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Texas Service Sector Outlook Survey: Survey Methodology, Performance and Forecast Accuracy

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Texas Service Sector Outlook Survey: Survey Methodology, Performance and Forecast Accuracy*

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Abstract

The Texas Service Sector Outlook Survey (TSSOS) is a monthly survey of service sector and retail firms in Texas conducted by the Federal Reserve Bank of Dallas. TSSOS indexes provide timely information about activity in the Texas private service sector, which makes up the bulk of the state economy. The survey provides invaluable information on regional economic conditions—information that the Dallas Fed president and economists use in the formulation of monetary policy and informing the public. This paper describes the survey methodology and analyzes the explanatory and predictive power of TSSOS indexes with regard to other measures of state economic activity. Regression analysis shows that several TSSOS indexes successfully track changes in Texas employment, gross domestic product and inflation. Forecasting exercises show that many TSSOS indexes are also useful in predicting future changes in some of the same metrics.

JEL Classification: B23, C83, C53, L80

Keywords: service sector, business outlook surveys, diffusion indexes

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1. Introduction

Businesses are an integral part of the nation's economy. Data from businesses can be used to gauge economic conditions and aid monetary policy formulation, which in turn aims to boost growth while maintaining stable prices. Surveying businesses is one way to acquire timely firm-level data. The Federal Reserve Bank of Dallas conducts several such surveys, including the Texas Service Sector Outlook Survey (TSSOS). Data collected include the month-to-month direction of change in firm revenue, employment, prices and wages, as well as company outlooks and expectations of change over the coming six months.

Business surveys in the U.S. often focus on the manufacturing sector because manufacturing is more cyclically sensitive, meaning activity is generally higher during economic expansions and lower during contractions compared with non-manufacturing sectors. Therefore, changes in manufacturing are useful for tracking the business cycle. However, manufacturing employment represents a declining share of total employment as the U.S. continues to shift toward a service-based economy and manufacturing becomes more capital-intensive.[1] This trend is no different in Texas.

The service sector, on the other hand, makes up the bulk of employment and output in the U.S. economy. Keeping track of the service sector is important in order to get a more complete picture of current economic conditions. The Institute for Supply Management (ISM) does this for the

[1] Manufacturing accounted for 8.0 percent of total U.S. nonfarm employment in 2024, down from 12.9 percent in 2000 and 20.5 percent in 1980.

U.S. with its Nonmanufacturing ISM Report on Business survey, while the Dallas Fed and some other Federal Reserve banks track service sector performance in their respective regions.[2]

A benefit of business surveys is that they are generally timelier than other data sources which can be both lagged and subject to large revisions. As is the case with the Dallas Fed's TSSOS, Federal Reserve banks' surveys provide a read on regional economic conditions before official statistics are available. TSSOS tracks the Texas private (non-government) service sector and is comprised of a survey of general services businesses plus TROS (Texas Retail Outlook Survey).[3] TROS is a component of TSSOS that collects information only from respondents in the retail and wholesale sectors.

TSSOS and TROS, along with the Texas Manufacturing Outlook Survey (TMOS), complete the family of Dallas Fed business surveys focusing on Texas. They join the Dallas Fed's toolkit of surveys, which includes the Dallas Fed Energy Survey, the Banking Conditions Survey, and the Quarterly Survey of Agricultural Credit Conditions.[4] These surveys provide invaluable information on current regional economic conditions—information used by Dallas Fed economists and the Bank president to help formulate monetary policy and inform the public.

[2] In addition to the Dallas Fed's Texas Service Sector Outlook Survey, other regional service sector business surveys include the New York Fed's Business Leaders Survey (started publication in 2014; data available from 2004), the Philadelphia Fed's Nonmanufacturing Business Outlook Survey (started publication in 2014; data available from 2011), the Richmond Fed's Fifth District Survey of Service Sector Activity (started publication in 1994; data available from 1993) and the Kansas City Fed's Services Survey (started publication in 2019; data available from 2014).

[3] General services businesses include transportation, warehousing, utilities, information, financial activities, professional and business services, education and health services and leisure and hospitality. Both surveys exclude organizations in the federal, state and local government sectors.

[4] Survey reports and data can be found on Dallas Fed's website https://www.dallasfed.org/research/surveys.aspx.

In order for TSSOS to provide reliable measures of economic conditions, the information it provides must be correlated with the economic activity it is intended to measure. Cañas and Kerr (2011) show that a number of TSSOS and TROS indexes help explain variation in private sector Texas services employment, retail sales and retail employment. This paper updates an earlier working paper, Cañas and Jordan (2018) that extended that research to explore how well TSSOS indexes correlate with changes in Texas employment, Texas gross domestic product (GDP), and the headline consumer price index (CPI) for Texas. In addition, we do a forecast evaluation.

2. TSSOS Methodology

TSSOS, like other Dallas Fed regional surveys, was created to help fill a regional data void. Economic data at the state and local level are typically lagged, sparse and often subject to substantial revisions. For example, employment is a good gauge of the overall health of a state's economy, but monthly payroll data for the state from the Bureau of Labor Statistics (BLS) are released with a three-week lag and can be significantly revised in later months.[5] TSSOS is much timelier; it is available at the end of the reference month and is not subject to monthly revision.[6] TSSOS also includes measures of output, which are proxies for overall economic activity. State GDP data are even more lagged than official employment data.

Business executives responding to TSSOS report on how business conditions have changed for a number of indicators, such as revenue (or sales for retailers), employment, and prices. Respondents are also asked to report on how they perceive broader economic conditions have

[5] Payroll data are based on the BLS survey of businesses called Current Employment Statistics.
[6] The annual seasonal adjustment revision can slightly alter the historical series; see the section on seasonal adjustment for more information.

changed, such as general business activity. All questions ask whether the indicator has increased, decreased or remained unchanged over the prior month.[7] Survey responses are used to calculate diffusion indexes by subtracting the percentage of respondents reporting a decrease from the percentage reporting an increase. Responses are not weighted in the calculation of diffusion indexes; that is, each survey response counts the same regardless of firm size. When the share of firms reporting an increase exceeds the share reporting a decrease, the index will be greater than zero, suggesting the indicator has increased over the prior month. If the share of firms reporting a decrease exceeds the share reporting an increase, the index will be below zero, suggesting the indicator has decreased over the prior month. In addition to asking about month-to-month changes, the survey also asks about expectations six months ahead for the same group of indicators.

Survey Design and Implementation

The Dallas Fed began collecting TSSOS data in January 2007. The original sampling framework was drawn from business database Reference USA. Invitations to participate in the new surveys went out to CEOs and other senior-level executives in single-location companies or company headquarters in Texas; branches were excluded to avoid duplicate responses from affiliated operations. The sample was relatively small in the early years of the survey. Recruitment has been conducted on an ongoing basis to expand the survey sample, with large-scale efforts in

[7] The sample survey form can be found on the Dallas Fed website at www.dallasfed.org/-/media/Documents/research/surveys/TSSOS/documents/tssos_form.pdf.

2014 and 2015. As of May 2025, 302 general service firms and 69 retailers and wholesalers receive the survey; roughly 250 to 280 respond each month.

TSSOS is sent to respondents via email mid-month, and respondents have seven business days to submit their survey responses online.[8] Responses are collected and assembled into diffusion indexes that are seasonally adjusted, as necessary, to better examine underlying trends. The Dallas Fed began releasing TSSOS results to the public in June 2011, after an initial four-year data collection period. Full reports of results along with the collection dates and number of firms responding are published every month on the Dallas Fed website the day after the release of the TMOS report.[9] Comments from respondents' completed surveys are also published, anonymously, with permission.

Seasonal adjustment

The Dallas Fed uses the X12 seasonal-adjustment procedure, developed by the U.S. Census Bureau, to statistically remove seasonal effects. TSSOS respondents are explicitly asked to take seasonal variations into account when assessing firm performance each month. However, as of May 2025, the X12 results indicate that 39 of the 46 indexes contained statistically significant seasonality.[10] For these indexes, the increase, decrease and no change components are separately adjusted. The index is then re-computed using the adjusted components. If the three adjusted component series do not sum to 100, they are normalized to add up to 100. In January each year,

[8] The sample survey form for TSSOS is found at www.dallasfed.org/-/media/Documents/research/surveys/TSSOS/documents/tssos_form.pdf and for TROS is found at www.dallasfed.org/-/media/Documents/research/surveys/TSSOS/documents/tros_form.pdf.
[9] The TMOS report is released on the final Monday of each month.
[10] A list of the seasonal indexes in TSSOS (for both general services and the retail component) is found at www.dallasfed.org/research/surveys/tssos/seasonal.

the Dallas Fed revises historical TSSOS data by recalculating the seasonal adjustment factors to account for an additional year of data.

Representativeness of the TSSOS Sample

TSSOS (including its retail and wholesale component, TROS) receives a robust number of responses every month—more than 250—and publishes the number of respondents each month with the report release. TSSOS was designed to fill a regional data gap. For the survey to provide consistently reliable indicators of economic conditions in the Texas private services and retail sectors, it must reflect the underlying industry composition within the Texas service sector. The Dallas Fed uses Quarterly Census of Employment and Wages employment shares—at the three-digit North American Industry Classification System (NAICS) level—to set a target composition for the panel of TSSOS participants. For example, if food services and drinking places account for 12 percent of Texas private services employment, ideally 12 percent of TSSOS general services participants would be food services and drinking places. A breakout of the industry composition is provided at the super-sector level in Figure 1.[11] Panel A shows the target composition, i.e. private services employment shares in Texas, and Panel B shows the TSSOS panel's industry composition. The TSSOS panel's industry distribution is not a perfect match with employment shares; however, all of Texas' major sectors are represented and efforts are ongoing by Dallas Fed staff to better target the representativeness of TSSOS panels through recruitment of companies in underrepresented industries.

[11] There are 42 three-digit NAICS codes represented in the TSSOS panel, so the super sector combinations are presented for brevity.

Figure 1a. Desired Industry Distribution of TSSOS Sample, 2024

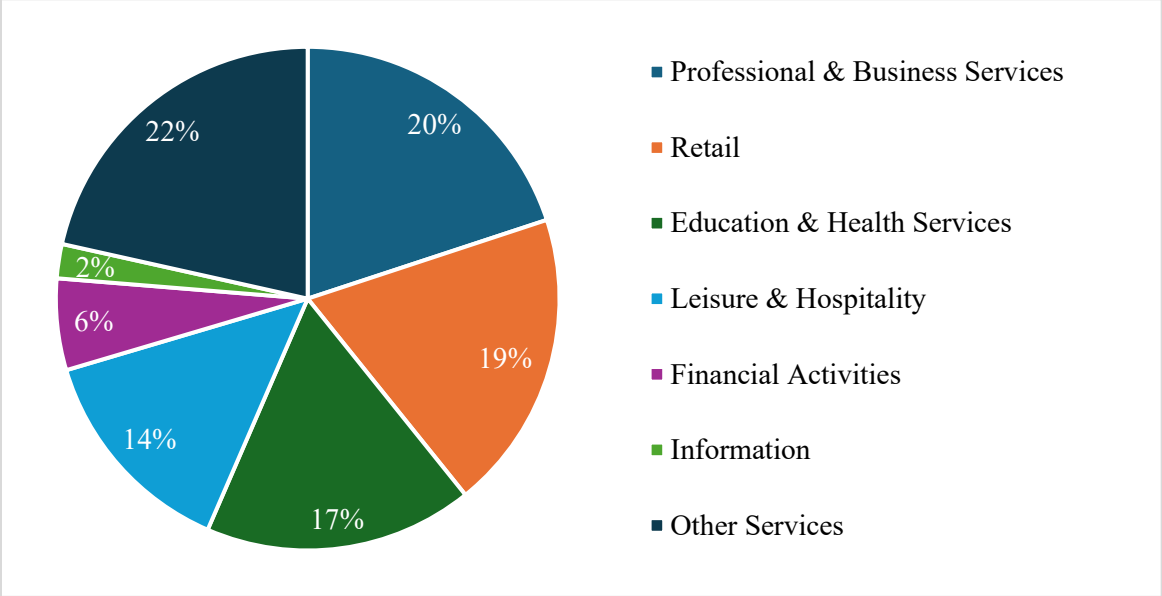
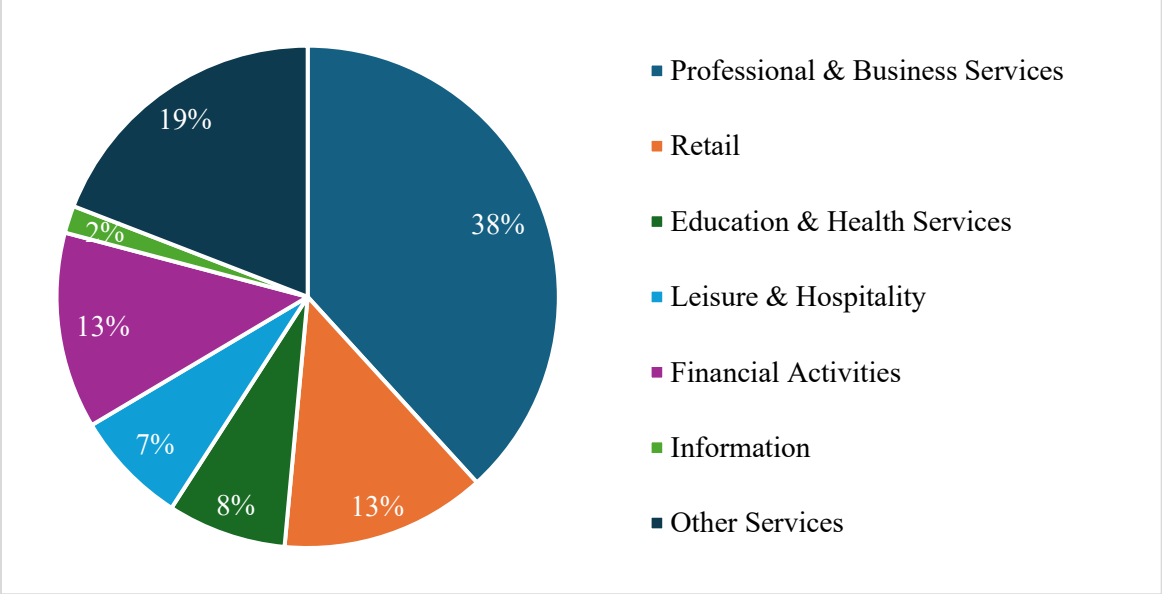


Figure 1b. Industry Distribution of TSSOS Sample, 2024



NOTE: Shown in Figure 1a is 2024 Texas service sector employment shares for selected industries, which account for 78 percent of total Texas services employment. Retail includes NAICS 42 wholesale trade and NAICS 44-45 retail trade. Employment data is from the QCEW.
SOURCE: Bureau of Labor Statistics.

Maintaining the TSSOS Sample

Survey participation is voluntary, and attrition and non-response occur. Firms drop out of the sample for a number of reasons including mergers, changing the location or nature of their operations, going out of business, or participating executives changing roles or leaving the company. Firms may also remain on the panel but not respond in a given month. Non-response can introduce selection bias into the survey indexes. It is important to retain existing contacts because it is far less costly than finding and enrolling new respondents. It is also important that, to the extent possible, the same firms respond to the survey every month. To this end, Dallas Fed staff launched a follow-up procedure in 2012 to systematically contact non-responding survey respondents in an effort to minimize attrition and boost response rates.[12]

In order to retain a robust survey panel and ensure representativeness, recruitment and retention are crucial. At the beginning of each year, Dallas Fed economists analyze the representativeness of the existing TSSOS panel. Target industries—three-digit NAICS codes where the survey panel is underrepresented—are identified, and recruitment efforts are focused on these industries. In addition, recruitment efforts are designed to increase the overall sample size. Recruitment methods have included mailed letters of invitation, invitation emails, invitation handouts, phone calls and personal interactions. New panelists are enrolled for the next monthly survey on a rolling basis.

[12] Dallas Fed staff call panelists who do not respond to three consecutive monthly surveys; a similar call to encourage resumption of participation is placed after six consecutive months of non-response. After nine consecutive months of non-response, panelists receive a follow-up email, and after 11 months, a letter. If a panelist does not respond after 12 consecutive months and these follow-up efforts, they are removed from the panel.

3. TSSOS Contribution to Regional Analysis

TSSOS contributes to the existing collection of regional business surveys focusing on the private service-providing sector, while TROS stands out for its focus on consumer spending by tracking the retail and wholesale sectors. Both Dallas Fed surveys focus on firms based in Texas, which make up the bulk of the Eleventh District economy.

Texas service sector GDP has grown quickly over the past several years. Table 1 compares Texas' GDP share and growth with that in the other Federal Reserve Districts undertaking service sector surveys. Texas accounts for 8.6 percent of total U.S. services output, similar to the Richmond Fed District (Fifth District). Texas real service sector GDP grew 50.6 percent over the last five years, faster than the U.S. overall, which expanded 37.4 percent. The New York Fed District (Second District) accounts for the largest share of services output, 12.3 percent, while growing 30.0 percent over the past five years, slower than the national average.

Table 1. Comparison of Private Service Sector GDP across Fed Survey Geographies

Region	Services GDP, 2023, $2023 millions	Share of U.S. Services GDP 2023 percent	Services GDP Growth 2018-2023 percent
Texas	1,705,535	8.6	50.6
Second District*	2,442,869	12.3	30.0
Third District**	1,435,821	7.2	29.8
Fifth District***	1,805,094	9.1	37.6
Tenth District****	1.226,814	6.2	38.3
U.S.	19,868,700	-	37.4

*Second District numbers include NY and NJ, a proxy for the New York Fed's survey which comprises NY, northern NJ and Fairfield County, CT.
**Third District numbers include PA, NJ and DE but are not a perfect measure of the area covered by the Philadelphia Fed's survey which comprises eastern Pennsylvania, southern New Jersey and Delaware.
***Fifth District numbers include VA, WV, MD, NC, SC and DC, but are not a perfect measure of the area covered by the Richmond Fed's survey which does not include all of West Virginia.
****Tenth District numbers include CO, KS, MS, NE, NM, OK, and WY, but are not a perfect measure of the area covered by the Kansas City Fed's survey which does not include all of New Mexico and Missouri.

Survey Collection Period

TSSOS is collected over a seven-business day period in the latter half of the month to allow participants to respond with a good idea of business activity for the current month. This collection period gives TSSOS data distinctive value compared with some other Fed service sector surveys that collect data earlier in the reference month. The later collection period allows a more complete picture of business activity during the reference month, and for almost half of Federal Open Market Committee meetings, TSSOS is the most recent Fed service sector survey data available.

Table 2. Collection Periods and Release Dates for Service Sector Surveys, January 2025

	Dec. 2024			Jan. 2025																													
	Su	M	T	W	Th	F	S	Su	M	T	W	Th	F	S	Su	M	T	W	Th	F	S	Su	M	T	W	Th	F	S	Su	M	T	W	Th	F
New York Fed	29	30	31	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31
Philadelphia Fed	29	30	31	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31
Richmond Fed	29	30	31	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31
Kansas City Fed	29	30	31	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31
Dallas Fed	29	30	31	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31

NOTES: Shaded areas mark survey collection periods. Boxed dates mark survey release dates. January 2025 is used as an example of a typical month. Collection periods and release dates may vary from month to month.

Survey Indexes

TSSOS includes well-defined, quantifiable measures of state service activity not available from other sources. In addition to asking about service sector revenues, TSSOS includes measures of prices and wages, all reported on a monthly basis. The general business activity index tends to reflect Texas firms' perceptions of broad economic activity, a measure not available from other sources. While service sector employment is available from BLS, this data is subject to substantial revision in the months and year after its initial release, whereas TSSOS employment indexes are not revised.

4. TSSOS Performance with Regional Economic Indicators

Monthly surveys of regional service activity can provide an early look of current economic conditions before official statistics become available. The most important gauge of their value, however, is whether the indexes are correlated with the economic activity they are intended to measure.

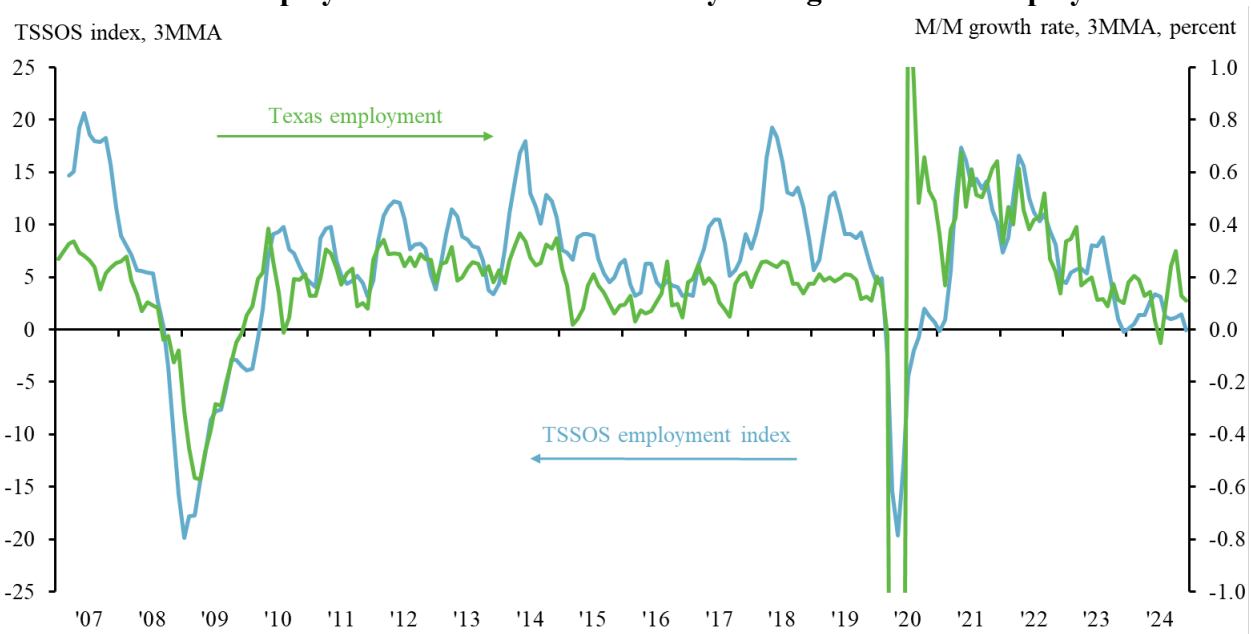
We examined the explanatory power of TSSOS indexes for several state economic indicators—employment, output (gross domestic product), and inflation (headline CPI). We used

autoregressive regression models to estimate how closely each index follows these aspects of Texas economic activity. To avoid bias from the COVID-19 pandemic's impact, we excluded data from the year 2020.

Employment

Chart 1 plots the monthly change in Texas employment against the TSSOS employment index. The index, like all TSSOS indexes, is centered at zero, meaning that values greater than zero are consistent with growth. In general, TSSOS indexes track changes in Texas employment growth as measured by payroll data from the Bureau of Labor Statistics, the timeliest and most comprehensive official indicator of state economic activity.

Chart 1. TSSOS Employment Index Tracks Monthly Changes in Texas Employment



NOTE: Data are monthly through December 2024.
SOURCES: Bureau of Labor Statistics; Texas Workforce Commission; Federal Reserve Bank of Dallas' Texas Service Sector Outlook Survey.

Several studies have documented a positive correlation between business activity indexes and regional economic indicators, such as manufacturing employment and personal income (see Trebing 1998, Harris et al. 2004, and Keeton and Verba 2004). Cañas et al. (2024) show that several Texas Manufacturing Outlook Survey indexes successfully explain monthly changes in Texas employment and quarterly changes in real state GDP.

Another factor to consider is whether survey indexes can provide any additional information about regional indicators beyond that contained in past values of the indicators. Trebing (1998) regressed monthly changes in the U.S. manufacturing component of the industrial production index on twelve lagged values of the change in the manufacturing production index plus the Philadelphia Fed's Business Outlook Survey (BOS) general activity index. The analysis found that the model could account for an additional 14 percentage points of the monthly variation in manufacturing production when the BOS diffusion index was added to the regression. Similarly, Keeton and Verba (2004) regressed monthly changes in Tenth Federal Reserve District employment on lagged values of district employment growth and the Kansas City Fed's Manufacturing Survey employment index and found that explanatory power substantially increases after including the survey index in the regression. Cañas et al. (2024) also found that including a Texas Manufacturing Outlook Survey index in an employment growth regression with three lags of the dependent variable increased the model's explanatory power.

In order to explore the relationship between the TSSOS indexes and Texas employment, we follow Cañas et al. (2024) using the regression equation:

$$\Delta TXEMPL_t = \beta_0 + \beta_1 TSSOS_t + \sum_{j=1}^{k} \alpha_j \, \Delta TXEMPL_{t-j} + u_t \quad (1)$$

Where $\Delta TXEMPL_t$ is the log difference in Texas employment, and $TSSOS_t$ is the index variable in levels in period t. The lag length of k=3 was chosen following the Akaike Information Criterion (AIC). The expected sign of the $TSSOS_t$ coefficient is positive and β_1 should be seen as the change in the job growth rate that corresponds to a one-point increase in the value of the diffusion index. The year 2020 was excluded due to the initial disruption from the COVID-19 pandemic.

Regression results show that the three prior values of employment growth explain 29 percent of the change in monthly employment growth. Adding TSSOS variables to these lagged values of employment growth provides an additional 14 percentage points of explanatory power as evidenced by the adjusted R^2 values noted in Table 3. All coefficients are statistically significant and with the expected sign. The highest correlated TSSOS index was employment; the regression including the employment index explained 43 percent of the variation in monthly Texas employment change, and suggests that a one-point increase in the diffusion index is associated with a 0.02 percentage point increase in the monthly change of Texas employment.

Table 3 also shows the breakeven point, a value for the TSSOS index that is consistent with no change in Texas employment growth. The breakeven point is equal to the negative of the ratio of the estimated intercept and slope coefficient. For example, if in equation (1) $\Delta TXEMPL_t$ is zero— that is, no change in employment from the previous month—and β_0 is 5 and β_1 is 2, then the TSSOS breakeven point should be -2.5 to be consistent with no change in state employment.

Only values above the breakeven point suggest growth for the current month, and values below the breakeven point suggest a decline. Breakeven points for additional TSSOS indexes can be found in Appendix A1.

Table 3. Texas Employment Growth Regressions

TSSOS Index	Coefficient (t statistic)	Adjusted R^2	Breakeven Point
No index		0.287	
Labor market indicators			
Employment	0.018 (7.127)	0.431	-0.790
Future employment	0.011 (6.158)	0.400	11.696
Part-time employment	0.023 (5.798)	0.389	-3.759
Hours worked	0.020 (5.120)	0.368	-2.780
Output indexes			
Future revenue	0.008 (6.077)	0.397	25.601
Revenue	0.010 (5.775)	0.388	1.707
Other indexes			
General business activity	0.006 (6.024)	0.396	-12.012
Company outlook	0.008 (5.767)	0.388	-5.038
Selling prices	0.012 (5.334)	0.374	-3.449
Future selling prices	0.010 (5.175)	0.370	13.454

NOTES: Table displays the top 10 TSSOS indexes most highly correlated with Texas employment growth. The period is 2007:05 to 2024:12, excluding 2020 because of the initial disruption from the COVID-19 pandemic. Texas employment is in log difference. Regressions include three lags of employment growth. Full results are shown in Appendix A1. N=204.

Economic Activity

We also used regression analysis to ascertain whether TSSOS indexes have statistically significant explanatory power for quarterly state real GDP growth, and we find that they marginally do. The prior quarter's real GDP growth explains only 5 percent of the variation in real GDP growth in a given quarter. The addition of TSSOS indexes pushes the adjusted R^2 up a bit, to as high as 10 percent.

The model excludes 2020 and includes a one-quarter lag (k=1) to account for any variation explained by the previous quarter's real GDP growth and was as follows:

$$\Delta TXGDP_t = \beta_0 + \beta_1 TSSOS_t + \sum_{j=1}^{k} \alpha_j \, \Delta TXGDP_{t-j} + u_t \qquad (2)$$

$\Delta TXGDP_t$ is real GDP growth from period t-1 to t, and $TSSOS_t$ represents the level of a given TSSOS diffusion index in period t.

Table 4 shows the goodness of fit (adjusted R^2) based on regression results of one lagged value of GDP growth, absent the TSSOS indexes. Table 4 also shows the adjusted R^2 values after adding each TSSOS index one at a time to the baseline model. Future hours worked is the TSSOS index with the most explanatory power for Texas real GDP, followed by selling prices and future selling prices. According to the regression results, each one-point increase in the TSSOS future hours worked index implies a 0.06 percentage point increase in Texas real GDP growth. A table with additional TSSOS indicators can be found in Appendix A2.

Table 4. Texas Real GDP Regressions

TSSOS Index	Coefficient (t statistic)	Adjusted R^2	Breakeven Point
No index		0.054	
Labor market indexes			
Future hours worked	0.055 (2.121)	0.104	-5.994
Employment	0.030 (1.758)	0.085	-15.916
Hours worked	0.041 (1.732)	0.084	-12.919
Future employment	0.017 (1.565)	0.076	-15.495
Part-time employment	0.034 (1.388)	0.068	-17.336
Output indexes			
Future revenue	0.013 (1.375)	0.068	-10.667
Other indexes			
Selling prices	0.023 (1.980)	0.096	-21.429
Future selling prices	0.023 (1.968)	0.096	-4.263
General business activity	0.011 (1.500)	0.073	-57.335
Future wages and benefits	0.017 (1.324)	0.066	-0.378

NOTES: Table displays the 10 TSSOS indexes most highly correlated with Texas real GDP. The period is 2007:Q4 to 2024:Q3, excluding 2020 because of the initial disruption from the COVID-19 pandemic. Texas real GDP is in log difference. Regressions include one lag of real GDP growth. Full results are shown in Appendix A2. N=67.

Inflation

In addition to employment and GDP, we measured the power of TSSOS indexes in explaining monthly variation in regional inflation as measured by the Texas headline CPI, which is the

weighted sum of CPI for the Dallas-Fort Worth and Houston metropolitan areas.[13] While Texas CPI is volatile, TSSOS prices indexes are helpful in tracking general trends in inflation. We ran the following regression to study the relationship between TSSOS indexes and headline CPI growth:

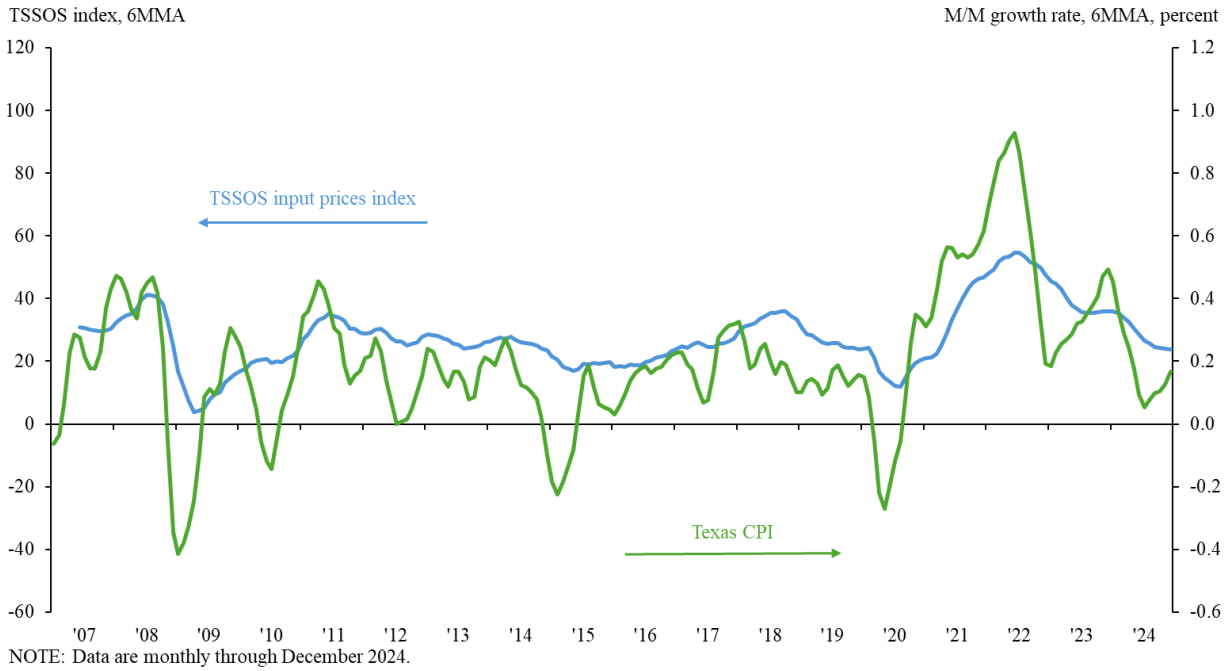
$$\Delta TXCPI_t = \beta_0 + \beta_1 TSSOS_t + \sum_{j=1}^{k} \alpha_j \, \Delta TXCPI_{t-j} + u_t \qquad (3)$$

Where $\Delta TXCPI_t$ is the log difference in Texas headline CPI, and $TSSOS_t$ is the index variable in in period t. This regression uses a lag length of k=2. β_1 represents the change in headline CPI growth that corresponds to a one-point increase in the value of the diffusion index.

The baseline model explains 61 percent of CPI variation, then TSSOS adds 6 percentage points to the explanatory power of the two prior CPI growth readings alone. The TSSOS input prices index was best at tracking inflation, followed by the selling prices and future selling prices indexes. Figure 4 plots the monthly change in Texas CPI against the TSSOS input prices index.

[13] Dallas Fed's Texas consumer price index can be found here: www.dallasfed.org/research/econdata/cpi/tx-cpi-pop.

Chart 2. TSSOS Selling Prices Index Highly Correlated with Texas CPI



NOTE: Data are monthly through December 2024.
SOURCES: Bureau of Labor Statistics; Federal Reserve Bank of Dallas; Federal Reserve Bank of Dallas' Texas Service Sector Outlook Survey.

Table 5 shows adjusted R^2 values based on regression results of two lagged values of headline CPI growth, with and without TSSOS indexes. The regression results indicate that a one-point increase in the TSSOS input prices index implies a 0.01 percentage point increase in Texas CPI growth. Full results are shown in Appendix A3.

Table 5. Texas CPI Regressions

TSSOS Index	Coefficient (t statistic)	Adjusted R^2	Breakeven Point
		0.6144	
Price indexes			
Input prices	0.010 (5.800)	0.669	14.840
Selling prices	0.008 (4.483)	0.648	-6.286
Future selling prices	0.006 (3.924)	0.641	9.128
Future input prices	0.008 (3.820)	0.639	31.810
Labor market indexes			
Future employment	0.005 (3.865)	0.640	5.947
Wages and benefits	0.008 (3.750)	0.638	3.494
Future wages and benefits	0.006 (3.445)	0.634	22.039
Hours worked	0.010 (3.345)	0.633	-6.112
Future hours worked	0.010 (3.150)	0.631	-2.858
Future part-time employment	0.007 (2.991)	0.629	-6.631

NOTES: Table displays the top 10 TSSOS indexes most highly correlated with Texas headline consumer price index growth. The period is 2007:04 to 2024:12, excluding 2020 because of the initial disruption from the COVID-19 pandemic. Texas headline CPI is in log difference. Regressions include two lags of Texas headline CPI growth. Full results are shown in Appendix A3. N=204.

5. TSSOS Indexes and Forecasting Regional Economic Indicators

In addition to analyzing the explanatory power for concurrent economic data, business survey indexes can also be evaluated based on their ability to forecast economic indicators. Schiller and Trebing (2003) find that the Philadelphia Fed's Business Outlook Survey is as accurate as national surveys in predicting the monthly change in the U.S. industrial production index for

manufacturing. Harris et al (2004) find that the Richmond Survey of Manufacturing Activity adds to the ability to forecast the PMI component of the ISM index, especially when combined with the Philadelphia Fed's survey results. Kerr et al. (2014) find that the Texas Manufacturing Outlook Survey (TMOS) general business activity index is the most accurate in forecasting industrial production growth and the second best in forecasting the ISM manufacturing index among the regional Fed manufacturing surveys. Cañas et al. (2024) find that several TMOS indexes improved accuracy in forecasting Texas employment growth.

In order to evaluate the contribution of TSSOS indexes in forecasting Texas economic indicators, we regressed the monthly change in Texas employment, GDP and headline CPI on TSSOS indexes with varying lags. We utilized the root mean squared forecast error (RMSFE), which is based on average squared difference between forecast and actual results, for accuracy comparisons. To make the forecast comparisons easier, the forecasting performance of the various indexes was benchmarked against the RMSFE of the base model with no TSSOS index. RMSFE values less than 1 suggest the survey index variable helps improve the accuracy of the forecasts; the lower the RMSFE, the more accurate the forecast.

Employment

Multiple TSSOS variables outperformed the baseline model in forecasting Texas employment growth (Table 6). The employment index performs best at improving forecast accuracy in comparison to the baseline model, followed by the future employment index. Out of 20 TSSOS indexes, 11 add significant forecasting value compared to the baseline model (full results shown in Appendix A4).

Table 6. Forecasting Changes in Texas Employment

TSSOS Index	RMSFE
Employment	0.851
Future employment	0.892
Selling prices	0.920
Future selling prices	0.934
Future revenue	0.936
Baseline model	1

NOTES: A lower relative root mean squared forecast error (RMSFE) indicates better forecasting performance. The baseline model has three lags of Texas employment growth and no TSSOS index. The sample period is May 2007 to December 2023, excluding 2020 because of the initial disruption from the COVID-19 pandemic; forecasts run from January 2024 to December 2024. Each entry represents a separate regression, and all include three lags of the dependent variable (Texas employment growth). The top five best performing TSSOS indexes with the lowest RMSFE are included. Full results are shown in Appendix A4.

Economic Activity

TSSOS indexes also improved forecast performance for Texas real GDP growth. The future wages and benefits index performs best, followed by the future employment index and revenue index (Table 7). In this case, out of 20 TSSOS indexes, five add forecasting value compared to the baseline model (full results shown in Appendix A5).

Table 7. Forecasting Changes in Texas Real Gross Domestic Product

TSSOS Index	RMSFE
Future wages and benefits	0.942
Future employment	0.976
Revenue	0.982
Input prices	0.984
Selling prices	0.987
Baseline model	1

NOTES: A lower relative root mean squared forecast error (RMSFE) indicates better forecasting performance. The baseline model has three lags of Texas GDP growth and no TSSOS index. The sample period is Q1 2007 to Q2 2023, excluding 2020 because of the initial disruption from the COVID-19 pandemic; forecasts run from Q3 2023 to Q3 2024. Each entry represents a separate regression, and all include three lags of the dependent variable (Texas GDP growth). The top five best performing TSSOS index with the lowest RMSFE are included. Full results are shown in Appendix A5.

Inflation

Current and future input prices indexes are best suited for forecasting Texas CPI changes, as they add the most to the forecast accuracy of the baseline model (Table 8). To forecast CPI, 16 of the 20 TSSOS indexes added forecasting value (full results shown in Appendix A6).

Table 8. Forecasting Changes in Texas CPI

TSSOS Index	RMSFE
Input prices	0.859
Future input prices	0.897
Future selling prices	0.909
Hours worked	0.914
Future capital expenditures	0.953
Baseline model	1

NOTES: A lower relative root mean squared forecast error (RMSFE) indicates better forecasting performance. The baseline model uses three lags of Texas CPI growth and no TSSOS index. The sample period is April 2007 to December 2023, excluding 2020 because of the initial disruption from the COVID-19 pandemic; forecasts run from January 2024 to December 2024. Each entry represents a separate regression, and all include three lags of the dependent variable (Texas CPI growth). The top five best performing TSSOS indexes with the lowest RMSFE are included. Full results are shown in Appendix A6.

6. Summary

The Texas Service Sector Outlook Survey—a monthly Dallas Fed survey of the state's service sector—tracks economic activity in Texas in a timely and comprehensive manner. TSSOS indexes help explain up to 43 percent of the variation in Texas employment growth, which is the most relied upon official measure of state economic conditions. TSSOS indexes are available three or more weeks in advance of Texas employment data, which makes the indexes particularly valuable for timely analysis of current economic conditions. They also help account for up to 67 percent of variation in the Texas headline consumer price index. TSSOS indexes are valuable indicators of the Texas business cycle, as they are available in real time and have effectively tracked Texas recessions.

Forecasting exercises show that the TSSOS employment and future employment indexes are useful in forecasting Texas employment growth. Several survey indexes help forecast movements in Texas GDP, and current and future input price indexes best boost forecast accuracy for Texas CPI growth.

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8. Appendix

Table A1. Texas Employment Regressions

TSSOS Index	Constant (t statistic)	Coefficient (t statistic)	Adjusted R^2	Breakeven Point*
Employment	0.014 (0.756)	0.018 (7.127)	0.431	-0.790
Future employment	-0.134 (-3.772)	0.011 (6.158)	0.400	11.696
Future revenue	-0.211 (-4.481)	0.008 (6.077)	0.397	25.601
General business activity	0.070 (3.67)	0.006 (6.024)	0.396	-12.012
Part-time employment	0.085 (4.318)	0.023 (5.798)	0.389	-3.759
Revenue	-0.016 (-0.735)	0.010 (5.775)	0.388	1.707
Company outlook	0.039 (2.037)	0.008 (5.767)	0.388	-5.038
Selling prices	0.041 (2.139)	0.012 (5.334)	0.374	-3.449
Future selling prices	-0.141 (-3.366)	0.010 (5.175)	0.370	13.454
Hours worked	0.055 (2.873)	0.020 (5.12)	0.368	-2.780
Future company outlook	-0.026 (-1.051)	0.006 (5.056)	0.366	4.419
Future hours worked	-0.017 (-0.719)	0.018 (5.017)	0.365	0.939
Future part-time employment	0.011 (0.539)	0.013 (4.975)	0.364	-0.853
Future general business activity	0.015 (0.701)	0.004 (4.666)	0.355	-3.515
Wages and benefits	-0.086 (-2.37)	0.013 (4.507)	0.351	6.814
Future capital expenditures	-0.108 (-2.56)	0.008 (4.281)	0.345	12.892
Future wages and benefits	-0.254 (-3.319)	0.010 (4.135)	0.341	26.546
Input prices	-0.102 (-2.405)	0.007 (4.079)	0.339	14.309
Capital expenditures	-0.013 (-0.473)	0.010 (3.654)	0.329	1.253
Future input prices	-0.252 (-2.652)	0.008 (3.268)	0.320	33.366

*The breakeven point is defined as the level of the diffusion index consistent with no change in the underlying official statistic according to the regression model. It is equivalent to the negative of the ratio of the estimated intercept and slope coefficient.
NOTE: Indexes are ordered by adjusted R^2. Regressions are based on the estimation period 2007:05 to 2024:12, excluding 2020, and include three lags of employment growth. Texas employment is in log difference.

Table A2. Texas Gross Domestic Product Regressions

TSSOS Index	Constant (t statistic)	Coefficient (t statistic)	Adjusted R^2	Breakeven Point*
Future hours worked	0.328 (1.711)	0.055 (2.121)	0.104	-5.994
Selling prices	0.488 (3.195)	0.023 (1.98)	0.096	-21.429
Future selling prices	0.096 (0.327)	0.023 (1.968)	0.096	-4.263
Employment	0.470 (2.906)	0.030 (1.758)	0.085	-15.916
Hours worked	0.532 (3.595)	0.041 (1.732)	0.084	-12.919
Future employment	0.263 (1.005)	0.017 (1.565)	0.076	-15.495
General business activity	0.612 (4.287)	0.011 (1.5)	0.073	-57.335
Part-time employment	0.591 (4.118)	0.034 (1.388)	0.068	-17.336
Future revenue	0.140 (0.382)	0.013 (1.375)	0.068	-10.667
Future wages and benefits	0.006 (0.013)	0.017 (1.324)	0.066	-0.378
Input prices	0.253 (0.832)	0.013 (1.312)	0.065	-19.056
Wages and benefits	0.348 (1.353)	0.018 (1.208)	0.061	-19.844
Future part-time employment	0.496 (2.905)	0.020 (1.186)	0.061	-24.804
Future general business activity	0.526 (3.294)	0.008 (1.148)	0.059	-66.400
Capital expenditures	0.442 (2.098)	0.018 (1.065)	0.056	-24.347
Revenue	0.481 (2.568)	0.013 (1.043)	0.056	-35.866
Future company outlook	0.484 (2.487)	0.009 (0.929)	0.052	-56.413
Future input prices	0.046 (0.072)	0.013 (0.893)	0.051	-3.652
Company outlook	0.586 (3.969)	0.007 (0.69)	0.047	-80.418
Future capital expenditures	0.553 (1.618)	0.002 (0.172)	0.040	-227.737

*The breakeven point is defined as the level of the diffusion index consistent with no change in the underlying official statistic according to the regression model. It is equivalent to the negative of the ratio of the estimated intercept and slope coefficient.
NOTE: Indexes are ordered by adjusted R^2. Regressions are based on the estimation period 2007:Q3 to 2023:Q4, excluding 2020, and include one lag of real GDP growth. Texas real GDP is in log difference.

Table A3. Texas Headline CPI Regressions

TSSOS Index	Constant (t statistic)	Coefficient (t statistic)	Adjusted R^2	Breakeven Point*
Input prices	-0.144 (-3.498)	0.010 (5.8)	0.669	14.840
Selling prices	0.048 (2.801)	0.008 (4.483)	0.648	-6.286
Future selling prices	-0.058 (-1.53)	0.006 (3.924)	0.641	9.128
Future employment	-0.032 (-0.994)	0.005 (3.865)	0.640	5.947
Future input prices	-0.252 (-2.877)	0.008 (3.82)	0.639	31.810
Wages and benefits	-0.027 (-0.834)	0.008 (3.75)	0.638	3.494
Future wages and benefits	-0.130 (-2.092)	0.006 (3.445)	0.634	22.039
Hours worked	0.060 (3.497)	0.010 (3.345)	0.633	-6.112
Future hours worked	0.029 (1.287)	0.010 (3.15)	0.631	-2.858
Future part-time employment	0.043 (2.182)	0.007 (2.991)	0.629	-6.631
Future revenue	-0.046 (-1.019)	0.004 (2.922)	0.629	13.077
Part-time employment	0.073 (4.375)	0.007 (2.502)	0.624	-9.741
Employment	0.053 (2.732)	0.005 (2.333)	0.623	-11.170
Capital expenditures	0.039 (1.577)	0.004 (2.018)	0.620	-8.795
Revenue	0.047 (2.116)	0.003 (2.018)	0.620	-15.650
Company outlook	0.069 (4.002)	0.002 (1.798)	0.619	-30.037
Future capital expenditures	0.014 (0.362)	0.003 (1.754)	0.618	-4.828
General business activity	0.076 (4.558)	0.001 (1.665)	0.618	-50.833
Future company outlook	0.053 (2.291)	0.002 (1.453)	0.617	-32.988
Future general business activity	0.065 (3.392)	0.001 (1.305)	0.616	-58.383

*The break-even point is defined as the level of the diffusion index consistent with no change in the underlying official statistic according to the regression model. It is equivalent to the negative of the ratio of the estimated intercept and slope coefficient.
NOTE: Indexes are ordered by adjusted R^2. Regressions are based on the estimation period 2007:04 to 2024:12, excluding 2020, and include two lags of Texas headline CPI growth. Texas headline CPI is in log difference.

Table A4. Texas Employment Forecasts

TSSOS index	RMSFE
Employment	0.851
Future employment	0.892
Selling prices	0.920
Future selling prices	0.934
Future revenue	0.936
Future wages and benefits	0.942
Wages and benefits	0.945
Future part-time employment	0.963
Future capital expenditures	0.968
Capital expenditures	0.990
Hours worked	0.995
Future input prices	1.002
Part-time employment	1.019
Input prices	1.024
Future hours worked	1.039
Revenue	1.063
Future company outlook	1.074
Future general business activity	1.110
General business activity	1.134
Company outlook	1.140

NOTES: Forecasts were based on regressions estimated from 2007:05 to 2023:12, excluding 2020, and a forecasting period of 2024:01 to 2024:12. Texas employment is in log difference.

Table A5. Texas Gross Domestic Product Forecasts

TSSOS index	RMSFE
Future wages and benefits	0.942
Future employment	0.976
Revenue	0.982
Input prices	0.984
Selling prices	0.987
Future input prices	1.000
Hours worked	1.008
Future hours worked	1.009
Wages and benefits	1.012
Future selling prices	1.023
Future capital expenditures	1.031
Capital expenditures	1.037
Company outlook	1.037
Employment	1.043
Future company outlook	1.048
Part-time employment	1.062
Future general business activity	1.076
Future part-time employment	1.079
Future revenue	1.080
General business activity	1.093

NOTES: Forecasts were based on regressions estimated from 2007:Q3 to 2023:Q2, excluding 2020, and a forecasting period of 2023:Q3 to 2024:Q3. Texas real GDP is in log difference.

Table A6. Texas Headline CPI Forecasts

TSSOS index	RMSFE
Input prices	0.859
Future input prices	0.897
Future selling prices	0.909
Hours worked	0.914
Future capital expenditures	0.953
Future employment	0.953
Capital expenditures	0.960
Selling prices	0.966
Wages and benefits	0.967
Employment	0.972
Revenue	0.973
Part-time employment	0.975
Future part-time employment	0.986
Company outlook	0.988
General business activity	0.990
Future wages and benefits	0.995
Future company outlook	1.006
Future revenue	1.009
Future general business activity	1.014
Future hours worked	1.635

NOTES: Forecasts were based on regressions estimated from 2007:05 to 2023:12, excluding 2020, and a forecasting period of 2024:01 to 2024:12. Texas headline CPI is in log difference.