need of research, but that this paper does not address.

Table 4 shows the annual rate of growth in taxable sales for both regions.[3] Exchange rates over the same time period are readily available, but income in San Diego and Tijuana are not, necessitating the use of a proxy. For San Diego, total employment is available from the United States Bureau of Labor Statistics (BLS). For Imperial County, the California Employment Development Department (EDD) provides employment data as far back as 1983, necessitating a shorter time span for the analysis. Quarterly employment in Tijuana and Mexicali are proxied with total employment in the maquiladora industry which is available from the Instituto Nacional de Estadística, Geografía e Informática (INEGI). The employment proxy for local income is supplemented with measures of Mexican and California incomes. In the case of Mexico, national GDP is used, and for California, state personal income.

Exchange rates and level variables such as employment, GDP, and personal income have trend components which require a test for nonstationary means and variances. Accordingly, augmented Dickey-Fuller tests were conducted; these show that most of the variables are nonstationary in levels and the hypothesis that each variable has a unit root cannot be ruled out. Unit roots imply that spurious correlation between the variables is a potential estimation problem. The solution is to take first differences of each of the variables and use those in place of the level values in the above equation.

Using first differences, the model becomes

$$\Delta q^d = \alpha + \beta_1 \Delta y_u + \beta_2 \Delta p_u + \beta_3 \Delta y_m + \beta_4 \Delta e + \beta_5 \Delta e^f + \eta,$$

[3] As might be expected, taxable sales show a significant amount of quarter-to-quarter variation and a strong seasonal component. In particular, rates of growth during the first quarter of each year are usually negative, reflecting a significant drop after the high growth of the fourth quarter.

where η is a random error term with zero mean and constant variance. Measurement of e^f is problematic since there is no clear way to determine how Mexican border area residents form their expectations about the future value of the peso. Consequently, two separate variables were created. The first is an actual forecast of the value of the peso based on the three most recent quarters. The assumption is that consumers determine their expectations about the current quarter based on the recent history of the peso:

$$\Delta e^f = \gamma_0 + \gamma_1 \Delta e_{t-1} + \gamma_2 \Delta e_{t-2} + \gamma_3 \Delta e_{t-3}.$$

This is technically more sophisticated than guessing, but it is probably no more accurate and may even be worse. Exchange rate prediction is notoriously difficult and, like the weather, the best guess is often that tomorrow will be like today.[4] Since the time period under consideration (1980 to 1997) had two major periods of rapid depreciation and high volatility, a simple alternative to the above forecast is to create a dummy variable for those two periods (1981:4 to 1988:1 and 1994:4 to 1995:4). The dummy cannot measure the strength of people's convictions about exchange rate movements, but it does capture the quarters when depreciations were greatest and when volatility was most notable.

The equations in Table 6 are four specifications of the same equation, each of which uses total taxable sales in San Diego county as the dependent variable. Four dummy variables are also included in the estimated equation; the first three control for quarterly variations, and a fourth controls for quarters in which the U.S. economy was in recession. The first equation in Table 6 includes all the controls on Mexican and U.S. growth, but it leaves out the forecast of the change in the value of the peso Δe^f. The

[4] This point is illustrated by the fact that spot rates in currency markets are usually better predictors of future rates than are today's forward rates.

economic growth variables are all insignificant with the exception of employment in San Diego and the dummy variable for a U.S. recession. The coefficient on the exchange rate variable is marginally significant. The second equation tests the hypothesis about expectations by adding the forecast of the expected change in value of the peso, Δe^f. The new variable is not significant, and it has no impact on the coefficient on the exchange rate variable, Δe. The third equation replaces the forecast variable, Δe^f, with the dummy variable marking the two periods of high volatility. The standard error of the regression, the Akaike information criterion, and the adjusted R^2 each indicate that this is a better specification. Using the same criteria, the fourth equation is preferred to the other three.[5] It replicates the specification of equation 3, but eliminates the variables with insignificant coefficients, except prices, which theory says should be included in the equation.[6]

The coefficients can be interpreted as follows. A one percent increase in employment leads to a three-fourths of one percent increase in taxable sales. In addition, holding San Diego employment constant, a recession reduces taxable sales by 2.2 percent. The exchange rate variables, both the current nominal rate and the variables used to capture the degree of uncertainty about future movements, are significant. Interpretation of these variables is as follows. The coefficient on the nominal exchange rate indicates that a one percent decrease in the value of the peso reduces real taxable sales by about 0.1

[5] In addition to the standard t tests on the coefficients and the goodness of fit tests reported in Table 6, a number of specification tests and tests on the residuals were carried out for the preferred, fourth equation. The Jarque-Bera test concluded that we cannot reject the hypothesis of normally distributed residuals (J-B = 1.99, p = 0.37), and a unit root test on the error terms rejected the hypothesis that the residuals had a unit root (ADF t statistic = -4.15, p < 0.01). The ARCH test ruled out autoregressive conditional heteroskedasticity (F = 2.69, p =0.105) and the Ramsey RESET test failed to reject the hypothesis of correct specification (log likelihood ratio = 0.118, p=0.73).

[6] Both of the measures of income and employment in Mexico proved to be insignificant. This could be due to the fact that the variables used to proxy income in Tijuana are not accurate enough measures to capture the impact of income shifts. Similarly, real personal income in California was insignificant.

percent or, to say the same thing another way, a ten percent depreciation reduces sales by about 1 percent, and a twenty-five percent depreciation reduces them by about 2.5 percent. In other words, the ratio is about 10:1 [(percent change in peso):(percent change in taxable sales in San Diego county)]. This is not necessarily the end of the story, however, because during periods of large depreciations and high volatility, Mexican consumers try to protect themselves by increasing current purchases before further depreciations take effect. The average increase in purchases during these episodes is equal to 2.3 percent change in taxable sales in San Diego county.

Table 7 pairs Imperial county along side San Diego county. For convenience and purposes of comparison, estimated equation (4) is repeated next to the same model specification applied to Imperial county. Table 7 also shows estimates for total taxable retail sales, a subset of total taxable sales.[7] As expected, the impact of a change in the value of the peso is much stronger in relative terms in Imperial county than in San Diego county. In particular, a 10 percent depreciation leads to a 2.22 percent fall in total taxable sales and a 1.93 percent decline in total retail sales. Compared to San Diego county's 10:1 ratio of peso to taxable sales decline, Imperial county's ratio is around 4.5:1, more than twice as large.

Several sub-components of total taxable sales were tested with the same model. Other categories include general merchandise, building materials, autos and automotive products, eating and drinking places, apparel shops and specialty stores.[8] These regressions are displayed in Tables 8 and 9. The results show that peso depreciations have

[7] Total taxable sales includes certain taxable, non-merchandise items such as business and personal services. Total retail sales are about 2/3 of total taxable sales.
[8]Specialty stores include jewelry stores, florists, sporting goods, music stores, photography stores, etc.

variable effects, depending on the type of merchandise considered and the locale of the store. Within San Diego county, sales of autos and automotive products are most strongly affected, followed by building materials, general merchandise, and eating and drinking places and apparel. (Specialty shops are anomalous.) The impact ratios [(percent change in the value of the peso):(percent change in sales)] vary from 6:1 for autos and auto products to 23:1 for eating and drinking places.

Imperial county has a different pattern with regard to the most impacted sectors. Apparel is the hardest hit sector after an unexpected depreciation, followed by specialty shops, general merchandise stores, eating and drinking places, and auto and automotive products. Impact ratios range from 1.7:1 for apparel to 6:1 for eating and drinking places. In every case, a change in the value of the peso has a much larger impact in Imperial county than it does in San Diego county. Note also that the large impact on apparel shops is consistent with Patrick and Renforth (1996) analysis of the effects along the Texas border after the 1995 peso collapse.

6. Conclusion

Bi-national markets such as San Diego and Imperial counties are sensitive to the relative value of currencies. Mexican shoppers that cross to the northern side of the border are responsible for a significant share of total sales, probably somewhere on the order of 7 percent in the metropolitan San Diego area (about $2 billion in 1997). Given that total taxable sales during the first half of 1998 were approximately $14 billion, Mexican citizens may have accounted for $980 million in sales. The figures for Imperial county are surely much larger in relative terms although not in absolute dollars.

These impacts are economically important. For example, if the peso drops by ten percent, then during the quarter of the peso's decline, San Diego merchants can expect to see a collective loss in taxable sales of an amount that is around $66 million. Furthermore, the effects are not distributed evenly over store types. Some types of shops may experience no decline in sales, while others such as autos and auto products will see a relatively larger decline than the estimated 1 percent.

This paper does not test the spatial variation in these effects, but based on other information and the simple logic of the situation, it is certain that some cities and shopping districts will experience much larger impacts than others. Cities and shopping districts closer to the border will be more adversely affected, while the important retail area of northern San Diego county may be largely or even entirely free from the effects. Within Imperial county, the spatial effects would play out across city boundaries, with Calexico receiving a larger share of the impact and El Centro a smaller share. The fact that monthly northbound border crossings for purposes of shopping in Imperial county are about seven times the total county population means that fluctuations in the value of the peso matter a great deal, both to merchants and to those that depend on the tax revenue generated by retail sales.

Table 1
The Effect on Mexican Prices of a Ten Percent Depreciation of the Peso in Quarter 1

Quarter 1	3.47 percent rise
Quarter 2	2.92 percent rise
Quarter 3	1.43 percent rise
Total after 3 quarters	7.82 percent rise

Source: JP Morgan, INEGI, author's calculations. See Appendix 2

Table 2
Quarterly rates of change in the dollar value of the peso

	Mean rate of change	*Standard deviation*
Group 1		
1981:4 to 1988:1 and 1994:4 to 1995:4	-16.68 percent	10.72 percent
Group 2		
1980:2 to 1981:3 and 1988:2 to 1994:3 and 1996:1 to 1997:3	-2.22 percent	2.83 percent

Source: Bureau of Labor Statistics (BLS), Instituto Nacional de Estadística, Geografía e Informática (INEGI), JP Morgan, author's calculations.

Table 3
Impacts of a devaluation of the peso

Factors that discourage cross border shopping	• Less income in dollar terms • Relative prices favor Mexican goods • Substitutability between U.S. and Mexican goods and services
Factors that encourage cross border shopping	• Dollarization of the Mexican economy • Rapid inflation in Mexican prices • Expectations of a future depreciation

Table 4
Annual rates of growth of total taxable sales, 1980-1997

	San Diego County	*Imperial County*
Nominal taxable sales	7.0 percent	4.0 percent
Real taxable sales	2.8 percent	0.1 percent

Source: California State Board of Equalization; author's calculations

Table 5
Augmented Dickey-Fuller Tests

Variable	**t value for unit root tests**	
	Levels	*First differences*
Total sales, San Diego County	-1.50	-11.67***
Total sales, Imperial County	-0.97	-7.00***
Total retail sales, San Diego County	-1.83	-14.11***
Total retail sales, Imperial County	-0.86	-7.22***
Employment, San Diego County	-1.65	-2.40
Employment, Imperial County	-2.59*	-10.65***
Maquila employment, Tijuana	-0.91	-4.54***
Maquila employment, Mexicali	2.10	-1.93
Personal income, California	-2.72*	-3.27**
GDP growth, Mexico	-0.86	-9.66***
Nominal exchange rate	-2.05	-2.52
Real exchange rate	-2.86*	-3.45**

Significant t values at the 10 percent, 5 percent, and 1 percent level are 2.59, 2.90, and 3.53. ***, **, and * indicate that the hypothesis of a unit root is rejected at the 1, 5, and 10 percent levels.

Table 6
Total Taxable Sales in San Diego County, 1980-1997

Dependent Variable: Growth rate of total taxable sales

	(1)	(2)	(3)	(4)
Constant	-0100*** (10.72)	-0.101*** (10.73)	-0.099*** (11.05)	-0.098*** (13.75)
Growth of San Diego employment	0.948** (2.01)	0.991** (2.09)	0.709 (1.54)	0.774* (1.97)
Growth of Tijuana employment (maquilas)	-0.016 (0.18)	-0.020 (0.23)	-0.064 (0.78)	
GDP growth, Mexico	-0.076 (1.41)	-0.023 (0.31)	-0.015 (0.26)	
Personal income growth, California	0.174 (0.55)	0.141 (0.44)	0.148 (0.49)	
Percent change in US CPI	0.209 (0.29)	0.386 (0.52)	0.516 (0.74)	0.782* (1.85)
Dollars per peso	0.066* (1.75)	0.066* (1.72)	0.112*** (2.77)	0.099*** (2.78)
Dollars per peso, forecast		-0.082 (0.95)		
Period of high peso volatility and large depreciation			0.024** (2.55)	0.023*** (2.88)
U.S. recession	-0.019** (2.01)	-0.020** (2.04)	-0.024** (2.56)	-0.022** (2.59)
Quarter 2	0.1576*** (12.79)	0.152*** (11.31)	0.159*** (13.50)	0.154*** (16.01)
Quarter 3	0.126*** (15.42)	0.124*** (15.07)	0.126*** (16.16)	0.123*** (17.37)
Quarter 4	0.140*** (9.58)	0.133*** (8.14)	0.134*** (9.51)	0.132*** (12.93)
Adj. Rsq	0.912	0.911	0.919	0.921
DW	2.36	2.35	2.33	2.38
S.E. of regression	0.021	0.021	0.020	0.020
Akaike information criterion	-7.55	-7.54	-7.63	-7.70
Observations	70	70	70	70

Absolute values of t statistics in parentheses. *** = significant at the 1 percent level, ** = significant at the 5 percent level, and * = significant at the 10 percent level.

Table 7
Total Taxable Sales and Total Retail Sales,
San Diego and Imperial Counties, 1980-1997

	Total Taxable Sales		***Total Retail Sales***	
	San Diego[a]	***Imperial[ab]***	***San Diego[a]***	***Imperial[ab]***
Constant	-0.098***	-0.138***	-0.116***	-0.102***
	(13.75)	(6.49)	(16.54)	(5.79)
Growth of county employment	0.774*	0.528***	0.572	0.082
	(1.97)	(2.96)	(1.47)	(0.57)
Percent change in US CPI	0.782*	3.056*	0.663	1.910
	(1.85)	(1.87)	(1.59)	(1.37)
Dollars per peso	0.099***	0.222**	0.097***	0.193**
	(2.78)	(2.38)	(2.79)	(2.41)
Period of high peso volatility and large depreciation	0.023***	0.045***	0.024***	0.024*
	(2.88)	(2.75)	(3.05)	(1.69)
U.S. recession	-0.022**	-0.004	-0.021**	-0.010
	(2.59)	(0.16)	(2.44)	(0.43)
Quarter 2	0.154***	0.199***	0.173***	0.169***
	(16.01)	(7.59)	(18.23)	(8.29)
Quarter 3	0.123***	0.133***	0.145***	0.017
	(17.37)	(3.10)	(20.67)	(0.50)
Quarter 4	0.132***	0.162***	0.169***	0.233***
	(12.93)	(5.39)	(16.71)	(9.87)
AR(1)		-0.308**		-0.218
		(2.14)		(1.52)
Adj. Rsq	0.921	0.800	0.939	0.868
DW	2.38	2.04	2.20	1.99
S.E. of regression	0.020	0.050	0.020	0.042
Observations	70	57	70	57

Absolute values of t statistics in parentheses. *** = significant at the 1 percent level, ** = significant at the 5 percent level, and * = significant at the 10 percent level.
[a]Ordinary least squares estimation.
[b]1983-1997

Table 8
Sub-components of Taxable Sales, 1980-1997

	General Merchandise		***Automotive Products***		***Building Materials***	
	San Diego[b]	***Imperial[ac]***	***San Diego[a]***	***Imperial[ac]***	***San Diego[b]***	***Imperial[bc]***
Constant	-0.354***	-0.286***	0.020	0.012	-0.030*	-0.076
	(33.53)	(9.08)	(1.51)	(0.33)	(1.97)	(1.64)
Growth of county employment	0.784**	0.001	0.130	0.007	1.14	-0.003
	(2.17)	(0.004)	(0.21)	(0.02)	(1.14)	(0.01)
Percent change in US CPI	1.012***	2.102	1.250*	1.651	0.078	4.775
	(4.01)	(0.91)	(1.90)	(0.62)	(0.07)	(1.66)
Dollars per peso	0.112***	0.264*	0.167***	0.171	0.127**	0.048
	(2.89)	(1.96)	(2.86)	(1.11)	(2.31)	(0.38)
Period of high peso volatility and large depreciation	0.024***	0.021	0.038***	0.040	0.044***	-0.012
	(3.01)	(0.90)	(3.08)	(1.48)	(2.35)	(0.44)
U.S. recession	-0.017**	0.017	-0.029**	-0.006	-0.052**	0.004
	(2.01)	(0.43)	(2.25)	(0.14)	(2.19)	(0.05)
Quarter 2	0.402***	0.342***	0.049**	0.109**	0.152***	0.131
	(21.73)	(8.50)	(2.41)	(2.43)	(7.52)	(1.63)
Quarter 3	0.376***	0.249***	-0.014	-0.159**	0.054***	-0.097
	(27.16)	(4.04)	(1.16)	(2.29)	(4.68)	(1.09)
Quarter 4	0.636***	0.608***	-0.104***	-0.027	-0.061**	0.142
	(40.45)	(13.35)	(4.99)	(0.54)	(2.46)	(1.35)
MA(1)	-0.622***					
	(6.20)					
AR(1)		-0.367***	-0.413***	-0.350**		-0.643***
		(2.71)	(3.74)	(2.44)		(4.40)
Adj. Rsq	0.957	0.900	0.724	0.567	0.611	0.522
DW	2.16	1.90	2.15	2.23	2.07	2.34
S.E. of regression	0.051	0.074	0.037	0.084	0.068	0.157
Observations	70	57	69	57	70	57

Absolute values of t statistics in parentheses. *** = significant at the 1 percent level, ** = significant at the 5 percent level, and * = significant at the 10 percent level.
[a]Ordinary least squares estimation.
[b]Weighted least squares estimation to correct for autoregressive conditional heteroskedasticity (ARCH).
[c]1983-1997

Table 9
Sub-components of Taxable Sales, 1980-1997

	Eating and Drinking Places		***Apparel***		***Specialty Shops***	
	San Diego[b]	***Imperial[bc]***	***San Diego[a]***	***Imperial[bc]***	***San Diego[b]***	***Imperial[ac]***
Constant	-0.005 (0.70)	0.061** (2.39)	-0.308** (17.05)	-0.308*** (32.32)	-0.196*** (17.18)	-0.211*** (5.57)
Growth of county employment	0.948*** (8.44)	0.087 (0.42)	2.335*** (3.10)	0.186* (2.00)	0.659 (1.39)	-0.231 (0.79)
Percent change in US CPI	0.689** (2.47)	3.287* (1.90)	1.679** (2.07)	4.174*** (3.74)	1.142** (2.19)	2.015 (0.64)
Dollars per peso	0.044** (2.55)	0.203** (2.27)	0.070 (0.96)	0.604*** (9.74)	-0.021 (0.38)	0.312* (1.78)
Period of high peso volatility and large depreciation	0.013*** (5.66)	0.015 (1.03)	-0.003 (0.21)	0.098*** (12.22)	0.007 (0.66)	0.040 (1.22)
U.S. recession	0.013*** (2.80)	-0.040 (1.44)	0.016 (0.96)	-0.068*** (5.56)	-0.009 (0.88)	0.005 (0.09)
Quarter 2	0.042*** (3.82)	-0.106*** (3.30)	0.395*** (13.13)	0.373*** (27.26)	0.191*** (10.99)	0.237*** (6.14)
Quarter 3	0.056*** (4.89)	-0.201*** (4.18)	0.341*** (22.34)	0.222*** (9.70)	0.222*** (15.46)	0.077 (1.08)
Quarter 4	-0.084*** (6.96)	0.033 (1.04)	0.455*** (14.79)	0.638*** (45.82)	0.380*** (19.72)	0.583*** (12.87)
MA(1)	-0.983*** (63.71)				-0.535*** (3.64)	
AR(1)		-0.378*** (2.75)	-0.531*** (4.72)			
Adj. Rsq	0.777	0.671	0.941	0.760	0.910	0.849
DW	2.20	2.30	1.92	2.34	2.15	2.15
S.E. of regression	0.032	0.068	0.049	0.147	0.047	0.087
Observations	70	57	69	58	70	58

Absolute values of t statistics in parentheses. *** = significant at the 1 percent level, ** = significant at the 5 percent level, and * = significant at the 10 percent level.
[a]Ordinary least squares estimation.
[b]Weighted least squares estimation to correct for autoregressive conditional heteroskedasticity (ARCH).
[c]1983-1997.

7. Appendix: Peso devaluations and prices

We can test how prices rise after a devaluation of the peso with a simple regression model. Let XR stand for the exchange rate, measured in dollars per peso, and TJCPI equal the consumer price index in Tijuana. Using quarterly data, 1980:1 through 1997:2, the relationship is measured with a distributed lag model. The purpose of including several lags of the exchange rate is to allow for the fact that not all the effects are likely to occur in the same quarter. Specifically, let the estimating equation equal the following:

$$TJCPI_t = \alpha_0 + \beta_0 XR_t + \beta_2 XR_{t-1} + \ldots + \beta_k XR_{t-k} + \varepsilon_t.$$

All variables were measured as natural logarithms, and first differences were taken in order to remove the element of nonstationarity. Dickey-Fuller tests indicated that the first differences of the logs were stationary. Statistical tests indicated that lags after t-2 were insignificant. Furthermore, tests also showed that the error terms were autocorrelated and the Cochrane-Orcutt AR(1) estimation procedure was used. The results are shown in Table 7.

Another issue that arises in this estimation procedure is the possibility that price increases cause exchange rate movements. This may occur instead of the direction of causation hypothesized above, or it may be that they are simultaneously determined. In order to test whether there is some reverse causation, a test for Granger causation was applied. The Granger test is built around the idea that if XR changes consistently precede changes in prices, then XR must be the causal variable. Conversely, if price change precede exchange rate changes, then prices are the causal variable.

Granger causality tests indicated that (1) we should accept the hypothesis that changes in prices do not cause changes in the exchange rate (F statistic = 0.025, prob. = 0.97), but that (2) we should reject the hypothesis that changes in the exchange rate do not cause changes in prices (F statistic = 4.968, prob. = 0.013).

Table 10
Prices and Exchange Rates

Dependent variable: Tijuana CPI			
Variable	*Eqn 1*	*Eqn 2*	*Eqn 3*
Constant	0.0202***	0.212**	0.0268***
	(3.66)	(2.36)	(2.93)
XR_t	-0.3225***	-0.3297***	-0.3477***
	(7.38)	(8.26)	(9.19)
XR_{t-1}	-0.2633***	-0.2737***	-0.2923***
	(5.60)	(6.89)	(7.70)
XR_{t-2}	-0.1412***	-0.1443***	-0.1432***
	(3.07)	(3.79)	(3.80)
XR_{t-3}	-0.0442	-0.0414	
	(0.94)	(1.04)	
XR_{t-4}	-0.0936**	-0.0604	
	(2.14)	(1.51)	
AR(1)		0.4620***	0.5248***
		(4.05)	(4.95)
Adj R^2	0.85	0.87	0.87
DW	1.12	1.84	1.86
SER	0.0310	0.0282	0.0279
Obs.	69	68	70

Absolute values of t statistics in parentheses. *** denotes significance at the 1 percent level, ** at the 5 percent level. SER is the standard error of the regression.

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