



# Southwest Economy



## Changing Economy Likely to Test Banks as Stimulus Ends, Growth Slows

### **PLUS**

- ▶ **Looking Back: Harris County Five Years After Hurricane Harvey Hit**
- ▶ **On the Record: Trade Binds Central America, Mexico to U.S. Despite Past Inequities**
- ▶ **Houston Still an Energy Town, Largely Pins Growth on the Sector**
- ▶ **Crypto Miners Eye Texas for Energy Abundance; Banks View Digital Entrée**
- ▶ **Spotlight: Federal Dollars Could Drive Electric-Vehicle Charging Across Texas**
- ▶ **Around the Region: Texas Home Prices Rose at Record Pace in 2021**

Looking back at a past *Southwest Economy* article, with updates to the story through today.

# Harris County Five Years After Hurricane Harvey Hit

In late 2017, then-Harris County Judge Ed Emmett went “On the Record” in *Southwest Economy* (“Harris County Faces Challenges Following Hurricane Harvey Deluge”) to discuss the response to Hurricane Harvey, the Category 4 storm that struck in August.

## Comparing Hurricane Harvey to previous severe weather events in the region:

There is no comparison—Harvey is by far the worst storm to hit Harris County. Unlike past events such as Hurricane Ike, Harvey was a rain and flooding event that affected a much greater number of people and businesses.

Over 50 inches of rain fell in parts of the county; there is very little you can do to prepare for that amount of rain in a short period of time. For homeowners, it has been a much more difficult event to deal with than [for] businesses since homeowners don’t have the resources to rebuild. Going forward, the biggest challenge is finding the money to rebuild and beef up infrastructure to reduce the impact of the next big flood.

**Update:** Harris County acquired \$7.7 billion in mostly federal funding to mitigate the impact of future storms. Almost \$2.8 billion was allocated for emergency work, flood-control infrastructure, housing, and planning and administration.

## How the recovery proceeded given that residential disruption was more pronounced than business disruption:

Businesses have the resources to start the repairs right away, and most were back on their feet relatively

quickly. Even a small restaurant I know of in Meyerland, one of the hardest-hit areas in the county, took on five feet of water but was back in operation within three weeks.

The issue with homeowners is that most people have a significant money shortage and don’t have the funds to rebuild. Many homeowners were not insured, and even those who were are waiting a long time for FEMA [Federal Emergency Management Agency] to send them checks. Even then, often the amount received doesn’t cover the cost to rebuild. So, many have been left waiting for additional aid or hoping for a buyout.

**Update:** Harris County has spent \$30 million for rehabilitation and repair of homes, much of it from the U.S. Department of Housing and Urban Development Homeowners Assistance Program.

## The most important points and biggest challenges in the county’s initial post-Harvey flood-control strategy:

The most important element of the plan is the overall vision. We need to acknowledge that we live in a flood-prone area and take action to reduce the impacts of future floods. Rather than fighting with our watersheds, we need to use them as assets and turn as many of them as possible into recreational areas and green spaces. We need to change our thinking and think of everything as a flood-control effort.

An important use of funds would be to buy out homes in true flood plains. If people have been allowed to build in flood-prone areas, where they really shouldn’t have built, we need to buy them out so that we don’t keep paying out insurance.

ON THE RECORD

A Conversation with Judge Ed Emmett

### Harris County Faces Challenges Following Hurricane Harvey Deluge

Edward M. Emmett became Harris County Judge in 2007. He is the chief administrative officer and director of emergency management in the county, which includes most of the city of Houston. He recently released a 15-point plan to prevent future flooding disasters. Harris County is the third-most populous U.S. county, accounting for two-thirds of the Houston metropolitan statistical area’s population of 6.8 million people.

Q. How did Hurricane Harvey’s aftermath compare to previous severe weather events in the region?

There is no comparison—Harvey is by far the worst storm to hit Harris County. Unlike past events such as Hurricane Ike, Harvey was a rain and flooding event that affected a much greater number of people and businesses.

Over 50 inches of rain fell in parts of the county; there is very little you can do to prepare for that amount of rain in a short period of time. With a hurricane, there is a storm surge that is localized and more predictable, which allows you to better prepare and evacuate people. What many people don’t understand is that Harris County has good drainage—that’s why most of the water was gone within a week. It was just too much rain in a very short period of time, and for homeowners, it has been a much more difficult event to deal with than businesses since homeowners don’t have the resources to rebuild. Going forward, the biggest challenge is finding the money to rebuild and beef up infrastructure to reduce the impact of the next big flood.

Q. What do you see as key differences in the response to Harvey compared with Superstorm Sandy and Hurricane Katrina?

Katrina was a game changer in terms of how large a political event it was and how governmental entities reacted to the aftermath. There was a lot of criticism of federal, state and local governments. What a lot of people remember in the aftermath was that FEMA was not in our region that during those kind of crises, the city, county and state need to work together. We don’t get caught up in who is in charge of what, we simply do what needs to be done to make sure everyone is safe.

Harricanes didn’t used to be political events. An example I use is the Houston area when Hurricane Alicia hit in 1984, and it wasn’t an event that came into the political realm. Nobody talked about the government’s response or how FEMA [the Federal Emergency Management Agency] managed the aftermath. That first changed with the performance of Hurricane Andrew [in South Florida] in 1992—an election

year—when President George H.W. Bush was judged to have responded. Since then, these storms have become political in the sense that the response in the event is judged and used as an assessment for the next election cycle.

Q. Businesses have had on that Harvey did not cause as much business disruption as it did residential disruption. How does this impact the recovery?

Businesses have the resources to start the repairs right away, and most were back on their feet relatively quickly. Even a small restaurant I know of in Meyerland, one of the hardest hit areas in the county, took on five feet of water but was back in operation within three weeks. For homeowners, however, the issue with homeowners is that most people have a significant money shortage and don’t have the funds to rebuild. Many homeowners were not insured, and even those who were are waiting a long time for FEMA to send them checks. Even then, often the amount received doesn’t cover the cost to rebuild. So, many have been left waiting for additional aid or hoping for a buyout.

Q. What do you see as the most important points of your recently announced flood-control program?

The most important element of the plan is the overall vision. We need to acknowledge that we live in a flood-prone area and take action to reduce the impacts of future floods. Rather than fighting with our watersheds, we need to use them as assets and turn as many of them as possible into recreational areas and green spaces. We need to change our thinking and think of everything as a flood-control effort.

Southwest Economy • Federal Reserve Bank of Dallas • Fourth Quarter 2017

Southwest Economy, Fourth Quarter, 2017

**Update:** A total of \$446.2 million had been spent on home buyouts in Harris County as of year-end 2021. More than 4,000 property owners have volunteered for a buyout; 1,600 were approved, 457 are in process; 718 were purchased as of April 2022.

## The Houston metropolitan area’s governmental structure and implementation of flood-prevention strategies:

We need a long-term revenue source that encompasses unincorporated Harris County to finance these infrastructure projects. A huge number of people live outside of incorporated areas of Harris County. Compared with Dallas County, where there are about 6,000 people in unincorporated areas, there are almost 2 million in Harris County—nearly the same as the city of Houston’s population.

**Update:** Counties that include large parts of the unincorporated Houston suburbs (not part of an established city) attracted new residents from 2017 to 2021—Waller County, up 3.7 percent; Montgomery, 3.2 percent; and Fort Bend, 2.8 percent. To avoid future catastrophic flooding, Harris County alone has spent \$1.5 billion on flood-control infrastructure and \$199.4 million on other flood-control projects as of year-end 2021.

—Updates from Luis Torres



# Changing Economy Likely to Test Banks as Stimulus Ends, Growth Slows

By Amy Chapel and Kory Killgo

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**ABSTRACT:** Banks in the region and the U.S., which have benefited from pandemic-era fiscal stimulus, face downside risks arising from Russia's invasion of Ukraine, ongoing COVID-19 shocks abroad and expectations of significant central bank tightening to address elevated inflation. If a meaningful macroeconomic shock occurs, banks could face decelerating loan growth, deteriorating asset quality and declining earnings.

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**T**he challenges to banks are numerous: decelerating global growth, high inflation, potential structural economic change, significantly tighter central bank policy and high cybersecurity risks.

All these factors confront institutions in the Eleventh District and across the country.<sup>1</sup>

The sources of these factors resemble those clouding the broader economic outlook—Russia's invasion of Ukraine and the continuing effects of the pandemic. Despite recent uncertainty, banks began 2022 on stronger footing and with a generally positive outlook.

Asset quality improved in 2021, with noncurrent loans as a share of total loans declining to lows not seen since before the 2008–09 financial crisis. Banks offered loan forbearance as part of the response to the pandemic which, combined with subsequent significant government stimulus, helped keep asset quality strong relative to pre-pandemic levels.

As a result, some banks reduced loan loss reserves, a move that boosted profitability last year. With asset quality at historically strong levels and a resumption of loan growth underway, it is unlikely banks will be able to further reduce loan loss reserves this year. Additionally, banks face significant hiring competition and wage pressures. These factors could further affect bank earnings this year.

Continued pressure on banks' net interest margins is also likely to weigh on earnings.<sup>2</sup> Net interest margins trended lower and were near historic lows in 2021. Despite the Federal Reserve beginning a monetary policy tightening cycle in March 2022, with higher short-term rates benefiting

margins, it's likely margins will remain compressed as short-term rates are expected to increase more quickly than long-term ones.

In addition to raising the benchmark federal funds rate, the Federal Reserve began reducing the size of its balance sheet, which grew significantly during the financial crisis of the late 2000s and again in response to the COVID-19 economic downturn. Over time, reduction of the asset side of the Fed's balance sheet will also decrease Federal Reserve liabilities, including banks' reserves at the Federal Reserve.

## Bank Profitability Rebounds

Profitability, as measured by return on average assets, recovered markedly in 2021.<sup>3</sup> Profitability was 1.33 percent for district banks in 2021, up 23 basis points (0.23 percentage points) from 2020, and 1.35 percent for U.S. banks, up 46 basis points (*Chart 1*).<sup>4</sup>

Releases from banks' loan loss reserves together with lower noninterest expense offset declining revenue.

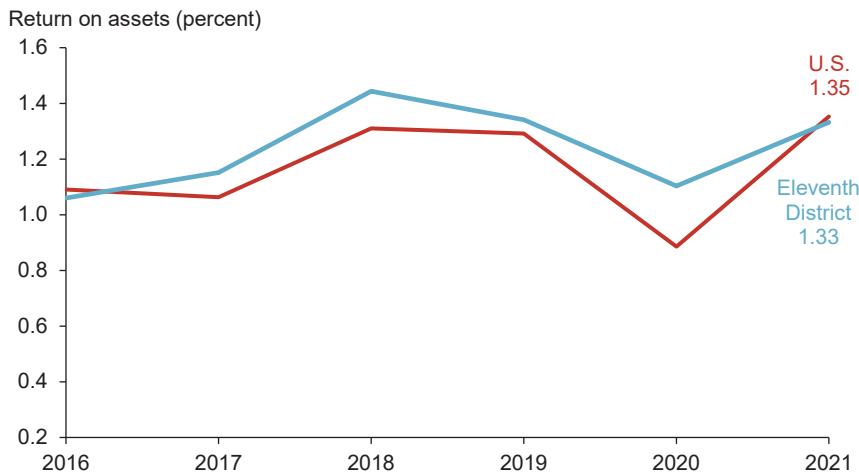
Both in the district and nationally, decreased provision for loan losses accounted for most of the improvement in profitability.<sup>5</sup> Provision expense went from historically reducing profitability to mildly supporting it in 2021, indicating a net release of loan loss reserves.

This was the first time since 1984—when the data began to be collected—that the U.S. banking industry in aggregate experienced negative provision expense. This is unlikely to continue. For district banks, reserve releases contributed 45 basis points to the improved return on average assets; nationally, it added 53 basis points.

Also contributing to profitability in 2021 was decreased noninterest

**CHART**  
**1**

**Eleventh District, U.S. Bank Profitability Rebounded in 2021**



NOTE: Data are for commercial banks with total assets less than \$100 billion.  
SOURCE: Federal Financial Institutions Examination Council, Reports of Condition and Income.

expense—which includes employee salaries and benefits, operating expenses and expenses for premises. At district banks, noninterest expense was down 22 basis points to 2.20 percent of average assets, while nationwide noninterest expense fell 22 basis points to 2.40 percent.

In an environment of rising wages and with the need for greater investment in technology and IT security, noninterest expenses could rise.

Conversely, noninterest income was a drag on profitability. Despite noninterest income increasing in 2021—which anecdotally was partially attributable to fee income from the federal COVID-19 Paycheck Protection Program (PPP) relief loans that banks administered—it rose more slowly than average assets, thus reducing the return on average assets.

Net interest margins—at near historic lows in 2021—also weighed on bank profitability. At district banks, net interest margins fell 30 basis points to 2.92 percent of tax-equivalent average earning assets in 2021. Nationally, margins fell 16 basis points to 3.22 percent.

Despite Federal Reserve monetary policy tightening beginning in March 2022, margins will remain compressed this year because of Treasury curve flatness.<sup>6</sup> This is the result of a relatively

small difference in the yield between short-term and long-term Treasury bonds. Banks take in deposits, paying a relatively low interest rate, and lend funds for longer terms at higher rates.

Banks seeking to boost net interest margins have increasingly invested in securities, including Treasuries, agency securities (bonds issued by federal government agencies and govern-

ment-sponsored entities) and agency mortgage-backed securities.

Securities increased \$42.5 billion for district banks in 2021—up 30.2 percent from 2020—and \$367.8 billion nationwide in 2021, up 31.8 percent (*Table 1*). Growth in securities drove bank balance sheet expansion last year. Banks’ total assets—including loans, securities and reserve balances at the Fed—increased \$70.8 billion (11.9 percent) in the district and \$637.3 billion (10.2 percent) nationwide in 2021 compared with 2020.

Another driver of asset growth was reserve balances at the Fed, attributable to the central bank’s asset purchases and to stimulus funds moving from the U.S. Treasury to taxpayers, who, in turn, increased their deposit balances at banks.

However, as the Fed’s Federal Open Market Committee reduces the Fed’s balance sheet while tightening monetary policy, bank reserve balances at the Fed and consumer bank deposits are expected to decline. While this could marginally worsen banking liquidity, it could provide some relief to bank leverage ratios, weakened by double-digit balance sheet growth during the pandemic.<sup>7</sup>

**TABLE**  
**1**

**Fed Balances and Securities Drive Bank Balance Sheet Growth**

	Change: Dec. 31, 2020–Dec. 31, 2021			
	Eleventh District banks		U.S. banks	
	Dollars (billions)	Percent	Dollars (billions)	Percent
Total assets	70.8	11.9	637.3	10.2
PPP	-18.5	-80.1	-192.2	-76.2
Loans (excl PPP)	17.8	5.7	283.0	7.4
Securities	42.5	30.2	367.8	31.8
Balances at the Fed	24.0	46.1	129.5	31.9
Other interest bearing	3.2	13.5	29.7	16.2
Other	1.8	4.4	19.5	4.3
Total liabilities	66.9	12.6	588.5	10.6
Deposits	73.7	14.8	662.6	12.8
Wholesale funds	-6.8	-38.9	-68.9	-27.7
Other	na	na	-5.2	-3.4
Equity capital	4.0	6.1	48.9	7.0

NOTES: Data are for commercial banks with total assets less than \$100 billion. PPP refers to the Paycheck Protection Program. Equity capital equals total assets minus total liabilities. The change from 2020 to 2021 is shown in both dollars and percent for Eleventh District and U.S. banks.  
SOURCE: Federal Financial Institutions Examination Council, Reports of Condition and Income.

**CHART  
2**

**Loan Growth Picks Up for U.S., Eleventh District Banks**



NOTE: Data are for commercial banks with total assets less than \$100 billion and have been adjusted to exclude Paycheck Protection Program loans.  
SOURCE: Federal Financial Institutions Examination Council, Reports of Condition and Income.

Bank balance sheet expansion eased last year as government pandemic support to businesses and consumers ended, slowing deposit growth. Deposit growth driven by pandemic interventions peaked in early 2021. Deposits rose 27.1 percent year over year at district banks as of March 31, 2021, and 22.7 percent nationwide. Anecdotally, bankers reported that the PPP produced an inflow of retail and small business deposits.

By year-end 2021, deposit growth had slipped to 14.8 percent year over year in the district and 12.8 percent nationwide. Deposit growth is expected to continue slowing in 2022, as stimulus measures end.

**District Loan Growth Uptick**

Loan growth, disrupted by the pandemic, regained its footing in 2021. Loans among district banks grew 5.7 percent last year, versus 1.9 percent in 2020 (Chart 2). They increased 7.4 percent nationwide in 2021, compared with just below 2.0 percent the prior year.<sup>8</sup>

Loan growth has picked up this year, though banks will likely face strong competition for loans after tepid COVID-19-era performance.

Loan growth was broad based across major categories last year (Chart 3). Nationwide, commercial and industrial loan growth led the recovery in 2021 after becoming the slowest-growing category in 2020 as businesses took on PPP loans instead. The recent performance is indicative of businesses responding to the recovery with renewed borrowing to

finance capital expenditures or restock inventories. Commercial and industrial loans rose 11.7 percent in the district and 12.6 percent nationwide in 2021.

The strength of consumers and demand for housing boosted consumer and residential mortgage loan growth, while new construction and a gradual return of employees to offices supported expansion of the commercial real estate category. In the district, commercial real estate loans rose 9.1 percent, consumer loans increased 7.9 percent, and residential real estate loans grew 1.5 percent.

By comparison, nationwide, consumer loans rose 8.6 percent, faster than both commercial real estate, 7.9 percent, and residential real estate, 3.5 percent.

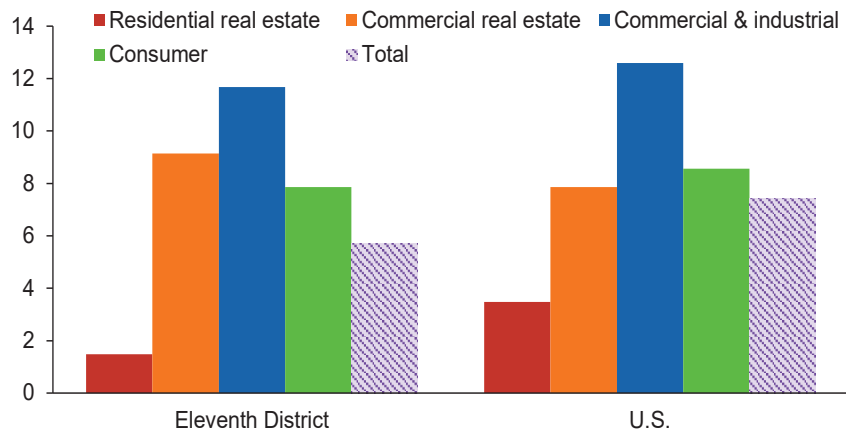
High concentrations of commercial real estate loans and their rapid growth have been historically associated with elevated risk of failures. Thus, banks' commercial real estate activity bears monitoring. At year-end 2021, 17.4 percent of district banks had material concentrations in the sector, the highest percentage since 2006.<sup>9</sup>

Nationwide, 8.8 percent of banks had material concentrations in commercial real estate—close to a record high. While these loans are performing well, underlying property prices have been supported by a period of low interest rates

**CHART  
3**

**All Major Categories of Bank Lending Improved in 2021**

Percent change Dec. 31, 2020–Dec. 31, 2021



NOTE: Data are for commercial banks with total assets less than \$100 billion and have been adjusted to exclude Paycheck Protection Program loans.  
SOURCE: Federal Financial Institutions Examination Council, Reports of Condition and Income.

and pandemic stimulus, and they bear watching as credit conditions evolve through the year.

### Strong Asset Quality

Asset quality improved steadily in 2021 for banks in the district and nationwide, with noncurrent loans reaching levels last seen before the financial crisis in the late 2000s. Limited deterioration in asset quality during the pandemic was largely due to banks providing loan forbearance—including payment deferrals, fee waivers and extension of payment terms—under the Coronavirus Aid, Relief and Economic Security Act. The action allowed traditional measures of asset quality to remain strong and improve as borrowers largely resumed normal payments. The quick economic recovery as well as government stimulus also bolstered borrowers’ financial positions.

Across the district, 0.58 percent of loans at year-end 2021 were noncurrent—past due 90 days or more or on nonaccrual status (not generating interest)—down from 0.91 percent at the end of 2020 (*Chart 4*). Nationwide, noncurrent loans fell to 0.85 percent in 2021 from 1.17 percent. These are the lowest noncurrent loan values since 2007 for banks both in the district and nationwide.

Of the major loan categories, residential real estate loans improved most in the district and nationwide.

Asset quality likely won’t improve further in 2022; it’s already near historic levels, loan growth is picking up, and the Russia-Ukraine war is clouding the economic outlook.

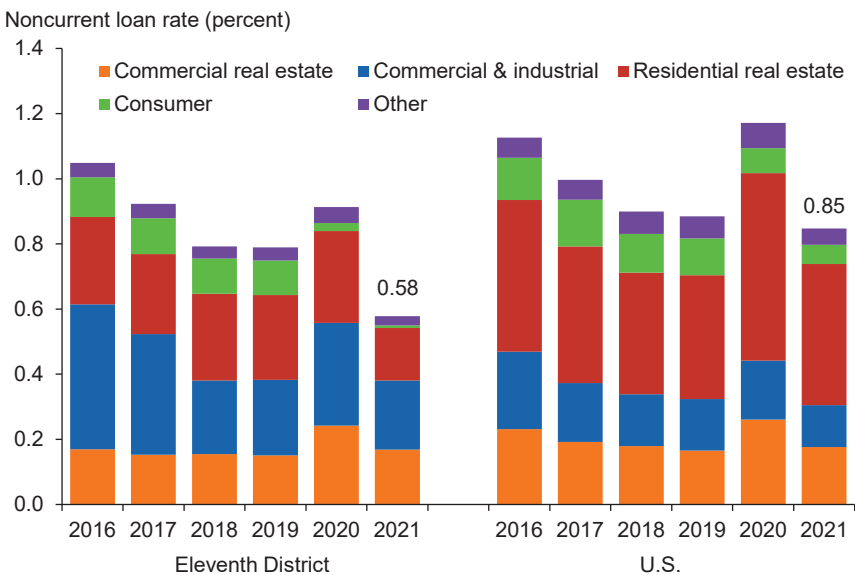
### Uncertain Outlook

Significant public sector stimulus in response to the pandemic has produced an environment where asset quality is historically benign and loan growth is improving, even while there are strong headwinds to bank earnings, and banks’ commercial real estate concentrations are high.

Downside risks in the near term arise from the Russia-Ukraine conflict, recurring COVID-19 shocks abroad and expectations of significant central

CHART  
4

Noncurrent Loan Rates Improve in 2021 in District, U.S.



NOTE: Data are for commercial banks with total assets less than \$100 billion.  
SOURCE: Federal Financial Institutions Examination Council, Reports of Condition and Income.

bank tightening to address elevated inflation. Should an economic downturn or other major macroeconomic shock occur, banks’ loan growth could decelerate, with asset quality deteriorating and earnings declining.

*Chapel is a macro-surveillance manager, and Killgo is a financial industry analyst in the Banking Supervision Department at the Federal Reserve Bank of Dallas.*

### Notes

- <sup>1</sup> The district comprises Texas, northern Louisiana and southern New Mexico.
- <sup>2</sup> Net interest margin is the difference between a bank’s interest income (loan and securities yields) and interest expense (deposit and other borrowing costs) weighted by average earning assets.
- <sup>3</sup> Bank profits consist of net interest income (interest income from loans and securities less interest paid on deposits and other borrowings) plus noninterest income (fees for services) less noninterest expense (salaries and benefits for employees). Profits also reflect gains or losses on the sale of securities and are reduced by provision expense (funds set aside to cover potential loan losses) and taxes.
- <sup>4</sup> The existing analysis includes commercial banks with total assets less than \$100 billion (over 99 percent of commercial banks nationwide and in district). Data for

- district banks have been adjusted for structure changes, such as mergers, acquisitions and relocations.
- <sup>5</sup> Provision expense is the amount banks set aside to cover loan losses; provision expense gets added to a bank’s loan loss reserve, the buffer against expected losses. Reductions from the loan loss reserve—negative provision expense—boost profitability.
  - <sup>6</sup> The relationship between the slope of the Treasury, or yield, curve and bank profitability as measured by net interest margin remains intact, according to an analysis in “Smaller Banks Less Able to Withstand Flattening Yield Curve,” by Pavel Kapinos and Alex Musatov, Federal Reserve Bank of Dallas *Economic Letter*, vol. 13, no. 8, 2018. <https://fraser.stlouisfed.org/title/economic-letter-6362/smaller-banks-less-able-withstand-flattening-yield-curve-607748>.
  - <sup>7</sup> Bank leverage ratios are a measure of a bank’s core capital relative to its total assets. A bank’s core capital includes assets that can be easily liquidated if the bank needs capital in the event of a large, unexpected loss or financial crisis.
  - <sup>8</sup> Loan growth values exclude PPP loans.
  - <sup>9</sup> A bank has a material commercial real estate concentration if its: (1) total reported loans for construction, land development and other land represent 100 percent or more of their total capital; or (2) total commercial real estate loans represent 300 percent or more of their total capital, and the outstanding balance of their commercial real estate loans has increased by 50 percent or more during the prior 36 months.

*A Conversation with Raymond Robertson*

## Trade Binds Central America, Mexico to U.S. Despite Past Inequities

*Raymond Robertson is the director of the Mosbacher Institute for Trade, Economics and Public Policy at the Bush School of Government and Public Service at Texas A&M University. He discusses the impact of free trade agreements on Mexico and Central America.*

### **Q. NAFTA (the North American Free Trade Agreement) ushered in an era of free trade in North America. How successful was it? How did it help Mexico?**

NAFTA certainly represented the beginning of a new North American era. When President George H.W. Bush started negotiations for NAFTA, the original motivation included taking advantage of trade to promote economic growth.

Most people do not realize that it was probably even more about locking in Mexican (economic) reforms after the lost 1980s and bringing Mexico and the United States (and Canada) closer together as neighbors in both the economic and political sense. To that extent, NAFTA was tremendously successful.

Mexico did not revert to the closed-economy paradigm and—except for some external shocks—has enjoyed macroeconomic stability for much of the past 30 years. NAFTA may not have lived up to the very high expectations expressed by U.S. and Mexican governments in 1992, but NAFTA helped Mexico transition from being a natural-resource exporter (like Russia and other developing countries) to being a manufacturing exporter that now focuses on automobiles, electronics and aerospace.

These industries provide very good formal sector jobs that draw workers out of agriculture and motivate investment in

education. Mexico's post-NAFTA transformation remains largely unappreciated.

### **Q. Under NAFTA, did Mexican manufacturing workers experience improved wages and working conditions? What was the impact on U.S. workers?**

President Lyndon Johnson allegedly expressed a preference for one-armed economists because he was often frustrated when economists said "... but on the other hand." Unfortunately, there are two sides to the experiences of workers in North America because of NAFTA.

NAFTA helped hitch Mexico's wagon to the U.S. manufacturing sectors. Integration with the U.S. manufacturing sector increased the demand for workers and was the driving engine of Mexican manufacturing employment for much of the past 30 years.

The comparison between Mexico's north and south [regions] shows the positive benefits of NAFTA in the sense that the much-more-integrated north has much higher wages and much more manufacturing employment. Mexico's south continues to struggle with lower wages and higher rates of agricultural employment. To that extent, one of the problems with NAFTA was that it did not go far enough to help Mexico's south.

At the same time, U.S. manufacturing workers have had a tough 30 years since

NAFTA due to technological advances and competition from China. These shocks have affected Mexico as well. Competition with China in the U.S. market hurt Mexican workers—especially women working in apparel.

In the integrated sectors, such as automobiles and other manufacturing, U.S. and Mexican manufacturing employment are highly correlated, suggesting that the U.S. and Mexico are not competing for jobs with each other as much as they are working together to produce final goods that compete in the global market.

North American integration has really helped U.S. consumers. Millions of U.S. consumers enjoy Mexican avocados and cars, for example. In the cases where U.S. workers were hurt by growing integration—and obviously, there were geographically concentrated employment losses—the U.S. government could have done much more to help workers.

Insufficient support for these workers is in many ways responsible for the backlash we see against NAFTA today. The gains from NAFTA in terms of expanding U.S. and Canadian employment due to improvements in productivity and lower prices for North American consumers receive much less media attention.

### **Q. Ten years after NAFTA came the Central American version, CAFTA-DR. How did it differ from NAFTA, and what was it supposed to accomplish?**

CAFTA-DR includes the United States, Costa Rica, the Dominican Republic, El Salvador, Guatemala, Honduras and Nicaragua and was signed in 2004 during the George W. Bush administration. I mention the date and countries because these are very different countries from Mexico and, of course, Canada.

Generally, Central American countries have much lower incomes, more workers in agriculture and rely much less on manufacturing for exports. While Mexico primarily exports cars and car parts, the main manufacturing export from most of the Central American countries is apparel.

Apparel is often the first manufacturing sector that emerging-market coun-



► *People are much less enthusiastic about trade, and the calls for “reshoring” are rising. I think that “near-shoring” that includes shifting production from China to Mexico and Central America would help promote growth in the U.S. as well as Latin America.*

tries enter along the path of economic development. While the goals of NAFTA were largely political, the goals of CAFTA-DR focused more on promoting trade and investment as a way to stimulate employment growth and foster stability.

Central America is an important source of U.S. immigration, and part of the logic of CAFTA-DR was to create jobs in Central America so that workers would not feel like they had to move to the U.S. to find employment.

**Q. You have extensively researched apparel and textile trade under CAFTA-DR and around the world. What have you learned?**

I have researched apparel trade for almost 20 years. Apparel is a really important sector because it often serves as a gateway for formal employment in developing countries. Workers come from subsistence agriculture and the informal sector to work in apparel factories. Apparel jobs are actually good jobs relative to most domestic alternatives in these countries.

It is a little bit surprising to hear apparel factory jobs described as “good” jobs, because they are often associated with the term “sweatshops” and are well known for very long hours; low wages; unfavorable working conditions, such as no temperature control and lack of safety measures; and, sometimes, outright abuse.

Compared with employment conditions in developed countries—like the U.S.—apparel jobs in developing countries are often very problematic. But the typical employment alternatives for

these workers—often young, less-educated women—are even worse. Agriculture usually has much lower wages and higher accident rates and fatalities than apparel factories, for example.

Other sectors that are not “globalized,” such as agriculture and the informal sector, may not get the same attention and, as a result, have worse conditions (than apparel factories) and less hope for change. By being the entry-level job in the formal sector, apparel jobs can be a springboard for other formal employment as well and help lay the foundation for careers.

Because apparel is easy to start up, has a global export market and offers jobs that bring people out of agriculture and informality, developing-country governments often try to promote apparel exports. At the same time, apparel trade is highly regulated.

The apparel trade is regulated today through rules of origin clauses in trade agreements. Every trade agreement needs rules of origin because they define what “made in America”—or “made in wherever”—means.

For example, rules of origin might specify that at least 60 percent of the value of a final good must be added in Mexico for a product to be considered “made in Mexico.” If the rules of origin set the level at 40 percent, Mexico could import 50 percent worth of the final good value in parts from other countries, assemble them and then export the good as a Mexican product.

Apparel rules of origin are often much more complicated. Consider the production of a shirt. Shirts are considered “apparel” and are assembled

(usually sewed) from pieces of fabric. Fabric is considered “textiles,” which is different from apparel. Fabric (textiles) is either woven or knit from yarn and threads, which are spun from, say, cotton or artificial fibers.

In some cases, rules of origin for apparel specify that not only does a shirt have to be sewn in, say, Honduras, to be counted as Honduras, but the fabric and textiles must also come from Honduras. The CAFTA-DR agreement goes even further than that. The CAFTA-DR agreement adopts a “yarn-forward” rule that says that the shirt, fabric and the yarn that goes into the fabric must come from a CAFTA-DR country.

As a result, CAFTA-DR countries that want to benefit from the provisions in the CAFTA-DR must use the relatively limited supply of fibers, threads and fabrics produced in CAFTA-DR countries. Central American countries grow very little cotton and produce even fewer artificial fibers. Even fabric production is limited in Central America.

As a result, Central America relies on U.S. thread, fibers and fabrics for its exports. Since the U.S. produces a limited range of thread, fibers and fabrics, Central American apparel exports are very limited by the agreement.

In a recent paper, I estimated the relationship between apparel trade and nearly every trade agreement in force worldwide. In some cases, such as the U.S.–Jordan agreement, there is a very large and significant trade increase. CAFTA-DR, however, is associated with approximately 70 percent less apparel trade than the “average” agreement and, shockingly, much less trade than



between country pairs that have no agreement at all.

### **Q. Why did CAFTA-DR fail where NAFTA succeeded?**

CAFTA-DR is associated with an increase in total trade that is statistically and economically significant. For apparel, however, the comparison between CAFTA-DR and NAFTA is really interesting.

In the first few years after NAFTA took effect (1994–2000), apparel trade between Mexico and the U.S. increased significantly. When China entered the World Trade Organization in 2001, however, apparel production shifted from Mexico to China.

During the 2000s, three trends have emerged. First, technology of textile production advanced, creating a wider range of fibers, yarns and textiles. Second, production, especially of textiles used in wearing apparel, shifted from the U.S. to other producers around the world. Third, being capital and technology abundant, the U.S. shifted textile production away from wearing apparel toward more advanced textile products, such as flame-resistant materials, filters and high-performance industrial fabrics.

The CAFTA-DR effectively restricted Central America’s textiles to those that remained in the U.S. As the U.S. share of the global range of textiles used in wearing apparel fell, Central America became less and less competitive because it lacked access to the global range of fabrics that consumers demanded.

Just think of how “simple” jeans have changed over the past 15 to 20 years. Jeans increasingly use “stretchy” fabrics, and there are many more available degrees of “stretchiness” in jeans. If using these newer fabrics means that you lose CAFTA-DR tariff preferences, you may want to stick with simpler products, like T-shirts.

Production shifting back to Mexico from China is generally not in apparel. Mexico is capturing much more sophisticated goods—auto parts, electronics and aerospace.

▶ *If we want to create jobs here, we need to increase exports. Mexico and Central America buy much more, per dollar of income, than China or other East Asian countries. Expanding employment in Mexico and Central America is a way to boost U.S. exports and, therefore, U.S. jobs.*

### **Q. What can we do to boost economic development in Central America? Would economic development in Central America damp outmigration and take some pressure off the Southwest U.S. border?**

It seems clear that the restrictive rules of origin in CAFTA-DR are holding back Central American apparel production. I estimate that if CAFTA-DR were changed so that it was associated with just the “average” increase in apparel production found in other trade agreements, about 100,000 new direct jobs would be created. This is a number that is comparable to the size of migration flows from Central America.

In other words, just updating CAFTA-DR would go a long way toward reducing Central American migration and promoting growth and development in the region.

Obviously, there are still some barriers to economic growth, but my estimates hold things like corruption and electricity prices constant and suggest that the trade agreement would go a long way. Furthermore, Mexico increasingly produces textiles that get exported to Central America.

To the extent that we would want to support Central America and Mexico, we should consider revising the CAFTA-DR to facilitate Mexico’s participation in textile production for Central America. Expanding the agreement to allow textile (and other) production from other countries, such as Colombia, would also promote development and stability in the region.

### **Q. Geopolitical tension is rising around the world, and global supply chains are under pressure. Are we seeing the end of the post-World War II free trade era?**

I think a lot of people see the COVID-19 crisis as a turning point in global trade, but the data suggest that the last financial crisis (2007–09) was a turning point for globalization. The share of trade in global GDP has either remained constant or has been falling since then.

People are much less enthusiastic about trade, and the calls for “reshoring” are rising. I think that “near-shoring” that includes shifting production from China to Mexico and Central America would help promote growth in the U.S. as well as Latin America.

We should be thinking of this kind of integration more than complete reshoring because it’s pretty clear from the last 20 years that manufacturers would respond to government pressure to reshore by increasing automation rather than bringing a lot of jobs back to the U.S.

If we want to create jobs here, we need to increase exports. Mexico and Central America buy much more, per dollar of income, than China or other East Asian countries. Expanding employment in Mexico and Central America is a way to boost U.S. exports and, therefore, U.S. jobs.

And if the production shifts from China, it’s going to be difficult to argue that Mexican or Central American development comes at the expense of U.S. jobs. Economic integration in the Americas is a win-win solution.

# Houston Still an Energy Town, Largely Pins Growth on the Sector

By Jesse Thompson

**ABSTRACT:** The COVID-19 pandemic decimated the oil and gas sector, whose delayed recovery slowed the Houston area's growth relative to the rest of Texas and the nation through most of 2021. In recent months, increasing oil and gas demand and shifting geopolitics have become tailwinds for energy production and exports—as well as for Houston.

At Houston's core, energy still rules. Two years after a COVID-19 lockdown helped collapse the energy sector and economic activity, historically high oil and gas prices and rising exports are propelling Houston ahead of the nation even as uncertainty and inflation erode the global economic outlook.

Some 25 months after the pandemic first struck, Houston has regained the 361,000 jobs that disappeared from February to April 2020 (*Chart 1*). Texas employment was 2.5 percent above its prepandemic level. By comparison, U.S. payrolls were 0.8 percent below prepandemic levels.

Apart from energy, the local service sector also suffered in the collapse, accounting for 330,000 lost jobs. Leisure

and hospitality alone (especially restaurants) shed 134,000 positions, while trade, transportation and utilities (notably retail); professional and business services; and education and health services together lost another 138,000 jobs. Meanwhile, goods-producing sectors dropped 41,000 positions, more than half involving construction.

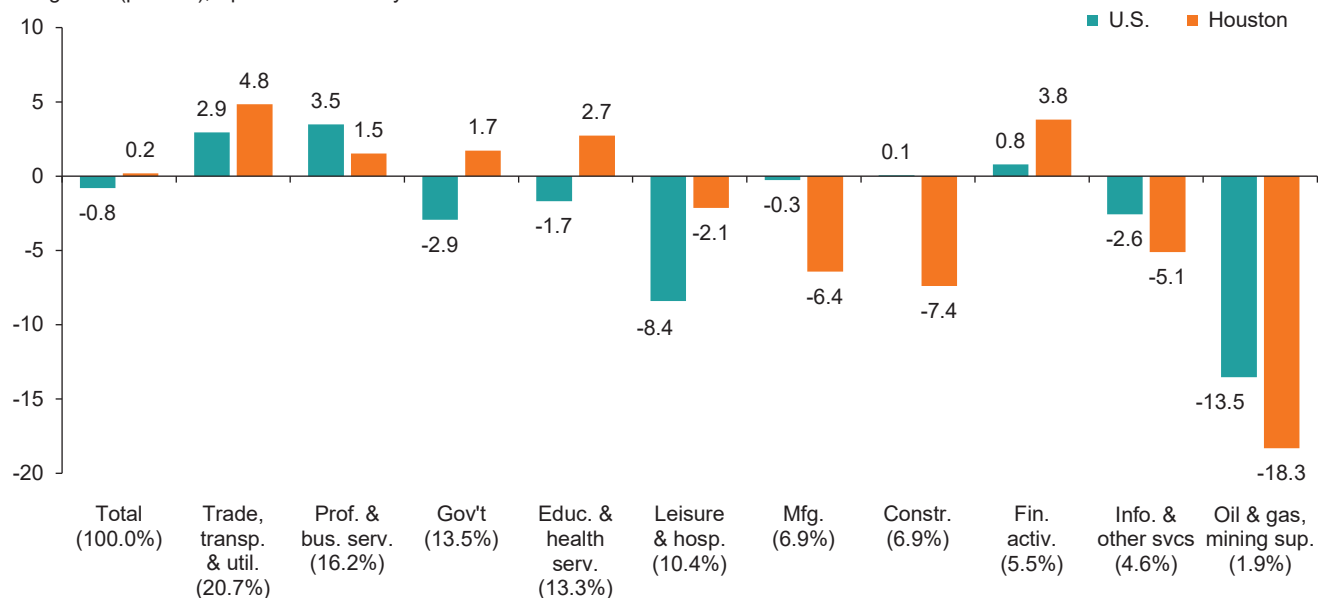
Houston, led by the service sector, initially declined more slowly than the U.S.; local employment fell 11.2 percent from February to April 2020 versus 14.4 percent in the U.S. By comparison, declines in area goods-producing industries continued into 2021.

Early in the pandemic, the energy downturn weighed on Houston manufacturing and construction industries. The fabricated metals industry, which

CHART 1

Houston Preceded U.S. in Recovery from Pandemic Job Losses

Job growth (percent), April 2022/February 2020

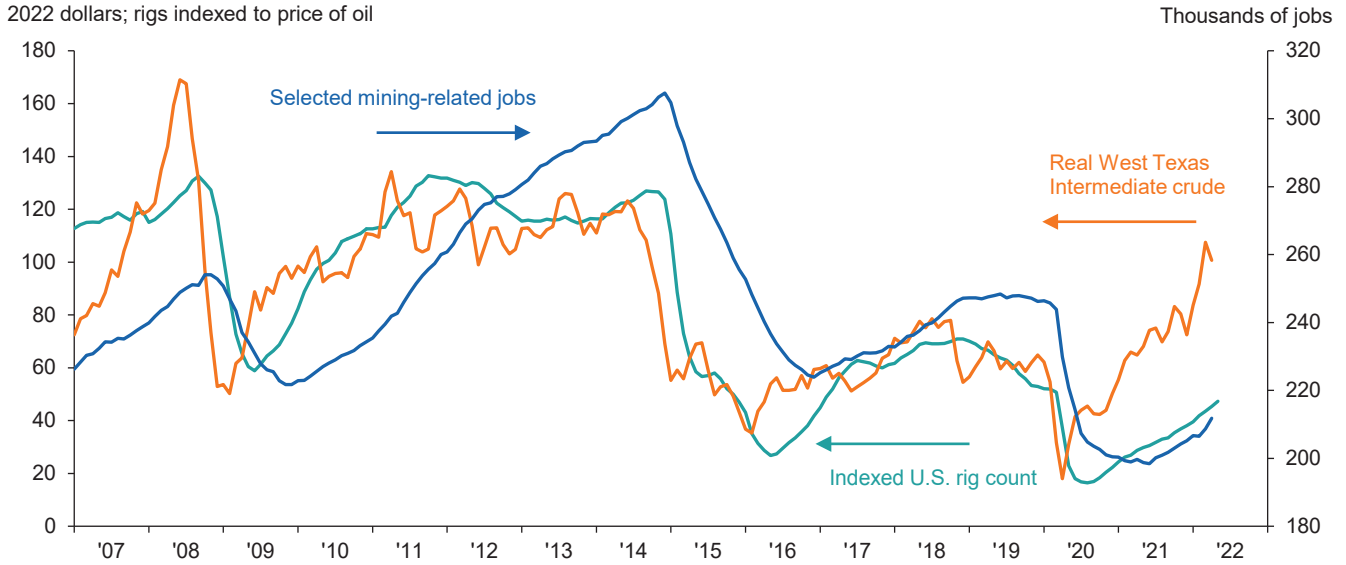


NOTE: Numbers in parentheses indicate the share of total state employment for April 2022.

SOURCES: Bureau of Labor Statistics; Texas Workforce Commission; Federal Reserve Bank of Dallas.

CHART  
2

Houston's Energy-Related Job Growth Anemic Despite Oil-Price Jump



NOTES: The U.S. rig count is indexed to the real price of oil such that the February 2016 rig count equals \$35 in February 2022 dollars (actual February 2016 rig count 532; actual February 2022 rig count 636). Houston's mining-related jobs include oil and gas extraction; support activities for mining; fabricated metals manufacturing; agriculture, construction and mining machinery manufacturing; pipeline transportation; and architecture, engineering and related services.  
SOURCES: Baker Hughes; Bureau of Labor Statistics; Energy Information Administration; adjustments by the Federal Reserve Bank of Dallas.

produces components used by the oil and gas sector, slowed. Oilfield machinery, pipeline and related equipment, making up a large share of local machinery manufacturing, weakened. Construction sank, in part because of project cancellations and delays related to oil and gas mining, pipelines and petrochemicals.

Service industries in Houston—retail and wholesale trade and transportation, education and health, government, and financial activities—had surpassed pre-pandemic employment levels by April 2022. Nationally, education and health and government employment still had shortfalls. Texas' decision to end pandemic restrictions on businesses earlier than most other states aided Houston's leisure and hospitality rebound.

**Energy Still Important**

The pandemic underscored that Houston, despite diversifying since the 1980s, remains deeply connected to oil and gas.<sup>1</sup> The industry, with many of its biggest players headquartered in the metro area, accounts for more than one-third of Houston's economy—including mining and refining as well as sizable segments of transportation, construction, manufacturing and services.

Energy's direct share of the area's GDP has averaged 7 percent over the past decade—even though very little oil and gas is produced locally. Non-durable goods manufacturing, mostly refining and petrochemical output, accounted for 13 percent of GDP, while durable goods manufacturing tied

to energy accounted for another 3–4 percent. There are also spillovers to other industries, such as construction and engineering and legal services, as well as indirect impacts of spending by energy sector employees.

Despite energy's large GDP impact, the employment share is relatively small. The industry is capital intensive, which means employment is relatively low but wages are high. From 2011 to 2020, it accounted for about 16 percent of Houston employment and 29 percent of wages paid.

**Slow Shift to Growth**

Even before the pandemic, U.S. fossil fuel producers struggled with poor rates of return on invested capital and dwindling access to funding. The 2020 oil demand collapse was devastating; global inventories of crude oil, gasoline and diesel swelled to historic levels and prices plummeted.

The West Texas Intermediate (WTI) crude oil benchmark fell to negative \$37 on April 22, 2020, meaning that producers paid to get rid of inventories. Oilfield activity fell 70 percent, and production from existing wells was in many cases capped or choked

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because there was nowhere to deliver product. One in five oil and gas mining jobs in Houston had disappeared by August 2020, though employment in the broader energy industry didn't hit bottom until March 2021 (*Chart 2*). Bankruptcies surged.<sup>2,3</sup>

As world economies began emerging from COVID-19 constraints in 2021, OPEC, Russia and other OPEC+ nations hewed to crude oil production growth limits; rising consumption drained oil stored from 2020. However, as inventories subsequently dwindled, OPEC+ producers couldn't restore output as quickly as promised and oil prices pushed higher.

U.S. drilling tends to follow oil prices, but the industry's response to rising real oil prices has been relatively lethargic since early 2021.

Before the pandemic, years of poor returns had sharply reduced access to capital from bond markets, banks and investors. The total return including reinvested dividends on Standard & Poor's (S&P's) basket of exploration and production (E&P) firms was negative 50 percent from December 2012 to December 2020. The return on the broad S&P 500 was 209 percent.

Separately, \$300 billion in energy debt was subject to bankruptcy proceedings in 2015 to 2021, according to the law firm Haynes and Boone. While some lenders abandoned energy, investors increasingly turned to alternative energy investments such as wind, solar and batteries.

Oil producers leaned on thousands of uncompleted wells in 2021 left from the pandemic-related collapse—wells that were drilled but not yet brought into production. This reduced the need to spend on drilling new wells. By year-end, rising real energy prices, the limited spending and large dividends turned energy stocks from the worst-performing to the best-performing sector in the S&P 500. The bankruptcy cycle came to an end, and energy companies could again borrow through the bond market.

Still, the industry continued to cite investor demands for capital discipline and only modestly boosted spending on drilling and production activity. The reticence to spend has coincided with surging input prices for steel pipe, sand and machinery along with supply-chain delays and a very tight labor market. Thus, oil prices exceeding \$100 per barrel may not generate

the same level of stimulus for Houston as prior oil upturns would suggest even if elevated prices persist well past 2022, as currently expected.

### Houston Exports Boom

Russia's invasion of Ukraine in late February 2022 came at a time when European natural gas inventories were at perilously low levels dating back to early 2021 as Russia slowed deliveries. (Europe is a major purchaser of Russian natural gas).<sup>4</sup> The price of European gas rose from \$7 per million British thermal units (MMBtu) at the start of 2021 to \$30 in October 2021 and surged to \$65 in the week following the invasion (*Chart 3*). Energy-hungry European buyers bid up liquefied natural gas (LNG) prices all around the world, including in the U.S.

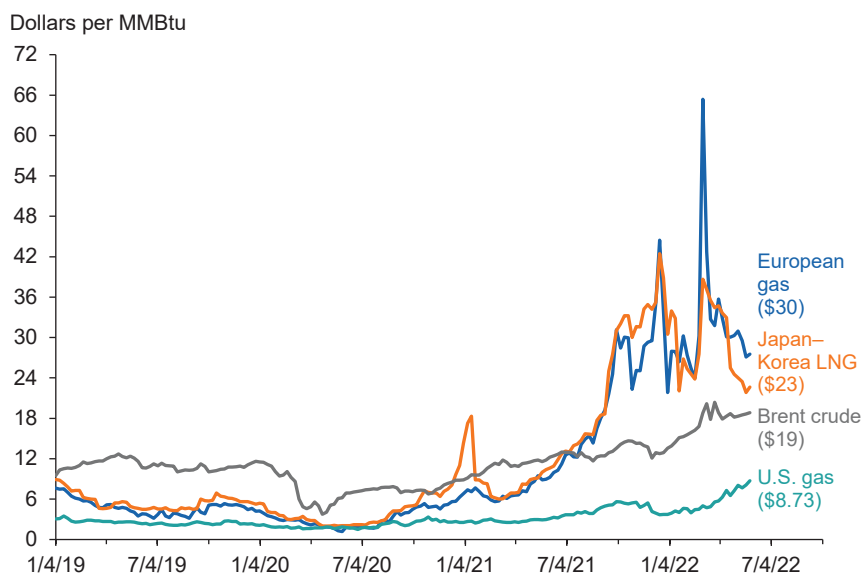
U.S. benchmark Henry Hub natural gas rose to nearly \$9 per MMBtu in May 2022 as moderate domestic supply growth met stronger domestic demand and growing LNG exports. A widening spread between U.S. and global energy benchmarks confers a cost advantage on U.S. firms with the capacity to export energy and energy-intensive products such as fuels and petrochemicals.<sup>5</sup>

Surging global demand for energy products has driven Houston exports to record highs. Chemicals, petroleum products, crude oil and natural gas make up three-quarters of the value of exports from the Houston-Galveston customs district, which extends along the Texas coast from Galveston and the Houston Ship Channel to Corpus Christi.

In the near term, the price differentials for natural gas will support elevated petroleum chemical product exports—to the extent supply chains can accommodate them. Spurred by sanctions against Russia and a desire to speed the energy transition to more carbon-neutral fuels, nations are moving to diversify sources of natural gas while displacing coal as an energy source. This would favor new investments in LNG capacity along the Texas coast, boosting heavy construction, manufacturing, logistics and support services for several years.

#### CHART 3

Curtailed Natural Gas Supplies, Strong Demand Push Prices Higher



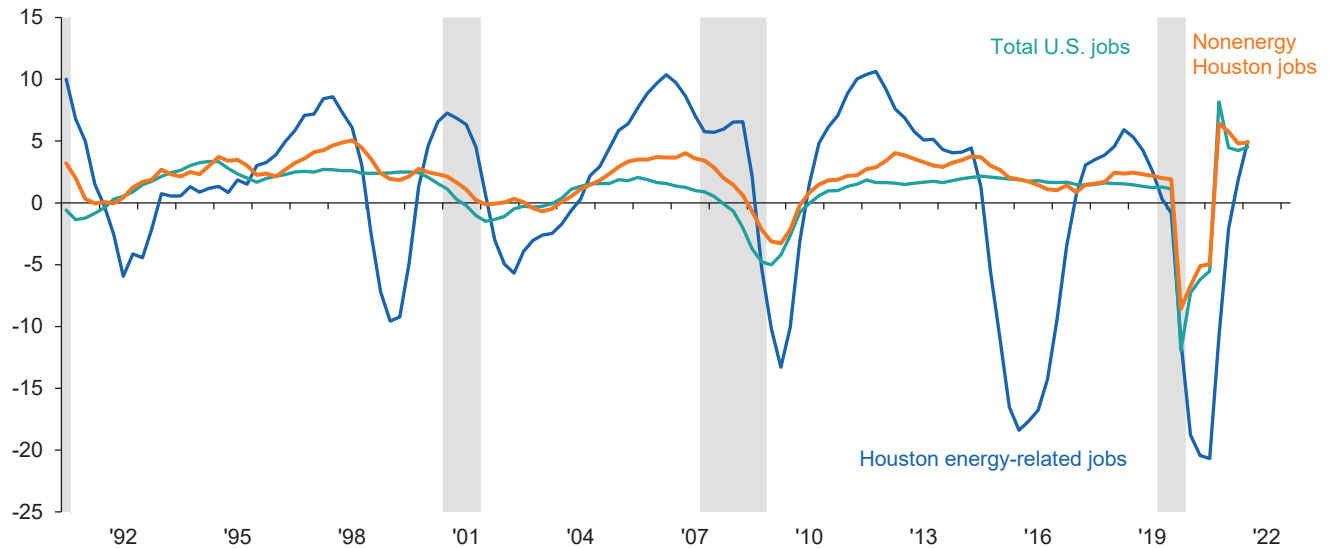
NOTES: MMBtu stands for million British thermal units. European gas is the Netherlands TTF (Title Transfer Facility) price, and U.S. gas is Henry Hub. LNG refers to liquefied natural gas. Currencies are converted using exchange rates. Prices in parentheses are for the week ended May 27, 2022.

SOURCES: Bloomberg; S&P Platts; author's calculations.

**CHART**  
**4**

**Houston Nonenergy Job Growth Resembles Overall U.S. Performance**

Year-over-year log change



NOTES: Energy-related jobs include oil and gas extraction; support activities for mining, fabricated metals manufacturing; agriculture, construction and mining machinery manufacturing; pipeline transportation; and architecture, engineering and related services. Data are quarterly through fourth quarter 2021. Gray bars indicate recessions. SOURCES: Bureau of Labor Statistics; seasonal and other adjustments by the Federal Reserve Bank of Dallas.

**U.S. Economic Drivers**

Outside of its oil and gas booms and busts, the Houston economy tends to be more closely correlated with the national economy (*Chart 4*).

Employment in Houston’s nonenergy sectors has grown at a 2 percent average annual pace over the past decade, while U.S. employment has expanded at a 1.3 percent rate. The area’s nonenergy jobs had in aggregate fully recovered to prepandemic levels by March 2022, with its annual performance resembling the rest of Texas and rarely falling below U.S. growth rates.

Professional and business services, education and health services, and leisure and hospitality are major drivers apart from energy.<sup>6</sup>

**U.S. Economy Slowing**

Energy-producing regions such as Texas tend to benefit from higher oil and gas prices, while most of the rest of the U.S. does not. At the same time, U.S. economic slowing will diminish some of Houston’s momentum.

The *Blue-Chip Economic Indicators* consensus of economic projections for the U.S. economy—an average of many

forecasts—suggested in May 2022 that U.S. real (inflation-adjusted) GDP would slow from the 5.5 percent year-over-year rate in fourth quarter 2021 to 1.5 percent at year-end 2022. The latest forecast is sharply lower than the 2.9 percent 2022 growth anticipated in the February estimate.

Factors figuring in the reduction included a weak estimate of first-quarter GDP, rising interest rates, worsening supply-chain issues and inflationary pressures.

Rather than seeing Consumer Price Index (CPI) inflation slow from 7.0 percent in late 2021 to 3.3 percent in 2022, the consensus panel in its May projections anticipated inflation exceeding 6.0 percent between fourth quarter 2021 and fourth quarter 2022. Longer term, forecasters anticipated that inflation wouldn’t fall into the Federal Reserve’s target range of 2–2.5 percent until 2024.

Meanwhile, job forecasts have accelerated on stronger-than-expected job growth. The Survey of Professional Forecasters (SPF) projection for U.S. job growth in 2022 reached 2.8 percent from 2.6 percent. Similarly, the Dallas Fed’s May projection for 2022 Texas

job growth increased robustly to 3.7 percent from 3.0, in part because of higher energy prices. In both the U.S. and Texas, the pace of growth through year-end is likely to slow.

**Houston to Outperform**

The drag on consumers from high fuel prices is more than offset in Houston by spending in oil and gas and related sectors. However, energy firms’ expenditures are expected to remain moderate compared with past episodes of high energy prices, limiting their impact. At the same time, exports of natural gas are likely to rise, supporting related investments for several years and giving Houston job growth a bit of a tailwind.

If recent projections for the U.S. prove accurate and energy prices remain elevated as anticipated, Houston payroll growth should outpace the national rate of 2.8 percent this year and could outpace the state. Thus, Houston should do well absent an unexpected, large increase in energy supplies, a negative demand shock such as a recession or a new, widespread COVID-19 outbreak.

*(Continued on the back page)*

# Crypto Miners Eye Texas for Energy Abundance; Banks View Digital Entrée

By Jill Cetina and Ally Hoffman

## ABSTRACT:

Cryptocurrencies have existed for over 10 years. Since their launch, cryptocurrencies have grown in quantity and market capitalization. Because they rely on decentralized technology that is computationally complex, cryptocurrencies are significant energy consumers. Texas' power-generating abilities have captured the attention of cryptocurrencies as miners move to the state.

Cryptocurrencies have been around over a decade, with their valuations rising notably, though not always steadily. Cryptocurrencies are a form of digital currency that can serve as a medium of exchange and a store of value, although they lack the backing of any central authority or government.

The market capitalization of bitcoin and ethereum—the two largest cryptocurrencies—totaled about \$781 billion as of June 1 (*Chart 1*). All told, there are about 100 significant cryptocurrencies, with a market capitalization of approximately \$1.2 trillion, down 60 percent from their recent peak in fall 2021.

Cryptocurrency mining refers to the work (done by computers) that manages the blockchain, the record of cryptocurrency transactions. Crypto mining is controversial, in part, because the process requires large quantities of electricity, which is often produced using fossil fuels such as natural gas or coal. Moreover, crypto mining is growing quickly in the U.S. and in Texas, following recent adverse regulatory and political developments in foreign centers of crypto mining activity—China, Russia and Kazakhstan.<sup>1</sup>

Mining activity is measured by hash rate—a metric of the computational power needed for calculations to

**CHART 1** Cryptocurrency Market Capitalization Up from Early 2020 but Volatility High



NOTES: Market capitalization for each cryptocurrency is computed as circulating supply for the number of cryptocurrency coins times the price for the coin in U.S. dollars. Data are through June 1, 2022.

SOURCE: Bloomberg.

maintain the blockchain and earn new cryptocurrency coins. The bitcoin hash rate plummeted to zero in China in 2021 while rising in the U.S. and other countries (*Chart 2*).

Although reliable data are hard to come by, some observers suggest Texas may be the largest state for crypto mining, accounting for 25 percent of the U.S. total.<sup>2</sup> Texas' attraction may be the state's relatively inexpensive energy and favorable regulations.

## A Digital Currency

Cryptocurrencies are supposed to be used like any other currency. But unlike traditional physical currencies such as the dollar, cryptocurrencies only exist electronically.

An individual can hold crypto as a store of value, an investment, and use it as collateral or as a means of payment. Digital coins can be "mined" or purchased on an exchange and stored in a digital wallet.

Transactions in which a cryptocurrency is used are verified and recorded in a distributed public ledger—a database that is spread across a network of computers—the best known of which is blockchain.

Transactions are stored in discrete blocks that taken together form a chain. Each block is a collection of detailed data, such as records or transactions. The blocks are iteratively linked in a chain based on an individual block's hash value—a calculation based on the data it holds relative to other such links in the chain.

In this process—which also serves as a security measure—the hash value of a previous data block determines the next block's hash value, which is then used to determine the value of the subsequent block.

There are several reasons for interest in cryptocurrencies. For some crypto enthusiasts, it derives from concern whether fiat currencies—like the U.S. dollar and euro—are a reliable store of value, especially when the Federal Reserve and other central banks have expanded their balance sheets and put significantly more currency in circulation following the Global Financial

▶ *Although reliable data are hard to come by, some observers suggest Texas may be the largest state for crypto mining, accounting for 25 percent of the U.S. total. Texas' attraction may be the state's relatively inexpensive energy and favorable regulations.*

Crisis in the late 2000s and again during the 2020–21 pandemic.

Hence, some investors not only buy and hold cryptocurrencies because they believe they will increase in value but also because they believe cryptos may act as an inflation hedge, although that hasn't been the case in the current high-inflation episode.<sup>3</sup> Of course, others worry that with no government backing, cryptocurrencies' value is not secured by any central authority and could collapse.

An additional appeal of cryptocurrencies is that the blockchain allows immediate encrypted transaction processing and in ways that can include other transaction information, such as contract and counterparty details. This appeals to many consumers and gamers, particularly for those who transact across borders or need real-time payments.

Lastly, blockchain technology allows for greater decentralization of finance because it occurs on a distributed ledger and isn't controlled by a government. Hence, another appeal of cryptocurrency is the unregulated and anonymous nature of the transactions. However, this feature likely attracts individuals who seek to evade taxes, money-laundering laws or capital controls.

## Transaction Costs, Speed

Cryptocurrencies can have high transaction costs and slow speed, and they carry the risk of manipulation. While decentralized finance has the potential to reduce costs and accelerate transactions (relative to traditional financial systems), it doesn't always deliver.

Transaction costs are volatile and can rise sharply as transaction volume increases. Bitcoin transaction fees were approximately \$1.30 per transaction in

June 2020, rose to \$13.15 by October 2020 and exceeded \$60 in April 2021.<sup>4</sup>

A recent study noted that a likely reason for high fees is a lack of competition in cryptocurrency markets, with its authors finding that bitcoin mining capacity is highly concentrated—the top 10 percent of miners control 90 percent of mining capacity. Even more telling, just 0.1 percent of miners account for about 50 percent of mining capacity.<sup>5</sup>

A new payment protocol dubbed "lightning" was added to bitcoin in 2018 to increase speed and reduce transaction costs associated with micropayments.<sup>6</sup> Lightning defers final settlement on the bitcoin blockchain, though that opens a security vulnerability that complicates tracing transactions.

Security concerns center on attacks on the blockchain. A 2020 study analyzed 14 attacks on 13 different cryptocurrencies where the blockchain was manipulated by gaining control over 51 percent of the mining nodes—computers searching for new pieces of cryptocurrency—to undermine the blockchain's integrity.<sup>7</sup>

## Keys to Crypto Mining

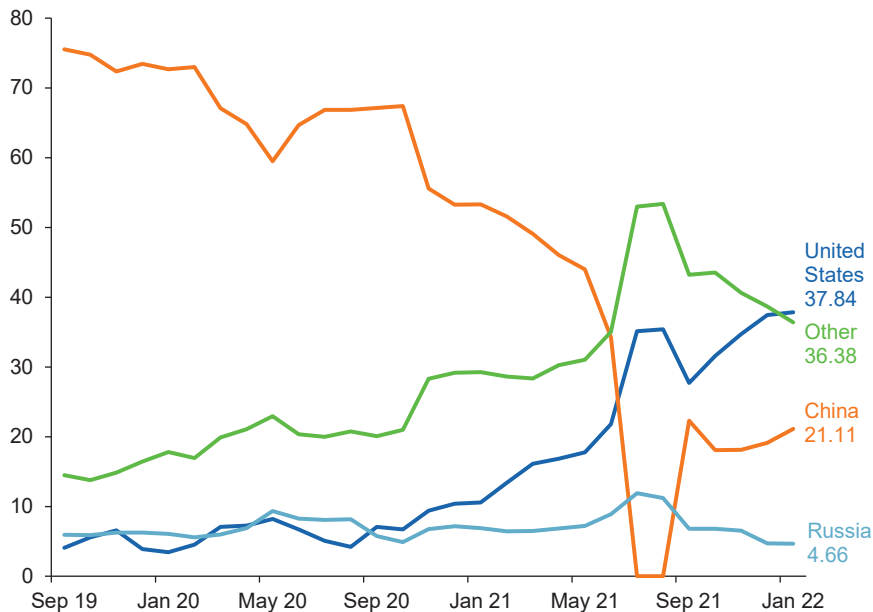
Cryptocurrency mining is the term describing the computers that approve blocks of transactions to become part of the blockchain. As compensation for maintaining the blockchain, miners receive new cryptocurrency.

For example, the compensation for mining one block of the bitcoin blockchain is 6.25 bitcoins, about \$30,000 based on the exchange rate as of June 1, 2022.<sup>8</sup> Given that there are about 144 blocks mined every day, miners collectively earn bitcoin worth approximately \$27 million daily.<sup>9</sup>

**CHART**  
**2**

**U.S. Share of Global Bitcoin Hash Rate Rises**

Share of global bitcoin hash rate (percent)



NOTES: The hash rate is a measure of the total computational power used to earn new cryptocurrency coins. The average monthly bitcoin hash rate share by country is based on geolocal mining pool data. The "Other" category includes countries such as Canada, Germany, Iran, Ireland, Kazakhstan and Malaysia. Data are available through January 2022.

SOURCE: Cambridge Centre for Alternative Finance, University of Cambridge.

To participate, miners must solve a complicated math problem, referred to as the “proof of work.” Solving this problem is slow and energy intensive, requiring significant amounts of computing power, with no guarantee that the time and energy expenditure will pay off—only the first miner to solve the proof of work earns compensation.

Proof of work is known as a “consensus protocol”—a way in which consensus can be reached on changes to a blockchain. Although the proof-of-work consensus mechanism is largely effective at allowing decentralization, it requires significant electric power.<sup>10</sup>

Critics argue that the process is wasteful; energy could be directed to more productive uses, such as powering homes and businesses.<sup>11</sup>

**Energy Economics**

Mining and trading of bitcoin consumes an estimated 91 terawatt hours annually, equivalent to the annual national energy consumption of Finland or Jordan.<sup>12</sup> Mining a single block on

the bitcoin blockchain consumes about 2,000 kilowatt hours, more power than an average U.S. household consumes in two months.<sup>13</sup>

The historically low cost of electricity in Texas relative to the nation and the state’s rapid growth of renewable energy sources, as well as light regulation, have likely helped attract crypto miners to the region.

What are the implications for Texas’ energy sector? On the one hand, there are concerns that crypto mining power demand can increase energy costs, reduce electricity grid stability and lead to greater carbon emissions.

On the other hand, crypto supporters say it is possible that co-locating

cryptocurrency mining with commercial renewable energy generation could mitigate pollution, improve the economics of renewable projects and attract investors.

This argument suggests crypto mining could be a key source of demand for renewable power during periods when electricity demand is low and power output is high and storing the excess electricity in batteries is impractical. Hence, combining crypto mining with renewable projects would provide more consistent, dependable electricity demand that could support renewable project cashflows and improve repayment prospects for windfarms and solar farms, for example.<sup>14</sup>

The relationship between cryptocurrency and energy markets suggests more research about the markets’ relationships may be appropriate. For example, depending on whether the price of bitcoin declines or increases, the payout for mining diminishes or grows, assuming a constant price for electricity. This rate-of-return calculation may affect the willingness of miners to participate. Miner participation determines how quickly new bitcoin comes to the marketplace, affecting its liquidity and value.

Additionally, the amount of mining activity may also prompt additional blockchain transactions, as some miners liquidate part of their crypto earnings to pay for the costs of mining.

The increase in demand for energy attributable to cryptocurrency mining is contingent on the continued use of the proof-of-work consensus protocol. The difficulty of mining new blocks on a proof-of-work blockchain increases as the number of miners rises. As concerns surrounding the energy cost for proof of work have grown, some cryptocurrencies may

▶ *The historically low cost of electricity in Texas relative to the nation and the state’s rapid growth of renewable energy sources, as well as light regulation, have likely helped attract crypto miners to the region.*



evolve to less energy-intensive consensus protocols.

Ethereum, the second-largest cryptocurrency, announced plans to convert from proof of work to proof of stake in late 2022. In proof-of-stake protocols, which are less energy intensive, miners serve as a validator in proportion to the amount of the cryptocurrency they control.

## Impact on Banks

Texas affirmed in June 2021 that state-chartered banks may offer custody services for virtual currency assets.<sup>15</sup> The state has also said banks can allow virtual currencies as collateral for loans.<sup>16</sup> State officials also appear to be responding to the security challenges of “physically” holding crypto, potential operating difficulties at established crypto exchanges and a desire to provide traditional financial institutions an entrée to providing crypto custody and related services.<sup>17</sup>

Banks seeking to offer crypto services must conduct an assessment—identifying and implementing controls to mitigate risks, including loss of client crypto assets, risk-monitoring capacity, money-laundering concerns and reputational risk.

Still, cryptocurrencies remain a novel development in the financial services ecosystem. As such, they may represent increased risk to the financial sector while simultaneously offering innovation that holds the potential for long-term change.<sup>18</sup>

*Cetina is a vice president and Hoffman is a senior risk specialist in the Supervisory Risk and Surveillance division of the Banking Supervision Department at the Federal Reserve Bank of Dallas.*

## Notes

<sup>1</sup> China's central bank banned all cryptocurrency transactions in September 2021; the Russian central bank proposed banning cryptocurrency in January 2022. While this proposal was pending, the U.S. and European Union took measures in April to sanction Russian entities active in cryptocurrency in light of Russia's war against Ukraine. In Kazakhstan, domestic energy shortages resulted in a government crackdown on more than 100 unlicensed crypto mining operations.

<sup>2</sup> “Texas Bitcoin Miners Seek Cheap Power, Land and a Place to Stay,” by Shelly Hagan, Bloomberg, May 4, 2022. Luxor Technologies, a mining platform, estimates that Texas accounts for 25 percent of total U.S. mining activity.

<sup>3</sup> “Inflation and Cryptocurrencies Revisited: A Time-Scale Analysis,” by Thomas Conlon, Shaen Corbet and Richard J. McGee, *Economics Letters*, vol. 206, 2021, <https://doi.org/10.1016/j.econlet.2021.109996>.

<sup>4</sup> “Fees Per Transaction (USD),” accessed June 15, 2022.

<sup>5</sup> “Blockchain Analysis of the Bitcoin Market,” by Igor Makarov and Antoinette Schoar, National Bureau of Economic Research, Working Paper no. 29396, October 2021, <http://dx.doi.org/10.3386/w29396>.

<sup>6</sup> “A Measurement Study of Bitcoin Lightning Network,” by Yuwei Guo, Jinfeng Tong and Chen Feng, July 2019.

<sup>7</sup> “Cryptocurrency Value and 51% Attacks: Evidence from Event Studies,” Savva Shanaev, Arina Shuraeva, Mikhail Vasenin and Maksim Kuznetsov, *The Journal of Alternative Investments*, Winter 2020, <https://doi.org/10.3905/jai.2019.1.081>.

<sup>8</sup> “Cryptocurrency Prices, Charts, Daily Trends, Market Cap and Highlights,” Coinbase, accessed May 27, 2022, [www.coinbase.com/price](http://www.coinbase.com/price).

<sup>9</sup> “What Is Bitcoin Mining?” Bitcoin.com, accessed May 27, 2022, [www.bitcoin.com/get-started/what-is-bitcoin-mining/](http://www.bitcoin.com/get-started/what-is-bitcoin-mining/).

<sup>10</sup> It is only largely effective because many miners aggregate their equipment to provide a higher likelihood of calculating the problem first and, thus, earning the compensation. These groups are commonly known as “mining pools.” See note 5.

<sup>11</sup> One study estimates that 90 percent of the transaction volume on the bitcoin blockchain is an unproductive byproduct of user strategies to impede the tracing of cash flows by moving funds over long chains of multiple

addresses. See note 5.

<sup>12</sup> “Bitcoin Uses More Electricity Than Many Countries. How Is That Possible?” by Jon Huang, Claire O'Neill and Hiroko Tabuchi, *New York Times*, Sept. 3, 2021.

<sup>13</sup> “Bitcoin Energy Consumption Index,” *Digiconomist*, accessed June 6, 2022.

<sup>14</sup> “Renewable Energy Projects Present Unique Lender Risks, Need for Oversight,” by SungJe Byun and Joe Kneip, Federal Reserve Bank of Dallas *Dallas Fed Economics*, April 12, 2022, [www.dallasfed.org/research/economics/2022/0412](http://www.dallasfed.org/research/economics/2022/0412).

<sup>15</sup> “Authority of Texas State-Chartered Banks to Provide Virtual Currency Custody Services to Customers,” Texas Department of Banking, June 2021, accessed June 6, 2022, [www.dob.texas.gov/sites/default/files/files/news/IndustryNotices/in2021-03.pdf](http://www.dob.texas.gov/sites/default/files/files/news/IndustryNotices/in2021-03.pdf).

<sup>16</sup> Texas House Bill No. 4474, passed June 15, 2021, accessed June 6, 2022, <https://legiscan.com/TX/text/HB4474/id/2406936/Texas-2021-HB4474-Enrolled.html>.

<sup>17</sup> “Move Along, Says Coinbase's Armstrong,” by Phillip Stafford, *Financial Times*, May 11, 2022.

<sup>18</sup> “Risk in the Crypto Markets,” speech by Federal Reserve Governor Christopher J. Waller, Board of Governors of the Federal Reserve System, June 3, 2022, [www.federalreserve.gov/newsevents/speech/waller20220603a.htm](http://www.federalreserve.gov/newsevents/speech/waller20220603a.htm).

# Federal Dollars Could Drive Electric-Vehicle Charging Across Texas

By Jessica Rindels and Michael D. Plante

**S**urveys often find that consumers who are reluctant to switch to electric vehicles cite inadequate charging facilities. The recently approved federal Infrastructure Investment and Jobs Act seeks to address such concerns, providing funding to expand charging infrastructure along interstates and in rural areas.

A total of \$7.5 billion is earmarked for construction of 500,000 chargers by 2030. Texas is set to receive more than \$400 million over the next five years, the most funding of any state. This could roughly double the number of charging stations along interstates in Texas.

The new facilities will boost the number of direct-current chargers, the most powerful chargers available, which can “refill” even the largest batteries in around 30 minutes. Less-powerful chargers, while cheaper, are much slower and can require hours for a full recharge.

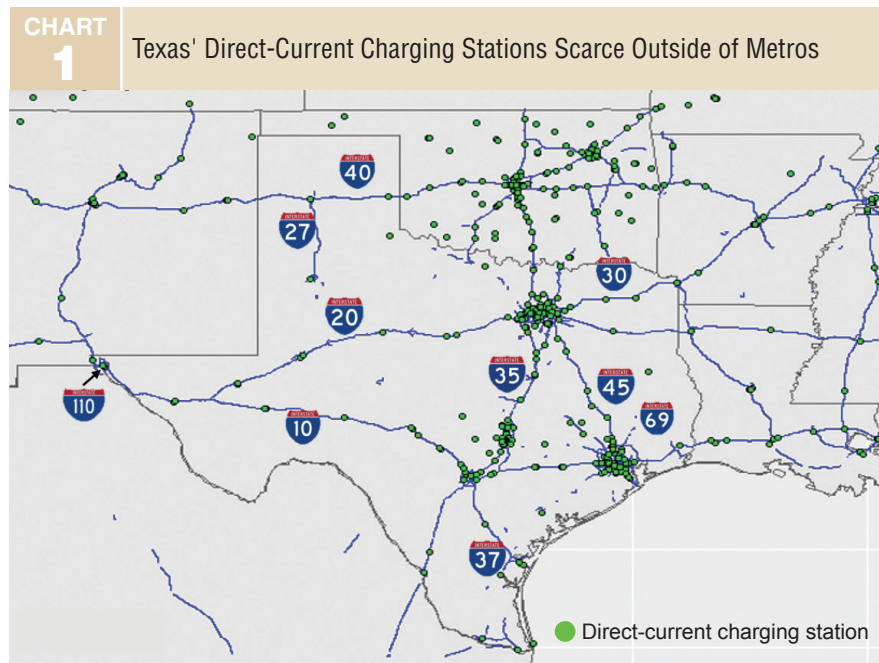
## Infrastructure in Texas

There are 266 charging stations with direct-current charging ports throughout the state.<sup>1</sup> Over 80 percent of those charging stations are in the vicinity of the Dallas–Fort Worth, Houston, Austin and San Antonio metropolitan areas (*Chart 1*). The remainder are scattered across the state, primarily along interstates.

The fast chargers are concentrated in the largest metros because that’s where most electric vehicles are—data show that these areas account for more than 85 percent of the roughly 88,000 battery-powered electric vehicles registered in Texas.<sup>2</sup>

## Expanding Charging Access

The small number of electric vehicles in rural areas reduces the economic incentives for building commercial charging stations there. As a result, infrastructure remains sparse in rural



NOTE: Each dot represents an electric vehicle charging station with at least one direct-current super charger.  
SOURCES: Department of Energy; OpenStreetMaps.

Texas and, more generally, in most neighboring states.

At the same time, the lack of charging infrastructure is believed to hold back electric vehicle adoption—the scarcity of facilities makes electric ownership less convenient for those unable to charge at home or at work. Additionally, while electric vehicle range has increased dramatically in recent years, surveys have found that consumers remain concerned about recharging during long trips away from home.<sup>3</sup>

For the 2021 model year, gasoline-powered cars had a median range of about 400 miles on a tank of gas; most electric vehicles go 60 to 80 percent of that distance on a charge.

A total of \$5 billion has been allocated to fast-charging infrastructure, requiring stations with at least four direct-current, fast-charging ports at least every 50 miles along interstates. Another \$2.5 billion will support charging in rural areas and other underserved communities.

States must submit final charging-station plans to the Joint Office of Energy and Transportation by Aug. 1, 2022, to be reviewed and approved by the Federal Highway Administration by Sept. 30, 2022.

Though the Texas Department of Transportation is still in the planning process, the agency has identified numerous “study areas” along major interstates and in nearly every county in Texas where new charging stations might be placed.

Subsequent planning and installation could take up to 18 months, but greater accessibility to charging infrastructure appears likely.

## Notes

<sup>1</sup> National Renewable Energy Laboratory, U.S. Department of Energy, accessed May 25, 2022.

<sup>2</sup> State EV Registration Dashboard for Texas, Atlas Public Policy's EV Hub, accessed May 25, 2022.

<sup>3</sup> “U.S. Electric Vehicle Experience Ownership Study,” J.D. Power, accessed May 25, 2022.

# Texas Home Prices Rose at Record Pace in 2021

By Luis Torres

**H**ouse prices in Texas metropolitan areas recorded historic year-over-year increases in 2021.

Austin registered the highest growth rate, with an average annual home price increase of 30 percent in fourth quarter 2021 (*Chart 1*). Fort Worth, San Antonio and Dallas home prices jumped 21 percent.

Home price growth also accelerated in El Paso, up an annualized 18 percent at year-end 2021. By comparison, Houston's rate of increase was the lowest among major metros at a healthy and still-elevated 13 percent.

The buyer frenzy in Texas housing markets began in summer 2020, just months after COVID-19 shut down the economy in March and April. Several factors contributed to the surge, including low mortgage rates, more people working from home, federal stimulus payments and unemployment benefits, a federal student loan payment pause, a surging stock market and accelerating domestic migration to the state.<sup>1</sup>

## Slow Inventory Growth

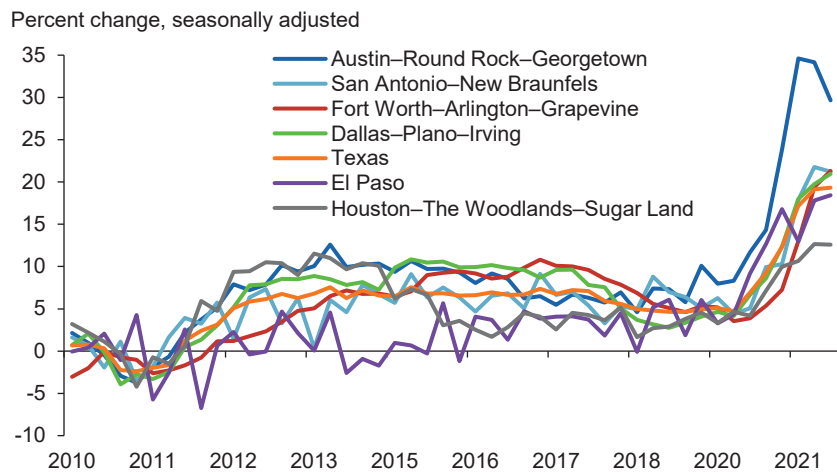
The inventory of homes was low even before the pandemic, further straining the marketplace. Texas homebuilders were slow to build back inventory after the Great Recession a decade earlier, and by some measures, construction had lagged demand for years, especially for lower-priced “starter” homes—those priced below \$250,000.

The pandemic demand boom further depleted the inventory of homes available for sale, propelling prices higher.

The difference in price pressures among Texas metros can be explained by each area's industry mix and the resulting pace of economic growth, which is highly correlated with the number of people moving to an area and its subsequent housing demand.

Austin home prices soared as the high-tech industry boomed during the pandemic and in-migration accelerated. The high-tech industry was also

**CHART 1** Texas Homes Reach Record High Rate of Price Increase in 2021



SOURCE: Federal Housing Finance Agency House Price Index, Purchase Only.

quick to adopt remote work arrangements, which aided worker mobility and relocation.

## Lofty Price Rises

The large price increases in Texas housing markets prompted discussion of a speculative housing bubble.<sup>2</sup> However, rapid home price growth does not necessarily indicate a bubble. Bubbles arise when there is a persistent misalignment of home prices with economic conditions and housing market fundamentals—which doesn't appear to be the case in the pandemic recovery.

Texas' months of inventory of homes for both existing and new homes have reached historical lows across all price categories, according to the Texas Real Estate Research Center at Texas A&M University.<sup>3</sup>

For example, there was less than one month's inventory in Austin and Dallas-Fort Worth in February 2022 and only a little more than one month in El Paso, Houston and San Antonio. Six months of inventory is typically considered a balanced housing market.

A scarcity of available homes—reflected in the low months of inventory—is a significant reason why housing

prices rose so abruptly and make it difficult to claim a housing bubble exists.

Still, identifying bubbles is no easy task. It requires extraordinary insight that even the savviest market participants sometimes lack. For example, unlike Arizona, California, Florida and Nevada, the Texas housing market did not experience explosive price growth during the mid-2000s' boom (and subsequent collapse). Texas' price growth was more aligned with fundamentals, including employment, income, new-home construction and population growth.

## Notes

<sup>1</sup> "Largest Texas Metros Lure Big-City, Coastal Migrants During Pandemic," by Wenli Li and Yichen Su, Federal Reserve Bank of Dallas *Southwest Economy*, Fourth Quarter, 2021, [www.dallasfed.org/research/swe/2021/swe2104/swe2104b.aspx](http://www.dallasfed.org/research/swe/2021/swe2104/swe2104b.aspx).

<sup>2</sup> "Real-Time Market Monitoring Finds Signs of Brewing U.S. Housing Bubble," by Jarod Coulter, Valerie Grossman, Enrique Martinez-Garcia, Peter C.B. Phillips and Shuping Shi, Federal Reserve Bank of Dallas *Dallas Fed Economics*, March 29, 2022, [www.dallasfed.org/research/economics/2022/0329](http://www.dallasfed.org/research/economics/2022/0329).

<sup>3</sup> See "Texas Housing Insight," Texas Real Estate Research Center at Texas A&M University, April 2022.

# Houston Still an Energy Town, Largely Pins Growth on the Sector

(Continued from page 13)

*Thompson is a senior business economist in the Houston Branch of the Federal Reserve Bank of Dallas.*

## Notes

<sup>1</sup> "Diversified Houston Spared Recession... So Far," by Jesse Thompson, Federal Reserve Bank of Dallas *Southwest Economy*, Third Quarter, 2015, <https://fraser.stlouisfed.org/title/southwest-economy-6378/third-quarter-2015-608994/spotlight-609740>.

<sup>2</sup> "Go Figure: COVID-19 Tanks U.S. Fuel Consumption, Prices," by Jesse Thompson and Olu Eseyin, Federal Reserve Bank of Dallas *Southwest Economy*, Second Quarter, 2020, [www.dallasfed.org/research/swe/2020/swe2002/swe2002f.aspx](http://www.dallasfed.org/research/swe/2020/swe2002/swe2002f.aspx).

<sup>3</sup> For related information on the impact of the pandemic on the energy sector, see *Energy Indicators*, by Jesse Thompson, Federal Reserve Bank of Dallas, May 2020 and June 2020, [www.dallasfed.org/research/energy/indicators/2020/en2005.aspx](http://www.dallasfed.org/research/energy/indicators/2020/en2005.aspx) and [www.dallasfed.org/research/energy/indicators/2020/en2006.aspx](http://www.dallasfed.org/research/energy/indicators/2020/en2006.aspx).

<sup>4</sup> *Energy Indicators*, by Jesse Thompson, Federal Reserve Bank of Dallas, January 2022, [www.dallasfed.org/research/energy/indicators/2022/en2201.aspx](http://www.dallasfed.org/research/energy/indicators/2022/en2201.aspx).

<sup>5</sup> "Booming Shale Gas Production Drives Texas Petrochemical Surge," by Jesse Thompson, Federal Reserve Bank of Dallas *Southwest Economy*, Fourth Quarter, 2012, <https://fraser.stlouisfed.org/title/southwest-economy-6378/fourth-quarter-2012-608983/booming-shale-gas-production-drives-texas-petrochemical-surge-609662>.

<sup>6</sup> "Houston—The Woodlands—Sugar Land: Texas' Gulf Coast Hub and Nation's Energy Capital," *At the Heart of Texas: Cities' Industry Clusters Drive Growth*, Federal Reserve Bank of Dallas, December 2018, [www.dallasfed.org/research/heart/houston](http://www.dallasfed.org/research/heart/houston).



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