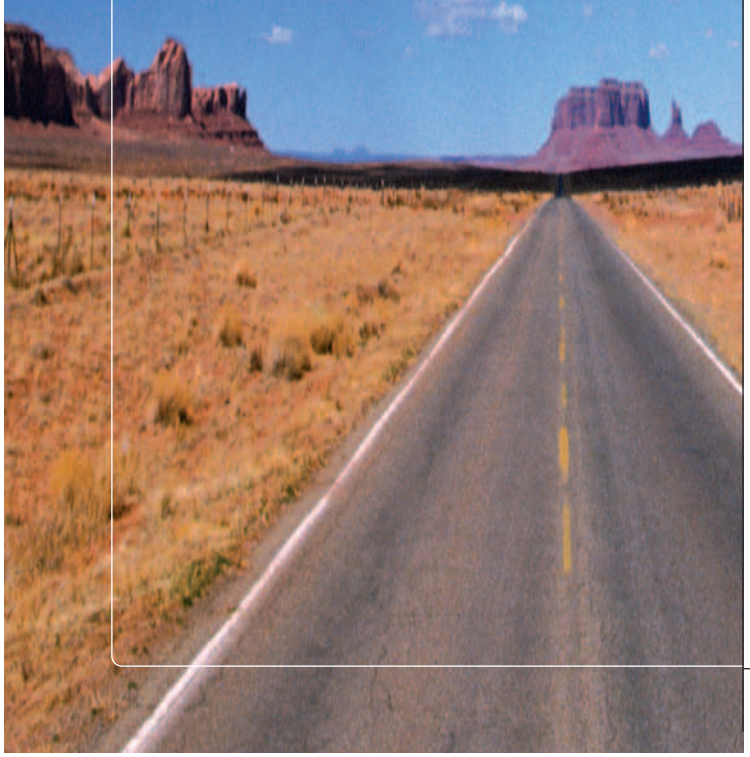
FEDERAL RESERVE BANK OF DALLAS • EL PASO BRANCH ISSUE 1 • 2005

Crossroads

ECONOMIC TRENDS IN THE DESERT SOUTHWEST

Unconventional Natural Gas Drives New Mexico Rig Count

Today's natural gas fields are uniformly spread over vast areas of coal, shale or impermeable limestone or sandstone.



Oil and natural gas in New Mexico are found in two important producing regions: the San Juan Basin in the northwest and the Permian Basin in the southeast. Although oil seeps were evident and small quantities of oil were reported in water wells of the San Juan Basin as early as the 1880s, commercial quantities of oil were not discovered in New Mexico until the Hogback pool near Farmington in 1922. This discovery set off a search for oil throughout the state's northwest quadrant.

Oil in southeast New Mexico began with Rupert Ricker's return from World War I, his decision to lease land from the University of Texas and, in 1921, to spud in Santa Rita No. 1 (named for the patron saint of hopeless causes). His Big Lake field in Texas turned the Permian Basin into one of the world's great oil plays. By 1924, oil exploration had spread westward to the vicinity of Artesia and Hobbs and the state's four southeastern counties became a major producing region of the Permian Basin.

Early energy exploration in New Mexico was almost completely driven by oil. But markets and transportation for natural gas developed rapidly after World War II. A pipeline built by the El Paso Natural Gas Co. in 1950 was important in connecting the isolated and gas-prone San Juan Basin to California. Another pipeline quickly followed to Washington and Oregon.

Today the tail has grown to wag the dog. Chart 1 shows that based on energy content, natural gas has ruled the modern era of hydrocarbons in New Mexico. Oil's share of production peaked at just over 40 percent in 1983; it has fallen to 19 percent today. The favorable trend for gas is being rein-

Cyclical Differences Emerge in Border City Economies

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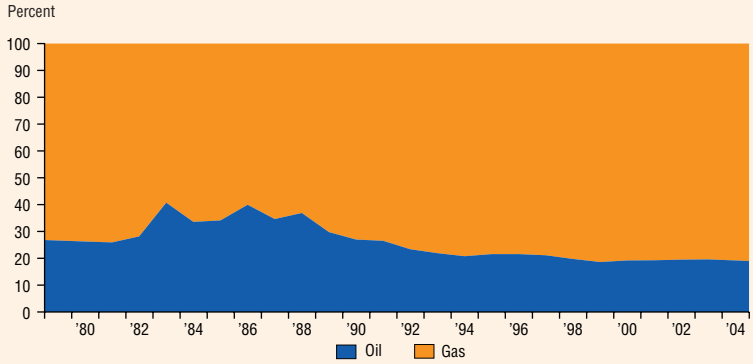
Chart 1
Share of Oil and Natural Gas Production in New Mexico



NOTE: Based on gas valued at oil-equivalents in terms of energy content.

SOURCES: New Mexico Institute of Mining and Technology; GO-TECH, octane.nmt.edu; author's calculations.

forced yet again by the development of unconventional, or continuous, gas reserves in the state. No more is production limited to domes or anticlinal structural traps of conventional gas; today's fields are uniformly spread over vast areas of coal, shale or impermeable limestone or sandstone. As New Mexico's rig count reaches some of its highest levels since 1986 (*Chart 2*), unconventional gas drives the search for hydrocarbons.

Important Industry

Oil and natural gas exploration and production make up an important industry in New Mexico. The industry directly employs 12,200 wage and salary workers in the state, a number that has jumped 10.2 percent in the last 12 months. These are well-paid jobs; New Mexico's natural resource and mining jobs pay 24.9 percent more than those in construction, 44.7 percent more than manufacturing and 56.6 percent more than finance.

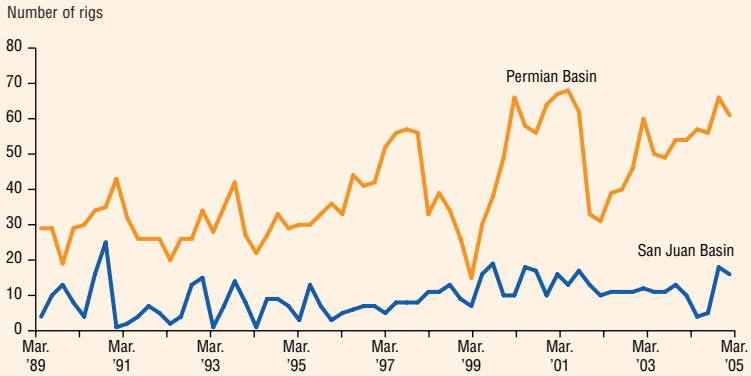
Oil and natural gas are important to the state's finances as well. In 2000, for example, the oil and gas industry paid $165.1 million to the state government in severance taxes, $169.5 million in emergency school taxes, and $34.6 million in conservation, equipment and other taxes. The combined $369.2 million was 10.9 percent of state government revenues. In addition are various gross receipt, ad valorem and corporate taxes paid either to the state or other levels of government.

Table 1 shows how New Mexico ranks among various states and regions in oil and natural gas reserves. It is No. 5 in oil reserves, behind the federal offshore, Texas, Alaska and California. It is No. 4 in natural gas reserves, behind Texas, the federal offshore and Wyoming. The eastern part of the state—home to the Permian Basin—has 98.7 percent of the state's oil reserves, while the San Juan Basin in the west has 80 percent of the state's natural gas reserves.

Oil and gas production follows the pattern set by reserves. In 2004, 95.7 percent of the state's oil production and 35.7 percent of natural gas came from the Permian Basin, with the San Juan Basin serving as a virtual mirror image in providing the rest. These shares have held steady for 20 years.

What has changed rapidly since 1984, however, has been the role of oil versus natural gas. Between 1984 and 2004, New Mexico oil production grew 46.2 percent, while natural gas grew 292.3 percent. This shift to natural gas reflects its abundance, low price and desirability as a clean fuel, especially for electricity production. In April 1988, 35.1 percent of working rigs in the United States were drilling for natural gas. In April 1994, that share was 55 percent and by April 2004, 86.2 percent. Chart 3 illustrates the rapid growth of gas production in both the San Juan and Permian basins.

Chart 2
Number of Rigs Working in New Mexico, 1989–2005



SOURCES: Smith Tool Activity Tracking System, www.smith.com/stats/new; author's calculations.

Unconventional Gas

Geologists call it continuous gas, but it is also called unconventional gas or even weird gas. Whatever you choose to call it,

Table 1
Oil and Natural Gas Reserves by State and Region, 2003

Oil	Millions of barrels	Natural gas	Billion cubic feet
Federal offshore	5,120	Texas	48,717
Texas	4,583	Federal offshore	23,033
Alaska	4,446	Wyoming	22,716
California	3,542	New Mexico	18,226
New Mexico	677	East	3,661
East	668	West	14,565
West	9	Colorado	15,839
United States	21,891	United States	197,145

SOURCES: Energy Information Administration, *U.S. Crude Oil, Natural Gas, and Natural Gas Liquids Reserves 2003 Annual Report*, November 2004.

you must give it due respect for its growing importance. The Department of Energy reports the share of unconventional gas doubled from 17 percent of Lower 48 natural gas supplies in 1990 to 35 percent in 2003. By 2025 it is projected to be 44 percent—matching the role of conventional gas—with the remaining 12 percent of domestic supplies imported.

Unconventional gas is methane or another light hydrocarbon similar to that found in the conventional anticlinal trap, but it is stored in the earth and produced differently.[1] It is stored uniformly in a formation that extends over a wide area but is trapped in a rock formation that requires additional resources to free it. New technologies have been developed to drill and complete and stimulate these wells.

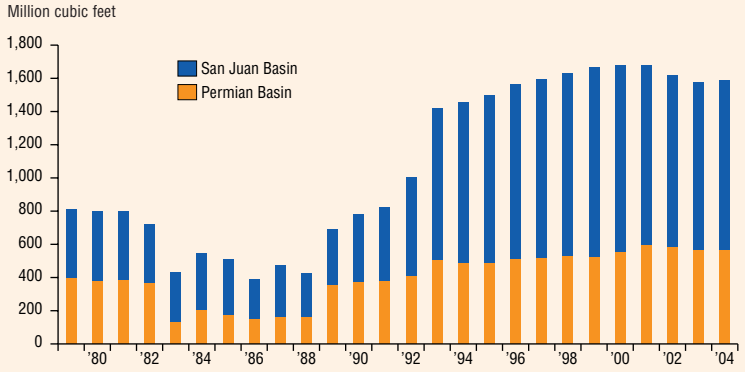
Tight gas is trapped in an unusually impermeable sandstone or limestone formation. The problem is to get the low-permeability formation to release sufficient gas to flow in economic amounts to the well bore. Hydraulic fracturing was first developed in the 1940s and applied to tight formations in the 1970s. Water is injected under high pressure, cracking the formation and opening fissures that boost gas production by a factor of 10 or more. New Mexico's San Juan Basin was the first western gas basin to produce gas from tight sandstone formations.

The San Juan Basin is also known as the initial proving ground for coal-bed methane. Coal-bed methane is a by-product of the formation of coal from plant material, not a result of the high temperatures and pressures that turn organic material to conventional natural gas found in structural traps. The coal-bed gas reserves remain trapped in the coal seams as long as the water table lies above it. To release the gas, a well is drilled and water is pumped out to lower the water table and release the gas to flow to the well bore. As the water table falls, the well produces less water and more gas over time. Coal-bed methane accounts for about 45 percent of the San Juan Basin's annual gas production.

The third important form of unconventional gas is Devonian shale. Shale is a nonpermeable rock, a clay compacted by pressure. Free gas is stored in the rock pores or in natural fractures. As with other unconventional gas types, the gas is stored continuously, and hydraulic fracturing is used to make it flow freely. The San Juan Basin's Mancos and Lewis formations are important producers for this form of gas. The Lewis formation, for example, has become a secondary and shallower target on the way to deeper tight-sand formations. Although research and technology have been important in producing all forms of unconventional gas, shales are particularly challenging; there is no universal formula for success in freeing the gas from the formation.

Development of technologies to successfully exploit unconventional formations was the product of tax credits offered on wells drilled from 1979 to 1993. Throughout the 1990s, subsi-

Chart 3
Natural Gas Production in New Mexico, 1979–2004



SOURCES: New Mexico Institute of Mining and Technology; GO-TECH, octane.nmt.edu; author's calculations.

dies on production from these wells paid about $1.05 per thousand cubic feet of unconventional gas delivered to market. The tax credits are now gone, but the technologies developed continue to lower the cost of delivering this gas, making it highly profitable at today's prices. Continuous gas wells typically have lower capital costs because they are shallower and use smaller rigs; in addition, there is little risk of a dry hole because the gas is uniformly spread over a wide area. The wells also tend to be long-lived. The small number of rigs needed to explore and develop the San Juan Basin (see Chart 2) is in large part a function of these no-miss, long-lived features of continuous gas.

The Permian Basin, although best known as an oil basin, has benefited from these technologies as well. For example, the Morrow sandstones became an important gas play in southeast New Mexico in the late 1990s. Interest runs high throughout the basin in effective stimulation of low-permeability carbonates and sandstones and effective production from regional shales. Despite the San Juan Basin's reputation for unconventional gas production, the Permian Basin in New Mexico has kept pace. From 1984 to 2004, northwest New Mexico saw gas production rise by 301 percent, but southeast New Mexico was right behind at 279 percent.

Outlook

The next 20 years of New Mexico oil and gas are secure, based on the state's existing and proven reserves. These reserves will, however, require further development. In the early 1990s, coal-bed methane dominated the activity in the San Juan Basin. Today, as coal-bed methane fields peak, we see activity swinging toward tight sands, with shale as a secondary target. A recent study by the New Mexico Institute of Mining and Technology predicted 16,000 subsurface completions over the next 20 years in the San Juan Basin. The study concluded with a reminder of the challenge of balancing this development with land-use and environmental issues.

This reminder about environmental sensitivity is offered again by two recent controversies outside the traditional geography of New Mexico oil and gas. The Raton Basin, a 6 million-acre region that straddles the line between Colorado and New Mexico's Colfax County, is one such case. Development of 8 trillion to 12 trillion cubic feet of coal-bed methane reserves was slowed for many years by a lack of infrastructure. The first pipelines entered the area in 1994 and 1998. With the basin now about 50 percent developed, oil companies have just begun to move from southern Colorado and into northern New Mexico. This entails drilling in the Carson National Forest, and the permitting process has provoked doubts and opposition from environmentalists and outdoors enthusiasts. Opposition centers primarily on the creation of a web of interlinking roads through wilderness areas to connect hundreds of well pads.

Similar opposition has sprung up against drilling in the Otero Mesa region of the Chihuahuan Desert, west of Carlsbad and northeast of El Paso. According to environmentalists, this particular stretch of desert is home to unique grasslands, endangered wildlife and the largest untapped reservoir of drinking water left in New Mexico. The oil industry has found enough natural gas to justify development of the fields and a pipeline to market. The question—as always—is where to strike the balance between development for today's needs and conservation for the future.

—Robert W. Gilmer

Gilmer is a vice president of the Federal Reserve Bank of Dallas.

Notes

[1] Some definitions of unconventional natural gas resources include gas trapped below 15,000 feet, although drilling to these depths is no longer a technological challenge. Others include geopressured zones or methane hydrates that pose largely unmet technological challenges. We consider here only continuous gas in tight formations, coal-bed methane and Devonian shale.

Cyclical Differences Emerge in Border City Economies

The Texas–Mexico border is a fast-growing region, a complex blend of U.S. and Mexican cultures, languages and customs. It is a dynamic area that has benefited from a large and growing population in northern Mexico, rapid growth in U.S.–Mexico trade and a tenfold increase in maquiladora industry activity over the past two decades. Total population in the four Texas border metropolitan statistical areas (MSAs)—Brownsville, El Paso, Laredo and McAllen—is about 1.8 million, and population growth since 1980 has been 65 percent, versus 24 percent nationally. A high birthrate and young population suggest that the border will continue its rapid growth.

This article describes the business cycles of the four main Texas border cities and, based on their economies' similarities and differences, relates them to the broader economies of the United States, Mexico and Texas.

Texas Border Cities

Texas border cities are characterized by some common economic features. There is more transportation and distribution activity than in other U.S. cities, mainly due to servicing international trade. We find a relatively large retail sector serving not only the American but the Mexican side as well. And border enforcement and programs that address high poverty levels make the government sector substantially larger than normal.

However, there are also differences. Retail trade is not as important to El Paso as it is to Laredo. Similarly, the economic impacts of the transportation and gas and oil sectors are uneven along the border. Table 1 shows 2003 contributions, by industry, to total earnings for the four Texas border metropolitan areas and the state of Texas. The manufacturing sector is the No. 1 earnings generator for El Paso, while it is No. 3 in Brownsville, No. 4 in McAllen and only No. 10 in Laredo. Transportation and warehousing is the top earnings generator in Laredo, while health care is at the top for McAllen and Brownsville. Retail trade is No. 2 for the border cities with the exception of El Paso, where it is No 3.

Measuring Regional Business Cycles

Analysts often measure regional business cycles by looking at movements in various economic indicators, such as employment or the unemployment rate. But different indicators sometimes lead to different conclusions. In analyzing the national economy, researchers consider movements in broad measures of the macro economy, such as real gross domestic product and employment, although neither of these measures is necessarily broad enough to completely reflect the underlying state of the economy.

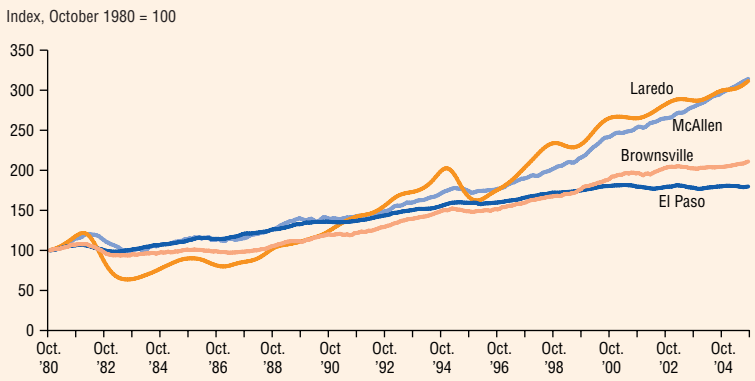
To better understand the economic performance of cities along the Texas–Mexico border, we designed a set of economic indexes that defines the current state of each economy over time—that is, its business cycle. The indexes are a weighted combination of seasonally adjusted changes in employment, the unemployment rate, real wages and retail sales.[1]

Table 1
2003 Contributions, by Industry, to Total Earnings

	Percent
Brownsville	
Health care and social assistance	18.1
Retail trade	8.9
Manufacturing	8.8
Transportation and warehousing	4.2
Accommodation and food services	3.7
Construction	3.6
Wholesale trade	3.5
Finance and insurance	3.2
Real estate and rental and leasing	1.6
Information	1.5
El Paso	
Manufacturing	11.8
Health care and social assistance	9.5
Retail trade	7.9
Real estate and rental and leasing	7.3
Transportation and warehousing	5.9
Construction	4.8
Wholesale trade	4.4
Finance and insurance	3.4
Accommodation and food services	2.7
Information	2.2
Laredo	
Transportation and warehousing	16.2
Retail trade	9.9
Health care and social assistance	9.7
Finance and insurance	4.8
Wholesale trade	4.3
Construction	4.0
Mining	3.8
Accommodation and food services	3.4
Real estate and rental and leasing	2.3
Manufacturing	1.2
McAllen	
Health care and social assistance	20.4
Retail trade	10.7
Construction	5.5
Manufacturing	4.6
Wholesale trade	3.9
Finance and insurance	3.5
Transportation and warehousing	3.3
Accommodation and food services	3.0
Forestry, fishing, related activities	1.7
Real estate and rental and leasing	1.5
Texas	
Manufacturing	12.8
Professional and technical services	8.6
Health care and social assistance	8.5
Retail trade	6.8
Finance and insurance	6.5
Construction	6.4
Wholesale trade	6.0
Transportation and warehousing	4.4
Mining	4.0
Information	3.8

NOTE: Excludes government earnings, which average 27.3 percent for all four border cities and 15.3 percent for the state.
SOURCES: Bureau of Economic Analysis; authors' calculations.

Chart 1
Border Business Cycles Similar, Yet Different



SOURCE: Authors' calculations.

As shown in Chart 1, from October 1980 to March 2005 the indexes are generally smooth and show a significant amount of correlation among the entire group. Declines occurred in all four of the border metro areas beginning in late 1981, early 1986 and early 1995. While it is evident that these cities share some common cyclical movement, it is also clear that they experience independent cycles, such as Laredo's downturn in 1999 and the cities' varied reactions to U.S. recessions in 1990–91 and 2001. Laredo, by far the smallest of the MSAs, has the greatest cyclical volatility over the period, while El Paso, the largest Texas border city, shows the least.

Regional business cycles are typically affected by their national counterparts. In the case of a metropolitan economy, business cycles are affected by both the national and state economies. For border economies such as Brownsville, El Paso, Laredo and McAllen, international business cycle considerations also come into play. One way to understand the local business cycle is to compare the performance of the border indexes with the broader economies of the United States, Texas and Mexico. A high correlation with the state or nation provides important clues about what drives local economic conditions.

The border business cycle indexes show that changes in the border region correlate with changes in the Texas, Mexican and U.S. economies, although to differing degrees. As highlighted in Chart 2, all of the border MSAs share cyclical relationships with the broader economies of Mexico, Texas and the United States. Laredo appears most tied to the Mexican economy, while El Paso seems to have the most in common with Texas and the nation.

To investigate the correlation of border business cycles before and after NAFTA, we divided our business cycle data into a pre-NAFTA period from July 1981 to December 1993 and a post-NAFTA period beginning in January 1994. For the pre-NAFTA period, we analyzed data from July 1981 through December 1993; for the post-NAFTA period, data from January 1994 through June 2002.[2]

Before NAFTA, the border cities behaved very much like each other and also were strongly correlated with the business cycle changes of Texas and Mexico. The U.S. business cycle was very different. One likely reason was the dominant role of oil prices during this period. Because Mexico and Texas are net energy producers, they benefited from oil price increases, while the United States, as a net consumer, was hurt. In 1986, when the price of oil dropped sharply, Texas and Mexico entered into recession and the border cities followed. Laredo is the only one of the border cities with a significant amount of oil and natural gas production.

During the post-NAFTA period, oil and gas prices stabilized, and U.S.–Mexico trade and maquiladora production surged. Two clusters of economic integration emerged. El Paso's economy now appears to be linked to the U.S. and Texas business cycles, while the South Texas border cities are aligned with Mexico's. El Paso has become increasingly dependent on the U.S. economy because of its ties to the large maquiladora industry in Ciudad Juárez, which has the most maquiladora jobs in Mexico. And with the rapid growth of high tech and diminished importance of oil in Texas, the state's economy has become more like the nation's.

On the other hand, the South Texas border cities have become more synchronized with the economic fortunes of Mexico due to their support of cross-border trade and the large numbers of Mexican shoppers.

Regional Reactions to Recession

South Texas Border. During the latest recession, El Paso was the only border city that followed the United States, Texas and Mexico into decline. The comparative success of the Rio Grande Valley economies is probably due to the atypical strength of the real value of the peso, especially during the Mexican economy's downturn. This was the first time in recent Mexican economic history that a

downturn was not driven by financial crisis and a significant fall in the peso's value. This moderate recession in Mexico was driven by the U.S. recession and its impact on the maquiladora industry.[3]

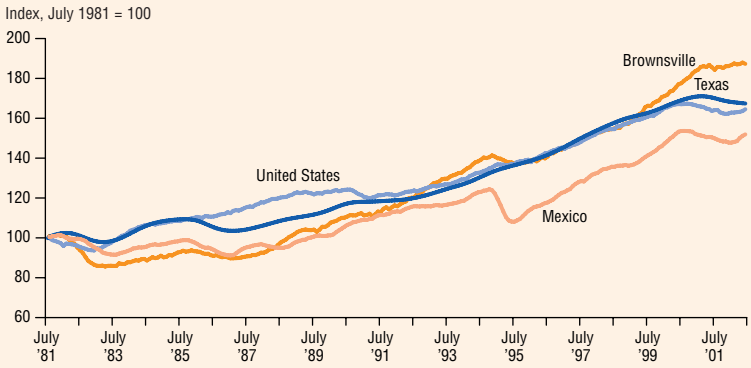
The strong peso had a greater effect on the South Texas border cities than it did on El Paso because retail spending by Mexican nationals represents a larger share of the economies of Brownsville, Laredo and McAllen than it does El Paso's. In 2001, Mexican shoppers accounted for more than $2 billion in retail sales, representing 1.2 percent of total Texas retail sales.[4] McAllen was the biggest net exporter of retail sales to Mexicans, with almost $1 billion. Laredo was second, with $540 million, and Brownsville third, with $256 million. El Paso, the largest city, exported $216 million to Mexican nationals (*Chart 3*).

Other factors have also impacted growth in the Valley and Laredo. Plentiful rainfall and high citrus prices in recent years have aided Valley agriculture, although apparel industry declines and low shrimp prices have hurt Brownsville. Laredo, the largest land port for U.S.–Mexico trade, has been boosted by strong international trade flows across the border.

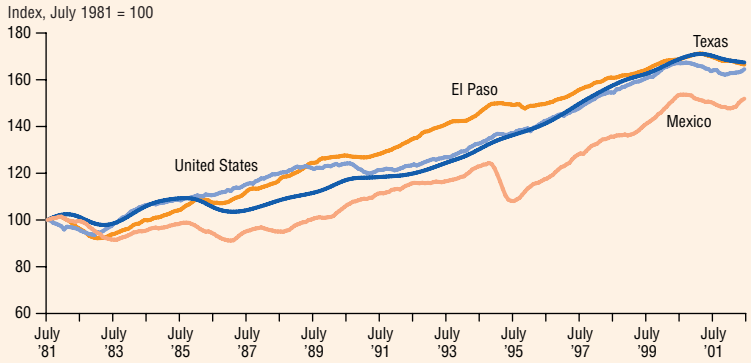
El Paso. El Paso's relationship to the U.S. and Texas business cycles changed after 1994. The El Paso economy increased its correlation with those of Texas and the nation and followed both into recession in 2001. This may be because of the large share of manufacturing jobs in El Paso and the city's close ties to the maquiladora industry in Juárez. Juárez has more than 200,000 maquiladora jobs and generates $3.4 billion in value-added each year. One estimate is that a 10 percent increase in maquiladora activity in a

Chart 2
Border Business Cycle Relationships with Broader Economies

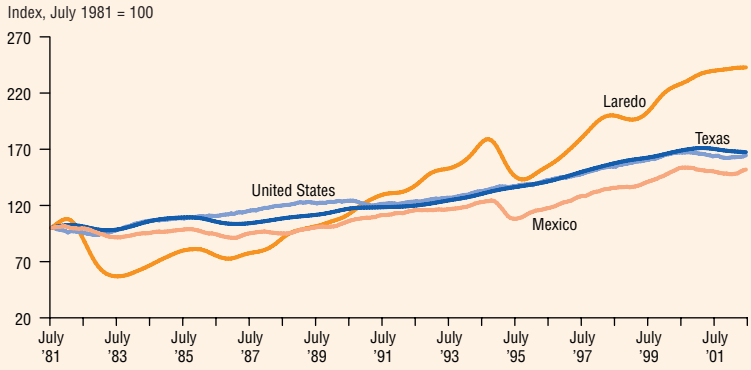
Brownsville



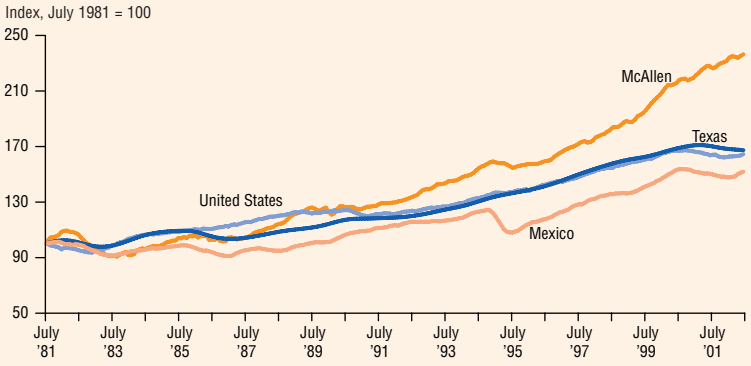
El Paso



Laredo

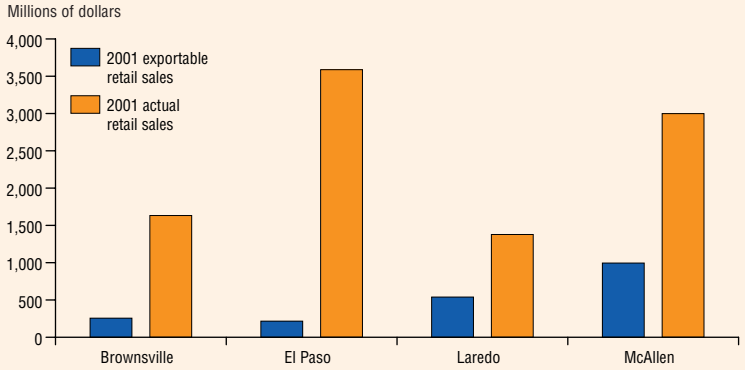


McAllen



SOURCE: Authors' calculations.

Chart 3
Retail Spending by Mexican Nationals in Border Cities



SOURCES: Authors' calculations, with data from the Texas Comptroller of Public Accounts.

Mexican border city leads to a 1 to 2 percent increase in employment in the neighboring U.S. border city.[5]

The severe setback to U.S. manufacturing that began with the 2001 recession set off a chain of events that quickly led to a downturn in Mexico's maquiladora industry and ultimately to recession in El Paso. Juárez' maquiladora employment plunged nearly 25 percent in 2001–02. Strength in U.S. manufacturing since mid-2003, however, has led to a resurgence in maquiladora jobs and improvement in the El Paso economy.

El Paso has also been negatively affected by declines in apparel manufacturing and deployments of soldiers overseas. Recent announcements of military realignments and a rebound in the maquiladora industry in Juárez, however, suggest that El Paso's economy will continue to improve over the next 12 months.

Summary

The areas along the Texas–Mexico border are often influenced by similar forces, yet can sometimes move in different directions based on their unique economic structures. Like brothers and sisters in a family, they often look alike yet behave quite differently. Each border city has experienced a unique business cycle that depends on its sensitivity to a wide variety of factors, such as movements in the broader economies of the United States or Mexico, trade between the United States and Mexico, the real value of the peso, and U.S. and Mexican industrial activity.

So far this decade, the business cycles of the southern border MSAs of Brownsville, Laredo and McAllen have benefited from the strong peso and retail sales to Mexican nationals. At the same time, El Paso's economy has followed the weakness in U.S. manufacturing and Mexico's maquiladoras. Since mid-2003, however, the maquiladora industry has rebounded with U.S. industrial production and the El Paso economy has begun to recover.

—Jesus Cañas
Roberto Coronado
José Joaquin Lopez

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Notes

[1] For more information on the methodology of the indexes of coincident economic indicators, see "Business Cycle Coordination Along the Texas–Mexico Border," by Keith R. Phillips and Jesus Cañas, Federal Reserve Bank of Dallas Working Paper no. 0502, July 2004, available at www.dallasfed.org.

[2] The relationship among the four metropolitan areas over time was defined by use of several techniques, including correlation, cluster analysis and spectral analysis. All led to the common conclusions discussed here.

[3] For more information, see "Trade, Manufacturing Put Mexico Back on Track in 2004," by Jesus Cañas, Roberto Coronado and Robert W. Gilmer, Federal Reserve Bank of Dallas *Houston Business*, March 2005, available at www.dallasfed.org.

[4] For more information, see "Texas Border Benefits from Retail Sales," by Keith R. Phillips and Roberto Coronado, in *The Face of Texas: Jobs, People, Business and Change*, Federal Reserve Bank of Dallas, forthcoming.

[5] See Gordon H. Hanson, "U.S.–Mexico Integration and Regional Economies: Evidence from Border-City Pairs," *Journal of Urban Economics*, vol. 50, September 2001, pp. 259–87.

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ISSUE 1 • 2005

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