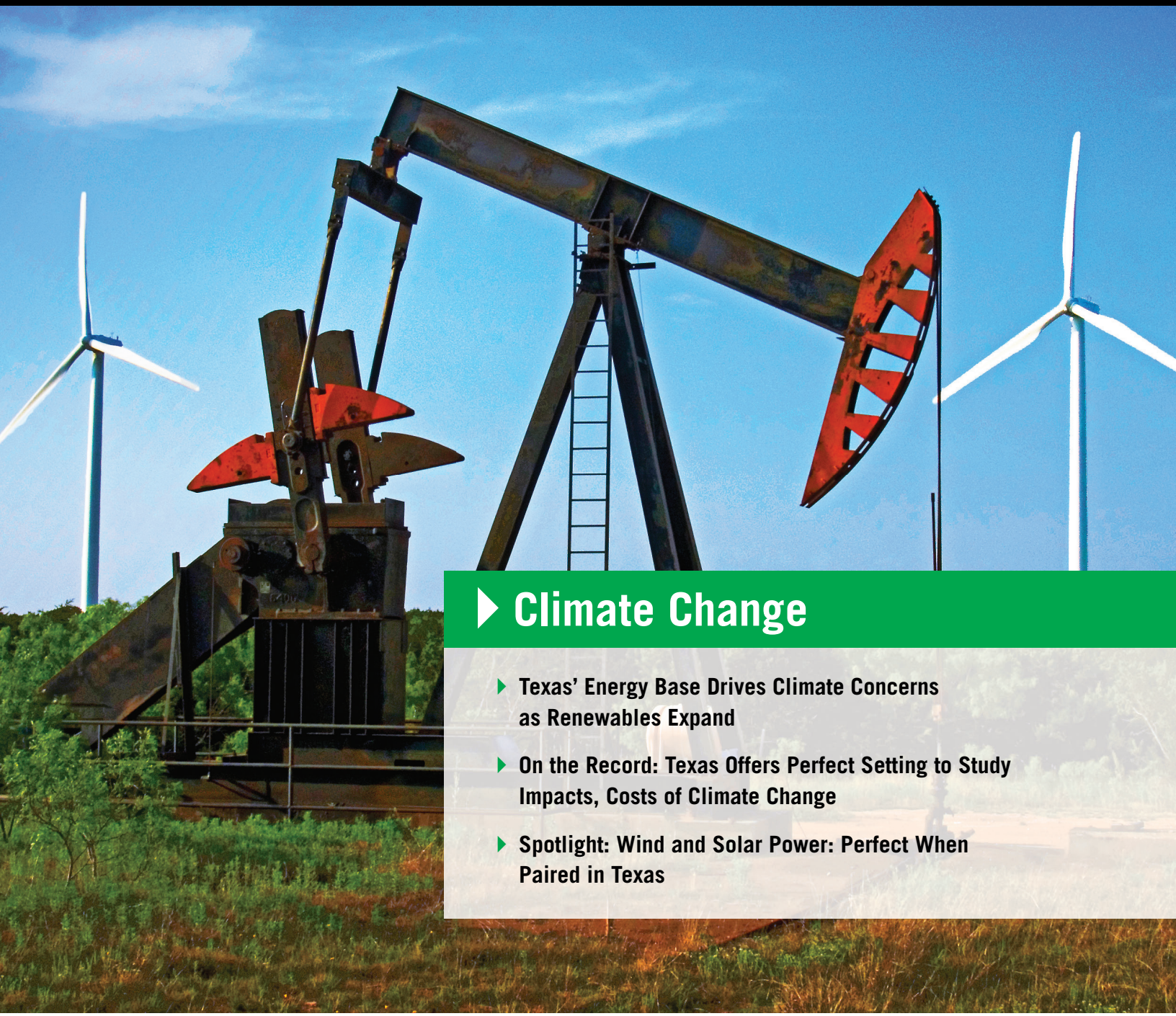
Federal Reserve Bank of Dallas

THIRD QUARTER 2019

Southwest Economy



Climate Change

- Texas' Energy Base Drives Climate Concerns as Renewables Expand
- On the Record: Texas Offers Perfect Setting to Study Impacts, Costs of Climate Change
- Spotlight: Wind and Solar Power: Perfect When Paired in Texas

PLUS

- Texans Help Drive National Increase in Auto Loan Debt
- Texas K–12 Education Spending Set to Rise, but Who Will Pay?
- Go Figure: Mexico Struggles to Move into Digital Payment Age

President's Perspective

Rob Kaplan, president and CEO of the Dallas Fed, regularly speaks and writes on the factors that affect economic growth in the nation and Eleventh District. Here are some of his recent thoughts on key issues:

On the Global Growth Outlook

"I am also highly attuned to the fact that, since early May, downside risks to the outlook have increased due to heightened trade tensions and decelerating rates of global growth. The economy is also being impacted by the waning of fiscal stimulus. The question is whether trade and global growth uncertainties are likely to persist in a manner that leads to a material deterioration in the outlook for U.S. economic growth."

Economic Conditions and the Stance of Monetary Policy (essay), June 24, 2019

On the Yield Curve

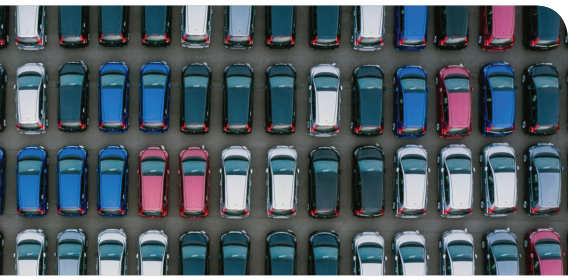
"As I have said before, I would be concerned about an inversion of the curve—either three-month to 10-year or one-year to 10-year—of some size and duration. My concern emanates from my belief that an inverted curve ultimately makes it more difficult for financial intermediaries to borrow short and lend long—and, if the inversion persists, it would likely begin to impede the creation of credit and lead to a tightening of financial conditions. I will continue to watch this carefully."

Economic Conditions and the Stance of Monetary Policy (essay), June 24, 2019

On Trade Tensions and the Prospect of Tariffs on Mexico

"You had the situation with China, which had some effect. But the thing that I think—talking to businesses, which I do regularly, extensively—the thing that had a significant effect was the threatened tariffs on Mexico. And I have lots and lots of businesses in my district who basically took me through—they literally said, 'Let me tell you the dollar cost to our business of this if this were to happen'—and I was surprised. [It was] substantial in terms of logistics, supply chains, increased costs. Even though it didn't happen—the threat of it and the significance of that—I had thought it might dissipate more. It hasn't dissipated that much in that most businesses I talk to regularly are basically saying to me, 'I think trade uncertainty is just going to be a feature of the outlook.'"

Wall Street Journal (interview), July 16, 2019



Texans Help Drive National Increase in Auto Loan Debt

By Wenhua Di

ABSTRACT: Despite strong economic growth in recent years, Texas auto loan delinquency rates have risen to levels approaching those seen just after the Great Recession. A recent drop in the subprime share of auto loan originations—typically involving less-creditworthy buyers—suggests delinquency rates are likely to fall. However, risks remain elevated because of factors including longer loan duration and young borrowers' increasing student loan indebtedness.

Consumers take on debt during good times for a range of purchases, including autos. During the shale oil boom that followed the Great Recession, Texans bought large numbers of cars and light trucks. Real per capita auto loan debt increased substantially, more so in Texas than in the U.S. *(Chart 1)*.[1]

Meanwhile, delinquency rates—those loans 90 days or more past due—never reached prerecession lows during the recovery. Instead, they began rising nationwide, including in Texas, beginning in 2015.

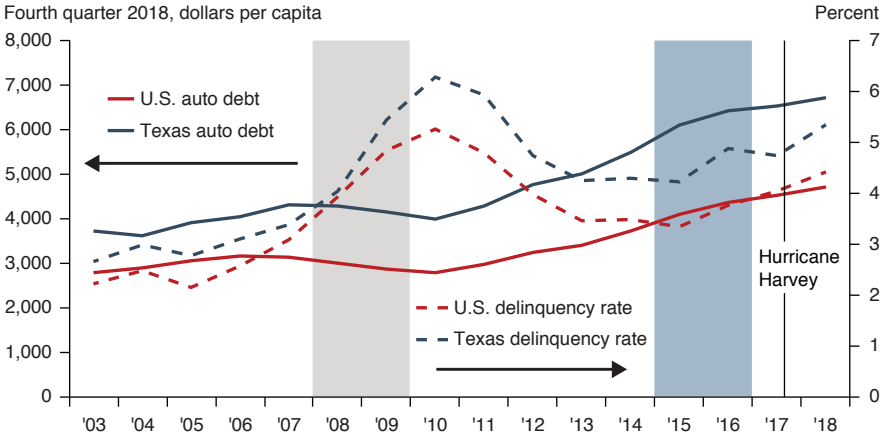
The recent increase is somewhat perplexing, given the end of the oil bust in 2016 and a strong state economy since 2017, during which historically low unemployment rates have pushed up wages.[2] The increases in the number and average balance of auto loans and rising delinquencies have raised concerns about consumers' ability to repay and the impact on the economy.

Passionate Vehicle Owners

Texans love their vehicles—essential for transportation across the sprawling state. Driving costs are relatively low because of inexpensive gasoline, ample parking and less congestion compared with other large states. Meanwhile, alternative modes of transportation are less abundant.

Texans spend more on vehicles than residents of other states partly because of relatively lower home prices. Per capita consumer debt was $43,660 in Texas and $50,090 in all 50 states as of the end of 2018, based on the Federal

CHART 1 Auto Loan Balance, Delinquency in Texas Exceed U.S.

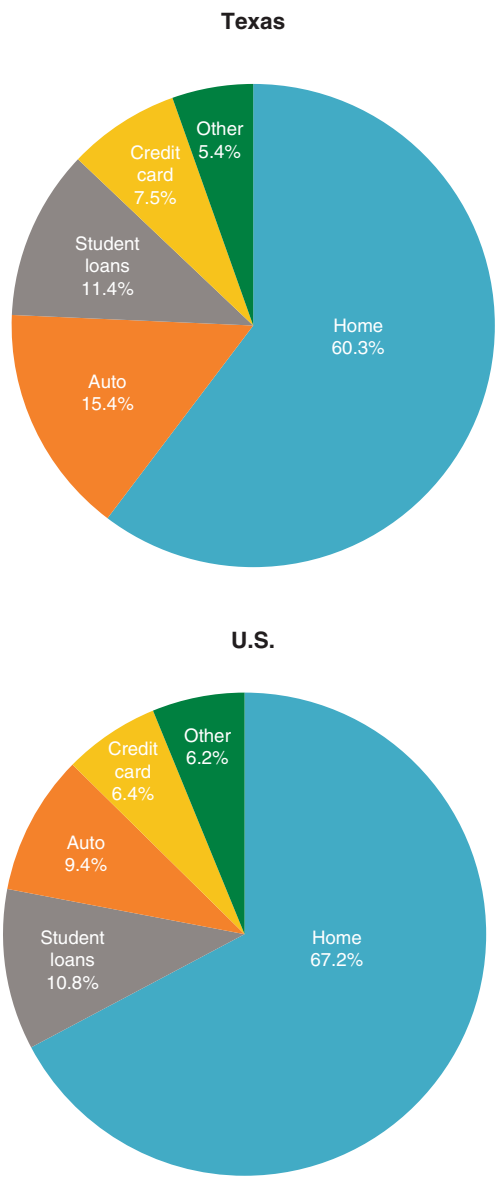


NOTES: Loans were deflated using consumer price index for new vehicles. Gray bar indicates U.S. recession; blue bar shows recent oil bust.

SOURCE: New York Fed Consumer Credit Panel /Equifax.

CHART 2

Auto Loans Bigger Piece of Debt Pie in Texas than U.S.



SOURCE: New York Fed Consumer Credit Panel/Equifax, fourth quarter 2018.

Reserve Bank of New York Consumer Credit Panel/Equifax data.

But Texans on average have a greater share of their debt in auto loans, which accounted for over 15 percent of per capita consumer debt, second only to mortgage debt *(Chart 2)*. Since 2003, this percentage in Texas has remained at least six percentage points higher than that of the nation.

Among all consumers in Texas with a credit report, about 45.6 percent held auto loan debt; the average balance was $17,106. Nationally, 38.1 percent of consumers had auto loans, and the average balance was $13,595. About 5.3 percent of auto loan debt in Texas was 90-plus days past due, 0.9 percentage points higher than nationally.

Subprime Loan Delinquency

While Texans may borrow more to buy their cars and trucks, the delinquency rate is driven higher by the performance of subprime borrowers—those with an Equifax risk score below 620—rather than the amount of the loan. Subprime loans account for over 95 percent of delinquencies (90-plus days past due) in the state and nation. Subprime borrowers accounted for about 28 percent of the outstanding auto loan balance in Texas, compared with 22.4 percent nationally.

Texas has larger young, low-income and immigrant populations, lower health insurance coverage and lower average education attainment—all associated with lower credit scores.

The interest rate on subprime auto loans can be five to 10 times higher than that on prime loans, especially for preowned vehicles or loans with longer terms to maturity. The higher interest payment adds to the debt burden for subprime borrowers and contributes to higher delinquencies. With a greater percentage of subprime borrowers, Texas has a higher delinquency rate than the nation.

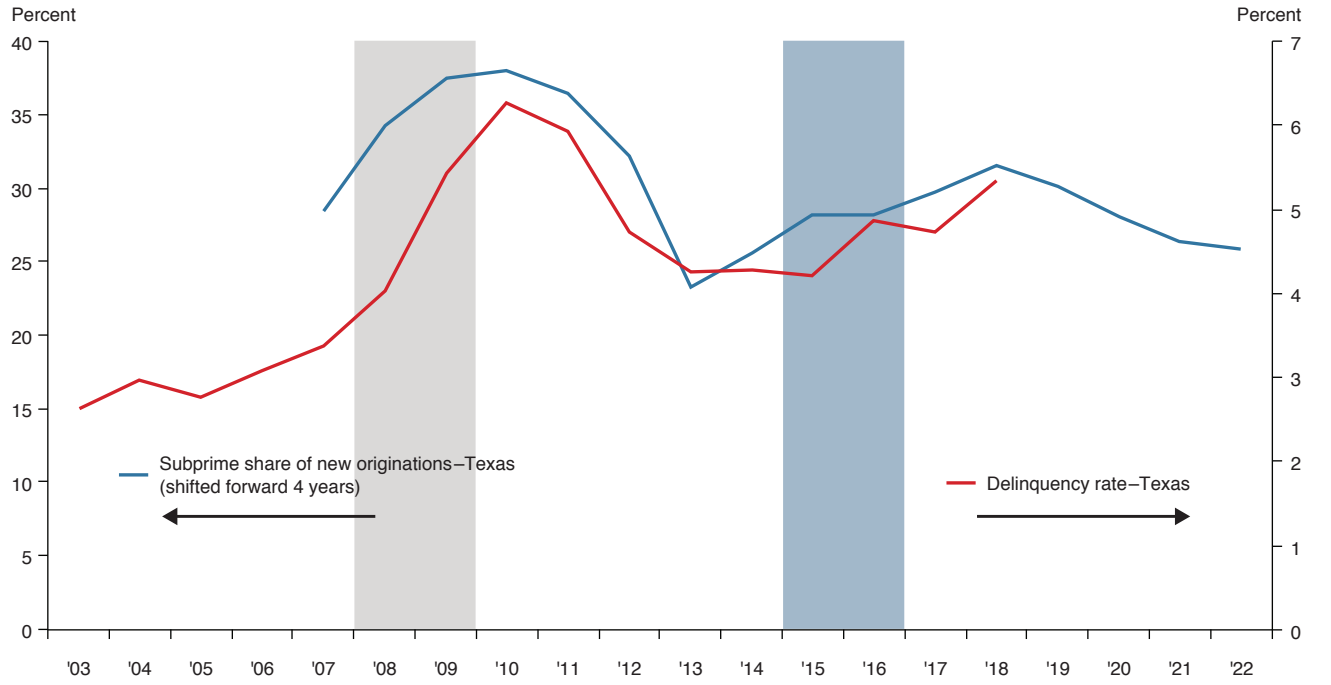
Auto loan underwriting became less strict following the Great Recession amid efforts to kick start the economy. Loose credit standards were followed by a tightening from 2016 to 2018 and a slowing expansion in subprime auto loan originations—possibly leading to decreasing delinquencies.[3] Delinquency rates—mostly involving debt incurred three or four years earlier—have lagged new subprime auto loan originations in recent years *(Chart 3)*.

Loan Balance and Terms

The increasing cost of vehicles reflects added power and technology along with more safety and environmental features. The average loan amount for new passenger cars has been increasing, exceeding $32,000 in 2018, with an average monthly pay-

CHART 3

Texas Delinquency Rise Follows Subprime Origination Increase



NOTES: The subprime share of new originations is shifted forward four years. Gray bar indicates National Bureau of Economic Research recession. Blue bar shows recent energy slump.

SOURCE: New York Fed Consumer Credit Panel/Equifax.

ment over $550.[4] About 85 percent of new-car purchases were financed in fourth quarter 2018, compared with 54 percent for preowned vehicles.[5]

Auto-loan balances are just one indicator. Consumers with prime credit and higher income may have access to lower-interest loans and can afford expensive cars, while those with lower income or higher loan interest rates for an inexpensive car can often find it difficult to manage the payments.

Car buyers with lower income and/or higher debt are often offered longer loan terms with the benefit of lower monthly payments. Average maturity of new-car loans at finance companies (weighted by amount financed) has increased by seven months in the past 10 years, from 59.5 months in fourth quarter 2008 to 66.5 months in fourth quarter 2018.[6]

Studies show that auto loans with longer terms tend to have higher delinquencies. Texas leads the nation in auto loans with the longest average term to maturity.[7] Longer terms generally come with higher loan rates and a greater chance that the market value of the car will be lower than the loan balance down the road, which increases default risk.

Lender Performance

Subprime borrowers are more likely to obtain a loan from an auto finance company rather than the two other main types of lenders—banks and credit unions. Auto finance companies are typically more lightly regulated and issue many of the risky loans.[8] Finance companies originated about 49 percent of outstanding auto loans in Texas at year-end 2018, compared with 46 percent nationally. These loans have accounted for about 64 percent of subprime auto loans for a decade, though these finance company loans remain below prerecession levels.[9]

Despite the role of auto finance companies in subprime lending, their share of the Texas market does not directly contribute to the state's higher auto loan delinquencies. In fact, auto finance companies' loan share has declined as delinquencies have increased.

Not all auto finance companies target subprime borrowers. These nonbank finance firms do not take deposits and usually use various strategies to raise capital, build partnerships and handle credit risks. They specialize in auto lending and provide loans to a wider range of consumers than banks and credit unions.

While some of these finance firms lend to consumers with subprime credit scores, others offer appealing loan products to super-prime borrowers. For example, "captive" nonbanks, finance companies owned by auto manufacturers, offer buyers with prime credit extremely low interest rates with shorter terms.

These captives regained popularity during the recovery from the Great

Recession and have more than half of the market share of new-car financing.[10] All types of auto lenders may also use similar strategies to attract potential borrowers.[11]

Oil Bust and Hurricane Harvey

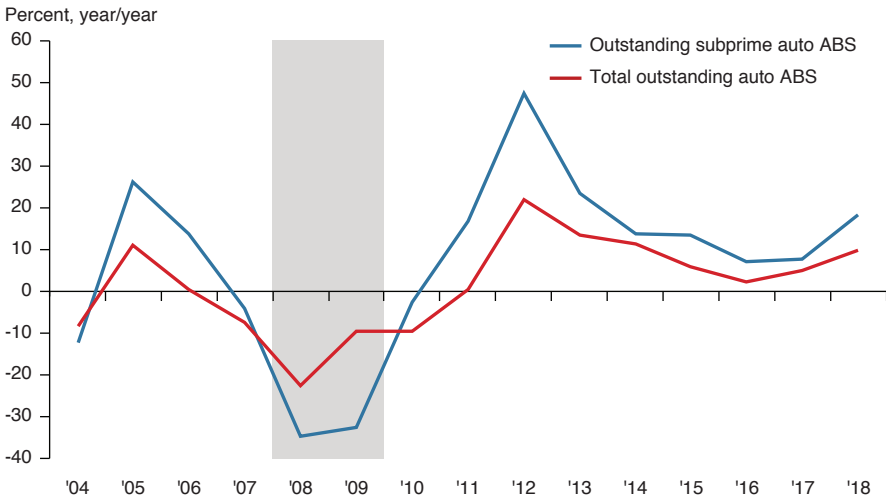
Statistical modeling of auto loan performance helps explain how the oil bust years and Hurricane Harvey in 2017 influenced Texas auto loan delinquencies. In this exercise, the serious delinquency rate is modeled as a function of loan origination locations and the interactions of the event years (which take into account occurrences such as the oil slump of 2015–16 and Hurricane Harvey in 2017) with affected states or counties. The model controls for the percent of auto loans originated to subprime and near-prime borrowers, borrower age, average amount borrowed and percent of lender types.[12]

The "serious delinquency rate" is defined as the percent of loan balance that was not current and more than 90 days past due. The analysis is done separately at the state level for the whole nation and at the county level for Texas, drawing on aggregated data from 20 percent of the New York Fed Consumer Credit Panel/Equifax database (equal to a 1 percent population sample). The county-level analysis was limited to counties with 50 or more auto loans in the sample.

Relative to the rest of the nation, Texas has a higher auto loan delinquency rate, and the gap with the U.S. has widened slightly since 2016. The trend is similar for other oil-producing states, such as Alaska, North Dakota and Wyoming. The top 10 oil-producing counties in Texas as a group also had higher auto loan delinquencies during the oil bust years.

The model shows that the 29 counties in Harvey's path have not experienced significantly worse auto loan performance since the storm. Storm effects may be only temporary and, therefore, don't lead to debt behavior change. Alternatively, flood and auto insurance and other assistance programs available to storm victims alleviate some repayment challenges.[13]

CHART 4 Subprime Growth Outpaces Total Outstanding Auto Securities



NOTES: Gray bar indicates National Bureau of Economic Research recession. ABS refers to asset-backed securities.
SOURCE: Securities Industry and Financial Markets Association.

Consistent with previous studies, the model results suggest that two factors are associated with a higher probability of delinquency—a lower credit score and younger borrower age. Conversely, loan balance and lender type are not definitively related to delinquencies.

Asset-Backed Securities

Despite a shrinking share of subprime auto loan originations in recent years, the secondary market of subprime auto-loan-backed securities remains relatively strong. Auto lenders, especially nonbanks, typically raise capital through collateralizing auto loans in the secondary market. Pools of individual loans are bundled together into asset-backed securities (ABS) and split into groups, or tranches, of varying credit quality. They are subsequently sold to investors.

Auto ABS carrying high credit risk—usually groups of nonprime loans—are attractive to fixed-income investors seeking yield above that offered by more conventional bonds. The issuance of auto-note securities accounted for 20.8 percent of all issuance of ABS in 2018, rising in recent years and exceeding prerecession levels.

This has raised concerns about a crash similar to one involving the residential mortgage-backed security market preceding the Great Recession. Investors' appetites for yield provides lenders, who subsequently bundle the car notes in an ABS issuance, incentive to extend loans to borrowers with lower credit ratings. The outstanding subprime auto ABS has steadily risen since the recession ended *(Chart 4)*.

However, auto ABS differ from mortgage-backed securities in several respects that make them an unlikely trigger for the next economic downturn. First, auto loans generally have lower prepayment risks for lenders and investors. Second, auto loans make up a much smaller share of consumer debt than mortgages, and the auto ABS is a relatively small part of the total liabilities.

Third, it is easier to repossess a car than to foreclose on a house, especially with the availability of technologies to track vehicles. In addition, given the overall improving credit quality, auto loan delinquencies may not continue increasing if borrowers make responsible purchases based on their payment capacity.

Still, the increase in subprime auto ABS merits attention. During the Great Recession, there was a sharp decrease in credit supply.[14] The impact of an

TABLE 1 A Time-Series Look at Auto Loans to 30-Year-Old Consumers, Texas Versus U.S.

	Texas			U.S.		
	Q4 2003 Born in 1973	Q4 2010 Born in 1980	Q4 2018 Born in 1988	Q4 2003 Born in 1973	Q4 2010 Born in 1980	Q4 2018 Born in 1988
Auto Loan Borrowing						
Number of borrowers (thousands)	116	138.8	177	1,375	1,459	1,871
Percent auto borrowers of all	39.9	40.7	47.4	36.4	35.8	43.1
Average auto debt (2018 dollars)	10,413	9,931	12,670	9,227	8,704	10,381
Percent with vehicle loans ≥$30K	16.1	20.0	29.8	11.9	14.0	18.4
Creditworthiness and Auto Loan Performance						
Average Equifax risk score	622	637	643	648	654	662
Percent subprime	49.8	43.6	39.1	35.6	35.5	31.6
Percent current	90.6	88.9	90.3	92.5	90.7	91.7
Percent 31–60 days past due	4.0	3.6	3.2	2.9	2.9	2.7
Percent 61–90 days past due	0.8	0.8	1.1	0.6	0.8	1.0
Percent 90+ days past due	1.3	0.8	0.5	0.9	0.8	0.7
Percent charge-off	1.4	4.7	4.0	1.8	3.6	3.1
Auto Lender Types						
Percent bank	14.5	18.6	20.8	25.6	24.6	20.8
Percent credit union	20.4	24.7	23.8	17.6	24.1	26.7
Percent auto financing company	56.6	50.7	51.4	50.7	46.0	49.0
Other Consumer Debt						
Percent with mortgage	42.9	37.4	28.6	46.7	40.9	29.8
Percent with student loan	19.1	33.1	36.5	20.6	38.9	40.5

SOURCE: Author's calculation based on 20 percent of New York Fed Consumer Credit Panel/Equifax auto loan trade line year-end data.

auto loan crisis (if one were to occur) on investors and the financial system would not be of the same magnitude as the mortgage meltdown. However, if a downturn occurs, investors would not receive expected returns as risky auto loan borrowers default.

Auto Loan Borrowers

Much has been written about the latest generation of young adults and how their behavior differs from that of their predecessors. They are more educated but struggle with greater student loan debt, marry later and delay home purchases.

Comparing average 30-year-old auto loan borrowers with past cohorts of 30-year-olds provides insight into changing behavior. Table 1 presents the borrowing and repayment experience for auto loan borrowers of three birth cohorts—those born in 1973, 1980 and 1988 who subsequently turned 30 in 2003, 2010 and 2018—in Texas and in the nation.

The number and share of 30-year-olds obtaining auto loans has substantially increased. Nearly half of 30-year-old Texans held auto loan debt in 2018, compared with 40 percent in 2003. The real value of the average loan balance has risen by more than $2,000 since 2010.

The share of borrowers taking out a loan exceeding $30,000 (in 2018 dollars) has nearly doubled. Despite improved credit scores and the drop in subprime share, auto loan performance has changed little, from the oldest cohort to the youngest. Consistent with the overall trend, more Texans

borrow from banks or credit unions than from auto finance companies.

Relative to the nation, a greater percentage of 30-year-olds of all three cohorts in Texas have auto loans, and more have balances exceeding $30,000. The average Equifax risk score in Texas has increased from earlier cohorts, but the youngest cohort remains 19 points lower than the comparative national figure.

The subprime share has fallen as the average credit score improved—with the pace of improvement faster in Texas. The Texas delinquency rate exceeds that of the nation in those loans 31 to 60 days past due. Charge-offs are also higher in Texas.

Nationally, consistent with previous studies, the share of 30-year-olds with mortgages has declined, while the proportion with student loan debt has almost doubled.[15] At age 30, when many borrowers have been out of college seven or eight years, more than 40 percent of those born in 1988 still held student loans.

In Texas, although student loan debt has not surpassed auto loan debt in the share of total consumer debt, 36.5 percent of 30-year-old auto loan borrowers have student loan debt. The burden to repay student loans can leave auto loan borrowers more vulnerable to an economic downturn and keep homeownership out of reach for longer.

Debt Burden Risks

Texas has historically experienced strong demand for vehicles, with a higher percentage of consumers holding auto loan debt than nationally. The gap in average auto loan borrowing between Texas and the nation is widening, and the delinquency rate spiked in Texas after the oil bust.

With the strong regional economy, recent improvement in overall creditworthiness and the drop in subprime originations, an auto loan crisis is unlikely. However, with the cost of vehicle purchases increasing, and the alarming increase in student loan debt, many borrowers continue to confront elevated risks.

Di is a senior research economist in the Research Department of the Federal Reserve Bank of Dallas.

Notes

[1] Auto or car loans are used interchangeably throughout the article to refer to loans used to finance the purchase of cars and light trucks.

[2] Texas Facing Historically Tight Labor Markets, Constraining Growth, by Christopher Slijk, Federal Reserve Bank of Dallas *Southwest Economy*, Second Quarter 2019, www.dallasfed.org/research/swe/2019/swe1902b.

[3] Net Percentage of Domestic Banks Tightening Standards for Auto Loans, https://fred.stlouisfed.org/series/STDSAUTO.

[4] Auto Loan Debt Sets Record Highs, by Matt Tatham, Experian, July 2019, www.experian.com/blogs/ask-experian/research/auto-loan-debt-study/.

[5] See "State of the Automotive Finance Market," Experian, Fourth Quarter 2018, www.experian.com/content/dam/marketing/na/automotive/quarterly-webinars/2018-q4-safm.pdf.

[6] "Average Maturity of New Car Loans at Finance Companies, Amount of Finance Weighted," Federal Reserve Bank of St. Louis, FRED, March 2019, https://fred.stlouisfed.org/series/DTCTLVENMNM.

[7] "The Perplexing Post-2011 Trends of Longer Maturities and Rising Default Rates of Auto Loans," by Paul Calem, Chellappan Ramasamy and Jenna Wang, forthcoming working paper, Federal Reserve Bank of Philadelphia, 2019.

[8] Auto finance companies were regulated by the state in which they were licensed. Starting in 2015, the federal Consumer Financial Protection Bureau began overseeing large nonbank auto finance companies, which originate 90 percent of nonbank auto loans and leases.

[9] There has been an increase in credit-union-originated loan balances and a decline in bank financing nationally, while the share of loans originated by auto finance companies has remained little changed. In Texas, bank and credit union shares have both increased. Because of the relatively large balance of bank loans relative to other lender types, the share of debt amount from auto finance companies in Texas dropped from 58 percent at the end of 2003 to 49 percent in 2018.

[10] See note 5.

[11] "Auto Lenders Ramp Up Risk to Win More Customers," by AnnaMaria Andriotis and Christina Rexrode, *Wall Street Journal*, June 10, 2018.

[12] The linear regression model is an econometrics method to fit the observed data in a linear relationship between two variables, holding others constant. The fixed-effect model is estimated with robust standard errors clustered at the treatment level.

[13] "Let the Rich be Flooded: The Unequal Impact of Hurricane Harvey on Household Debt," by Stephen B. Billings, Emily Gallagher and Lowell Ricketts, SSRN working paper, July 20, 2019, https://papers.ssrn.com/sol3/papers.cfm?abstract_id=3396611.

[14] "Auto Financing During and After the Great Recession," by Ralf R. Meisenzahl, Board of Governors of the Federal Reserve System FEDS Notes, June 22, 2017, https://doi.org/10.17016/2380-7172.2015.

[15] "Young Student Loan Borrowers Retreat from Housing and Auto Markets," by Meta Brown and Sydnee Caldwell, *Liberty Street Economics* (blog), April 17, 2013, https://libertystreeteconomics.newyorkfed.org/2013/04/young-student-loan-borrowers-retreat-from-housing-and-auto-markets.html.

Texas' Energy Base Drives Climate Concerns as Renewables Expand

By Emma Marshall and Jesse Thompson

ABSTRACT: The energy industry's large presence in Texas—production and refining—is a key contributor to carbon emissions. At the same time, the state is a renewable energy leader, especially with its large share of wind-based electricity generation. Both trends place the state in the center of the debate about climate change and reducing greenhouse gases.

Texas emits more carbon dioxide (CO_2) gas—a leading contributor to climate change—than any other state in the U.S., though much of the discharge is indicative of the state's larger economy and population.[1] It also reflects the prominence of the region's energy industry.

The Permian Basin produced 32 percent of the nation's crude oil in 2018, and significant portions of the nation's refining and petrochemical capacity are concentrated along the Gulf Coast.

Texas also has the nation's second-largest population (28 million residents) and economy ($1.7 trillion in economic output) after California. CO_2 emissions in terms of population and output—the carbon intensity of the state—put the state in the middle of the pack. Viewed that way, Texas emitted 23 metric tons of CO_2 per capita, ranking 12th nationally, and 0.4 metric tons per $1,000 of gross domestic product (GDP), ranking 18th nationally *(Chart 1)*.[2]

Emissions of CO_2 are important because CO_2 is a primary greenhouse gas, which prevents heat from radiating into space. According to government reports, the burning of fossil fuels contributed substantially to a 40 percent net increase in the CO_2 content of the Earth's atmosphere between 1750 and 2011.[3]

To the extent that climate change results in global warming and more frequent extreme weather events, it will have repercussions for the U.S. and Texas economies.

Emissions and the States

The top CO_2-emitting states by GDP are Wyoming, West Virginia and North Dakota, due to their relatively high use of coal for energy, low population densities and long, cold winters.

By comparison, New York has the lowest emissions per capita and per dollar of GDP, due to high population density, a relatively service-sector-focused economy and heavier reliance on natural gas and carbon-free nuclear power. New York City, accounting for much of the state population, has large numbers of multifamily housing units, including high-rise buildings, which distribute heat relatively efficiently. Moreover, extensive public-transit commuting contributes to a lower-emissions environment.[4]

Accumulated greenhouse gas is changing the Earth's climate, contributing to rising average temperatures and increases in extreme weather events, according to the most recent National Climate Assessment (NCA), a scientific report published by the federal government. Studies suggest that the Federal Reserve Bank of Dallas' region of Texas, northern Louisiana and southern New Mexico, already known for temperamental weather, faces the probability of stronger storms and increased episodes of hail and tornadic activity.[5]

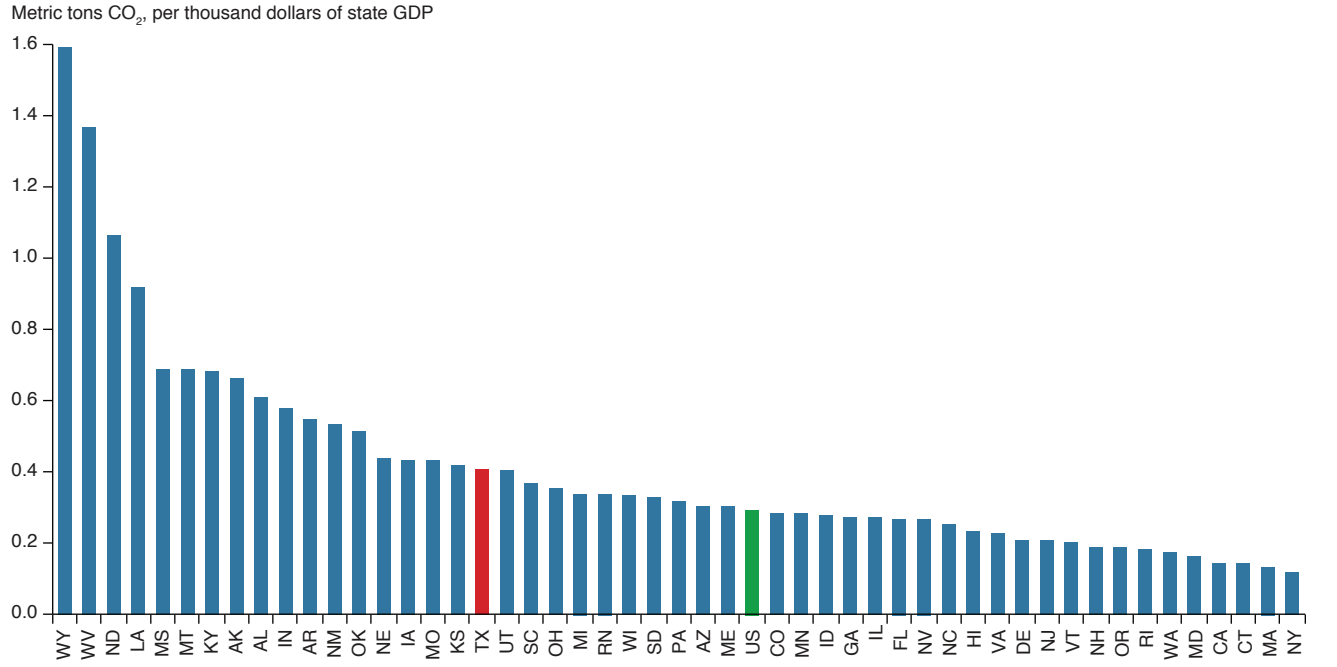
Climate change will require greater investment for emergency preparedness and more resilient infrastructure. It may also lead to government policies directed at reducing global warming, changes that would likely target carbon emissions and the activities that produce them.

Most Overall Emissions

Texas' CO_2 emissions have been increasing. The state's outsized volume of emissions arises in part from the state's disproportionate share of energy-intensive manufacturing as well as its growing auto-dependent population. Nationwide, motor vehicles are

CHART 1

Texas Has Less Carbon Emissions per Thousand Dollars of GDP than 17 States



NOTE: 2016 state gross domestic product (GDP) in chained 2012 dollars.
SOURCES: Bureau of Economic Analysis; Energy Information Administration; authors' calculations.

a leading CO_2 contributor in major population centers.

Texas is an important supplier to domestic and global markets of a range of products from motor fuels to petrochemicals.

Texas emitted almost twice as much CO_2—653 million metric tons (MMT) in 2016—as the next-highest state, California at 361 MMT *(Chart 2)*. Texas' emissions have increased by 13 MMT since 2001 despite dipping in 2009, when the Great Recession depressed industrial production. By comparison, California reduced its discharge by more than 20 MMT during the period.

Petrochemical, Refinery Output

Texas was about 8.4 percent of the nation's economy in 2016, but it produced 13 percent of the nation's carbon emissions. The Energy Information Administration (EIA) breaks down its emission estimates, based on fuel consumption, into groups. Nearly all of Texas' CO_2 pollution came from three of them: transportation, electric power and industrial *(Chart 3)*.

The EIA-estimated carbon emissions don't include the flaring of natural gas, common in the Permian Basin energy production sites in West Texas.[6] Reported flaring in Texas was responsible for nearly 4.8 MMT of CO_2 in 2016, representing a statewide emissions increase of 0.7 percent in 2016.[7]

Nationally, the industrial sector accounted for 18 percent of emissions in 2016. That compares with 30 percent in Texas, the equivalent of 198 MMT of CO_2. The fuels responsible for most of the industrial sector's CO_2 were natural gas (102 MMT) and "other" petroleum (95 MMT).[8]

Texas' high industrial share largely results from the production of energy-intensive goods such as motor fuels and petrochemicals, which yields substantial CO_2 waste. The state is home to 30 percent of U.S. refining capacity and 70 percent of the nation's basic petrochemical capacity.[9] These industries rely on crude oil, natural gas liquids (NGLs) and natural gas as material inputs for manufacturing as well as for power in the production of these goods. Indeed, mining, bulk chemical production and refining combined account for about 58 percent of total U.S. industrial energy consumption.

Texas produced nearly half of U.S. crude oil and NGLs and nearly a quarter of the nation's output of natural gas in 2016.[10] Rising production from prominent shale regions, such as the Permian Basin, substantially damped energy costs. This incentivized increased utilization and investment at refineries and induced the petrochemical industry to engage in a decade-long build-out of capacity focused on exports, contributing to Texas' carbon footprint.

Role of Transportation

Transportation was the largest contributor to Texas CO_2 emissions—totaling 225 MMT—for a second consecutive year in 2016. The number of passenger vehicles—cars, pickups, minivans and SUVs weighing less than 6,000 pounds—amounted to approximately 0.9 vehicles per person that year. The ratio has remained roughly

constant as the number of registered vehicles has kept pace with population growth, yielding a 17 percent increase in daily light-duty vehicle miles traveled in Texas from 2001 to 2016.[11]

However, rising fuel economy has helped hold down emissions growth. For example, the fuel economy of an entry-level Toyota Camry and a Ford F-150—the most common vehicles in Texas—rose nearly 23 percent and 30 percent, respectively, from 2001 to 2016. Increasingly stringent federal fuel-efficiency mandates have played a role.

Electricity Generation Evolves

Electric power generation is another top carbon-emitting sector in Texas, contributing 208 MMT of CO_2 in 2016, 124 MMT of which came from coal. Coal emissions peaked in 2011 during a blistering heat wave and a long-term drought that lasted from May 2010 to July 2015.[12]

Since then, coal-fired plants have been retired, and coal has played a diminishing role in electric power as new capital investment favored relatively low-cost natural gas and renewables *(Chart 4)*.[13] Natural gas, though a fossil fuel and contributor to carbon emissions, is far cleaner than coal and has helped lessen power generation's environmental impact.

Texas has taken a leading role in the use of wind power, which has benefited from declining installation costs. Plentiful wind and policies, such as a state target for renewable energy and federal regulation of greenhouse gases, has helped make Texas the nation's top generator of electricity from renewable fuels, excluding hydroelectric, since 2010.[14]

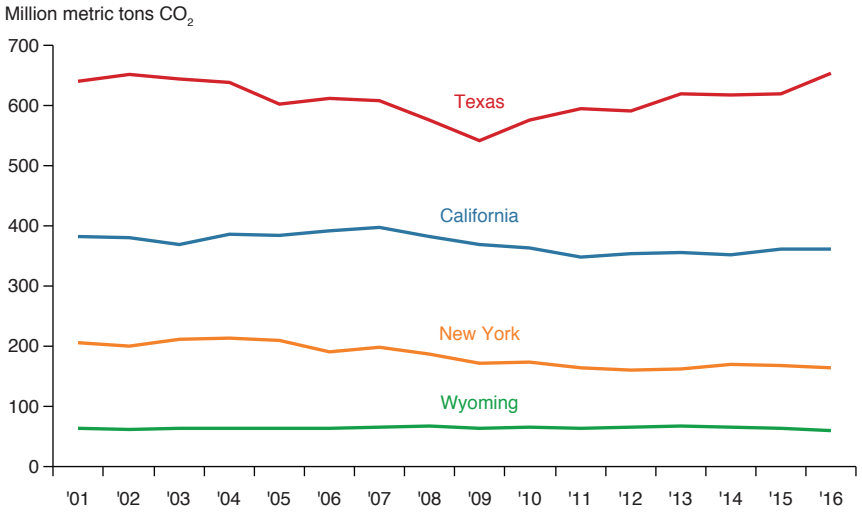
Texas, with its lower-carbon mix of electric generation capacity, produced more electricity per pound of carbon emitted than any other state and the most electricity overall in 2016. Texas emitted 1.5 metric tons of CO_2 per megawatt hour of electricity generated, compared with California's 1.8 metric tons. Renewables' share of Texas electricity has since risen. Wind-generated power increased 32 percent from 2016 to 2018, amounting to 75.8 million megawatt hours, or 16 percent of the total—equivalent to avoiding 59 MMT of CO_2 had that power been coal generated.

Federal, State Policy

Carbon emissions regulation is a fairly recent phenomenon. The Clean Air Act, approved in 1970 and amended in 1977 and 1990, was the first concerted national effort to curtail air pollution but targeted only particulates, mercury and sulfur compounds. It was not until 2007 that the Environmental Protection Agency included CO_2 and other greenhouse gases among pollutants to be regulated under the act.

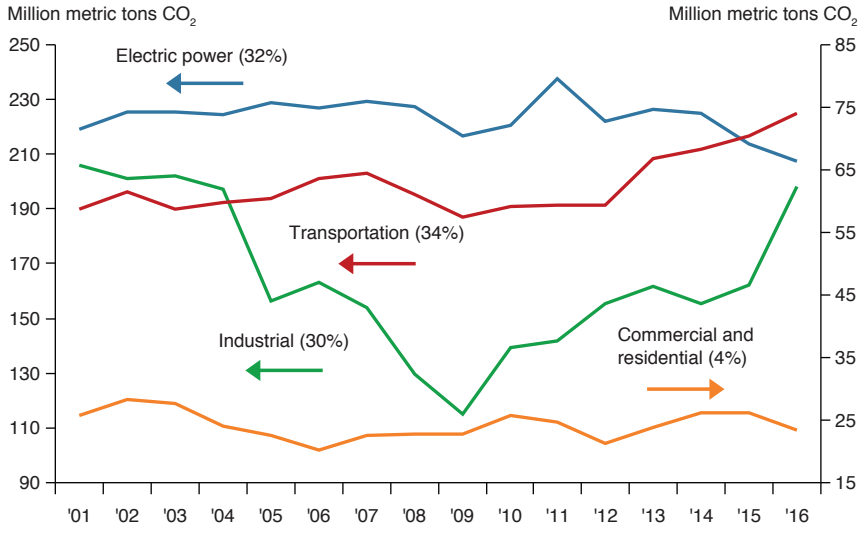
Emissions-reducing regulations in the U.S. have taken several forms. Some

CHART 2 Large-Population States Lead in Carbon Dioxide Emissions



SOURCE: Energy Information Administration.

CHART 3 Texas Industrial Carbon Emissions Growing Quickly



NOTE: Percentages represent share of total Texas carbon emissions in 2016.
SOURCE: Energy Information Administration.

stipulate limits to emissions that may require adopting compliant technologies, such as scrubbers in smokestacks to remove sulfur compounds, or curbing nitrogen oxides from some diesel engines. A national efficiency mandate, such as the Corporate Average Fuel Economy standard, sets targets for mileage and fuel consumption for new vehicles. These kinds of standards can also contribute to lower greenhouse gas emissions.

Several Texas Commission on Environmental Quality programs also support emissions reductions. The voluntary Texas Emissions Reduction Plan seeks to aid organizations that want to shrink their carbon footprint or get funding for related research and development. These programs subsidize purchases that improve fuel efficiency or enable a switch to less carbon-intensive fuels—such as converting diesel-powered equipment to natural gas.

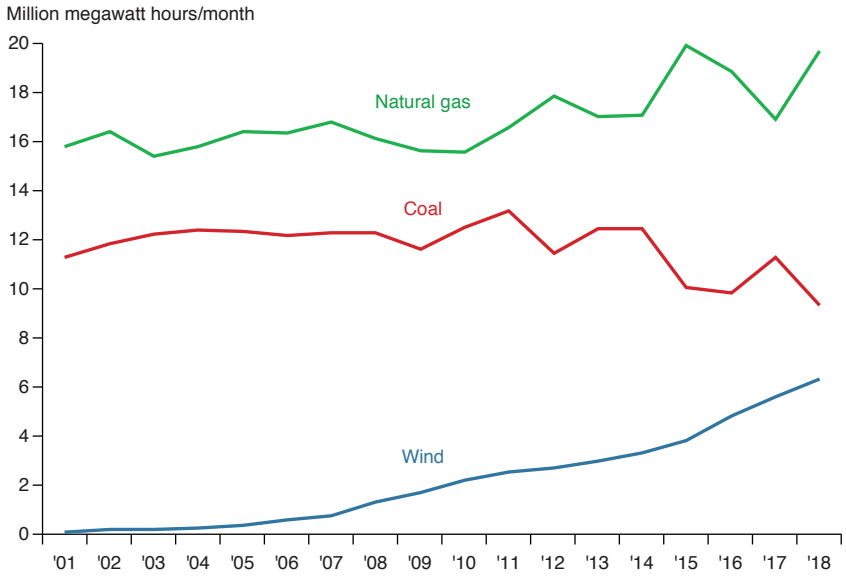
Many economists who have studied environmental policy favor setting prices on emissions rather than simply regulating them.[15] Taxing carbon or implementing cap-and-trade systems allowing emitting entities to pay for the ability to pollute are economic approaches that incentivize behavioral changes.

The European Union has a cap-and-trade framework, which limits the total carbon emissions allowed and allocates pollution rights across firms. Firms can then trade their right-to-pollute tons of CO_2 at a price determined in the marketplace. Texas uses a cap-and-trade approach on some emissions, such as sulfur dioxide, a pungent chemical that when emitted into the atmosphere contributes to acid rain and the formation of particulate-matter pollution that can exacerbate conditions such as asthma or heart disease.

Taxing carbon is another approach involving government intervention. Such a levy could involve extracting a specific "cost" for every ton of carbon emitted from burning fossil fuels. A U.S. carbon tax of $50 per ton in 2020, for example, would reduce carbon emissions by 11 to 25 percent in the first full year of implementation, one comparison of academic modeling exercises found.[16]

Most of the reductions would come through fuel switching from coal to natural gas in electric power generation and continue over the longer term. However, the lower emissions would come at a cost to energy producers and consumers, who would share the burden through higher prices on commodities such as coal, natural gas and gasoline. Simultaneously, demand would weaken for the energy that Texas produces—including crude oil and natural gas—as well as for refined goods and petrochemicals.

CHART 4 Wind, Natural Gas Rise as Sources of Texas Electricity Generation



SOURCE: Energy Information Administration.

Diversification Holds Promise

The concentration of the energy industry in Texas, both in production and processing, contributes to making carbon emissions bigger in Texas. However, the main driver is simply the size of the state's economy, accounting for the state's No. 18 ranking based on emissions per dollar of economic activity.

Policymakers, acting on climate change concerns, will likely implement policies that will slowly lead to decreased reliance on carbon-based energy over time. Texas can be better prepared for the future by continuing to diversify its sources of energy and overall economic activity.

Marshall is a research analyst in the Research Department and Thompson is a senior business economist in the Houston Branch at the Federal Reserve Bank of Dallas.

Dallas Fed President Rob Kaplan assesses climate change and its impacts on the Eleventh District in *Dallas Fed Economics*, **www.dallasfed.org/research/economics/2019/0627b.**

Notes

[1] Emissions data are based on estimates of the amount of CO_2 released in the consumption of different energy sources. Energy consumption comprises approximately 80 percent of total greenhouse emissions by weight on a carbon-equivalent basis. Other greenhouse gas emissions, such as methane or refrigerants, can be exponentially more potent, complicating state-to-state comparisons. See "Documentation for Estimates of State Energy-Related Carbon Dioxide Emissions," U.S. Energy Information Administration, October 2018, www.eia.gov/environment/emissions/state/pdf/statemethod.pdf.

[2] Federal Reserve Bank of Dallas calculation, chained 2012 dollars, based on U.S. Bureau of Economic Analysis and Energy Information Administration data.

[3] See U.S. Global Change Research Program, *Fourth National Climate Assessment*, vol. II, 2018, p. 39, https://nca2018.globalchange.gov/downloads/NCA4_2018_FullReport.pdf. Also see the Intergovernmental Panel on Climate Change, Climate Change 2014 Synthesis Report Summary for Policymakers, p. 4, www.ipcc.ch/site/assets/uploads/2018/02/AR5_SYR_FINAL_SPM.pdf.

[4] See "Energy-Related Carbon Dioxide Emissions by State, 2005–2016," U.S. Energy Information Administration, February 2019, www.eia.gov/environment/emissions/state/analysis/.

[5] See note 3, U.S. Global Change Research Program, p. 990.

[6] Natural gas flaring is permitted as part of oil and gas operations for limited periods, primarily following well completions. See Texas Administrative Code Part 1, Chapter 3, Rule 3.32.

[7] Natural gas flaring emits approximately 120.7 pounds of CO_2 per thousand cubic feet of gas flared. State agencies provide flaring data to the U.S. Energy Information Administration. Texas vented and flared more than 87 billion cubic feet of natural gas in 2016. Satellite data analyzing flaring activity suggests that this reporting underestimates total flaring by as much as 50 percent. See "Flaring in Two Texas Shale Areas: Comparison of Bottom-Up with Top-Down Volume Estimates for 2012 to 2015," by Katherine Ann Willyard and Gunnar W. Schade, *Science of the Total Environment*, vol. 691, pp. 243–51, November 2019. Also see "Permian Natural Gas Flaring and Venting Reaching All-Time High," Rystad Energy, press release, June 4, 2019. www.rystadenergy.com/newsevents/news/press-releases/Permian-natural-gas-flaring-and-venting-reaching-all-time-high/.

[8] Other petroleum includes asphalt, coke, petroleum coke and miscellaneous hydrocarbon fuels.

[9] See "Booming Shale Production Drives Texas Petrochemical Surge," by Jesse Thompson, Federal Reserve Bank of Dallas *Southwest Economy*. Fourth Quarter, 2012; and "Shale Revolution Feeds Petrochemical Profits as Production Adapts," by Jesse Thompson, *Southwest Economy*, Fourth Quarter, 2013.

[10] Emissions from the oil and gas sector focus on the consumption of fuels such as diesel to operate drilling rigs or to fuel the thousands of truckloads of supplies needed for well production. Emissions from natural gas flaring are not included in the calculation. This likely contributes to an underestimation of total CO_2 emissions in Texas for the period. See note 7.

[11] Vehicle Titles and Registration Data, Texas Department of Motor Vehicles, June 2019.

[12] See "Drought in Texas," National Integrated Drought Information System, National Oceanic and Atmospheric Administration and Texas Water Development Board, and "The Drought Is Over in Texas," *Texas Tribune*, July 20, 2015.

[13] See "Pollution: More Natural Gas, Less Coal Pace CO_2 Emissions Drop," by Amy Jordan, Federal Reserve Bank of Dallas *Southwest Economy*, Fourth Quarter, 2012.

[14] See "Average U.S. Construction Costs for Solar and Wind Continued to Fall in 2016," U.S. Energy Information Administration, *Today in Energy*, Aug. 8, 2018; and "Wind Generators' Cost Declines Reflect Technology Improvements and Siting Decisions," U.S. Energy Information Administration, *Today in Energy*, July 12, 2018. See "Abundant Sunshine Not Enough to Power Texas Residential Solar Energy," by Benjamin Meier and Jesse Thompson, Federal Reserve Bank of Dallas *Southwest Economy*, First Quarter, 2019.

[15] See "Climate Change and the Federal Reserve," by Glenn Rudebusch, Federal Reserve Bank of San Francisco *Economic Letter*, March 25, 2019, and "Global Perspectives: Greg Mankiw on Economic Advice, Climate Change and Trade," by Mark Wynne, Federal Reserve Bank of Dallas *Dallas Fed Economics*, March 28, 2019.

[16] See "Policy Insights from the EMF 32 Study on U.S. Carbon Tax Scenarios," by Alexander R. Barron et al., *Climate Change Economics*, vol. 9, no. 1, February 2018, pp. 1–47.

A Conversation with Katharine Hayhoe

Texas Offers Perfect Setting to Study Impacts, Costs of Climate Change

Katharine Hayhoe is an atmospheric scientist and professor at Texas Tech University in Lubbock, where she directs the Climate Science Center. She was a lead author of the Fourth National Climate Assessment, *released in November 2018, which documents the extent of climate change. She also hosts* Global Weirding, *a video series produced by Lubbock's PBS affiliate, KTTZ.*

Q. How do scientists differentiate between extreme weather and climate change?

Climate is the statistics of weather over at least 20 to 30 years. When we look at our extreme weather, we see that the statistics of that weather are changing. In Texas, our heat waves are getting more intense, and stronger and more frequent. Our heavy rainfalls that especially occur in the eastern half of the state are becoming more frequent. We're seeing that hurricanes are not more frequent, but there's a lot more rainfall associated with them today than there would've been 50 or 100 years ago.

It's estimated that almost 40 percent of the rain that fell during Hurricane Harvey would not have fallen if the same storm had occurred 100 years ago. In West Texas, our own work has shown that as the world gets warmer, we expect our droughts—which are, of course, a natural part of our weather here—to become more frequent and more severe.

So, we know that here in Texas, we see all kinds of extreme weather naturally, but as the climate changes, as the world warms, we are seeing a lot of this extreme weather become intensified—some more frequent, some more intense, some stronger, some longer, and some all of the above.

Q. How did you get into studying climate change and what makes Texas Tech a good base for the work that you do?

Well, I was planning on becoming an astrophysicist, and I was almost finished with my undergraduate degree in physics. I needed an extra course and saw this interesting course on climate science over in the geography department, and I thought, "Well, I'll take that." I was absolutely shocked to find out that climate science was all physics—in fact, some of the very same physics that I had been learning in my astronomy classes.

I ended up at Texas Tech University because they were recruiting my husband. My husband is a linguist, and I wasn't really too sure about moving to Texas and doing climate science. But now that I've been here for over 12 years, I realize that this is the perfect place to study climate change.

Q. What makes Texas such a good place for climate change study?

Texas already naturally gets more extreme climate [events] than any other state in the country. Since 1980, we have experienced 106 events that have caused at least $1 billion worth of damage. And one of the ways that climate change is affecting us is by increasing the frequency or the risk associated with extreme weather and climate events. So, Texas is really on the forefront of being vulnerable to the impacts of a changing climate.

Then, what's the solution to the changing climate?

Digging up and burning coal and gas and oil is the No. 1 reason why the planet is warming. Texas, of course, is a huge producer of fossil fuels. We have the highest carbon emissions of any state in the country, but Texas is also the leading producer of wind energy. We are simultaneously the state that currently contributes the most to the problem but, together with California, we are arguably the state that has the most to contribute to fixing the problem.

Texas is also the perfect place to be because there are so many people here who aren't really on board with the idea that the climate is changing. The impacts matter to us here in the places where we live today, and we need to fix the problem.

Almost every day, I run into somebody—whether it's at church, a neighbor, at the university or a student who has questions—who says, "How do we know that this is real?"

And when they find somebody who lives here in Texas, who studies this full time, they have a lot of questions.

A lot of people are just really confused. It's the perfect place to be to talk about climate change to help people understand it, to encourage our investment and solutions, and to help people understand how we are vulnerable to the impacts of a changing climate and what we need to do to prepare.

Q. In a normal weather cycle, what should be going on in Texas?

What many people don't realize is that climate scientists study past climate, too. We study all of the natural factors that cause the climate to change. In fact, as a group, we scientists actually spend more time studying natural causes of climate change and natural variability and past climate than we do studying how humans are affecting climate.

Photo credit: Texas Tech University

> *Texas already naturally gets more extreme climate [events] than any other state in the country. Since 1980, we have experienced 106 events that have caused at least $1 billion worth of damage.*

We've learned that the earth has been warmer and cooler before in the past. When we study the causes, we find that there are a couple of really important factors at play affecting our climate. One is the amount of energy we get from the sun, which goes up and down over time. Another is the configuration of the earth's orbit around the sun. That's actually responsible for the ice ages and the warm periods in between like we're in right now.

We know that large sustained volcanic eruptions can temporarily cool the earth, and we also know that there are natural cycles like El Niño—which, of course, everybody in Texas has heard of—that exchange heat between the ocean and the atmosphere. When we have an El Niño, our air temperature tends to be a bit warmer than average because heat is going into the ocean, and when we have a La Niña, our air temperature tends to be a bit cooler than average because heat is coming out of the ocean.

So, when we see the climate changing as we see it today, we don't automatically jump on the bandwagon and say, "Oh, it has to be humans."

We look at all the natural factors that caused climate change in the past to see if they could be responsible. When we look at the sun, we find that the sun's energy has actually been going down since the 1970s, not up. So, if our temperature were being controlled primarily by the sun right now, we'd be getting cooler, not warmer.

We find that, according to orbital cycles, we should be gradually cooling heading into the next ice age sometime in the next 1,500 years—which we don't want to do because the last time we had an ice age, most of North America was covered with a mile of ice.

Q. What changed the natural cycle?

Large-scale agriculture and deforestation and heat-trapping gas emissions that resulted from these activities [changed the cycle]. The more land area we cultivate [and] the more forest we cut down, the greater the impact we have on climate.

So, by the time we got to the Industrial Revolution, when people were already spreading across North America, cutting down forests here [and] turning them into farmlands, we had just about perfectly stabilized the climate.

We had counteracted the effect of orbital cycles on our climate, which is actually what we want. We like a nice stable climate: Just like Goldilocks, we don't want it too cold, we don't want it too hot, we want it just right.

Then, all of a sudden, along came the Industrial Revolution. We started digging up massive amounts of coal and gas and oil [and] burning it, and our temperature started to increase really quickly.

Q. How is our regional economy affected by climate change, and are certain industries more impacted than others?

A fundamental assumption that underlies our society—one that we don't think about very often—is that the climate is relatively stable. That assumption has been valid not just over the past 100 or 200 years but really over the course of human civilization on this planet. We have not seen any significant change in our average climate on the order of what we have experienced over the last two decades.

In the past, when we designed our building codes, when we set our flood zones, when we built our cities and a lot of very expensive infrastructure—ports, transportation, industrial facilities—along the coastline, we assumed that where sea level was in the past was an accurate predictor where sea level would be in the future.

We've built our industry and a large part of our economy around the unstated and unvoiced assumption that the climate is relatively stable, that conditions of the past are an accurate predictor for conditions of the future.

But today, that isn't valid anymore. So, where and how we grow our crops is already starting to change. Just because your family has always grown cotton in the same place in Texas does not necessarily mean that the next generation will be able to grow the same crop in the same place.

As conditions change, we find that our infrastructure is unprepared [for] and vulnerable to the more frequent or more severe extreme weather events that we are already experiencing in many places—let alone that we'll experience in the future.

The implication of all of these is that it will cost a lot to adapt to the changes.

Q. What other economic effects can Texas expect?

In Houston, Harvey was not the first extreme flood that they have had. They actually had, in some places, three 500-year flood events in three years. Harvey was the third one. That's not a 500-year flood event when you have three of

them in three years. The majority of the emergency calls and the majority of the flooding that occurred during those events, especially during Harvey, were outside the flood zone. That meant that many affected homes and buildings did not have flood insurance.

The insurance industry is one of the industries that is most aware. They've had their finger on the pulse of changing weather statistics over the last few decades because they are the ones who make the payments when disasters happen. And they are increasingly concerned about [whether] some types of insurance are even viable in a changing climate.

South Miami is raising the level of its streets by two feet and installing pumps. As sea level rises, they're already experiencing sunny-day flooding today—flooding when there's no storm, just a king tide.

A few months ago, there was a headline that the oil and gas industry—which is one of the industries most responsible for a changing climate—asked for protection from rising seas for some of their facilities on the Gulf Coast.

Well, who's going to pay for that protection? Really, it comes down fundamentally to economics. The costs of Harvey were estimated at around $125 billion. Other estimates have shown that if you actually factor in not just the direct damages, but also lost productivity, the human migration, the loss of wages, the impact of any severe event lasts for decades beyond that event. And the assessed cost of the direct damages tends to be on the order of about 10 percent of the actual cost.

Q. How long lasting are the economic impacts of events arising from the changes in climate and extreme weather?

There are some counties in Oklahoma and Texas where you can still see the signal of the Dust Bowl in their revenues today.

Of course, the dust bowl was a natural event, but it was a natural event that was exacerbated by human behavior. In that case, it wasn't climate change at the global scale, but it was the agricultural techniques that people were using that contributed to the dust bowl, making it more severe than it would have been and longer than it would have been without human interference.

So, we already have cautionary tales from the past of how naturally occuring weather extremes have been exacerbated by human choices, human activities and human behavior that have been economically devastating for certain regions in the United States.

> *We have to transition to new, clean ways of getting energy. And again, Texas is leading the way in that, but it is not a global leader.*

Q. What can we do in the near term to prepare for climate change?

That is the trillion-dollar question. For many Texas cities, water is a big problem. I've worked with cities such as Austin and with the North Texas Municipal Water District, just north of Dallas. The goal is to incorporate climate projections into their long-term water planning so they actually have realistic estimates of what their supply and their demand will look like in the future in a changing climate.

For other cities—Washington, D.C., Chicago and others—we look at specific thresholds that have to do with how much energy they will need in the future. How will energy demand shift change between heating in the winter and cooling in the summer so they can start to prepare for less oil and gas in the winter, but more air conditioning in the summer?

Here in Texas, one of the things that people are doing is transitioning from big pivot irrigation systems, where they spray water on the ground and a lot of the water evaporates before it actually hits the ground, to in-ground direct irrigation that uses a lot less water.

Individually, I think it's important to be aware of the way that climate change can affect us. I've had calls from some farmers and producers and ranchers asking, "Should I sell my land? Should I be moving further north? If I still want to grow the same types of crops, what types of places are going to be conducive to growing those crops in the future?"

The other half of the picture is that we need to reduce and eventually eliminate our carbon emissions. We have to transition to new, clean ways of getting energy. And again, Texas is leading the way in that, but it is not a global leader. China is. A lot of people don't realize that China has more wind and solar energy than any other country in the world.

We are in serious jeopardy of being left behind in the new clean-energy economy because around the world last year, 70 percent of new installed energy was renewable. It's being installed in India, in China and in developing countries around the world, and that's what we have to do to move forward into the future.

Individually here in West Texas, a lot of farmers and producers are opening up their land to wind turbines because the check arrives in the mail and you can still farm around the turbine.

There are a lot of things we can do. We might say, "Well, I don't own land. I can't put wind turbines on my land."

A lot of our choices relate to our food—reducing food waste and eating lower down the food chain and reducing the amount of beef that we eat, focusing more on fish and on plant-based food. That's where there are important things that we can do to reduce our own carbon footprint.

But the most important thing we can do is talk about it, because if we don't talk about it, why would we care? And if we don't care, why would we act?

For audio excerpts of our interview with Katharine Hayhoe, go to dallasfed.org/research/swe/2019/swe1903e.

Texas K–12 Education Spending Set to Rise, but Who Will Pay?

By Jason Saving

ABSTRACT: The Texas Legislature approved increased public school spending while at the same time limiting property tax increases. Because new revenue to fund this increase over the longer term was not identified, the latest fix may not fully provide a long-term solution to meeting local districts' needs.

Education funding in Texas has substantially trailed the national average for K–12 students over the past 10 years. In a world characterized by ever-greater globalization and ever-faster technology-enabled disruption, projections suggest the jobs of tomorrow will require substantially higher education levels than the jobs of today. This has raised concerns about the adequacy of Texas' education expenditures.

Since 2012, another trend has entered the picture: rapidly rising property values. This has boosted home appraisals (and property tax bills) to unprecedented levels— and prompted mounting calls to lawmakers to stem rising property taxes.[1]

The Legislature, partly in response to those calls, passed an education-reform package in May 2019 consisting of two parts. The first raised K–12 education spending, while the second scaled back future property taxes that in recent years have become the primary funding source for K–12 education.

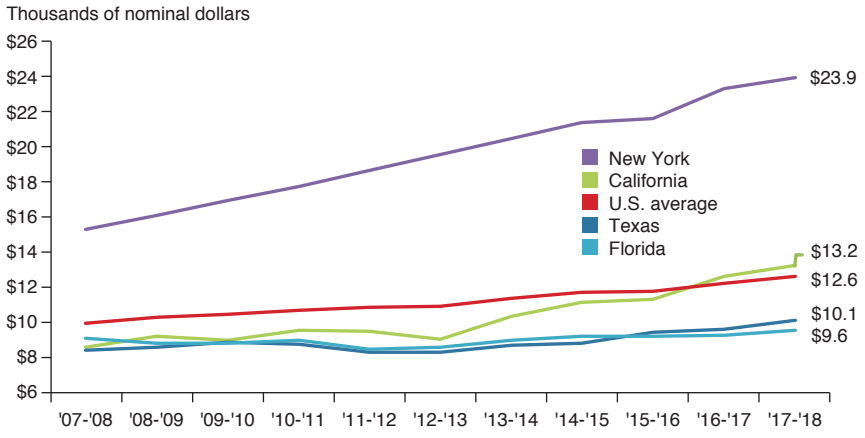
The juxtaposition of more education spending and less reliance on property taxes may seem odd at first glance. However, these issues are inextricably linked because of the way Texas finances education. The current school funding formula dictates that state contributions fall when local property values soar, which in recent years has led to local school districts bearing an unusually large share of the K–12 funding burden.

Tamping down future property tax growth changes this calculus, setting the stage for larger state contributions going forward.

Lagging Education Expenditures

For a variety of reasons, the jobs of today require more education and training than the jobs of yesterday. This trend is very likely to continue, leading many to wonder whether state education systems are well-positioned—and sufficiently funded—to meet worker demand.

CHART 1 Texas Per-Student K-12 Spending Increasing, Still Lags U.S. Average



NOTE: Data refer to spending per student enrolled in fall of each school year.
SOURCE: National Education Association.

Nationally, average K–12 education spending per student grew by 3.0 percent, to $12,602 per year, during the 2017–18 school year *(Chart 1)*. This figure has varied to some degree over the course of the business cycle, rising at a relatively slow pace during the Great Recession and its aftermath and then at a faster pace during the economic expansion.

The comparable figure for Texas rose 5.6 percent to $10,124. While increasing at nearly twice the national average during the 2017–18 academic year, Texas' per-student K–12 spending remained 20 percent below the national average, with only 12 states spending less.

However, overall spending does not necessarily determine how effectively school districts educate children.[2] Performance also reflects on what schools spend their money. In Texas, despite relatively low per-student K–12 spending, students performed at or slightly below the level of their national counterparts on the National Assessment of Education Progress test, which is the best available metric for comparing student performance across states.

On the 8th grade mathematics test, for example, Texas tied the national average of 282 points, exactly halfway between top-scoring Massachusetts and bottom-scoring Louisiana *(Chart 2A)*. Other tests at different grade levels produced mixed results, with Texas significantly below the national average on 4th- and 8th-grade reading but slightly above the national average on 4th-grade mathematics and 8th-grade science *(Chart 2B)*.

Encouragingly for an increasingly diverse state, minority students fared better on the tests than their U.S. counterparts. On the 8th-grade mathematics test, for example, African-American students in Texas ranked seventh among the 47 states that break down scores by race, while Hispanic students ranked eighth. However, the Hispanic scores still trailed those of non-Hispanic whites in the state.

Taken together, the evidence suggests Texas teachers produce better results than would be expected given the state's relatively low K–12 education spending. While economic research suggests that more money does not automatically lead to better outcomes, if Texas teachers are skilled at doing more with less, it seems reasonable to suppose they could parlay additional resources into stronger performance.

Rising Property Taxes

If more education funding is needed, the central role of property taxation in Texas school funding suggests a tax increase might be a possibility. However, recent housing price trends combined with the intricacies of the state's education formula argue against this approach. To understand why, it's necessary to first examine trends in housing prices and then how they affect school funding.

Historically, Texas housing markets do not participate in national boom-bust cycles.[3] During the great national home-price appreciation cycle of 2001–06, U.S. home prices rose by one-third while Texas home prices increased only 10 percent *(Chart 3)*. Abundant land availability, relatively few zoning restrictions and unusual restrictions on home equity lines of credit are among factors that have tamped down Texas home price growth.

The historical pattern has broken down in recent years. Texas home values rose in line with the nation in 2012–18, resulting in historically rapid home price appreciation and greater housing wealth for millions of Texans. However, it does hurt new homebuyers by making home ownership less affordable. Rapid home price appreciation also carries with it the unwelcome obligation of a rising property tax burden, leading to calls for tax limits.

Linking Schools, Taxes

Many people think that property taxes are the main or even the only funding source for K–12 education. However, a combination of state and local resources along with a small, but significant federal contribution pays the bills in Texas. While a full accounting of school funding involves a number of complexities, a few key elements are especially pertinent.[4]

Texas' Foundation Schools Program provides the bulk of per-student funding for K–12 education. Under the program, the state essentially sets a minimum per-student spending level and then "tops up" each school district's property tax receipts in order to reach that minimum sum.[5]

One implication of this formula is that the state bears much of the fiscal risk posed by unexpected fluctuations in economic activity. If the housing market were to cool and housing prices began to fall, then property tax revenue would fill a lower percentage of the foundation schools' amount, and Texas lawmakers would need to make up the difference with state funds.

But if the state economy were to cool, bringing with it slower consumer purchases, and thus, reduced sales tax receipts, Texas lawmakers would need to find a way to maintain the contribution to school districts. Alternatively, the Legislature could decide to reduce state payments for education, as it did in 2012–13.

A second implication is that a prolonged period of home price appreciation in the state will necessarily reduce the share of education funding provided by the state vis-à-vis local school districts. Indeed, this is exactly what occurred during the 2012–18 period of rapid home price appreciation.

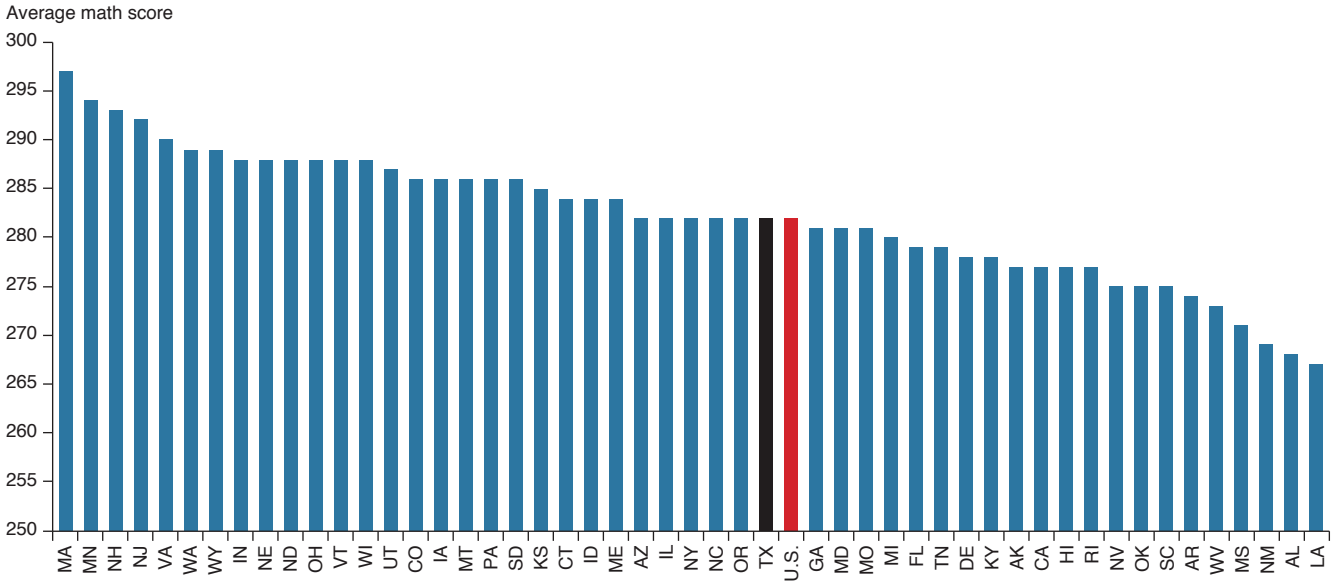
After accounting for identical 45 percent local/state shares of per-student education funding in the 2007–08 academic year, rapid home price appreciation following the Great Recession pushed the local share to 51.4 percent in 2017–18 and to a projected 53.5 percent in 2018–19. At the same time, the state share fell to 39.7 percent and was projected to fall further to 37.6 percent in 2018–19 *(Chart 4)*.

From the vantage point of 2018 or even early 2019, it appeared that rapid home price appreciation might continue for some time, further increasing an already-large property tax burden on homeowners while simultaneously propelling the local share of education funding to unprecedented highs. This is where the recent education package enters the picture.

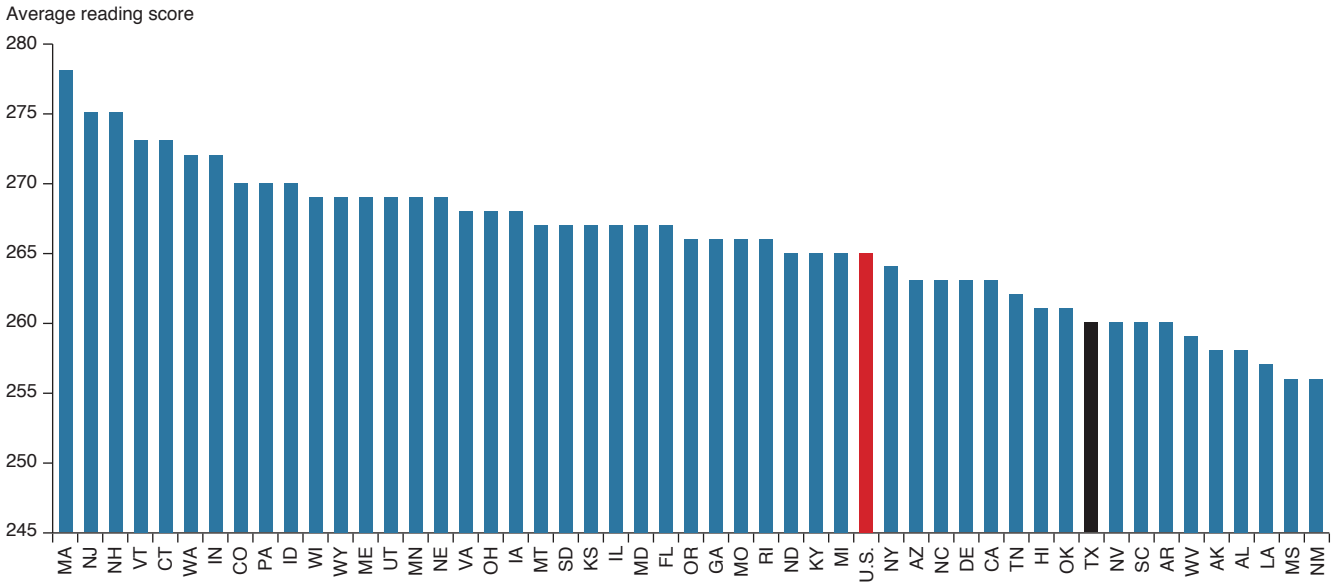
CHART 2

Texas Earns Mixed Grades on Student Achievement

A. Texas Matches U.S. Average on 8th-Grade Math Test



B. Texas Trails U.S. Average on 8th-Grade Reading Test



NOTE: Data refer to 2017 math and reading assessment scores for 8th-grade students.
SOURCE: The Nation's Report Card.

Texas House Bill 2, signed into law in June 2019, increased the state's baseline per-student funding by $890. It includes other provisions, such as a more funded full-day pre-K for eligible 4-year-olds. The law also reduces property taxes by 13 cents per $100 valuation—about $325 per year for a $250,000 house.

In the short run, property tax reductions coupled with a one-time boost to per-student funding would cumulatively rebalance the scales by increasing the state share of education funding while reducing the local share. Yet if another period of rapid home price appreciation were to emerge, then over the medium term, local school districts would once again find themselves shouldering an increasingly larger share of the education-funding burden.

The Texas property tax reform portion of the package (House Bill 3) addressed this issue in a creative fashion. Rather than lower the current 10 percent

yearly cap on *individual* assessment growth, the state imposed a new 2.5 percent yearly cap on *school district* revenue growth from property taxes, with exceptions for new property development. Such a cap carries other policy and economic implications.

Shifting Payment Burdens

One implication is that homeowners have greater protection during housing-market booms. If a house appreciates 10 percent per year, but its taxable value only rises 2.5 percent annually, for example, the homeowner would be shielded from 75 percent of the property-tax increases that would otherwise be paid.

Were this to continue for an extended period of time, a growing portion of the state's residential property tax base would eventually go untaxed (as has happened in California where a 1979 proposition sharply limited property tax increases for many homeowners).

Another implication is that school districts over time will contribute a smaller share of education funding, with the state required to make up the difference. This is a mathematically inevitable feature of capping school district revenue growth.[6]

Official cost analyses also suggest the price tag on these reforms will rise over time, from $11.6 billion in 2020–21 to $13.5 billion in 2022–23 and more thereafter.[7] However, the recently approved law does not provide a clear answer as to where the funding will be found.

Higher-than-previously-estimated tax revenue for 2020–21 should lead to a temporary surplus. Over the longer term, barring dramatic changes in economic growth or demands for state services, additional state education funding would have to either be redirected from other areas such as health services (which together with education comprise three-quarters of the state budget) or else generated through higher state taxes *(Chart 5A)*.[8]

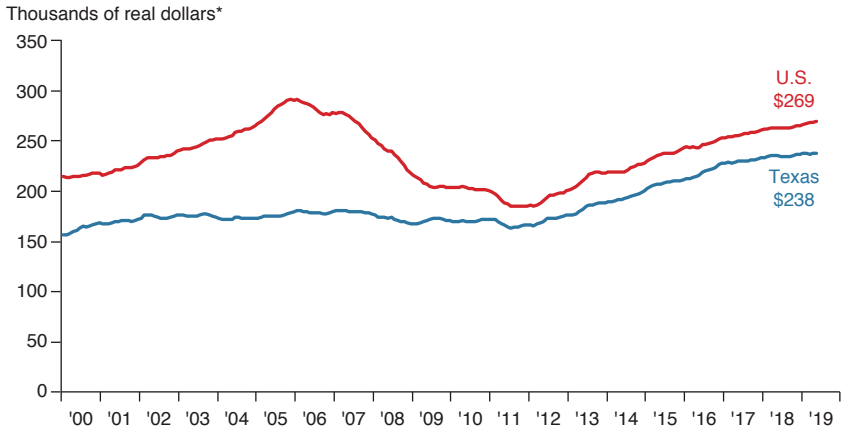
However, rising fiscal contributions to the Medicaid program for indigent health care along with the state's high uninsured rate make health spending extraordinarily difficult to reduce, and the state's sales tax rate is already well above the national average.

This is not to say adjustments in those areas would be impossible. However, it's important to keep in mind that Texas' tax system is already relatively regressive—levying a relatively larger burden on individuals regardless of earnings—because of its heavy emphasis on sales taxation and would become even more so if the state puts more emphasis on the sales tax vis-à-vis the property tax *(Chart 5B)*.[9]

A shift in state spending from health services to education would likely also represent a net transfer away from lower-income Texans, who disproportionately consume Medicaid and other state health services.

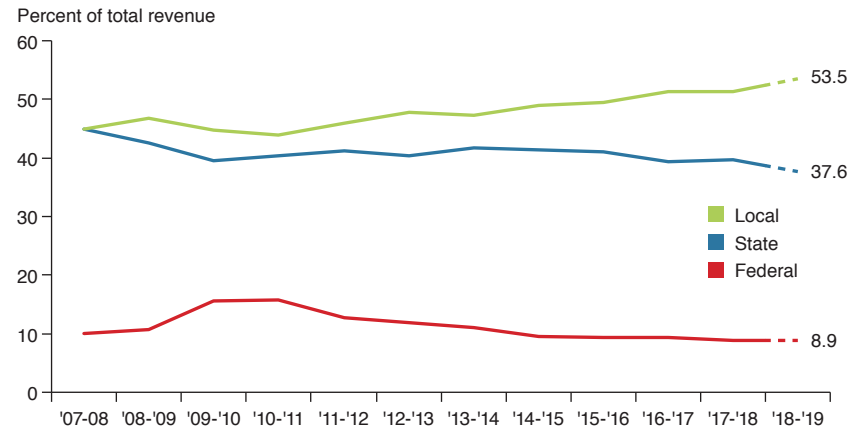
This leaves the state in a potentially difficult situation, attempting to provide more money for education while

CHART 3 Texas Home Values Follow National Trend Since 2012



*Four-month moving average, seasonally adjusted.
NOTES: U.S. data refer to median sales price of single-family homes; Texas data refer to median sales price of single-family homes, condominiums and townhomes. Data are through May 2019.
SOURCE: The Real Estate Center at Texas A&M University.

CHART 4 State Share of K-12 Education Funding Declines



NOTES: Data are for Texas. Dates refer to school years. 2018–19 data are a projection without the recent education spending increase.
SOURCE: National Education Association.

also meeting pressing needs in health and infrastructure and adapting to the realities of demographic change.

Complicating decision-making is a desire to maintain the low-tax, business-friendly climate that traditionally enables Texas to grow about a percentage point faster annually than the rest of the nation. Whether it can achieve a workable solution will determine whether Texas workers are well-positioned for the future and may determine whether the state can keep its growth advantage in years to come.

Saving is a senior economist in the Communications and Outreach Department at the Federal Reserve Bank of Dallas.

Notes

[1] See "Texas Property Taxes Soar as Homeowners Confront Rising Values," by Jason Saving, Federal Reserve Bank of Dallas *Southwest Economy*, Third Quarter 2018, www.dallasfed.org/research/swe/2018/swe1803c.

[2] See "Education Spending and State Economic Growth: Are All Dollars Created Equal?" by John Deskins, Brian C. Hill and Laura Ullrich, *Economic Development Quarterly*, vol. 24, no. 1, February 2010, pp. 45–59.

[3] See "Texas Housing Market Soars to New Highs, Pricing Out Many," by Laila Assanie, Federal Reserve Bank of Dallas *Southwest Economy*, First Quarter 2017, www.dallasfed.org/research/swe/2017/swe1701f.

[4] For a more detailed summary of Texas school finance, see "Texas School Finance: Doing the Math on the State's Biggest Expenditure," Texas Comptroller of Public Accounts, *Economy*, FiscalNotes, January 2019, https://comptroller.texas.gov/economy/fiscal-notes/2019/jan/foundation.php.

[5] Other components of the Texas education funding system are less equal, leading to sometimes-substantial per-student revenue differences across school districts. Additionally, questions have been raised about the constitutional adequacy of state funding for public schools. These issues are outside the scope of this article. For more on this, see "Texas School Finance System Survives Recent Supreme Court Review," House Research Organization Focus Report 84-10, Sept. 27, 2016, https://hro.house.texas.gov/pdf/focus/Schoolfinance.pdf.

[6] The governor's "Property Tax Policy" document anticipated this to some degree, stating: "A major effect of capping the growth of local property tax collections will be to reduce the extent to which local revenue for public schools is able to grow. The state must therefore be prepared to increase its share," www.gregabbott.com/wp-content/uploads/2018/01/PropertyTaxReform.pdf.

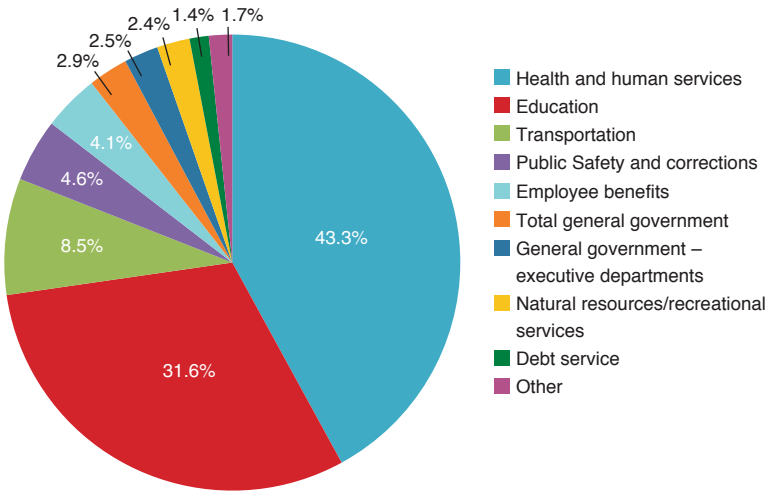
[7] See fiscal note for House Bill 3 from the Legislative Budget Board.

[8] The reform package also directs the Texas Comptroller of Public Accounts to create a new fund into which funds from the Available School Fund and online sales tax collections would be deposited.

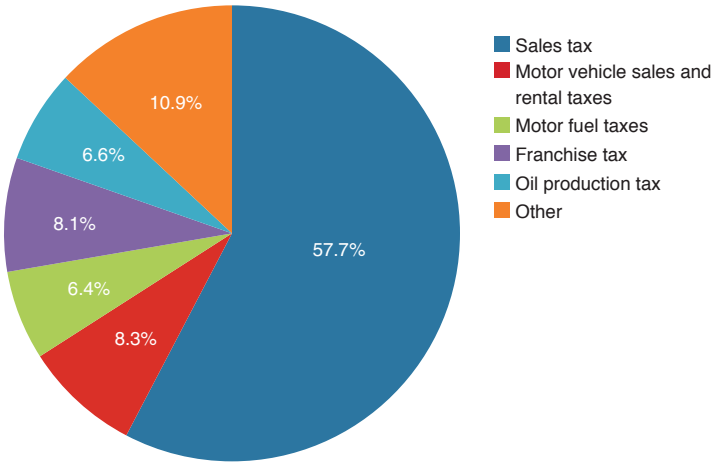
[9] For more on the distributional impact, see, "Texas Taxes: Who Bears the Burden?" by Jason Saving, Federal Reserve Bank of Dallas, *Southwest Economy*, Third Quarter 2017, www.dallasfed.org/research/swe/2017/swe1703b.

CHART 5 Texas Expenditures, Funding Sources Heavily Concentrated

A. Health, Education Account for 75 Percent of State Spending



B. Sales Tax Accounts for 58 Percent of State Tax Revenue



NOTES: Chart A data refer to fiscal 2018 (September 2017 through August 2018). Chart B data refer to fiscal 2019 year to date (September 2018 through June 2019).
SOURCE: Texas Comptroller of Public Accounts.

Wind and Solar Power: Perfect When Paired in Texas

By Aquil Jones, Soojin Jo and Christopher Slijk

As wind and solar power generation becomes more competitive economically relative to conventional coal and natural gas generation, states will likely increase their dependence on such renewable sources. Texas gets about 19 percent of its electricity from renewables, which, though they can't be depleted, offer limited capacity to produce power at any given time.

Wind production accounted for roughly 94 percent of Texas' renewable electricity, or 75 million megawatt hours (MWh) in 2018. The total is equivalent to the electricity needed to power 7.2 million households, based on the average annual national consumption rate.

Solar generation was significantly less than wind, with 3 million MWh in 2018, but sufficient to rank Texas fifth in the U.S. in solar production by state.

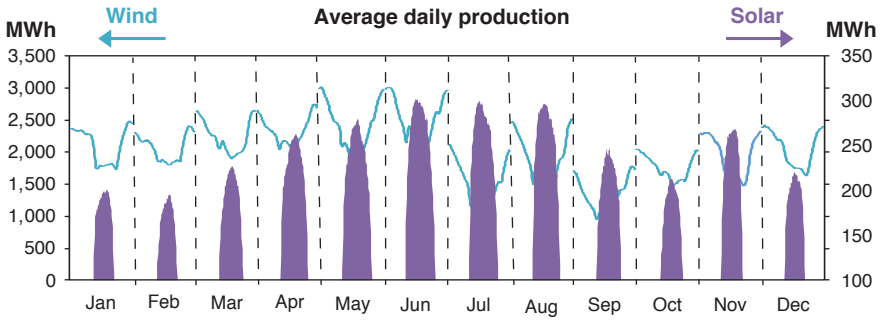
Problem of Reliability

Simply put, wind power is generated only when it is windy; solar power requires sunny days. Businesses and residents depend on electricity regardless of the weather conditions and are accustomed to conventional sources reliably producing enough electricity to meet demand.

One way to overcome the reliability issue is to create geographically dispersed renewable electric grids. International studies have found that the electricity production of wind turbines separated by 20 miles or more is relatively unaffected by sudden weather fluctuations.[1] Thus, relatively small-scale weather events won't shut down larger renewable grids.

Diversity across renewable sources is also key to smoothing out power generation. Regional studies suggest that lulls in wind energy production in Texas are correlated with peaks in solar energy production, and vice versa, on an annual and daily basis.[2] This is evident in the average daily patterns of production throughout the year; wind generation surges as solar generation tapers off in the evenings *(Chart 1)*.

CHART 1 Complementary Wind, Solar Energy Help Stabilize Production



NOTE: The series depicts average daily electricity production for each month, in megawatt hours (MWh) of the ERCOT grid, in 15-minute intervals from midnight to midnight during 2018.
SOURCE: Electric Reliability Council of Texas (ERCOT).

Additionally, wind and solar complement each other seasonally, with lulls in summer wind production coinciding with increases in solar production.

Because solar production in the state is much smaller in scale than wind, the peaks in solar generation at current levels only partially offset the daytime drop in wind generation. The average range in wind generation within a day was about 900 megawatts in 2018, while for solar it was about 250 megawatts. Thus, solar made up only 27 percent of the drop in wind-generated electricity.

Renewables Stepping Up

While the combination of wind and solar shows the potential to supply the grid a consistent source of energy, the need for reliability suggests that the mix of production sources should change throughout the day.

The Electric Reliability Council of Texas, which manages 90 percent of the Texas electrical grid, estimated that over the next 10–15 years, natural-gas-based generation will remain the primary source of electricity to the Texas grid. The council also predicts that older coal and gas facilities will be replaced by wind, solar and increasingly efficient gas power production.

Additionally, battery storage plants can augment renewable power generation, storing excess solar and wind energy and releasing it to the grid to meet periodic gaps between demand and production. A planned 495-megawatt battery storage system is expected to increase Texas' battery storage capacity fivefold, to 584 megawatts in 2021.

Notes

[1] "Response to 'Burden of Proof: A comprehensive Review of the Feasibility of 100% Renewable-Electricity Systems,'" by Tom W. Brown et al., *Renewable and Sustainable Energy Reviews*, vol. 92, September 2018, pp. 834–47, www.sciencedirect.com/science/article/pii/S1364032118303307.

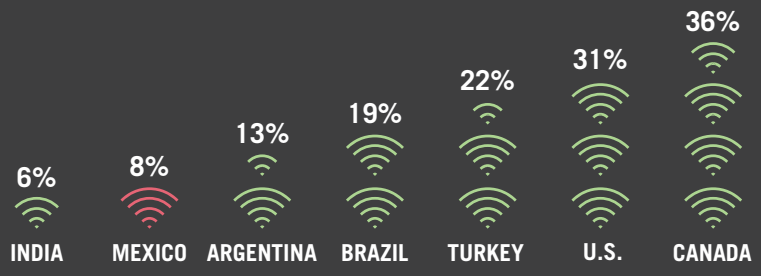
[2] "Assessing Solar and Wind Complementarity in Texas," by Joanna H. Slusarewicz and Daniel S. Cohan, *Renewables: Wind, Water, and Solar*, November 2018, https://link.springer.com/article/10.1186/s40807-018-0054-3.

Mexico Struggles to Move into Digital Payment Age

Design: Justin Chavira; Content: Michael Perez

Mexico Lags Other Countries

The slow adoption of digital payments is leaving Mexico behind the U.S., Canada and many developing countries.[1]



Value of Digital Payments as Percentage of Gross Domestic Product

Why Is Mexico Behind?

- **53%** of workers are off the books.
- **90%** of transactions are in cash.
- **65%** of people age 15 or older don't have an account with a financial institution.
- **75%** of people don't have a debit card.
- **88%** of people don't take out loans from a financial institution or use a credit card.

With a higher share of digital payments, Mexico could:

- Increase payment and transaction speed
- Increase financial transparency
- Increase access to credit
- Decrease crime and corruption

[1]Digital payments are defined as the total value of debit, credit and e-money payments (with cards and e-money issued inside the country).
SOURCES: Bank for International Settlements, Committee on Payments and Market Infrastructures; World Bank Global Financial Inclusion Index; Better than Cash Alliance; PYMNTS; Instituto Nacional de Estadística y Geografía (National Institute of Statistics and Geography).

Federal Reserve Bank of Dallas
P.O. Box 655906
Dallas, TX 75265-5906

PRSRT STD
U.S. POSTAGE
PAID
DALLAS, TEXAS
PERMIT #1851

SNAPSHOT

Domestic Migration to Texas Slows

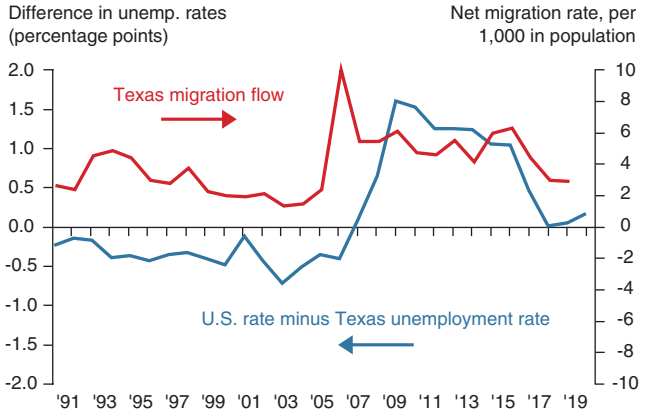
Despite a strong economy and historically low unemployment rates in Texas, net domestic migration to Texas from other states has slowed since 2015.

During the 2015–16 oil bust, the state economy downshifted, the Texas unemployment rate grew closer to the national average, and net domestic migration declined. While economic growth improved in Texas in 2017 and 2018, conditions were also strong throughout the U.S., and the unemployment rates for the two areas were almost the same.

During the period of net domestic migration from July 2017 to July 2018, the unemployment rate in Texas averaged 3.6 percent, while the U.S averaged 3.8 percent. A simple regression with one lag of net domestic migration and the unemployment rate differential suggests that net domestic migration in Texas this year will be about 90,500—above the 2018 figure of about 82,500, but more than 25 percent below the post-Great Recession average of 123,000.

—Adapted from Dallas Fed Economics, *Sept. 3, 2019, by Keith R. Phillips and Alexander T. Abraham*

CHART 1 Net Domestic Migration to Texas Slows as State, U.S. Labor Markets Tighten



NOTES: Both the annual migration flow and average annual unemployment rate are calculated July to July. A positive-value difference in the unemployment rate means the U.S. rate exceeded the Texas rate.

SOURCES: Census Bureau; Bureau of Labor Statistics.

Federal Reserve Bank of Dallas

Southwest Economy

is published by the Federal Reserve Bank of Dallas. The views expressed are those of the authors and should not be attributed to the Federal Reserve Bank of Dallas or the Federal Reserve System.

Southwest Economy is available on the Dallas Fed website, www.dallasfed.org.

Federal Reserve Bank of Dallas
2200 N. Pearl St., Dallas, TX 75201