Business Cycle Coordination Along the Texas-Mexico Border

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Abstract: In this paper we use a dynamic single-factor model originally due to Stock and Watson [18, 19] to measure the business cycle in four Texas border Metropolitan Statistical Areas (MSAs) and Mexico. We then measure the degree of economic integration between border cities, the US, Texas, and Mexican economies using correlation, spectral and cluster analysis. Results suggest border MSAs are significantly integrated with the broader economies and that major changes have occurred in these relationships since 1994, the year in which NATFA was enacted and the time maquiladora industry began to accelerate.

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Introduction

The Texas/Mexico border is a fast growing region that is a complex blend of U.S. and Mexican cultures, languages and customs. It is a dynamic region that has benefited from the large and growing populations in northern Mexico and the rapid growth in U.S./Mexico trade. Total population in the four Texas border MSAs is about 1.8 million, and growth since 1980 has been 65 percent, versus 24 percent nationally. A high birth rate and a young population suggest that the border will continue to grow rapidly. The 1990s have been a particularly strong period for the border region. The gains in the 1990s have come during a period marked by the implementation of the North American Free Trade Agreement (NAFTA) and an acceleration of the maquiladora industry.[1]

This study uses a dynamic single-factor model originally due to Stock and Watson [18, 19] to measure the business cycle in the Texas border MSAs and Mexico. The business cycle indexes show that changes in the border region are correlated with changes in the Texas, Mexican and US economies, although to differing degrees.

[1] A maquiladora is a labor-intensive assembly operation. In its simplest organizational form, a Mexican maquiladora plant imports inputs from a foreign country, —most typically the United States—processes these inputs, and ships them back to the country of origin for finishing and sale. For a summary of the factors impacting the Texas/Mexico border economy in the 1990s see Orrenius and Berman [11], and Phillips [12].

Correlation, spectral, cluster, and regression analysis are used to study these cyclical relationships. We also look at the separate periods 1980 to 1994 and 1994 to 2002 to study the impacts of NAFTA and acceleration in maquiladora activity. We find that since 1994 the business cycles of the southern border MSAs of Brownsville, McAllen and Laredo have moved in a more similar fashion to the business cycle in Mexico, while El Paso's economy has become relatively more aligned with cycles in Texas and the U.S. In further analysis we show some evidence that this is due to El Paso's greater dependence on the maquiladora industry, which is heavily dependent on the U.S. economy, while the southern border cities are more tied to the movements in the peso and their impact on local retail sales.

Measuring Regional Business Cycles

One way to study a regional economy is to look at its relationships to other larger economies. If a city's economy is highly correlated to the state or nation that it resides in, then it is likely that the city would enter a recession if one was expected for the broader economy. For example, Carlino and Defina [2] find that significant spillovers and linkages exist in regions throughout the United States, and Carlino and Still [3] find that the timing and duration of business cycles across major US regions are highly correlated. Crone [5] uses cluster analysis to define six broad regions of states based on common comovement of their business cycles and finds that all but three states are clustered with contiguous states.

The conversion of time series data into the frequency domain via the Fourier transformation and the use of cross-spectral analysis have also been used to study the comovement of different regional cycles. Smith [17] uses cross-spectral analysis to study if world equity markets have become more interdependent since the 1987 stock market crash. He finds that at low frequencies (long cycles), the markets in the U.S., U.K., Germany and France have become more closely linked. Rosenthal [16] uses cross-spectral analysis to study the degree of co-movement and the timing of the interrelationships among regional house price markets in the UK.

While analysts often measure regional business cycles by looking at the movements in measures such as nonfarm employment or the unemployment rate, different indicators can result in different conclusions. In studying the national economy, economists often look at movements in broad measures of the macro-economy, such as Real Gross Domestic Product and employment, although neither of these measures is broad enough to represent the underlying state of the economy. The Conference Board (CB) calculates a coincident index of the economy by combining changes in personal income less transfer payments, employees on nonagricultural payrolls, industrial production and manufacturing and trade sales. After adjusting the changes in each indicator by the inverse of their volatility, the components are given equal weights.

Stock and Watson [18, 19] advance the notion of the business cycle by statistically estimating the weights on the component series that best identifies a single underlying factor that is time dependent and best represents the co-movement in the components. While the resulting coincident index is very similar to the CB coincident index, the Kalman filter/smoother approach, by smoothing across time as well as across indicators, results in an index which is smoother and thus turns down less often during expansions and increases less often during recessions. The strong theoretical and empirical arguments supporting the Stock and Watson approach have led regional researchers to apply the methodology to regional economies. Clayton-Matthews and Stock [4] apply the methodology to measures of employment, the income tax base, the sales tax base and the unemployment rate to create a coincident index for the state of Massachusetts. Phillips [14] uses an improved version of Texas nonfarm employment, a quarterly measure of Texas Real Gross State Product and the Texas unemployment rate to create a coincident index for Texas. Crone [6] uses three variables that are available for the 48 contiguous states – nonfarm employment, average weekly hours in manufacturing and the unemployment rate – to estimate coincident indexes for each of the 48 contiguous states.

The structure of the Stock and Watson model is:

(1) $Y_t = \beta + \gamma(L)\Delta C_t + \mu_t$

(2) $D(L)\ \mu_t = \varepsilon_t$

(3) $\phi(L)\Delta C_t = \delta + \eta_t$

where $Y_t = \Delta\chi_t$ are the stationary first differences in natural logs of the coincident component series and C_t represents the log of the unobserved state of the economy. L denotes the lag operator. The disturbances ε_t and η_t are assumed to be serially uncorrelated and uncorrelated with each other at all leads and lags. The lag polynomial matrix D(L) is assumed diagonal so that the μ_t's in different equations are contemporaneously and serially uncorrelated with each other.

Equation (3) defines the dynamics of the underlying state of the economy, while equation (1) shows how each of the component series is related to this underlying growth process. Idiosyncratic components of each of the time series are modeled in equation two. If the component series Y_t move in tandem with the economy, then their common comovement C_t has the natural interpretation as the current state of the economy or the coincident index.

As described in Clayton-Mathews and Stock [4], there are three outcomes to estimating the equations 1-3: $\Delta C_{t/t-1}$, which are the prediction estimates, $\Delta C_{t/t}$, which are the filtered estimates, and $\Delta C_{t/T}$, which are the smoothed estimates. In most engineering problems only data up to the point of estimation is known and thus the filter is estimated. But in economic problems, such as this, future data is also available (except at the end of the sample) and it is useful to incorporate the Kalman smoother. We use the Kalman smoother with weights that rapidly approach zero as they move from the current period. As the data approaches the end of the sample the estimates go to $\Delta C_{t/t}$.

Seasonally-adjusted changes in non-farm employment, the unemployment rate, real wages, and retail sales are used to define coincident indexes for the Texas/Mexico border MSAs of El Paso, Laredo, Brownsville/Harlingen (Brownsville), and McAllen/Edinburg/Mission (McAllen). The series are converted to first difference in natural logs (except the unemployment rate which is just differenced) and normalized by subtracting its mean difference and dividing by the standard deviation of its differences. This results in β=0 in equation 1 and δ=0 in equation 3. The scale of the γ(L) coefficients is fixed by setting the variance of η to unity, and the timing of the coincident index is fixed by setting γ_1(L)= 0 for employment in equation 1. For all other variables we assume that γ_i(L)= 0 for all lags greater than 2. This allows the component to have up to a two-month or two-quarter lag with the business cycle index. For McAllen, retail sales were insignificant using the coincident and two lag values. Given that retail sales can lead changes in the economy, we incorporate lags of –1 and –2 into the regression to test a leading relationship in that region. Statistically insignificant lags are dropped one at a time starting with the least significant. In some cases, however, dropping insignificant lags led to a deterioration in a specification test described below and so these lags were retained.

Since the Kalman filter models each of the component series as left-hand-side variables with the (unobserved) coincident index on the right hand side, quarterly variables are modeled as a function of current and past values of the monthly latent series. In this way, quarterly data enter into the equations with monthly data. Also, the timing of the index is determined by the most recent data available since the program reduces the dimension of the vector equation for the missing data.[2]

The coefficients of the model are shown in Table 1. In the table the b prefix represents the γ parameters from equation one, the ar prefix refers to the autoregressive parameters from equation two, the s parameters measure the variance of the error terms in equation 2, and the coinindxar values represent the autoregressive coefficients ($\phi(L)$) of ΔC_t as described in equation 3. For all MSAs, employment, retail sales and wages are strongly significant and of the expected sign. For McAllen, retail sales enter with a two-quarter lead. The unemployment rate is also of the correct sign and in El Paso and Laredo is included coincidently and with a one-month lag. Shocks to the Laredo economy have the greatest persistence as measured by the .92 sum of the autoregressive coefficients. All of the regional business cycle indexes show a significant autoregressive process.

[2] While this adjustment provides a more timely index it is realized that since some data is missing that will later be incorporated, the most recent values of the series may be subject to a significant degree of revision. We thank Alan Clayton-Matthews for the programs that allow for these adjustments.

Table 2 displays the results of a whiteness test performed on the one-step-ahead errors from equation 2. The tests, described in Clayton-Matthews and Stock [4], verifies that one-step ahead forecast errors $\varepsilon_{t/t-1}$ are uncorrelated with past values of itself, the forecast errors of the other indicators and past changes in the indicators. In each regression, the dependent variable is one of the one-step ahead forecast errors of the component series, and the independent variables consist of a constant and six lags of the forecast errors or indicators. An F-test is then performed on the joint significance of each regression. The results shown on the top section of each MSA box, generally confirm the whiteness of the errors and thus the validity of the models. Following Clayton-Matthews and Stock [4], we look for a pattern of highly significant values and accept that several of the test values may come up significant just due to the large amount of tests performed.

The bottom half of Table 2 shows the cumulative dynamic multipliers and the component shares. As shown here, employment gets the greatest weight in all MSAs except Laredo, where it is essentially equal to the weight given to changes in the unemployment rate. Changes in employment and the unemployment rate together have a weight between 76 and 86 percent. Given the reliability of the employment series and the timeliness of both employment and the unemployment rate, these weights are perceived as a positive for the model and should reduce the impact of revisions caused by the later incorporation of the quarterly data values for retail sales and wages.

As a check on model stability, the MSA models shown were originally run in early 2002 with data through the end of 2000. In August 2002 the models were run again with new wage data through the end of 2001 and with complete employment and unemployment rate data through June of 2002. The models' diagnostic checks revealed no significant changes in the structure and performance of the original specifications.

The indexes produced by the Stock and Watson methodology are designed to be stationary and with unit variance. To make the indexes reflective of the unique trends and volatility in the regions, we make two adjustments. First, for each MSA, we calibrate the variance of the growth rates of the index to the average variance of the growth rates in the component series. We then set the average growth rate in the index to equal the average growth in annual real personal income over the period.

As shown in Chart 1, from July 1981 to June 2002 the indexes are generally smooth and show a significant amount of correlation to each other. Declines occurred in all four of the Border MSAs beginning in late 1981, early 1986, and early 1995. While it is clear that these regions share some common cyclical movement, it is also clear that they experience independent cycles such as the downturn in Laredo in 1997 and the differing experiences of the regions to the US recessions in 1990-91 and 2001-02. Laredo, by far the smallest of the MSAs, had the greatest cyclical volatility over the period while El Paso, the largest MSA, had the least cyclical volatility.

Border Business Cycles: Correlation with Broader Economies

Regional business cycles are generally impacted by their national counterparts. In the case of a metropolitan economy, business cycles are impacted by both national and state economies. For border economies such as El Paso, McAllen, Brownsville, and

Laredo, international business cycle considerations come into play.[3] In order to compare border business cycles to those of their surrounding economies, we construct a Stock and Watson coincident index for the Mexican economy and use two previously constructed ones for the US and Texas.

To construct the Mexico coincident index, we use real gross domestic product, industrial production and secured employment. The components were seasonally adjusted using the Census Bureau X-12 procedure with particular care to adjust for peso shocks, such as in 1995, and the Easter effect present within the months of March and April. The results of this index model are shown in Table 3. As shown in the lower part of the table, the shares on the components are fairly even, ranging from 27.8 percent for RGDP to about 39 percent for industrial production.

For Texas, we use a Stock and Watson type coincident index constructed with nonfarm employment, the unemployment rate and quarterly real gross state product from Phillips [14]. For the US economy we use the experimental index of coincident indicators produced by Stock and Watson.[4]

As highlighted in Charts 2-5, all of the Border MSAs share cyclical relationships with the broader economies of Mexico, Texas and the U.S. Laredo appears most tied to the Mexican economy while El Paso seems to have the most in common with the U.S. The most atypical period seems to be the latest recession where all the MSAs but El Paso did not follow the broader economies into decline. This is likely due to the fact that the

[3] See Tom M. Fullerton "Specification of a Borderplex Econometric Forecasting Model," *International Regional Science Review*, Vol. 24, 2001.
[4] Keith Phillips, "A New Texas Coincident Index", *forthcoming*. See James H. Stock web page at http://ksghome.harvard.edu/~.JStock.Academic.Ksg/xri/INDEX.HTM for U.S. index data and methodology.

real value of the Mexican peso was atypically strong during the downturn in the Mexican economy. Retail spending by Mexican nationals represents a larger share of the economies of Laredo, Brownsville and McAllen than it does in El Paso.[5] El Paso likely is impacted more by the large maquiladora presence in its neighboring city of Juarez. Juarez has the largest concentration of maquiladoras of any Mexican city with more than 200 thousand jobs and value added of $3.4 billion. Because of the large decline in US manufacturing in 2001, the maquiladoras in Juarez declined sharply.[6]

Shown in Table 4 are the Pearson correlation coefficients of the logged differences in the business cycles indexes. From January 1981 to June of 2002, most of the Border MSAs had statistically significant correlation with each other and with cycles in the US, Texas and Mexico. The border MSA's generally had the highest correlations with other border MSAs, slightly weaker correlations with the Texas and Mexican business cycles and considerably weaker correlations with the U.S. business cycle. All of the correlations were significant at the one percent level with the exception of the McAllen/US correlation.

One interesting question to look at is if the business cycle correlations changed after 1994 – the year in which NAFTA was implemented boosting US/Mexico trade, and about the same time that maquiladora activity accelerated. Gruben [8] argues that while both of these shifts occurred at about the same time, the acceleration in maquiladora activity was separate from NAFTA impacts. Table 5 highlights that some of the coincident relationships between the business cycles did change after 1994. In particular, Laredo, McAllen and Brownsville experienced a statistically significantly smaller correlation

[5] For more information regarding border retail sales, see Phillips and Manzanares, [13].
[6] See Canas [1].

with the Texas business cycle in the post NAFTA period[7]. Laredo, which is the largest land port for U.S. Mexico trade and through which about 40 percent of all land trade travels between the US and Mexico,[8] experienced a large statistically significant increase in its correlation with the Mexican business cycle. As also shown in the table, the border cities had a statistically stronger correlation with the Texas business cycle than with the Mexican cycle in the pre-NAFTA period. Post 1994, however, with the exception of El Paso, the border business cycles had a higher correlation with Mexico than with Texas, and in Laredo and Brownsville this difference was statistically significant.

Cross-Spectral Analysis

One method to analyze the cyclical relationship between two stationary stochastic time series is cross-spectral analysis. Spectral and cross-spectral analysis transforms time domain data into the frequency domain via the Fourier transform. As described in Jenkins and Watts [9] the spectrum, or the variance of the series decomposed by cycle frequency, is related to the autocovariance function according to the Fourier transformation and thus knowledge of the autocovariance function is equivalent to knowledge of the spectrum of the process.[9] Cross-spectral analysis measures the coherence (analogous to correlation in the time domain) between cycles of the same frequency (length) in two series. Cross-spectral analysis is analogous to running separate regressions on different frequencies in two series. One benefit of cross-spectral analysis

[7] We assume that the two samples are drawn from bivariate normal populations and apply the Z-test given in Morrison [10] page 105.
[8] For more information on the impacts of transportation on the Border economy see Phillips and Manzanares [13].
[9] For example, pages 218 and 219 of Jenkins and Watts [9] show the spectra of a first order autoregressive process.

versus cross correlation analysis is that it allows for different time delays across frequencies and thus different models for different frequencies. For example, the analysis of the business cycles for two regions might reveal high coherence at 1-year and 10-year cycles and the phase, or time delay, might be one month for the 2-year cycle and 12 months for the 10-year cycle.

As described in Jenkins and Watts [9] and Priestley [15] the standard Fourier transformation produces inconsistent estimates of both the spectrum and cross-spectrum because the variance does not decrease as the length of the time series increases[10]. Smoothing can reduce the variances of the spectrum and cross spectrum. The standard approach is to truncate the data into k sections of window length M=T/k where T is the sample size. Jenkins and Watts (J/W) discuss several different smoothing windows that tend to have good properties. For the Parzen window, which we use in this study, J/W show that the variance of the smoothed cross-spectral estimator is reduced to .539M/T of the variance of the sample cross-spectrum. For the time period from November 1980 to October 2002, we use a window of .106T resulting in a smoothed cross-spectral variance that is 5.7 percent of the variance of the sample cross-spectrum.

As shown in Charts 6-3 each of the border MSAs exhibit high coherence with each of the broader economies of the US, Texas and Mexico. Plotted on the charts are the coherences for cyclical periods of at least 12 months – which is generally considered to be the minimum length of one complete business cycle. To test for statistical significance we use an F-test suggested by Priestley and a somewhat more restrictive one

[10] For the crossspectrum, on page 708 Priestley [15] shows that without smoothing the coherency estimates would equal unity at all frequencies irrespective of the form of the true coherency spectrum.

suggested by J/W[11]. For the coherences shown in charts 6-9, significance at the 5 percent level is achieved at a coherence value of .064 for the test suggested by Priestley and a level of .168 for the test suggested by J/W. Since the peak coherences with all three broad economies for all of the MSAs reach at least .7, the cross-spectrums confirm the important business cycle relationships that these border areas share with all three of the broader economies that surround them.

Plotted below the coherences are the phase statistics converted to months[12], with a positive phase indicating that the MSA cycle leads the broader economy cycle by the number of months shown on the vertical axis. In general the phase statistics show that for the low frequency coherences near peak levels, the U.S. economy generally has a lead time of 10 months or less while Mexico and Texas have leads or lags of five months or less. This suggests that movements in the U.S. business cycle generally take longer to transmit to the border business cycles than do movements in the Texas or Mexican business cycle.

Overall, the coherence results for El Paso suggest that the metro area's business cycle is correlated most closely with that of the nation and Texas. Peak coherences with the U.S. occur at cycle lengths of 33 to 44 months with the U.S. cycle leading the El Paso cycle by 5.2 to 6.2 months. El Paso has high coherence with Texas for many cycle lengths from 14 months though 53 months with changes in El Paso leading Texas by

[11] The test suggested by Priestley [15] is given on page 706 and the one suggested by Jenkins and Watts (1968) is given on page 433.

[12] The phase is typically measured in radians and is the fraction of a cycle by which one series leads the other series. We convert the phase to lead months (LM) by the following formula: LM = (phase/2Π) x cycle period.

about 1-3 months at the longer cycles and lagging by 1.5 months or less at the shorter cyclical lengths.

Results for the other three metros are similar to El Paso except that Mexico generally has higher coherence and is similar in magnitude to the coherences with the U.S. and Texas. The coherences generally peak at cycles of between 38 and 53 months with the US cycle leading by 6 to 10 months and the US and Texas having between a two month lead and a two month lag. One interesting result is that in relation to the U.S., the border MSAs had low coherences when the timing of the cycles were close to one month but high coherences at U.S. leads of six months and more. Thus the relatively longer lead time of the U.S. cycle with the border MSAs likely impacted the lower coincident correlations shown in Table 4.

To investigate whether the coherences changed following NAFTA, we run the cross-spectra analysis for the pre- and post-1994 periods. In order to compare cycles of the same length, we restrict the data in the pre-NAFTA period to start in March 1985 so that there would be the same number of observations (106) in each sample. As shown in Charts 10 – 13, the peak and average coherences with Mexico generally increased in all four of the border MSAs. While the peak coherence slipped slightly for McAllen, the average over all cycle lengths 12 months and above was higher, giving some evidence of a stronger relationship in the second period. For the NAFTA period, Laredo and Brownsville experienced the highest peak coherence with Mexico, while McAllen and El Paso had slightly higher peak coherences with Texas. Looking at the average coherences, Laredo, McAllen and Brownsville had the strongest overall relationship with the Mexican economy, while El Paso was related more to the Texas economy. In the pre-

NAFTA period, the Texas and/or U.S. business cycles had higher peak and average coherences with all MSAs than did Mexico.

To test if the coherences after NAFTA were drawn from the same population as the coherences prior to NAFTA , I first test the coherence distributions for normality. For coherence distributions that are normally distributed we use the t-test to test if the two periods are drawn from the same population. For several distributions that fail the normality test, we use the non-parametric Wilcoxon signed rank test. The results are shown in Table 6.

As shown in the table, all four of the MSAs experienced a statistically significant shift in the strength of their relationship with the Mexican economy following the implementation of NAFTA, as measured by their average coherences. El Paso, at the 5 percent level of significance, experienced an increase in average coherence with the business cycles of the U.S. and Texas. At the 5 percent level of significance, the other three metros did not see an increase in average coherence with Texas and the U.S., although at the 7 percent level of significance Laredo experienced a stronger relationship with the US business cycle.

The change in the relationships with the U.S. and Texas business cycles after 1994 was different in El Paso than in the other Texas border MSAs. This may be because El Paso is by far the largest of the MSAs, has the largest share of jobs in manufacturing and is closely tied to the maquiladora industry in the neighboring Mexican city of Juarez. While the El Paso apparel manufacturing industry experienced large declines in the second half of the 1990s, industries that produce goods and services for the maquiladora industry experienced growth. As Canas [1] describes, many service industries in El Paso provide support for the maquiladoras in Juarez. Thus in 1995 when the peso devalued, El Paso's direct tie to the maquiladora industry (which can benefit from a peso decline since the labor costs in US dollars decline) and its less dependence on Mexican shoppers helped it to decline less than Laredo and Brownsville. And in 2001, when a US manufacturing decline resulted in a sharp decline in the maquiladora industry (while the peso remained strong), El Paso declined more than the other border cities.[13]

Comparing the results in Tables 5 and 6, it is apparent that allowing different models of different cyclical length and different timing relationships produces evidence of a stronger relationship between the cycles in the MSAs and the broader economies than the simple coincident correlations. While the correlation analysis provided weak evidence that NAFTA resulted in a strengthening of the cyclical relationships between the Mexican economy and the economies of Brownsville, Laredo and McAllen, the spectral analysis provided much stronger evidence of this shift and also of the same shift occurring in El Paso. Phase results revealed that the El Paso's strengthening relationship with Mexico might have been missed with the correlation analysis because strong coherence occurred with Mexico leading the El Paso cycle by about seven months and low coherence occurred at near coincident timing. The correlation analysis revealed weak (statistically insignificant) evidence that the relationship between El Paso and the economies of Mexico and Texas had increased while the spectral analysis provided statistically significant evidence of the increase.

[13] For an overall view of the key industries in the Border cities see Gilmer, Gurch and Wang [7].

Cluster Analysis

As a further analysis of the relationships between the border economies and the broader economies, we perform cluster analysis on the changes in the normalized business cycle indexes. The cluster analysis shows if there are any natural groupings of business cycles that occur. The iterative procedure starts by choosing an initial cluster for splitting based on the largest eigenvalue associated with the second principal component. The chosen cluster is split into two clusters by finding the first two principal components, performing an orthoblique rotation, and assigning each variable to the rotated component with which it has the highest squared correlation. This is performed using an alternating least-squares method and converges rapidly. The number of well-defined clusters is determined when each cluster has only a single eigenvalue greater than one, thus satisfying the most popular criterion for determining the sufficiency of a single underlying factor dimension.[14]

Table 7 shows the proportion of the total variation that is explained by the cluster components as the number of clusters goes from one to seven. In the next column is the maximum second eigenvalue in a cluster. For the period from 1981 to December 1993, two clusters exist based on the criterion of a single underlying factor dimension in each cluster. Based on these criteria, the US business cycle is separated by itself and the rest of the economies are clustered together. Thus, during this time period, the border cities behaved very much like each other and also like the business cycles in Texas and Mexico. One likely reason for this result is the dominant role that oil prices played during this period. Since Mexico and Texas are net energy producers, they benefit from

[14] See the Background description of the VARCLUS procedure in Chapter 68 in the SAS manual or on the web at http://v8doc.sas.com/sashtml/stat/chap68/sevt2.htm.

increases in oil prices while the US, as a net consumer, is hurt. In 1986 when the price of oil dropped sharply, Texas and Mexico entered recession and the border cities followed suit. While most border cities are not large producers of oil and gas, during this time period Laredo had a significant share of employment in oil and gas production.

The period beginning in 1994 had much more stable oil and gas prices and a growing importance of US/Mexico trade and the maquiladora industry in Northern Mexico. As mentioned earlier, these factors had important impacts on the border cities. As shown in Table 8, two clusters are defined post-1994 with El Paso linked to the US and Texas, and the south Texas border cities linked with Mexico. This is consistent with the spectral analysis showing the strengthening relationship that El Paso experienced with Mexico and Texas post-NAFTA. It is also consistent with the statistically larger correlation with Texas than with Mexico that El Paso experienced and the statistically stronger correlation with Texas than with Mexico that the other three metros experienced. El Paso has become increasingly dependent on the US economy through its ties to the large maquiladora industry in Juarez. And as high-tech has grown rapidly in Texas, the state's economy has become more like that of the nation. On the other hand, the border cities in south Texas have become more linked to the fortunes of Mexico by supporting cross border international trade and as a destination for Mexican shoppers.

Regression Analysis

In order to test some of the factors that may have caused differing linkages of the border economies with the broader economies, we regress the first differences of natural logs of the border business cycles on six lags of itself and lags of the log differences in oil prices, maquiladora employment in the Mexican sister city, the real value of U.S./Mexican trade and changes in the real value of the peso. In order to distinguish these factors from the impacts of the movements in the surrounding large economies, we also include a version of the regression with the log differences in the business cycle indexes of the three broader economies. We used the heteroskedasticity-consistent estimator of the variance-covariance matrix, due to White [20], in estimating the four separate regressions. Since the underlying dynamics of the border business cycle indexes are based on the dynamic Kalman Smoother that smoothes over time and across components, it was expected that most of the dynamics in the models would be explained by the lags in the dependent variable. Shocks in the other independent variables likely would not be transmitted into the border business cycle dynamics unless those shocks were large enough to be associated with cyclical movements.

Table 9 defines the variables used and Table 10 shows the results. As shown in Table 10, the border economies of McAllen, Brownsville and Laredo are significantly impacted by changes in the real peso/dollar exchange rate, regardless of whether or not the movements in the business cycles of the broader economies are included in the regression. As stated earlier, big swings in the peso have important impacts on these areas which have a large share of their retail sales purchased by Mexican nationals. In the past, swings in the peso were highly correlated with changes in the Mexican business cycle. But since the peso began to float in the mid-1990s this relationship has changed. During 2001, with the economies of Texas, Mexico and the US in (mild) recession, a relatively strong peso appears to have helped the economies of McAllen, Brownsville and Laredo to avoid recession. Thus, while the previous analysis provided evidence that the business cycles in these three border MSAs have become more aligned with Mexico since the implementation of NAFTA, the regression analysis gives evidence of the significant and independent impacts of movements in the real value of the peso.

For El Paso, the model without the changes in the broader economy business cycles shows that changes in the maquiladora industry have a positive statistically significant (at the 5 percent level) impact on the El Paso business cycle. Once the broader economies are included, however, the relationship is no longer statistically significant and changes in the Texas economy are statistically significant but have a negative impact. Thus the models present some evidence of the importance of the maquiladora industry to El Paso, although the interrelationships between the maquiladora growth and growth in the broader economies of Texas, Mexico and the U.S. causes this evidence to dissipate when these broader economies are included in the model.

Summary

The Texas/Mexico border is a fast growing region that is a complex blend of US and Mexican cultures, languages and customs. It is a dynamic region that has benefited from the large and growing populations in northern Mexico and the rapid growth in US/Mexico trade. In this historically low-wage, high job-growth region, per capita income and earnings in the 1990s have outpaced the national average. The gains have come during a period marked by the implementation of the North American Free Trade Agreement (NAFTA), a prolonged expansion of the maquiladora industry and despite a sharp mid-decade decline in the Mexican peso and economy.

In this paper we use a dynamic single-factor model originally due to Stock and Watson [18, 19] to measure the business cycle in four Texas border Metropolitan Statistical Areas (MSAs) and Mexico. We then measure the degree of economic integration between border cities, the US, Texas, and Mexican economies using correlation, spectral and cluster analysis. Results suggest border MSAs are significantly integrated with the broader economies and that changes have occurred in these relationships since 1994, the year in which NATFA was enacted and the time maquiladora industry began to accelerate. We find that since 1994 the business cycles of the southern border MSAs of Brownsville, McAllen and Laredo have moved in a more similar fashion to the business cycle in Mexico, while El Paso's economy has become relatively more aligned with cycles in Texas and the U.S.

The differing changes in the border MSAs may be due to the greater importance of retail spending by Mexican nationals in the southern border MSAs and the greater importance of the maquiladora industry in El Paso. To study these and other factors we utilize Granger-type regression analysis. Results suggest that changes in the real value of the peso have had significant impacts on Laredo, Brownsville and McAllen whereas changes in the regional maquiladora industry have been more important to the El Paso economy.

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Table 1
S/W Coincident Index Estimates for Texas Border MSAs

El Paso	Coefficient	T-stat	Laredo	Coefficient	T-stat
bEMP	0.422***	4.704	bEMP	0.126***	3.981
bRETSAL	0.028**	2.338	bRETSAL	0.017***	3.504
bWAGES	0.031**	3.112	bWAGES	0.016***	3.868
bUR	-0.339**	-2.443	bUR	-0.204***	-3.023
bUR1	0.185	1.331	bUR1	0.133**	2.293
arEMP1	-0.262**	-2.506	arEMP1	-0.316***	-4.688
arEMP2	-0.221***	-2.783	arEMP2	-0.173***	-2.614
arRETSAL1	-0.229**	-2.165	arRETSAL1	0.079	0.711
arRETSAL2	0.044	0.424	arRETSAL2	0.126	1.146
arWAGES1	-0.545***	-4.945	arWAGES1	-0.549***	-4.549
arWAGES2	-0.093	-0.849	arWAGES2	-0.202*	-1.772
arUR1	-0.429***	-6.594	arUR1	-0.331***	-5.035
arUR2	-0.176**	-2.248	arUR2	-0.255***	-3.854
sEMP	0.798***	11.720	sEMP	0.795***	21.075
sRETSAL	0.940***	13.421	sRETSAL	0.747***	12.328
sWAGES	0.827***	13.047	sWAGES	0.681***	11.348
sUR	0.849***	13.590	sUR	0.852***	19.493
coinindxar1	0.633***	2.627	coinindxar1	0.917***	7.831
coinindxar2	-0.352	-1.217	coinindxar2	0.693***	3.624
coinindxar3	0.434***	2.941	coinindxar3	-0.693***	-5.720
Sum of AR=.715			Sum of AR=.917		

Table 1 (continued)
S/W Coincident Index Estimates for Texas Border MSAs

Brownsville	Coefficient	T-stat	McAllen	Coefficient	T-stat
bEMP	0.522***	5.974	bEMP	0.486***	5.270
bRETSAL	0.106***	5.116	bRETSAL	0.097***	4.773
bWAGES	0.060***	4.506	bWAGES	0.161***	3.794
bUR	-0.202***	-4.397	bWAGES1	-0.085*	-1.906
arEMP1	-0.263**	-2.247	bUR	-0.240***	-3.904
arEMP2	-0.123	-1.008	arEMP1	-0.416***	-5.110
arRETSAL1	-0.094	-0.652	arRETSAL1	-0.177	-1.168
arRETSAL2	-0.006	-0.052	arWAGES1	-0.175	-1.455
arWAGES1	-0.511***	-4.510	arUR1	-0.356***	-5.599
arWAGES2	-0.248**	-2.225	arUR2	-0.224***	-3.585
arUR1	-0.499***	-8.188	sEMP	0.734***	12.507
arUR2	-0.280***	-4.633	sRETSAL	0.783***	9.753
sEMP	0.755***	11.688	sWAGES	0.722***	10.144
sRETSAL	0.701***	9.473	sUR	0.885***	21.233
sWAGES	0.809***	12.005	coinindxar1	0.319**	2.001
sUR	0.853***	21.804	coinindxar2	0.107	1.061
coinindxar1	0.116	0.648	coinindxar3	-0.331***	-2.670
coinindxar2	0.007	0.055	coinindxar4	0.465***	3.788
coinindxar3	0.521***	4.059			
Sum of AR=.645			Sum of AR=.561		

*p<.10; **p<.05; ***p<.01
Monthly data range is 1980:01 -- 2002:11 for McAllen, Brownsville, and Laredo. For El Paso data range is 1978:01--2002:11.
Quarterly data range is 1980:01 -- 2002:02 for Brownsville, and Laredo. In the case of McAllen quarterly data leads to 2002:04. For El Paso quarterly data range is 1978:01 2002:02.

Table 2
Specification Tests for Border Coincident Indexes
F-Statistics for 6-lag specification test, dependent variable is one-step ahead forecast error

	Dependent Variables					Dependent Variables			
El Paso	eEMP	eRETSAL	eWAGES	eUR	Laredo	eEMP	eRETSAL	eWAGES	eUR
eEMP	1.101	0.763	2.768**	0.363	eEMP	0.729	3.842***	0.634	1.836
eRETSAL	3.598***	1.355	0.856	1.000	eRETSAL	1.140	1.220	0.939	2.506**
eWAGES	2.791**	1.141	0.599	2.224*	eWAGES	1.920	0.819	0.116	0.593
eUR	0.539	1.051	0.792	0.928	eUR	2.764***	2.207**	2.324**	0.692
EMP	0.709	0.360	2.639**	0.184	EMP	0.740	3.982***	1.309	1.095
RETSAL	3.400***	1.413	1.094	0.815	RETSAL	1.401	1.462	1.136	1.984
WAGES	2.794**	0.631	2.006	2.540**	WAGES	0.425	1.640	0.657	1.413
UR	0.507	0.650	0.693	1.505	UR	2.863***	1.783	2.431**	0.671
Brownsville					McAllen				
eEMP	0.648	1.223	1.736	1.682	eEMP	1.298	1.767	1.184	1.843*
eRETSAL	1.155	1.094	1.228	0.930	eRETSAL	2.452**	0.802	0.951	1.304
eWAGES	0.621	0.629	0.224	0.363	eWAGES	1.803	1.533	0.570	0.355
eUR	1.112	0.420	0.688	1.198	eUR	2.690**	1.422	1.013	1.035
EMP	0.458	1.727	1.856	1.495	EMP	1.066	1.954**	0.829	1.375
RETSAL	1.421	1.102	2.159*	1.207	RETSAL	2.198	1.842*	0.955	2.259**
WAGES	0.925	1.052	0.254	0.880	WAGES	2.371**	1.652	0.723	0.916
UR	0.921	0.333	0.416	1.696	UR	3.033***	1.617	0.464	1.494

Table 2 (continued)
Cumulative Dynamic Multipliers

El Paso	Multiplier	Share	Laredo	Multiplier	Share
EMP	1.252	52.138	EMP	2.819	39.135
RETSAL	0.107	4.472	RETSAL	0.570	7.920
WAGES	0.220	9.178	WAGES	0.904	12.551
UR	-0.821	34.210	UR	-2.910	40.393
Brownsville			McAllen		
EMP	0.841	55.293	EMP	0.808	54.938
RETSAL	0.212	13.987	RETSAL	0.135	9.227
WAGES	0.141	9.332	WAGES	0.217	14.800
UR	-0.325	21.387	UR	-0.309	21.032

*p<.10; **p<.05; ***p<.01. Ho: Coefficients are jointly zero.
Monthly data range is 1980:01 -- 2002:11 for McAllen, Brownsville, and Laredo. For El Paso data range is 1978:01--2002:11.
Quarterly data range is 1980:01 -- 2002:02 for Brownsville, and Laredo. In the case of McAllen quarterly data leads to 2002:04. For El Paso quarterly data range is 1978:01--2002:02.

Table 3
S/W Coincident Index Parameter
Estimates for Mexico

Mexico	*Coefficient*	*T-stat*
bINDPROD	0.293***	4.781
bGDP	0.104***	5.145
bADJEMP	0.420***	5.209
arindprod1	-0.540***	-8.042
arindprod2	-0.110	-1.683
argdp1	-0.666*	-1.913
argdp2	-0.117	-0.479
aradjemp1	0.237**	2.849
aradjemp2	-0.254***	-3.414
sindprod	0.814***	20.161
sgdp	0.342***	3.087
sadjemp	0.803***	16.183
coinindxar1	0.425**	1.997
coinindxar2	0.216	1.201

*p<.10; **p<.05; ***p<.01
Monthly data range is 1980:01 -- 2002:10.
Quarterly data range is 1980:01 -- 2002:03

Whiteness Tests and the Cumulative Dynamic Multipliers
F-Statistics for 6-lag specification test

	eINDPROD	eGDP	eADJEMP
eINDPROD	0.612	1.192	2.847***
eGDP	0.884	0.741	1.463
eADJEMP	0.804	1.173	1.166
INDPROD	0.897	0.757	3.544***
GDP	0.605	1.284	2.445**
ADJEMP	0.742	1.225	1.452

	Multiplier	Share
INDPROD	0.555	38.969
GDP	0.396	27.824
ADJEMP	0.473	33.207

*p<.10; *p<.05; ***p<.01. Ho: Coefficients are jointly zero.
Monthly data range is 1980:01 -- 2002:10.
Quarterly data range is 1980:01 -- 2002:03

Table 4
Pearson Correlation Coefficients
Nov. 1980 to Oct. 2002
p-values for significance of coefficient reported below coefficient value

	Mexico	El Paso	Laredo	Brownsville	McAllen	Texas	USA
Mexico	1.0	0.31968	0.58997	0.38447	0.26305	0.43502	0.22234
	0.0	0.0	0.0	0.0	0.0	0.0	0.0
El Paso		1.0	0.61497	0.54967	0.32946	0.54853	0.29892
		0.0	0.0	0.0	0.0	0.0	0.0
Laredo			1.0	0.63432	0.52187	0.62486	0.17003
			0.0	0.0	0.0	0.0	0.0
Brownsville				1.0	0.37353	0.50893	0.19218
				0.0	0.0	0.0	0.0
McAllen					1.0	0.39756	0.03704
					0.0	0.0	0.5
Texas						1.0	0.29768
						0.0	0.0
USA							1.0

Table 5
Pearson Correlation Coefficients*

	Mexico	Texas	U.S.A.
El Paso (1981-1993)	0.41629	0.56366	0.29142
(1994-2002)	0.27267	0.63885	0.38607
p-value	0.2010	0.3576	0.401
Laredo (1981-1993)	0.56396	0.74553	0.169
(1994-2002)	0.78784	0.18329	0.17299
p-value	0.001	0.001	0.976
Brownsville (1981-1993)	0.4097	0.57491	0.21554
(1994-2002)	0.41551	0.26121	0.10718
p-value	0.960	0.002	0.384
McAllen (1981-1993)	0.27493	0.43701	0.02486
(1994-2002)	0.34241	0.18872	0.06498
p-value	0.562	0.036	0.774

P-value that correlation with Mexico is less than (81-93) or greater than (94-02) Texas

	1981-1993	1994-2002
El Paso	0.04	0.99 (.001)**
Laredo	0.002	0.001
Brownsville	0.03	0.078
McAllen	0.051	0.11

* P-value is for the null hypothesis that the correlation coefficients are equal in the two periods. See Morrison, pages 104-105.

** Test that correlation is greater with Texas than Mexico

Table 6
Coherence Summary Statistics

	1985-1993 period			1994-2002 period		
	Peak (phase)@	Median	Mean	Peak (phase)@	Median	Mean
El Paso vs. U.S.	0.69243 (-2.2)	0.0985	0.25469	0.92992 (-3.6)	0.58664	0.59080
El Paso vs. TX	0.71192 (-.4)	0.3043	0.38644	0.93743 (1.7)	0.74151	0.68741
El Paso vs. Mexico	0.71647 (-3.5)	0.1748	0.29327	0.87903 (-6.9)	0.64622	0.60900
Laredo vs. U.S.	0.5639 (-2.9)	0.3051	0.34587	0.78274 (3.6)	0.44846	0.44304
Laredo vs. TX	0.96522 (2.6)	0.7645	0.66522	0.83963 (-.3)	0.58661	0.54602
Laredo vs. Mexico	0.87477 (1.8)	0.4343	0.45612	0.93512 (-1.8)	0.84993	0.80075
Brownsville vs. U.S.	0.90747 (-4.6)	0.6390	0.53169	0.5973 (-.7)	0.48105	0.39508
Brownsville vs. TX	0.90753 (-.6)	0.5681	0.59260	0.79606 (4.0)	0.56433	0.56116
Brownsville vs. Mexico	0.78782 (2.5)	0.4100	0.42581	0.84018 (4.0)	0.68445	0.63887
McAllen vs. U.S.	0.89094 (-1.5)	0.5347	0.55571	0.70396 (1.0)	0.33558	0.36523
McAllen vs. TX	0.6696 (2.2)	0.4074	0.41121	0.81366 (5.2)	0.49289	0.41641
McAllen vs. Mexico	0.76574 (-1.9)	0.3093	0.32555	0.75506 (-10.6)	0.63366	0.60652

Table 6 (continued)
Coherence Summary Statistics

	Test for Mean Change			JB Test[b]		
	U.S.A.	Texas	Mexico	U.S.A.	Texas	Mexico
El Paso						
1985-1993	0.2547	0.3864	0.2933	5.1697	5.0410	3.0259
1994-2002	0.5908	0.6874	0.6090	1.9826	1.8272	2.5777
p-value	0.0031	0.0062	0.0085			
Laredo						
1985-1993	0.3459	0.6652	0.4561	4.8731	7.5004	4.8466
1994-2002	0.4430	0.5460	0.8008	2.0965	25.3118**	3.7048
p-value	0.0699	0.314*	0.0072			
Brownsville						
1985-1993	0.5317	0.5926	0.4258	4.8823	4.3716	5.2555
1994-2002	0.3951	0.5612	0.6389	1.8209	2.4657	2.7719
p-value	0.2160	0.7103	0.0142			
McAllen						
1985-1993	0.5557	0.4112	0.3255	3.4715	8.96**	5.3263
1994-2002	0.3652	0.4164	0.6065	2.0586	2.5909	2.5370
p-value	0.0637	0.953*	0.0120			

[a]Mean Equality Test. Ho: $mean_1=mean_2$; Ha: Not Ho.
[b]Jarque-Bera statistic follows a Chi-square distribution with 2 degrees of freedom (JB=5.999, at 5% significance level). Ho: Normality; Ha: Not Ho.
[*]Computed by applying the Wilcoxon Signed Ranks Tests since the assumption of normality was not met. Ho: $mean_1=mean_2$; Ha: Not Ho. [**] Normality assumption rejected at the 5% significance level.
[@] Represents the lead (+) or the lag(-) of the Metropolitan Statistical Areas in months at the peak coherence.
Coherence analysis based on periods of approximately 12 months or longer.

Table 7
Oblique Principal Component Cluster Analysis
1981-1993 period

No. of Clusters	Proportion of Variation Explained by Clusters	Maximum Second Eigenvalue in a Cluster
1	0.6373	1.0636
2*	0.7607	0.5412
3	0.8305	0.5029
4	0.8955	0.3231
5	0.9417	0.2675
6	0.9794	0.1445
7	1.0000	0.0000

Cluster Description

Cluster 2	**Cluster 3**	**Cluster 4**	**Cluster 5**	**Cluster 6**
Mexico El Paso Laredo Brownsville McAllen Texas	El Paso Laredo Brownsville McAllen	El Paso Laredo Brownsville	El Paso Laredo Brownsville	Laredo Brownsville
USA	USA	USA	USA	USA
	Mexico Texas	Mexico Texas	Mexico	Mexico
		McAllen	McAllen	McAllen
			Texas	Texas
				El Paso

Table 8
Oblique Principal Component Cluster Analysis
1994-2002 period

No. of Clusters	Proportion of Variation Explained by Clusters	Maximum Second Eigenvalue in a Cluster
1	0.5636	1.4993
2*	0.7693	0.5683
3	0.8407	0.4022
4	0.8919	0.3501
5	0.9420	0.2430
6	0.9767	0.1633
7	1.0000	0.0000

Cluster Description

<table>
<tr><th>Cluster 2</th><th>Cluster 3</th><th>Cluster 4</th><th>Cluster 5</th><th>Cluster 6</th></tr>
<tr><td rowspan="4">Mexico
Laredo
Brownsville
McAllen</td><td rowspan="2">Mexico
Laredo</td><td rowspan="2">Mexico
Laredo</td><td rowspan="2">Mexico
Laredo</td><td rowspan="2">Mexico
Laredo</td></tr>
<tr></tr>
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Texas</td><td rowspan="2">El Paso
Texas</td><td rowspan="2">El Paso
Texas</td><td>El Paso</td></tr>
<tr><td>McAllen</td></tr>
<tr><td rowspan="3">El Paso
USA
Texas</td><td rowspan="2">Brownsville
McAllen</td><td>McAllen</td><td>USA</td></tr>
<tr><td rowspan="2">Brownsville
McAllen</td><td>USA</td><td>Brownsville</td></tr>
<tr><td>USA</td><td>Brownsville</td><td>Texas</td></tr>
</table>

Table 9
Variable Definition

BC	Coincident index for each Texas–Mexico border Metropolitan Statistical Area (MSA) El Paso, McAllen, Brownsville, and Laredo
MAQEMP	Maquiladora employment for Mexican cities bordering with Texas MSAs. El Paso–Ciudad Juarez; McAllen–Matamoros; Brownsville–Reynosa; Laredo–Nuevo Laredo
OIL	Spot Price of West Texas Intermediate Crude oil deflated by U.S. CPI
RER	U.S.–Mexico real exchange rate estimated by Federal Reserve Bank of Dallas
TRADE	Dollar value of U.S.–Mexico total trade deflated by U.S. CPI

NOTE: All independent variables are seasonally-adjusted and smoothed with the filter 1/6(1,2L,2L**2,1L**3). In the regressions variables were logged and differenced, with the exception of RER that was run in first difference.

Table 10
Estimated Equations Explaining Variation in Border Business Cycles

Change in Coincident Index	Past changes in CI	MAQEMP	OIL	RER	TRADE	$\overline{R}^2$	Chow Breakpoint test[a]
El Paso	0.736***	0.146**	0.012	-0.121	0.143	0.78	0.785
McAllen	0.659***	0.043	0.027	-0.349**	-0.036	0.64	0.511
Laredo	0.864***	-0.009	-0.009	-0.037***	0.013	0.99	1.176
Brownsville	0.556***	0.022	-0.045	-0.390***	-0.200	0.64	0.922

Change in Coincident Index	Past changes in CI	MAQEMP	OIL	RER	TRADE	USA	TEXAS	MEXICO	$\overline{R}^2$	Chow Breakpoint test[a]
El Paso	0.768***	0.094	-0.024	-0.059	0.189	0.029	-0.033***	0.073	0.79	0.591
McAllen	0.626***	0.015	-0.034	-0.298**	-0.037	0.020	0.084***	0.020	0.65	0.719
Laredo	0.945***	-0.017	-0.010	-0.039***	-0.007	-0.001	0.014	0.019	0.99	1.652**
Brownsville	0.607***	2.020	-0.116	-0.329***	0.176	-0.005	0.132**	-0.041	0.64	0.719

Variable definitions are given in Table 9. Models were estimated using a 5-lag structure for El Paso, McAllen, and Brownsville. For Laredo a 6-lag structure was used.
Lag structure was defined by starting with 6 lags of each variable and then simultaneously dropping one lag of each variable until the Akaike information criterion reached a minimum.
Coefficients reported are the sum from each lagged variable in standardized format. Data range was 1981:08–2002:10, except for Laredo, where maquiladora employment limited the data to 1990:01-2001:10.
*,**,*** denotes jointly significant at the 10%, 5%, and 1% levels, respectively. Ho: Coefficients are jointly zero.
[a]Test for structural change after 1993:12. Each cell reports the F-statistic. Ho: No structural change.

Chart 1
Border Business Cycles
S/W Coincident Indexes

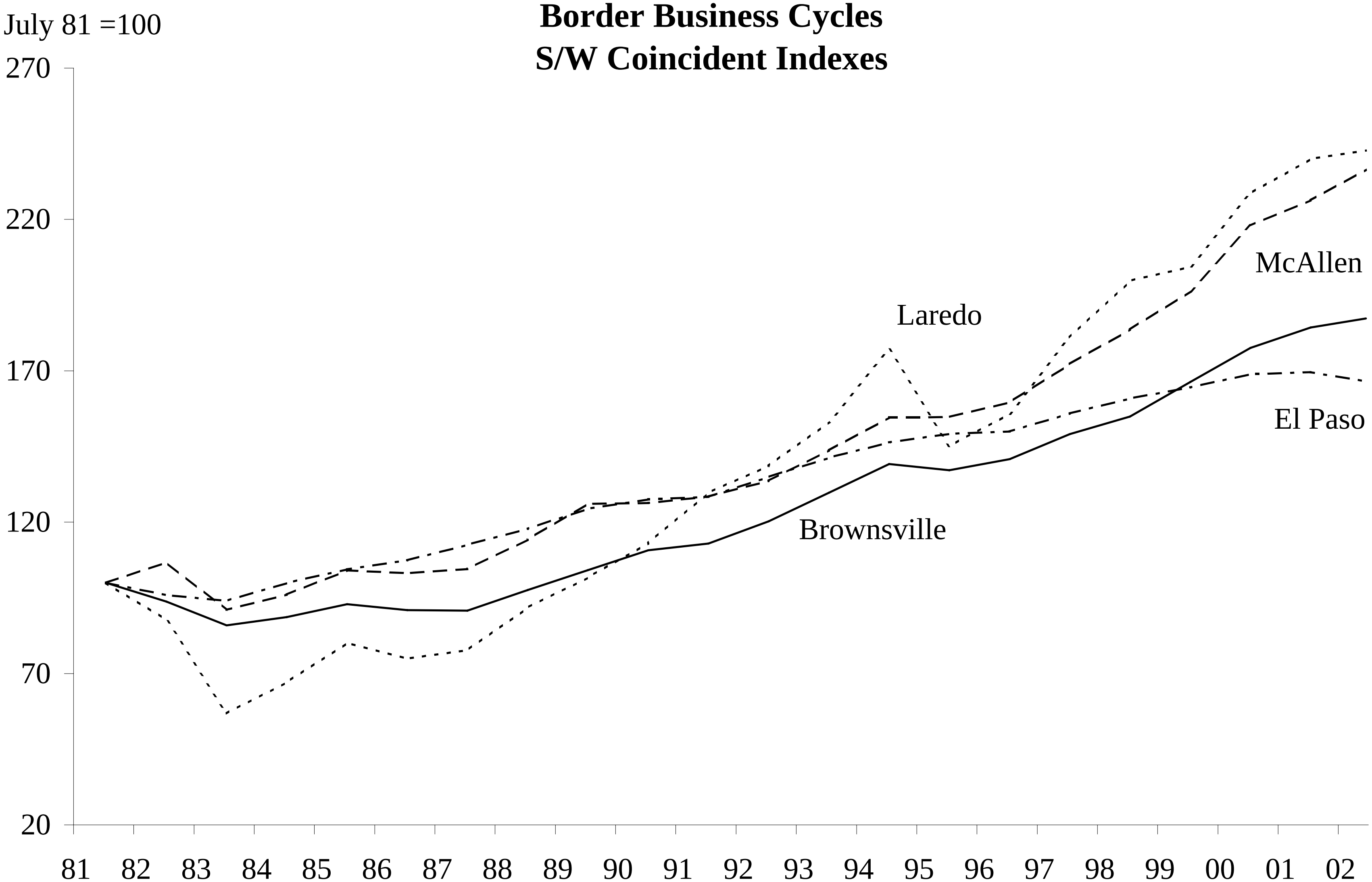


Chart 2
El Paso and Broader Business Cycles
S/W Coincident Indexes

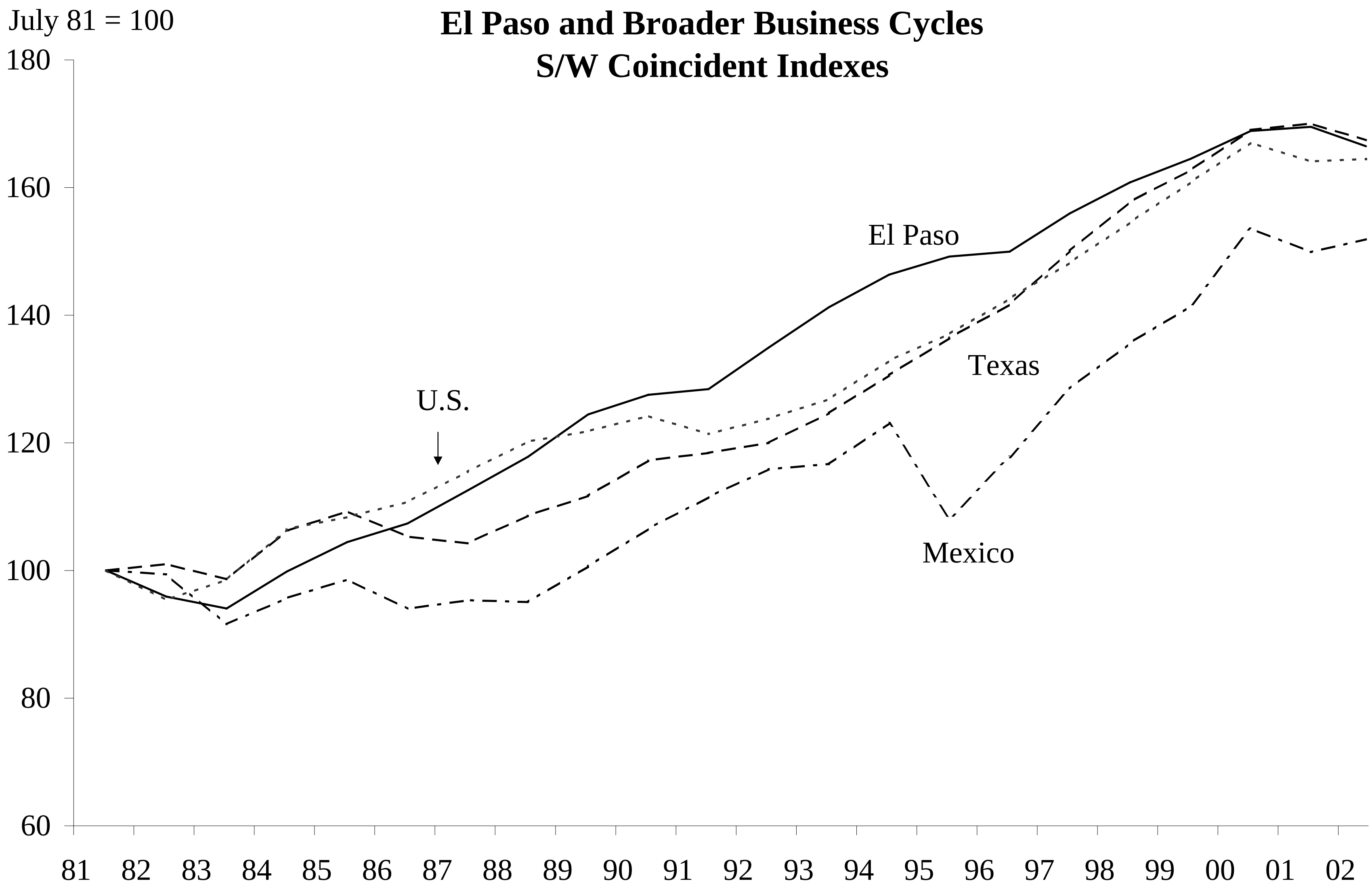


Chart 3
Brownsville and Broader Business Cycles
S/W Coincident Indexes

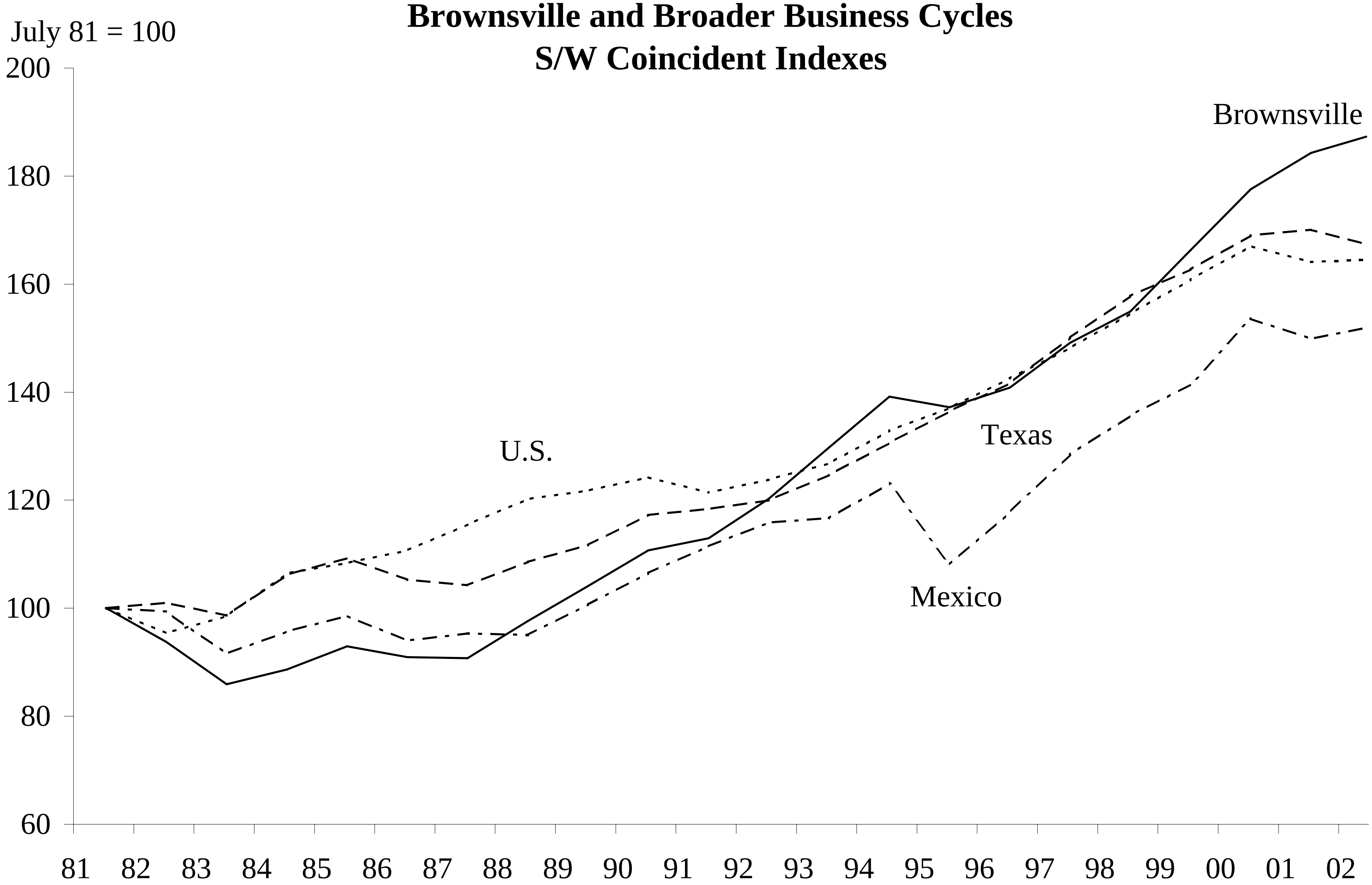


Chart 4
Laredo and Broader Business Cycles
S/W Coincident Indexes

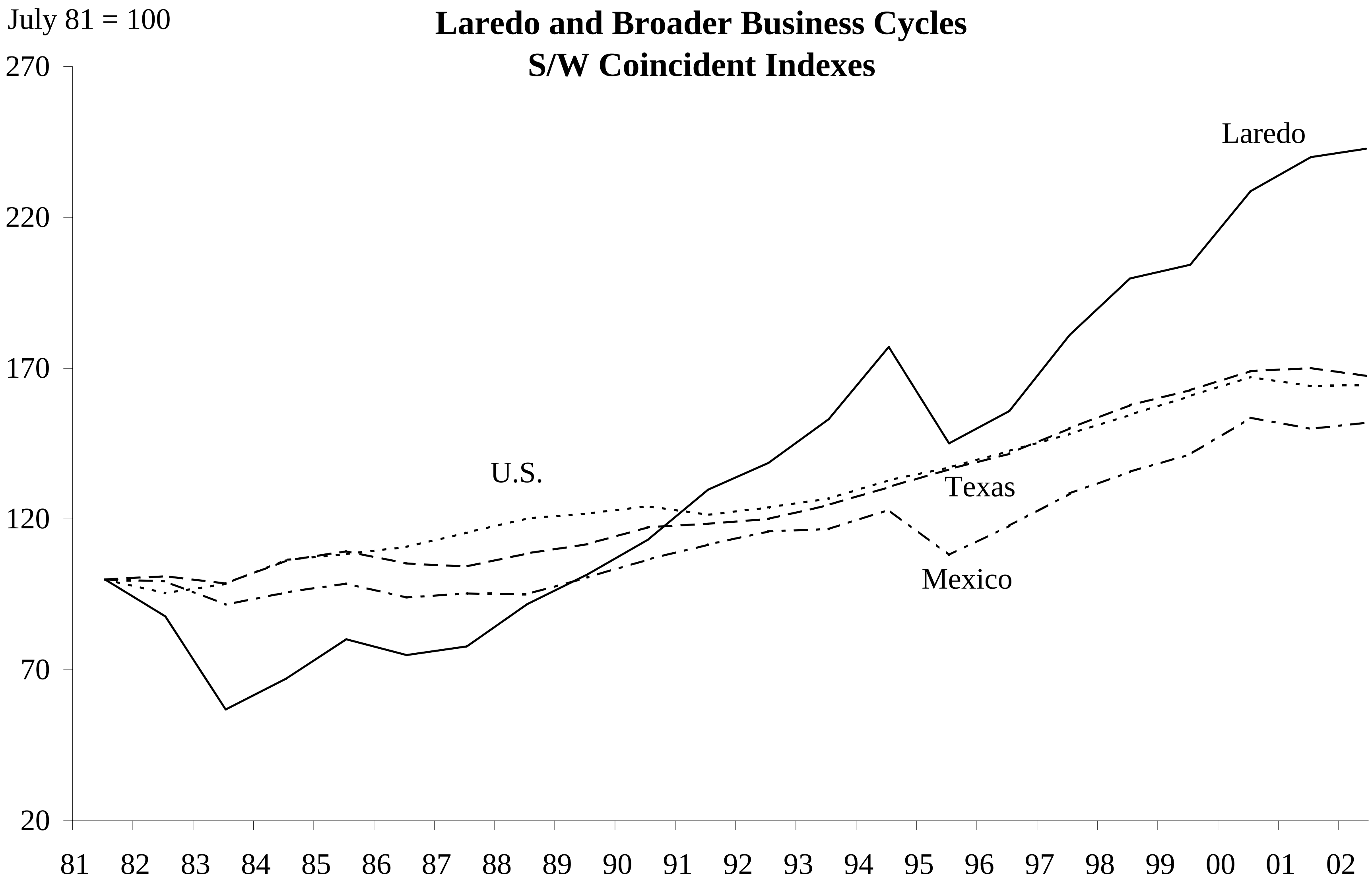


Chart 5
McAllen and Broader Business Cycles
S/W Coincident Indexes

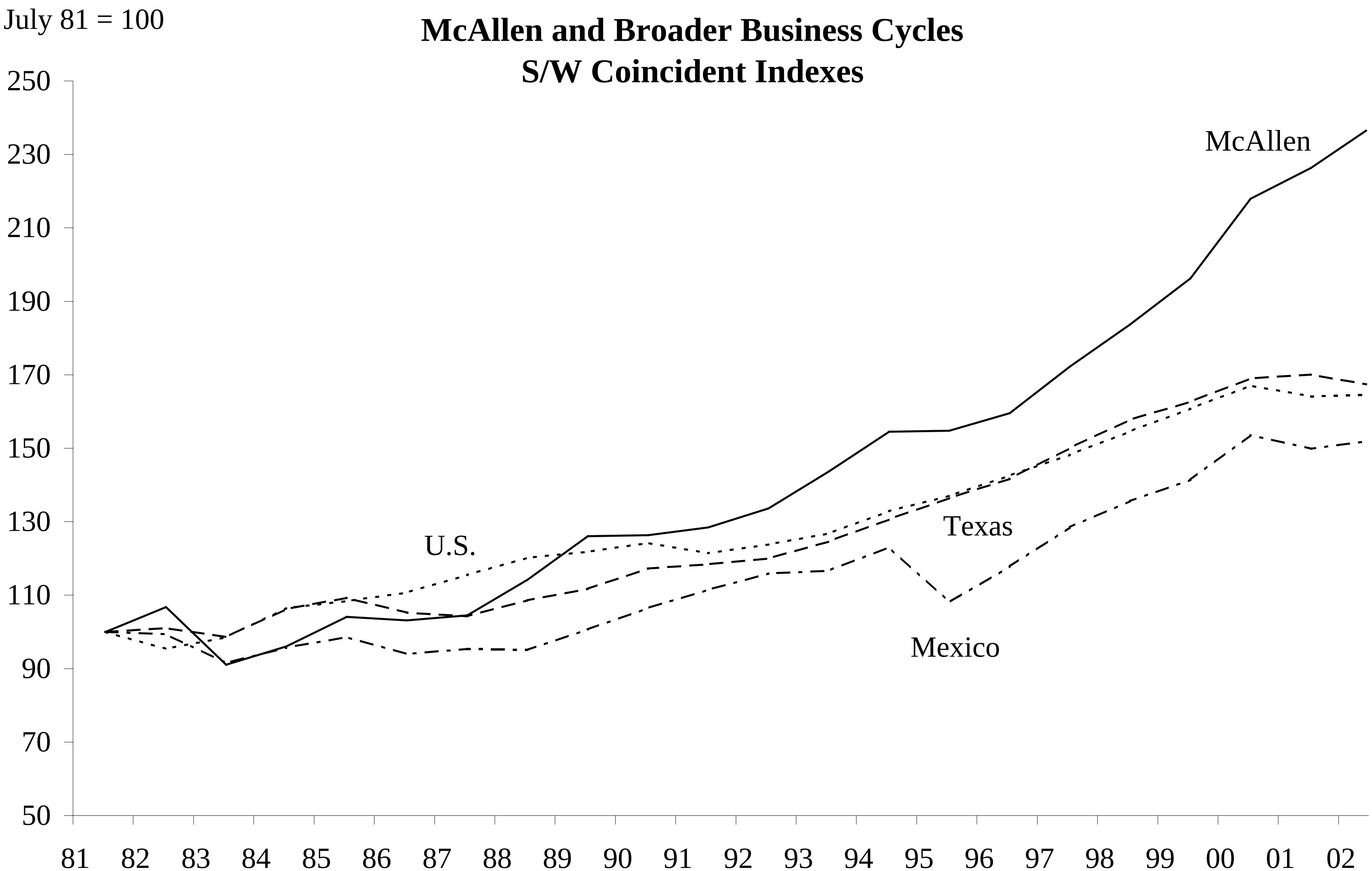


Chart 6a
El Paso
Coherence vs. Period, 1981-2002

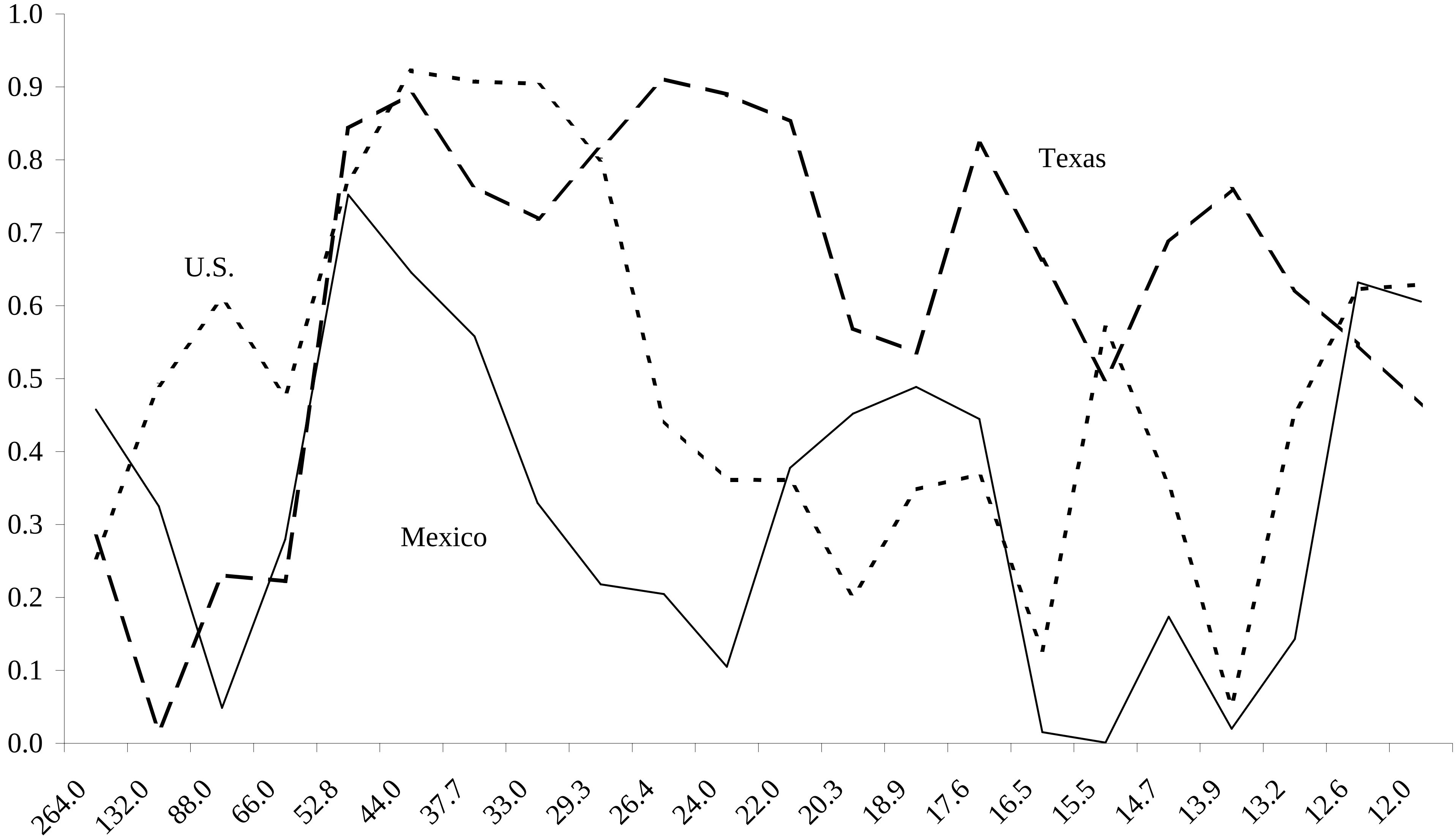


Chart 6b
El Paso
Adjphase vs. Period, 1981-2002

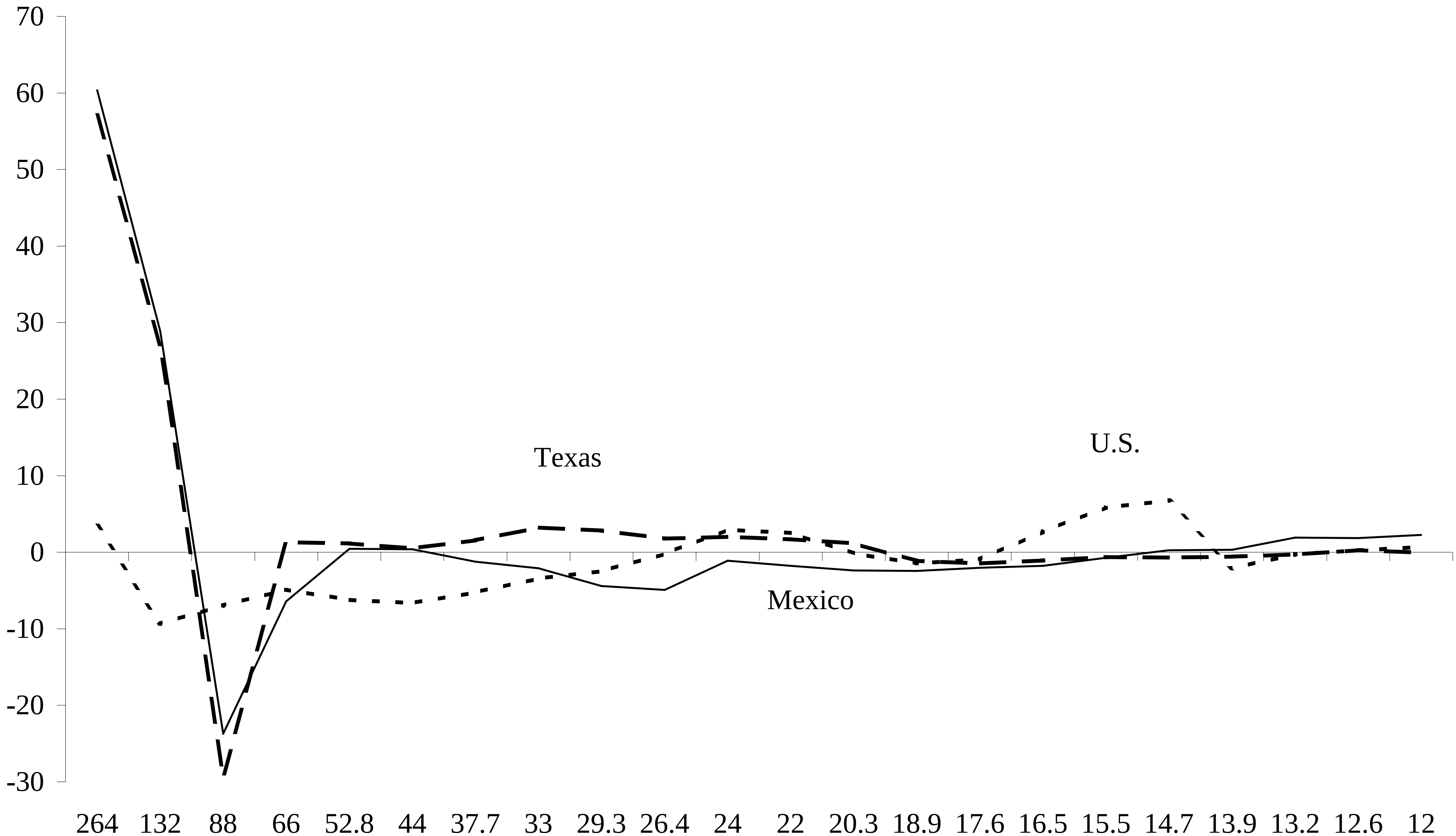


Chart 7a
Laredo
Coherence vs. Period, 1981-2002

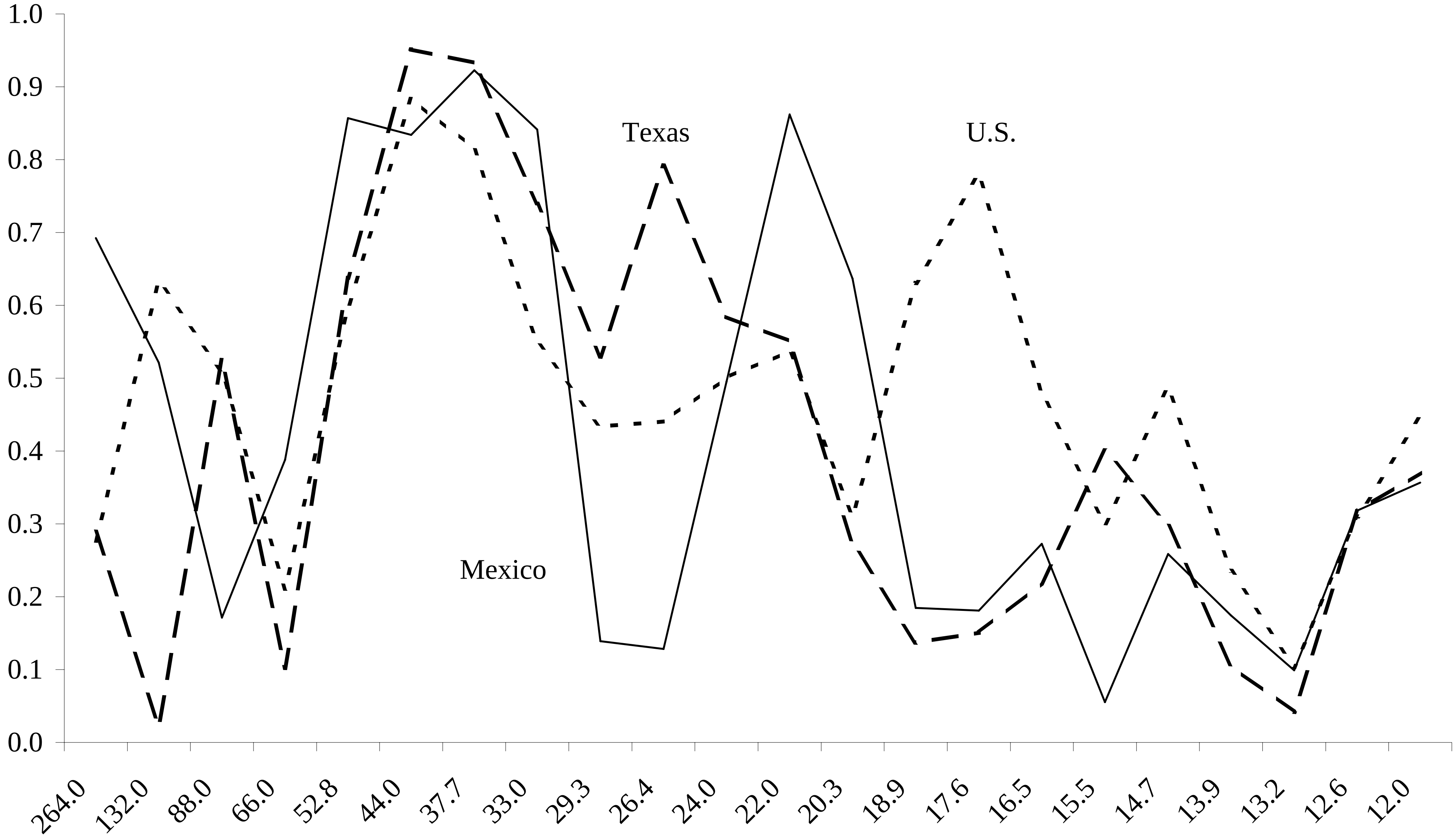
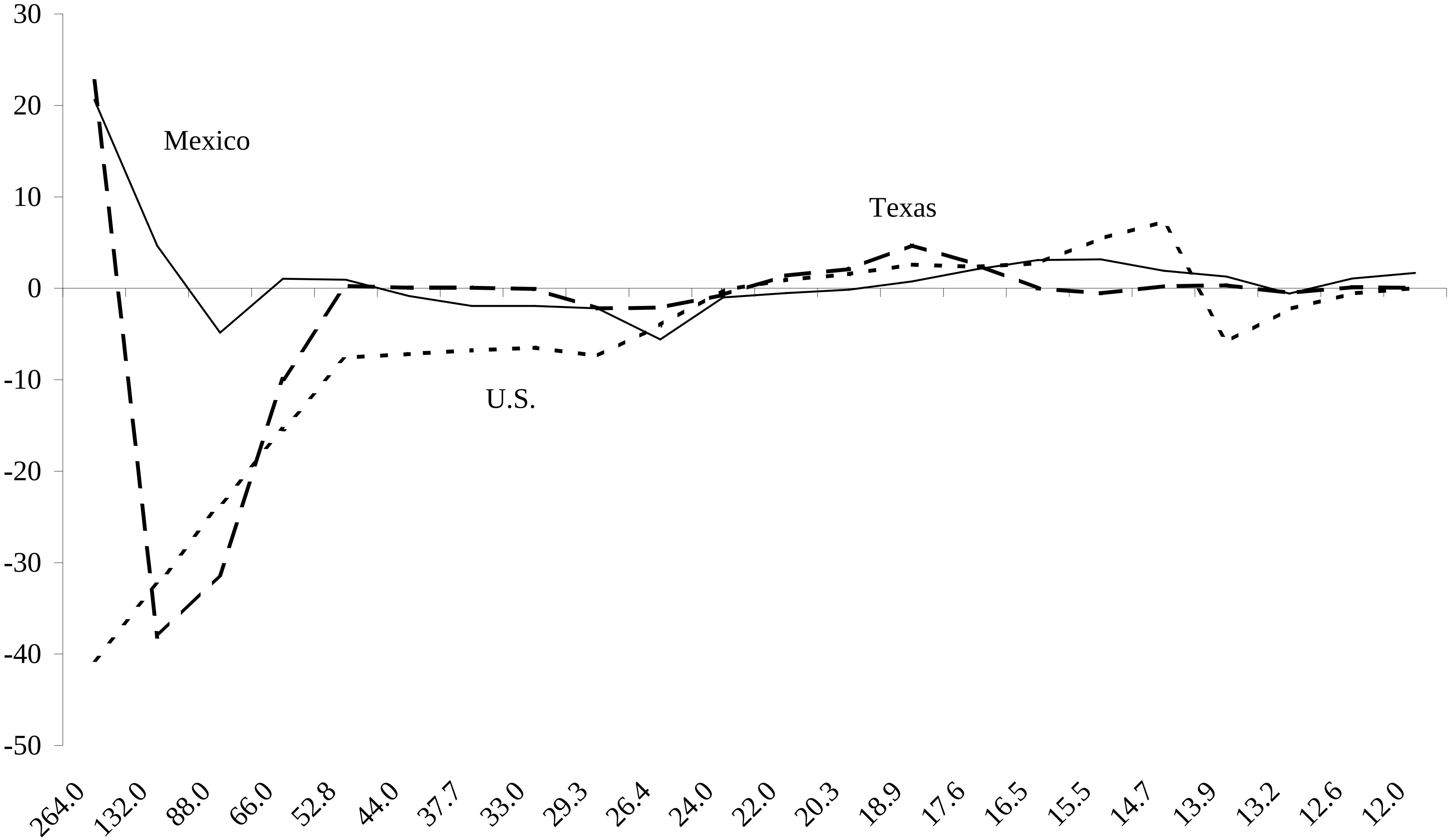


Chart 7b
Laredo
Adjphase vs. Period, 1981-2002



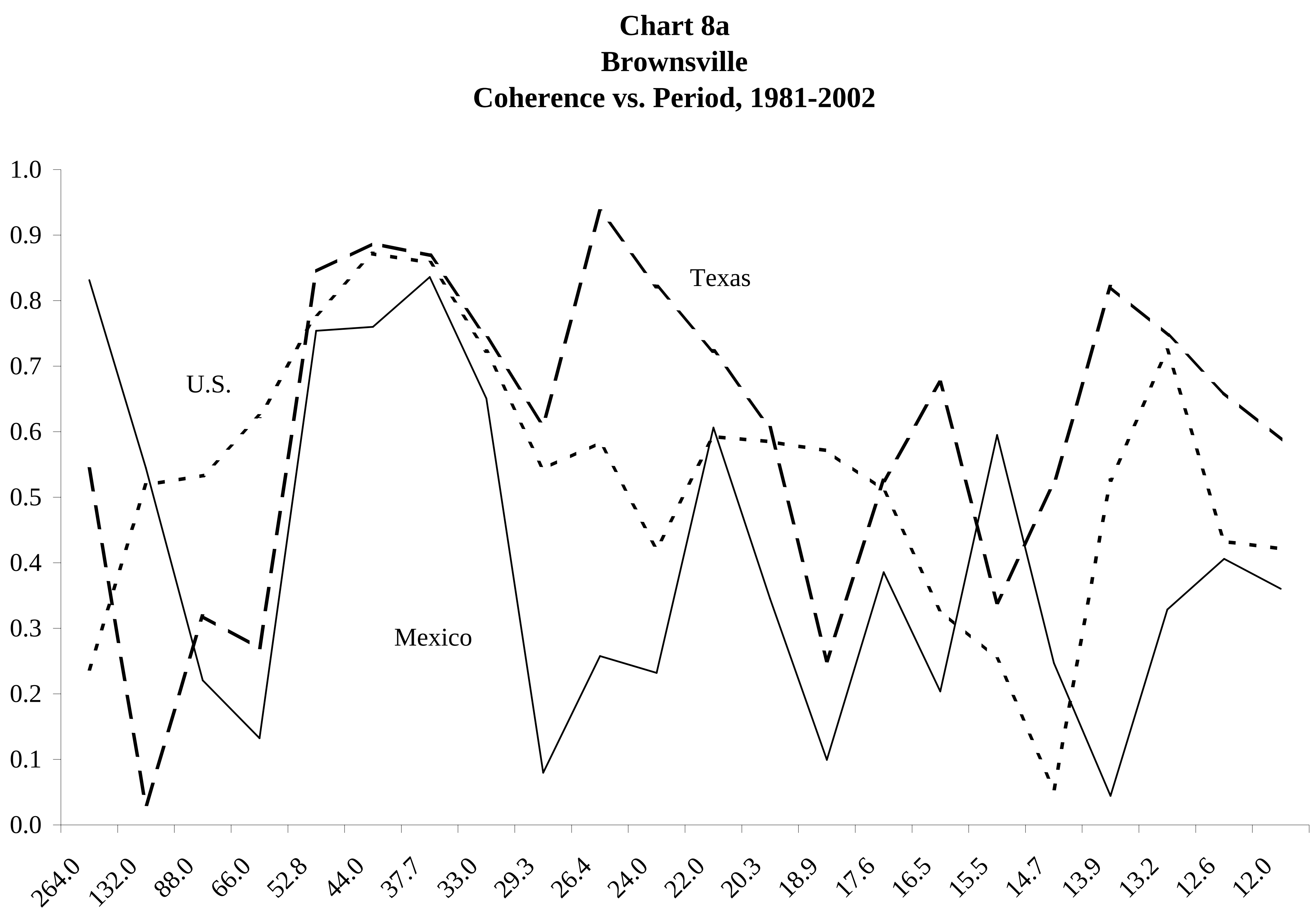


Chart 8a
Brownsville
Coherence vs. Period, 1981-2002
1.0
0.9
0.8
0.7
0.6
0.5
0.4
0.3
0.2
0.1
0.0
Texas
U.S.
Mexico
264.0
132.0
88.0
66.0
52.8
44.0
37.7
33.0
29.3
26.4
24.0
22.0
20.3
18.9
17.6
16.5
15.5
14.7
13.9
13.2
12.6
12.0

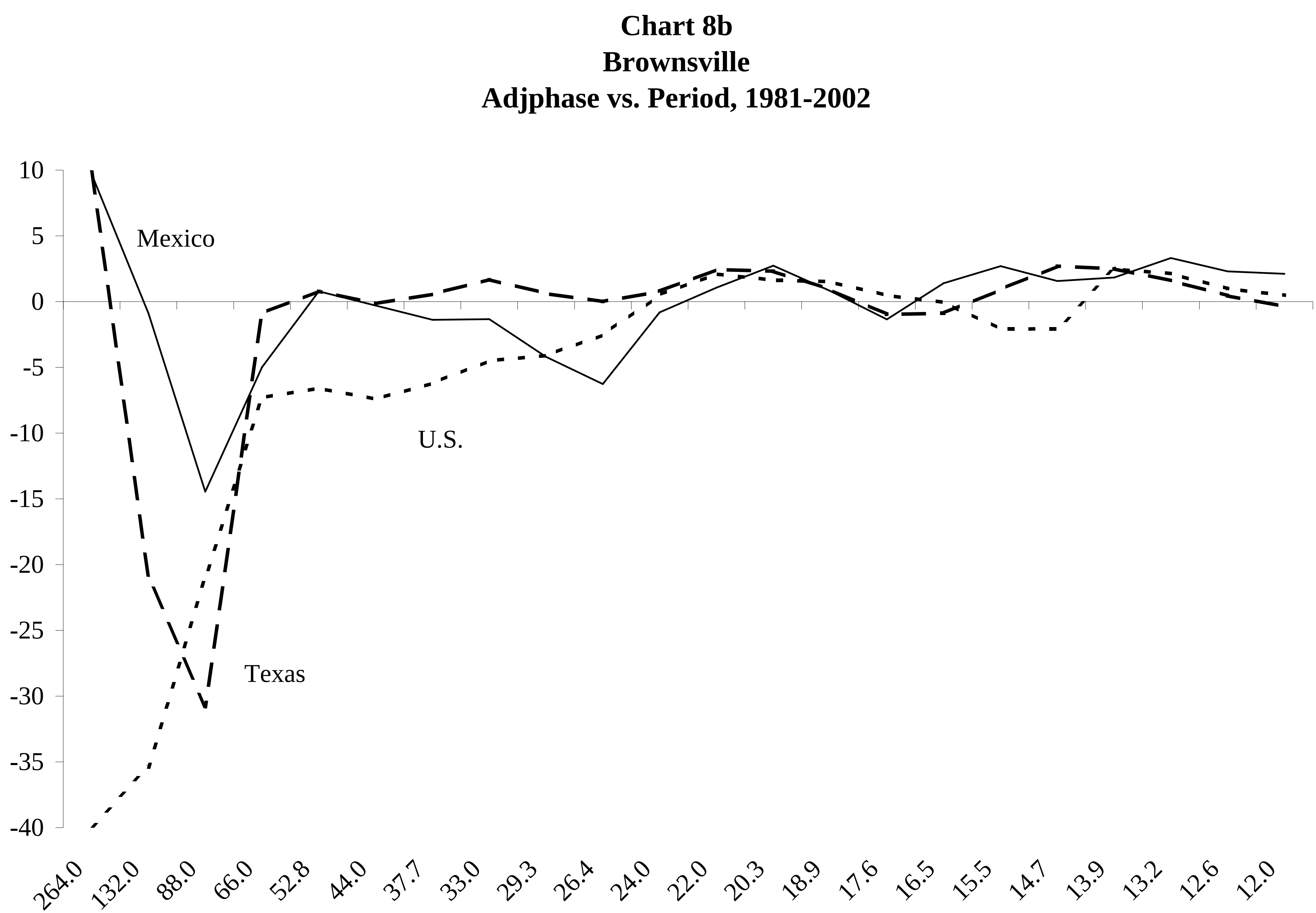


Chart 8b
Brownsville
Adjphase vs. Period, 1981-2002
10
5
0
-5
-10
-15
-20
-25
-30
-35
-40
Mexico
U.S.
Texas
264.0
132.0
88.0
66.0
52.8
44.0
37.7
33.0
29.3
26.4
24.0
22.0
20.3
18.9
17.6
16.5
15.5
14.7
13.9
13.2
12.6
12.0

Chart 9a
McAllen
Coherence vs. Period, 1981-2002

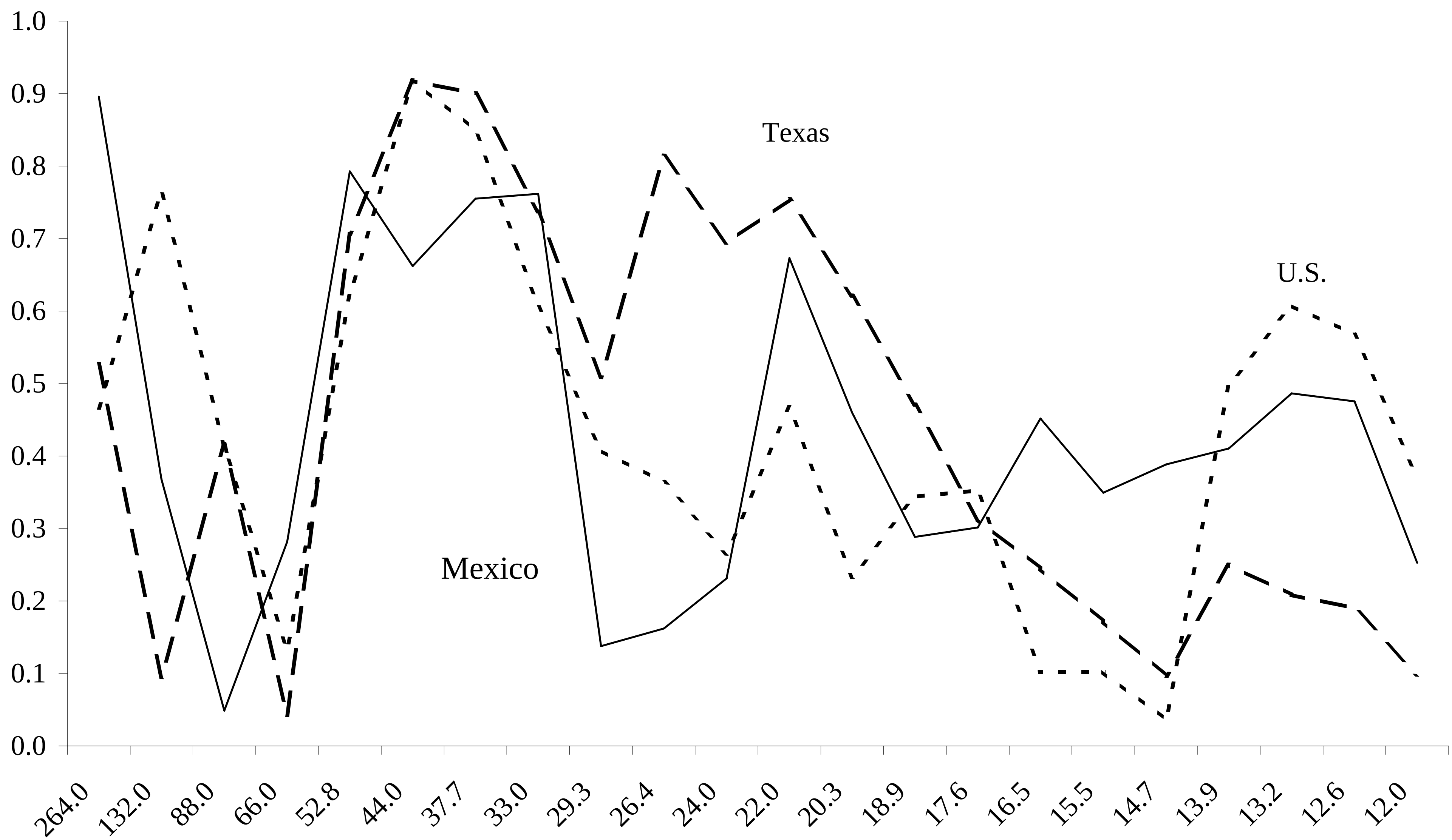


Chart 9b
McAllen
Adjphase vs. Period, 1981-2002

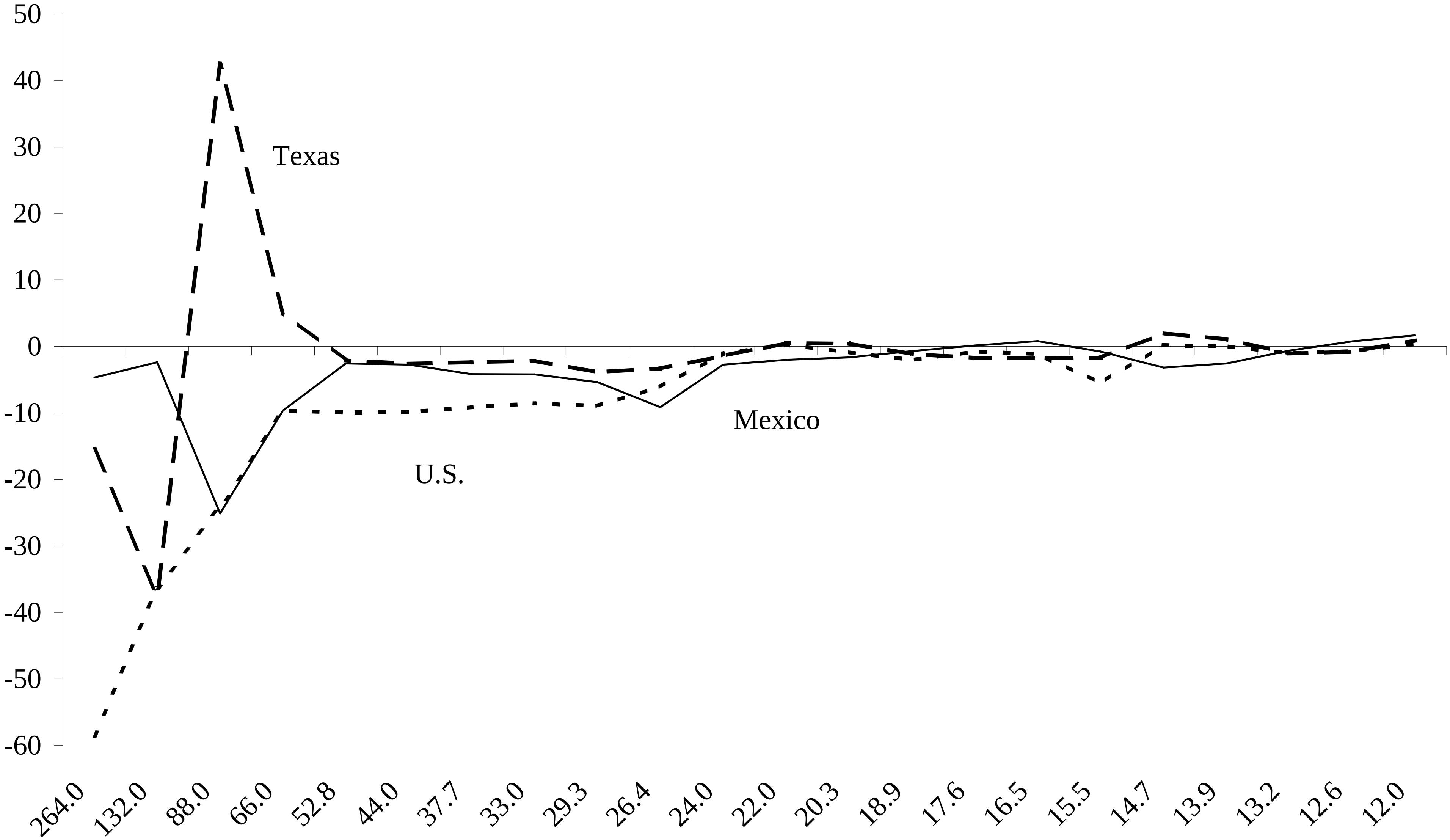


Chart 10a
El Paso
Coherence vs. Period, 1985-1993

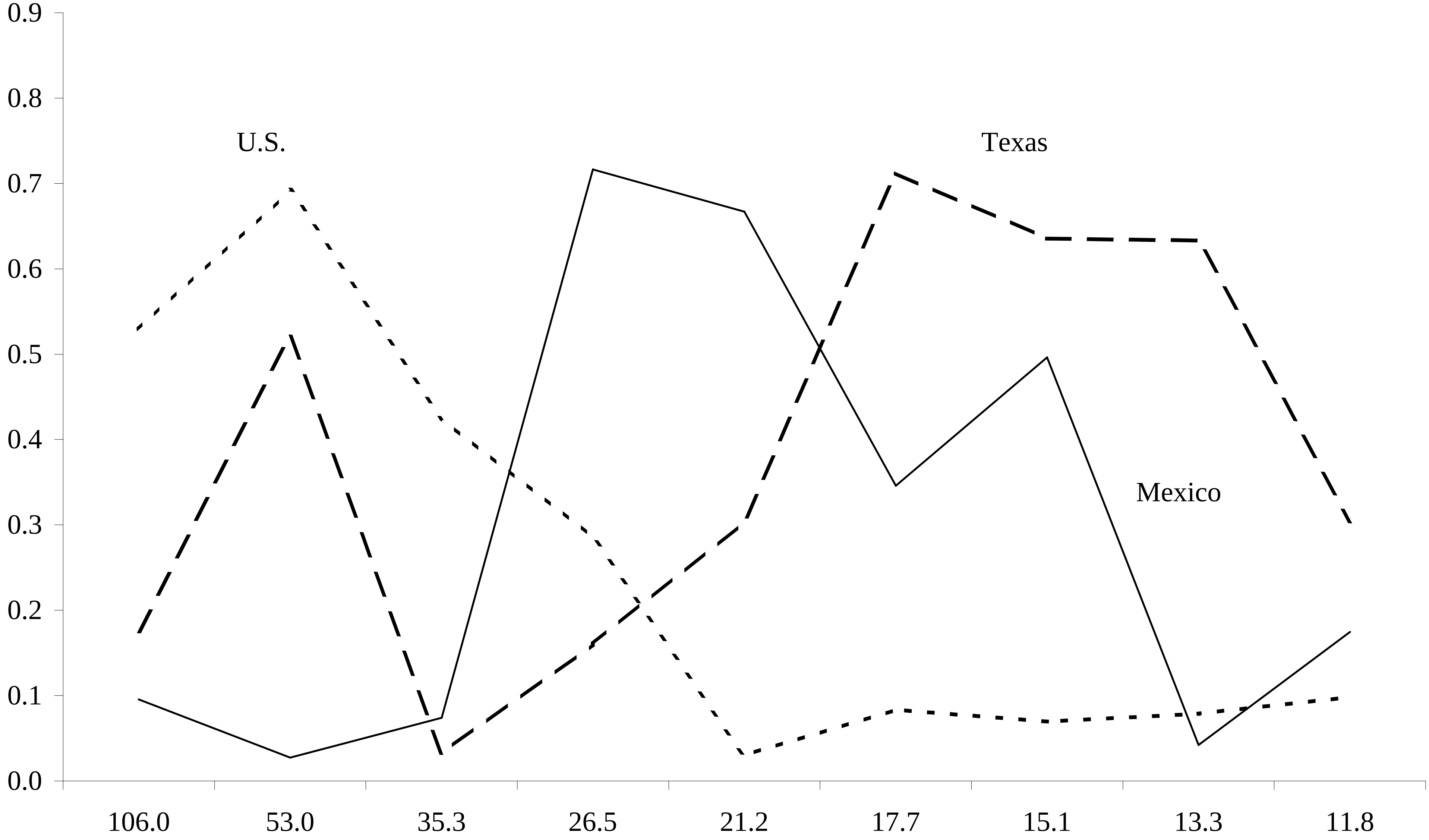


Chart 10b
El Paso
Coherence vs. Period, 1994-2002

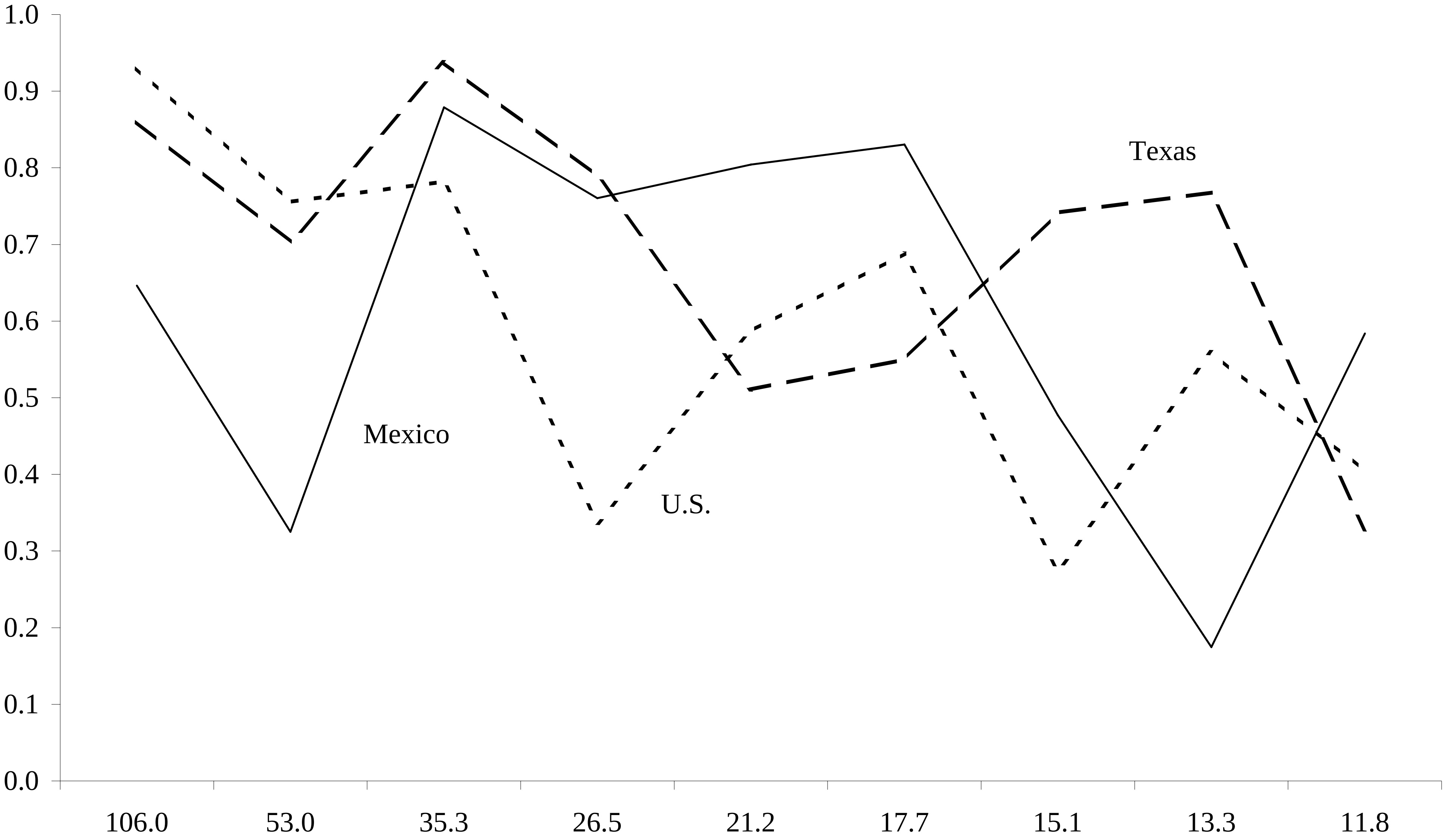


Chart 11a
Laredo
Coherence vs. Period, 1985-1993

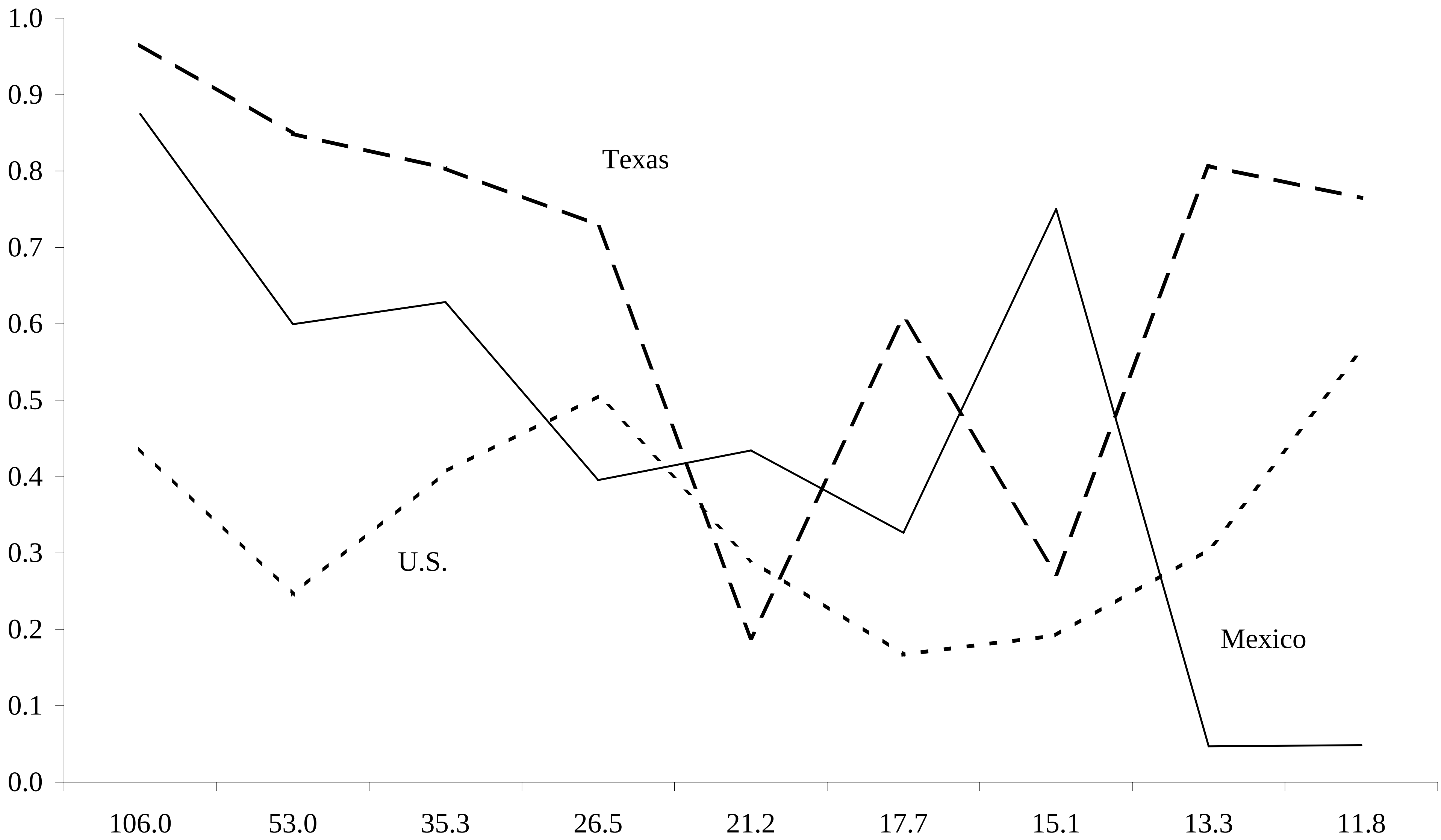


Chart 11b
Laredo
Coherence vs. Period, 1994-2002

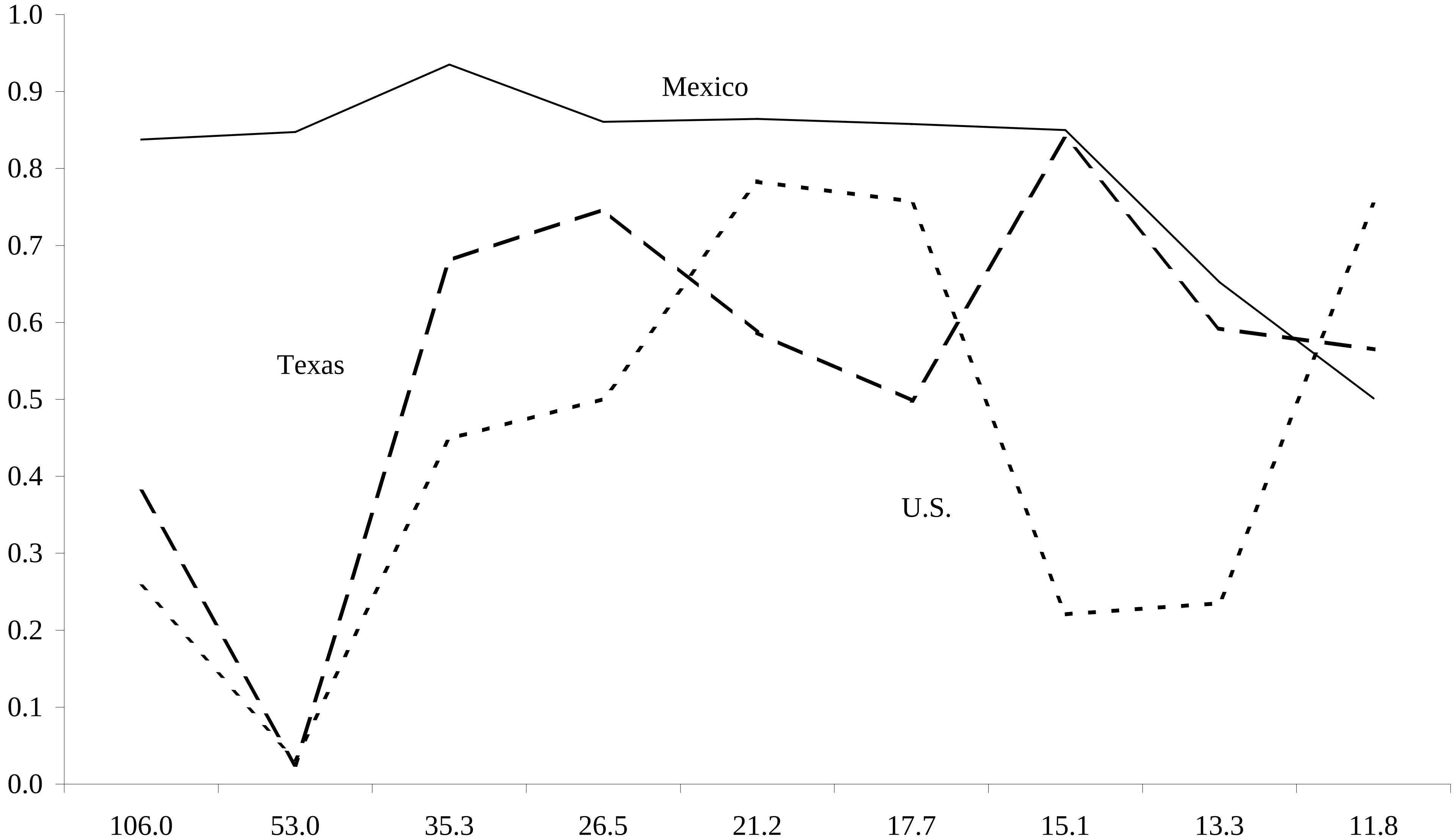


Chart 12a
Brownsville
Coherence vs. Period, 1985-1993

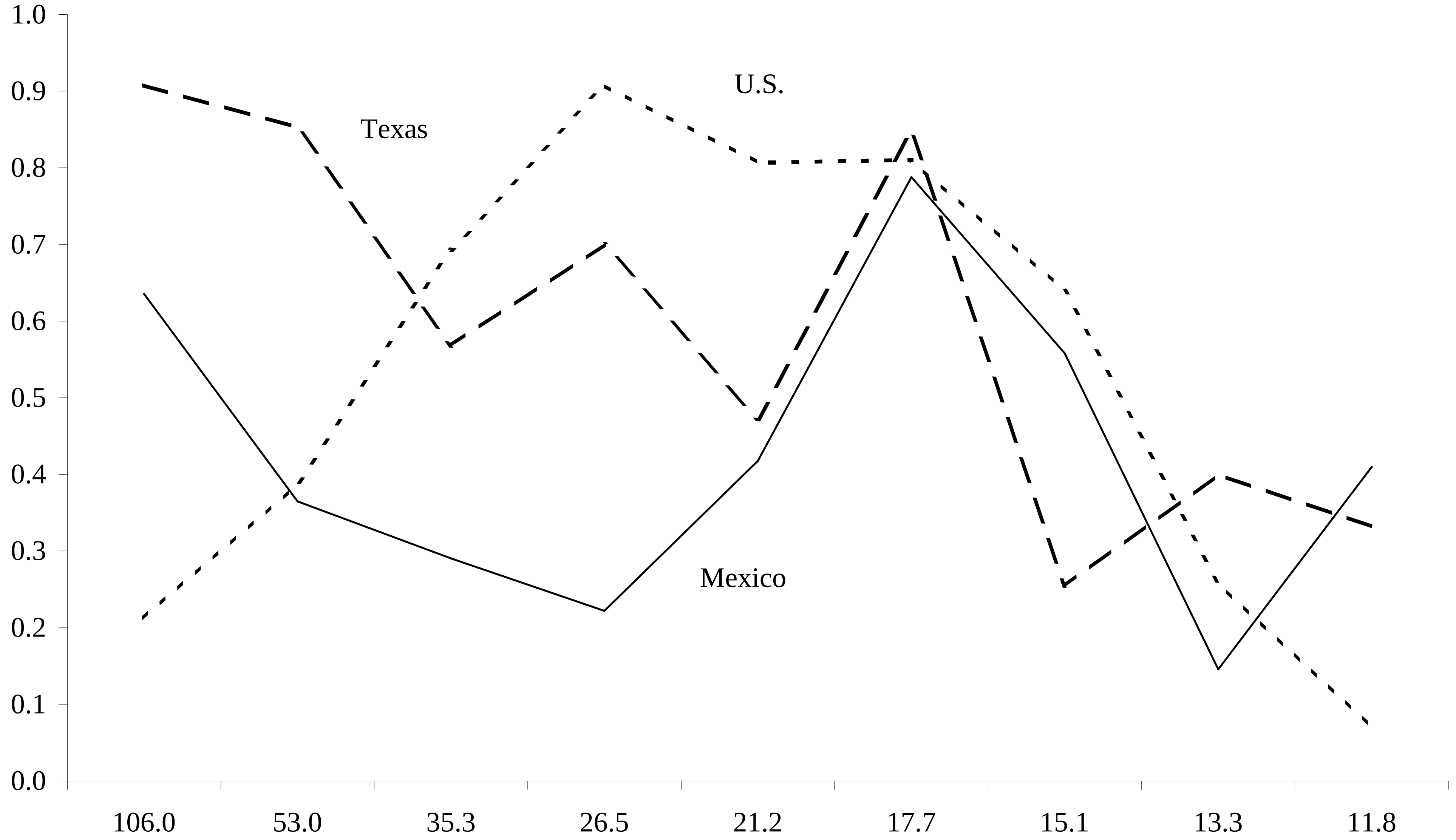


Chart 12b
Brownsville
Coherence vs. Period, 1994-2002

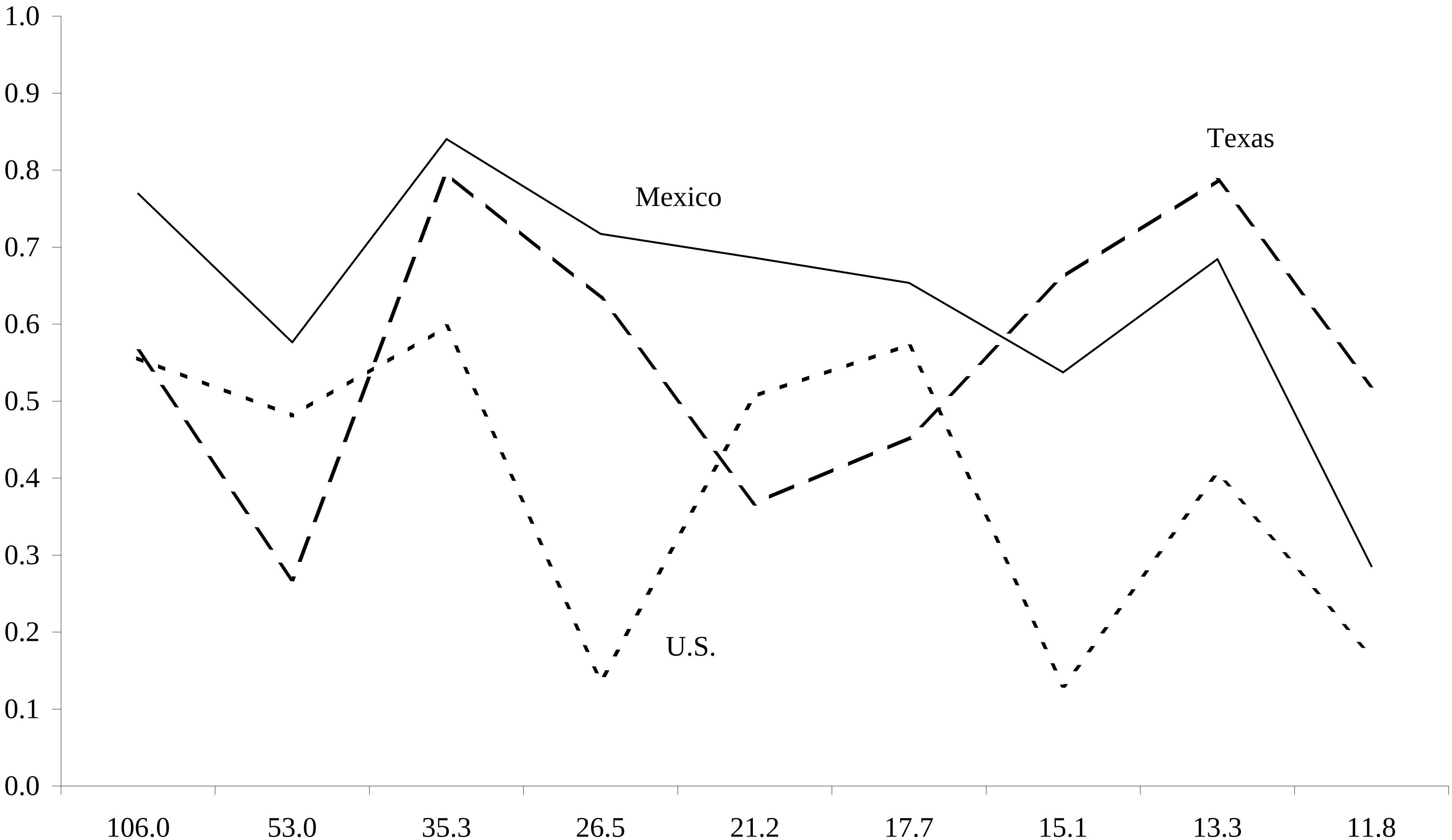


Chart 13a
McAllen
Coherence vs. Period, 1985-1993

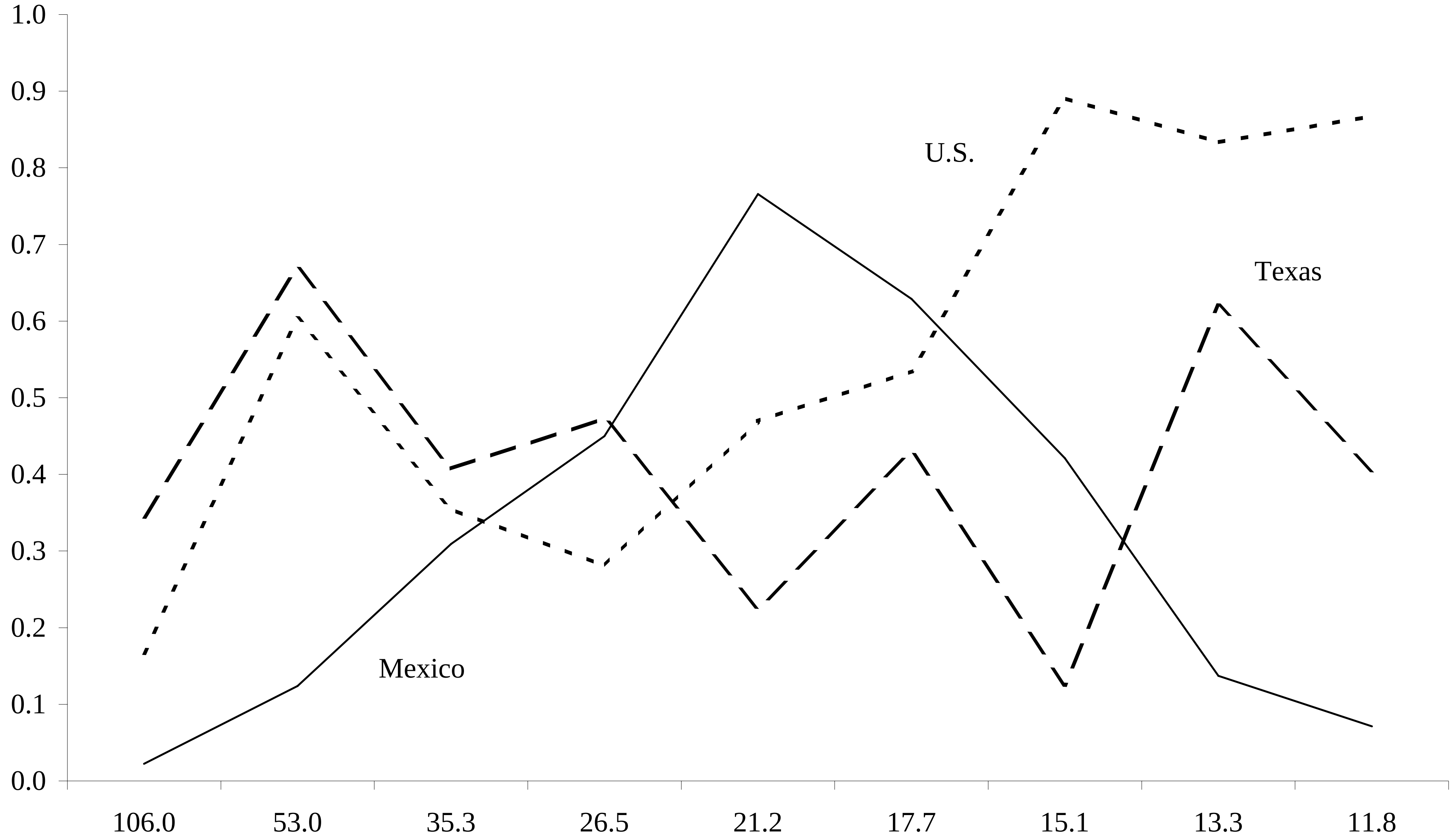


Chart 13b
McAllen
Coherence vs. Period, 1994-2002