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A Perspective on the Houston Economy

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The Simple Economics of the Texas Triangle

This article takes a close look at the Texas Triangle cities and examines the conjecture that proximity has shaped and specialized their economies.

The Texas Triangle is outlined by Houston, San Antonio and the Dallas/Fort Worth metroplex, with Austin inside the Triangle. The cities are relatively close and connected by major highways, giving the Triangle sides of 268, 199 and 243 miles.

Table 1 summarizes the cities' economies and illustrates their importance to the state. The D/FW metroplex was the largest of the Triangle metro areas in 2001 based on population, employment or income. Austin was the smallest, although it has closed rapidly on San Antonio in recent years, and the differences between the two cities are now small. Houston was the most affluent metro area based on per capita income, and San Antonio's income level lagged the rest of the group by a significant margin.

Although the Triangle cities make up only 62 percent of Texas' population, they provide 68 percent of the state's wage

and salary jobs and 71 percent of personal income. The last issue of *Houston Business* described these cities' rapid growth in recent years, which is the primary reason for the convergence of Texas' per capita income to U.S. income levels.

The size of the four metropolitan areas combined would place them among the largest in the United States, comparable with New York, Los Angeles or Chicago. Indeed, if history and geography had been slightly different, the Triangle cities easily could have been one. Although the cities are spread throughout the heart of the state, their proximity has likely influenced their growth and development. As each city found specialized economic roles to serve the rest of the Triangle and the state, the others sought out complementary roles. Since there is relatively little overlap in their economic activities, and despite the distances between them, the Triangle cities might be better seen as a single economic entity.

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Table 1
Economic Characteristics of Texas Triangle Cities, 2001

	Population (millions)	Employment (millions)	Personal income (billions of dollars)	Per capita income (dollars)
Texas	21.37	10.06	608.5	28,472
Triangle cities	13.18	6.81	433.4	32,897
Austin	1.32	.71	41.7	33,247
Dallas/Fort Worth	5.42	2.91	180.1	31,511
Houston	4.81	2.39	168.0	34,916
San Antonio	1.63	.80	43.7	26,887

NOTE: Based on metro area definitions; Dallas/Fort Worth and Houston are consolidated metro definitions.
 Employment is wage and salary jobs only.

SOURCE: Bureau of Economic Analysis.

roles of these cities, it would mean there is little basis for the historic rivalries that have arisen among them, particularly between Houston and Dallas.¹

Past and Present

Numerous Texas rivers run north to south toward the Gulf of Mexico, including the Sabine, Trinity, Brazos and Colorado. The problem presented to early Texas settlers was that none of these rivers were navigable for any significant distance, leaving ox- or mule-drawn freighter as the primary means to reach market, across a coastal plain legendary for its thick gumbo mud when it rained.

The Allen brothers founded Houston in 1836 at the headwaters of Buffalo Bayou, seeking out the most interior point with year-round access to the Gulf of Mexico by water. Houston's location gave it access to the sugar and cotton plantations of the Brazos Valley to the west and to the timberlands to the east, offering the enormous advantage of cutting 50 miles off the wagon trip to the sea.²

San Antonio was a century old at the time of the Texas Revolution. The city was founded as part of the Spanish mission and presidio system to civilize and protect New Spain. It was the most important mission center in the colony, with two missions established there

in 1720 and 1731 and three more relocated there later from eastern Texas as the Spanish withdrew the lines of their frontier. Although San Antonio was located in a large fertile plain and almost all observers commented on its physical beauty, by the time of the Texas Revolution it had been reduced to a small, somewhat wretched village. Population had shrunk steadily in the early 19th century because of the consolidation of the Mexican states of Texas and Coahuila and the shift of the capital to Saltillo, the disruptions caused by the Mexican revolution for independence, and continued local flooding.

Austin was the almost single-handed creation of Mirabeau B. Lamar, second president of the Republic of Texas. He was determined to have a planned capital city for Texas along the lines of Washington, D.C., and was equally determined that it should be near the center of the young republic. Lamar picked the location for the capital while on a hunting trip in the Colorado River Valley. Much of Austin's early history was as a remote village struggling against Indian attack with little more than state business to support it.

Dallas was founded in 1841 by John Neely Bryan, who set up a trading post on the only natural ford on the Trinity River

for many miles. Two highways proposed by the Republic of Texas soon converged nearby. Dallas grew into a service center for surrounding farmlands based on its transportation links. By the 1850s, it had such signs of civilization as grocery and dry goods stores, a drugstore, boot and shoe shops, an insurance agency and a newspaper. Access to markets by water was limited to shipments through the inland port of Jefferson, where only during certain months of the year could goods move on Cypress Bayou, across Caddo Lake and ultimately to New Orleans. Dallas' growth would wait for the railroads, the explosion of population on the Blackland Prairie cotton farms after the Civil War, and the development of the city as a major cotton-processing center.

Houston is the state's major port; San Antonio is a distribution and agricultural center for South Texas and northern Mexico; Dallas is an inland distribution point for much of Texas, Oklahoma, Louisiana and Arkansas; Austin is the political capital. These are geographic and political roles that could have been scrambled together in many other ways. The presence of one great navigable river through the heart of the state, or a navigable saltwater inlet that stretched to Waco, Temple or Brownwood, could have caused several or all of the roles described above to fall together in a single, true megalopolis.

However, nearly 170 years removed from the founding of the Republic of Texas, these cities have assumed important roles in the state and become much more than distribution centers.

Houston. The state's major deepwater port—the second largest in the United States based on tonnage—Houston is

home to Texas' international business community. However, the city's bread and butter are oil and natural gas, with oil producers, oil services and machinery companies, refineries and petrochemicals directly or indirectly accounting for half the jobs. The Texas Medical Center and Johnson Space Center, along with companies such as Continental Airlines, American General Insurance Co. and HP/Compaq, help define the non-oil part of Houston's economy.

Dallas/Fort Worth. The metroplex still plays its original role as a major inland transportation hub and distribution and service center for the surrounding area, but now the area it serves stretches over several states. It is home to D/FW Airport, the fifth busiest in the world. Following the oil bust, Dallas has clearly emerged as the state's banking and financial center. Dallas and Fort Worth also have a significant presence in oil-related activity, notable on any standard except that set by Houston. High-technology industries, especially telecommunications, became a major center of growth in the 1990s, partly a legacy of the region's history in aviation and defense electronics.

Austin. As the state capital and home to the University of Texas' main campus, Austin's major strength has historically been a robust government sector. Beginning in the late 1960s, Austin began developing a significant presence in high technology—IBM Corp. in 1967, Texas Instruments in 1969 and Motorola in 1974. The arrival of chipmaker-consortium International Sematech in 1988 provided the momentum for the 1990s. Today, about 120,000 employees—25 to 30 percent of the local workforce—are tied to technology industries, and Dell has emerged as the city's most

important technology employer. Austin is also renowned for its music industry. Billed as the "Live Music Capital of the World," it sponsors a number of music-related festivals and conventions.

San Antonio. The Alamo City's historic role has been as the distribution point for South Texas and northern Mexico. This role has grown with the rapid expansion of the maquiladora industry and the implementation of NAFTA. Tourism is a major industry, with Fiesta Texas and SeaWorld located there, as well as the River Walk, El Mercado and other attractions. Lackland and Randolph Air Force bases and Fort Sam Houston represent a major military presence.

An Analytical Look

History, geography and the descriptions above would imply complementary roles for the Texas Triangle cities, but is there a way to quantify what these cities do and test for complements? One way to isolate what a city does well, and to find which of its industries export to the rest of the nation, is to compute location quotients (LQ_{ij}).

$$LQ_{ij} = \frac{\text{percent share of income earned in industry } i \text{ in city } j}{\text{percent share of income earned in industry } i \text{ in the United States}}$$

If LQ_{ij} is greater than 1, it indicates a larger than normal concentration of activity in the city (with the "normal" comparison based on a typical place in the United States) and that industry i is a likely source of local exports.³ If LQ_{ij} is less than 1, the industry is not well represented in the city, and the goods produced by the industry are probably imported. Some goods are inherently local—dry cleaners and grocery stores—and the location quotient is typically close to 1 in all cities, as the goods are neither exported nor imported.

Table 2 lists all location quotients greater than 1.15 for the Texas Triangle metro areas, indicating an industry that is 15 percent or more overrepresented in that city compared with a typical place in the United States. The list is based on wages, salaries and employer-paid benefits in each industry in 2001, using the industry definitions of the Standard Industrial Classification (in use up until last year). About 60 industries were compared, with a number of industries not available for some cities due to nondisclosure of data.⁴ We assume that this list is a first approximation of exports from these cities, important in defining the local economy because exports will generate the income to pay for imports and support local activity.

The selected export sectors in Table 2 broadly confirm the city descriptions given above. There are six export industries for Austin, 14 for Dallas/Fort Worth, 15 for Houston and 19 for San Antonio. Austin has the shortest list of export sectors, made up primarily of tech or tech-related industries such as industrial machinery (computers), electronic and electrical equipment, communications and business services, plus state government. In Houston, we see oil's dominance in oil and gas extraction, chemicals, refining (petroleum and coal products), pipelines, and backward linkages from oil into manufacturing through industrial machinery and equipment. Heavy construction and engineering and management services are closely tied to construction of large chemical and refining facilities.

Dallas/Fort Worth's important distribution role shows up in wholesale trade, transportation services and transportation by air. Its role in finance is seen in insurance and in depository and nondepository institutions.

Table 2
Export Sectors in Texas Triangle Cities as Indicated by Location Quotients

Austin. Industrial machinery and equipment (3.69); electronic and other electrical equipment (3.32); communications (1.17); wholesale trade (2.08); business services (1.47); state government (2.27).

Dallas/Fort Worth Metroplex. Oil and gas extraction (4.82); electronic and other electrical equipment (2.47); trucking and warehousing (1.17); transportation by air (2.49); transportation services (2.12); communications (1.82); wholesale trade (1.47); home furniture and furnishings stores (1.38); depository and nondepository institutions (1.16); insurance agents, brokers and services (1.16); real estate (1.54); holding and other investment offices (1.16); business services (1.35); miscellaneous services (1.37).

Houston. Oil and gas extraction (13.81); heavy construction (3.03); industrial machinery and equipment (1.26); chemicals and allied products (2.43); petroleum and coal products (4.97); water transportation (3.38); transportation by air (1.40); pipelines, except natural gas (6.78); transportation services (3.32); electric, gas and sanitary services (3.69); real estate (1.27); holding and other investment offices (2.10); miscellaneous repair services (1.58); legal services (1.34); engineering and management services (1.40).

San Antonio. Oil and gas extraction (1.30); general building contractors (1.16); heavy construction (1.18); miscellaneous manufacturing (1.18); transportation services (2.85); communications (1.96); electric, gas and sanitary services (3.13); general merchandise stores (1.19); food stores (1.29); auto dealers and service stations (1.28); eating and drinking places (1.35); miscellaneous retail (1.18); insurance carriers (2.35); holding and other investment offices (1.72); private households (1.28); auto repair, services and parking (1.19); federal civilian (1.84); military (4.70); local government (1.16).

NOTE: Location quotients are shown in parentheses; only LQs greater than 1.15 are shown.
 SOURCE: Author's calculations.

It maintains one foot in oil (oil and gas extraction) and one in tech (electronic and electrical equipment). San Antonio's large tourist industry is represented in a number of retail and service industries, and the expected strength in federal civilian and military sectors is present. There is also some activity tied to oil in San Antonio, both upstream (oil and gas extraction) and downstream (heavy construction).

In 12 of 60 sectors, some overlap in industrial activity is indicated among the cities. Overlap is expected in regional distribution industries such as wholesale trade and transportation services. Industrial machinery is produced in both Austin and Houston, but the machinery is computers in Austin and oilfield equipment in Houston. Large airports are found in both Dallas/Fort Worth and Houston, but D/FW's airport traffic is largely domestic, while Houston's is international. Real estate, communications, and electric, gas and sanitary services have a large element of service to surrounding hinterland regions rather than exports from the region.⁵ Head-to-head competition is apparent primarily in oil and

gas extraction and semiconductors (electronic and electrical equipment) in Austin and Dallas and heavy construction in San Antonio and Houston.

We can use these location quotients to ask whether the Texas Triangle cities have developed as rivals or if they complement each other in production. If these cities complement each other, exports from one will be matched by imports in other cities in the same industry. Where one city has a location quotient greater than 1, the others have an LQ value less than 1. If we combined the Texas Triangle cities by simply adding them together, the variance of the computed LQ s for the combination should be smaller than an average of the variance of the individual cities.

Table 3 shows an elementary example of cities that are highly dependent on each other and that complement each other in production. We use it to show how, for these complementary cities, variance of LQ s falls once the cities are combined. The three cities (A, B and C) produce four kinds of widgets.

City A specializes in green widgets, B in white and C in blue, with each city earning \$300. They divide production of yellow widgets, a local good, equally among the cities, to earn \$100 each. If we combine the three cities, there is equal income earned of \$300 from each kind of widget.

We can compute the location quotient for each kind of widget. For example, for green production in City A, the LQ is $(300/400)/(300/1,200) = 3$. The other cells can be filled out, and the average LQ for each city is $LQ' = (3 + 0 + 0 + 1)/4 = 1$. This makes the computed variance for each city:

Table 3
Variance Change in a Hypothetical Example

	Income earned (dollars)			
	City A	City B	City C	Combined
Green	300	0	0	300
White	0	300	0	300
Blue	0	0	300	300
Yellow	100	100	100	300
Sum	400	400	400	1,200

	Location quotients			
	City A	City B	City C	Combined
Green	3	0	0	1
White	0	3	0	1
Blue	0	0	3	1
Yellow	1	1	1	1

Table 4
Variance Change Among Location Quotients
in the Texas Triangle

	Average LQ	Variance	Share
Austin	.79	.45	.09
San Antonio	.99	.55	.10
Dallas/Fort Worth	.98	.48	.43
Houston	1.26	3.59	.38
Weighted average	1.07	1.67	
Triangle combined	1.07	.92	

SOURCE: Author's calculations.

$$\begin{aligned}
 S^2 &= (1/N-1) \text{ Sum } (LQ_i - LQ)^2 \text{ for } 1 \\
 &= 1, \dots, 4 \\
 &= (1/3) [(3-1)^2 + (0-1)^2 + (0-1)^2 \\
 &\quad + (1-1)^2] = 2
 \end{aligned}$$

If we combine the cities, however, the combination is self-sufficient in every kind of widget, and all the *LQs* are equal to 1 for every industry. Because they are all equal, variance of the *LQs* falls to zero. Looked at separately, the cities have an average *LQ* variance of 2; once combined, the cities' variance falls to zero.

We did these same calculations for 60 industries in the Texas Triangle cities; the results are shown in Table 4. The average *LQs* for Austin, San Antonio, Dallas/Fort Worth and Houston are shown, along with the computed variances of the *LQs* across all industries. A weighted average of the *LQs* and variances is shown at the bottom of the table, using the weights or shares shown in the third column, based on each city's contribution to wages, salaries and employer-paid benefits in the combined region. Treating each city separately, the average *LQ* in the Texas Triangle is 1.07, and the weighted variance is 1.67.

If we combine the Triangle cities and recompute the *LQs*, the average *LQ* is again 1.07, but the variance for the combined cities falls from 1.67 to 0.92. A standard statistical test tells us we can be about 99

percent sure that the variance has declined significantly, and the roles played by the four cities are highly complementary to each other.⁶

Conclusion

The Texas Triangle cities developed as economic complements, providing unique goods to the other Triangle cities and importing goods that represented strength elsewhere. Why is this important? First, it means that the Texas Triangle is in fact a megalopolis in the sense that we can add the pieces together with a minimum of duplication. It is spread over a triangular area of roughly 250 miles on each side. Second, it implies that despite traditional rivalries and competition among these cities, especially Houston and Dallas, they don't really overlap much in their economic roles. We could isolate only a few areas where meaningful rivalry might take place—oil and gas extraction and semiconductors (Austin and Dallas) and heavy construction (San Antonio and Houston).

By and large, however, one or two Triangle cities have such a secure niche in each export industry that others are unable to compete effectively. Given the lack of competition across cities, a cooperative effort at industrial recruitment and economic development programs makes sense, even though the cities are spread over an area as large and diverse as the Texas Triangle.

— Robert W. Gilmer

Notes

¹ The fact that Dallas and Houston have economic structures that complement rather than compete with each other has been noted in a different context by R. W. Gilmer and Jun Ishii, "Driven by Differences: GRP of Houston and

Dallas," Federal Reserve Bank of Dallas *Houston Business*, May 1995.

² For the early economic history of Houston, Austin and San Antonio, see Kenneth W. Wheeler, *To Wear a City's Crown: The Beginnings of Urban Growth in Texas, 1836–1865* (Cambridge, Mass.: Harvard University Press, 1968). For Dallas, see Jackie McElhaney and Michael V. Hazel, "Dallas, Texas," in *The Handbook of Texas Online* (Austin: Texas State Historical Association, 2002), www.tsha.utexas.edu/handbook/online.

³ The base of the location quotient used here means that any indicated exports are sold to the surrounding hinterland and to cities either in the Triangle or throughout the United States. By changing the base to a list of peer cities of comparable size, it is also possible to isolate imports that leave the hinterland and are sold on a broader regional or national basis. Both comparisons were carried out, but the picture of the economic role played by these cities was largely unchanged. See Robert W. Gilmer, Stanley R. Keil and Richard S. Mack, "The Service Sector in a Hierarchy of Rural Places: Potential for Export Activity," *Land Economics* 65 (August), 1989, pp. 217–27, and Robert W. Gilmer, "Identifying Service Sector Exports from Major Texas Cities," Federal Reserve Bank of Dallas *Economic Review*, July 1990, pp. 1–16.

⁴ Data are not disclosed in U.S. government statistical publications unless there are three or more respondents in the sector or one respondent is so large that its data will dominate the results.

⁵ Holding and other investment offices appears as an "export" industry in three cities. However, this simply reflects a business organizational form more common in the South—including Texas—than in other parts of the United States. Overrepresentation in this case does not imply exports but an organizational anomaly.

⁶ The appropriate test is an *F* test that the variance of the *LQs* for the combined cities is less than the variance of the cities taken individually. It is a one-tailed test, with the computed ratio of the two variances being $(1.67/.92) = 1.82$, with 59 degrees of freedom in the numerator and denominator. The computed ratio of the variances falls almost exactly on the 1 percent critical value for the test from the tables of the *F* distribution. In other words, we can be approximately 99 percent sure that the variance of the combined cities has fallen.

The Houston economy continues to follow the lead of the U.S. economy, with ample signs of economic growth but no job growth to accompany it. The rig count is up by more than 50 percent from its early 2002 low, the Purchasing Managers Index is indicating 11 consecutive months of expansion, and a respectable retail performance over the holidays points to consumer income gains. At the same time, revised employment data indicate only the smallest of upturns in Houston job growth in mid-2003. Rapid productivity growth is the culprit on both sides, providing solid income and production gains but holding back job growth.

Retail Sales

Retailers reported good holiday sales, although the season started slowly and was not uniformly good among all stores. The immediate post-holiday shopping period has become more important to overall results, making early sales look slow and inventories seem high as the season wears on. High-end retailers did best, while department stores struggled to achieve moderate gains.

Real Estate

Apartment occupancy continues to decline, reaching the lowest levels in a decade. Concessions are already being made on all fronts to attract renters, and another 20,000 units are under construction. MLS sales of existing homes set a November record by 1 percent, and home prices are up 4 percent over the same

period. New housing starts are expected to slow this year because sales have softened and inventories are 25 percent above year-earlier levels. An overbuilt apartment market is making home ownership less attractive.

Office occupancy and rents continue to fall. Only selected suburban markets such as The Woodlands and Sugarland are doing well.

Energy Prices

Crude oil prices strengthened in mid-November in response to lower OPEC supplies, very low crude inventories, terrorism uncertainties and approaching winter. Spot prices ranged from \$30 to \$33, with high natural gas prices and cold weather affecting prices through mid-December. U.S. crude inventories were at the lowest levels ever for December.

Heating oil was the key actor in product markets, and wholesale prices swung from 82 cents to 96 cents per gallon with cold weather, a spike in natural gas prices and higher crude prices. Distillate inventories were well within the normal range for December.

Natural gas prices jumped more than 40 percent in December, pushing gas prices to near \$7 per thousand cubic feet in midmonth. The very early and very cold weather ran counter

to forecasts for a mild winter and caught some by surprise. Inventories were near the five-year average in late December.

Energy price swings did little to change the listless pattern of drilling in the United States. The domestic rig count remains near 1,100, while international activity continues to improve. Forecasts for the coming year are for more of the same, with perhaps a slight decline in U.S. drilling.

Refining and Petrochemicals

Refiner margins were strong seasonally, helped by very cold weather. Refiners raised output in mid-December in response to higher heating oil prices, and supplies have been helped by high import levels of refined products. Gasoline demand was very strong throughout 2003, but refiners have built inventories back to within the normal range.

Petrochemical producers suffered through another feedstock price shock as natural gas prices shot up. In response, domestic producers found themselves absorbing the cost or cutting production. Prices for plastic resins were generally stable through December.



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