

**Texas Service Sector Outlook Survey:
Survey Methodology and Performance**

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Texas Service Sector Outlook Survey: Survey Methodology and Performance

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Abstract

The Texas Service Sector Outlook Survey (TSSOS) and Texas Retail Outlook Survey (TROS) are monthly surveys of service sector and retail firms in Texas conducted by the Federal Reserve Bank of Dallas. TSSOS and TROS track the Texas private services sector, including general service businesses, retailers and wholesalers. The surveys provide invaluable information on regional economic conditions—information that Dallas Fed economists and the Bank president use in the formulation of monetary policy. This paper describes the survey’s methodology and analyzes the explanatory and predictive power of TSSOS and TROS indexes with regard to Texas employment growth. Regression analysis shows that several TSSOS and TROS indexes help explain monthly variation in Texas employment. In addition, most TSSOS and TROS indexes are also useful in forecasting Texas employment growth.

Keywords: Services, Surveys, Forecasting

JEL Classifications: B23, C83, C00, B23

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Overview

Businesses are drivers of a nation's economy, and data from businesses can be used to gauge economic conditions and to aid policy formulation and decision making, which aim to boost growth. Business surveys are one way to acquire such firm-level data. The Federal Reserve Bank of Dallas conducts several such surveys, including the Texas Service Sector Outlook Survey (TSSOS) and the Texas Retail Outlook Survey (TROS). Data collected include production, sales, new orders and prices and wages, as well as company outlooks.

Business surveys in the U.S. often focus on the manufacturing sector because manufacturing is cyclically sensitive, meaning activity is generally higher during economic expansions and lower during contractions as 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 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

¹ Manufacturing accounted for 8.5 percent of total U.S. nonfarm employment in 2016, down from 15.9 percent in 1990 and 20.5 percent in 1980.

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

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 and TROS, Federal Reserve banks' surveys provide a read on regional economic conditions before official statistics are available. TSSOS tracks the Texas private services sector and is comprised of a survey of general services businesses plus TROS.³ The TROS is a component of the TSSOS that uses information only from respondents in the retail and wholesale sectors.

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

In order for TSSOS and TROS to provide reliable measures of economic conditions, the information they provide must be correlated with the types of economic activity they are intended to measure. Cañas and Kerr (2011) show that a number of TSSOS and TROS indexes help explain variation in private sector services employment, retail sales and retail employment. This paper updates and extends that research, exploring how well TSSOS and TROS indexes

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 in 1993), and the Chicago Fed's Survey of Business Conditions (started publication in 2015; data available from 2013).

³ General services businesses include transportation, warehousing, utilities, information, financial activities, professional and business services, education and health services and leisure and hospitality.

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

correlate with changes in Texas employment and to what extent they forecast future employment.

Methodology

TSSOS and TROS, like other Dallas Fed regional surveys, were 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 revision. 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 Texas Workforce Commission are released with a five-week lag and can be significantly revised in later months. TSSOS and TROS are much timelier, they are available at the end of the reference month and are not subject to revision.⁵ They also include measures of activity, which are proxies for gross domestic output (GDP). State and local GDP data are even more lagged than official employment data.

Survey responses are used to calculate diffusion indexes for each indicator, similar to the well-known non-manufacturing Purchasing Managers' Indexes (PMI) from ISM,⁶ which reflect the change in the current month relative to the previous month. Respondents report how business conditions have changed, if at all, for a number of indicators specific to the service and retail industries, including revenue or retail sales, prices, inventories and employment.

⁵ The annual seasonal adjustment revision can slightly alter the historical series; see the section on seasonal adjustment for more information.

⁶ More information on the non-manufacturing PMI can be found on the ISM's website at <https://www.instituteforsupplymanagement.org/ismreport/nonmfgrob.cfm>.

Each index is calculated by subtracting the percentage of respondents reporting a decrease from the percentage reporting an increase. When the share of respondents 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 respondents reporting a decrease exceeds the share reporting an increase, the index will be below zero, suggesting the indicator has decreased over the prior month. An index will equal zero when the share of respondents reporting an increase is equal to the share reporting a decrease.

Survey design and implementation

The Dallas Fed began collecting TSSOS and TROS data in January 2007. The original sampling framework for general services was drawn from business database Reference USA, while the sampling framework for the retail and wholesale component grew out of the Dallas Fed's contacts with retailers in the Beige Book panel. Invitations to participate in the new surveys went out to 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 2014 and 2015. As of May 2018, over 350 general service firms and about 80 retailers and wholesalers receive the survey; 280 to 300 respond each month.

TSSOS and TROS are sent to respondents via email mid-month, and respondents have seven business days to submit their survey responses online. TSSOS and TROS both ask how business conditions have changed for a number of indicators such as revenue, employment, prices and company outlook. Respondents are also asked to report on how they perceive broader economic

conditions have changed. Questionnaires for TSSOS and TROS are slightly different—TROS includes additional questions on inventories and companywide activity, as well as internet sales. For all questions, respondents are asked whether the indicator has increased, decreased or remained unchanged compared with the prior month. They are also asked about expectations six months ahead.⁷ Responses are collected and assembled in diffusion indexes that are seasonally adjusted, as necessary, to better examine underlying trends. The Dallas Fed began releasing TSSOS and TROS results to the public in June 2011, after an initial four-year data collection period. Reports are published every month on the Dallas Fed website the day after the release of the TMOS report.⁸

Seasonal adjustment

The Dallas Fed reports TSSOS and TROS indexes on a seasonally adjusted basis. To statistically remove seasonal effects, the Dallas Fed uses the X12 seasonal-adjustment procedure developed by the U.S. Census Bureau. Indexes are regularly tested for seasonality and for indexes identified as seasonal; 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 prior to re-computing the index. In April each year, the Dallas Fed revises historical data for TSSOS and TROS by recalculating the seasonal adjustment factors to account for an additional year of data. The X12 seasonal-adjustment procedure requires a minimum of 36 months of data to seasonally adjust a time series, although 60 months is preferred for a high degree of confidence. TSSOS and TROS had 132 months of

⁷ See Appendix for sample survey forms for both TSSOS and TROS.

⁸ The TMOS report is released on the final Monday of each month.

data from January 2007 through December 2017 at the time of the last annual seasonal factors revision.

Survey respondents are explicitly asked to take seasonal variations into account in assessing their firm's performance each month. However, the X12 results indicated that 17 of 20 general services indexes and 20 of 26 retail indexes contained statistically significant seasonality.⁹

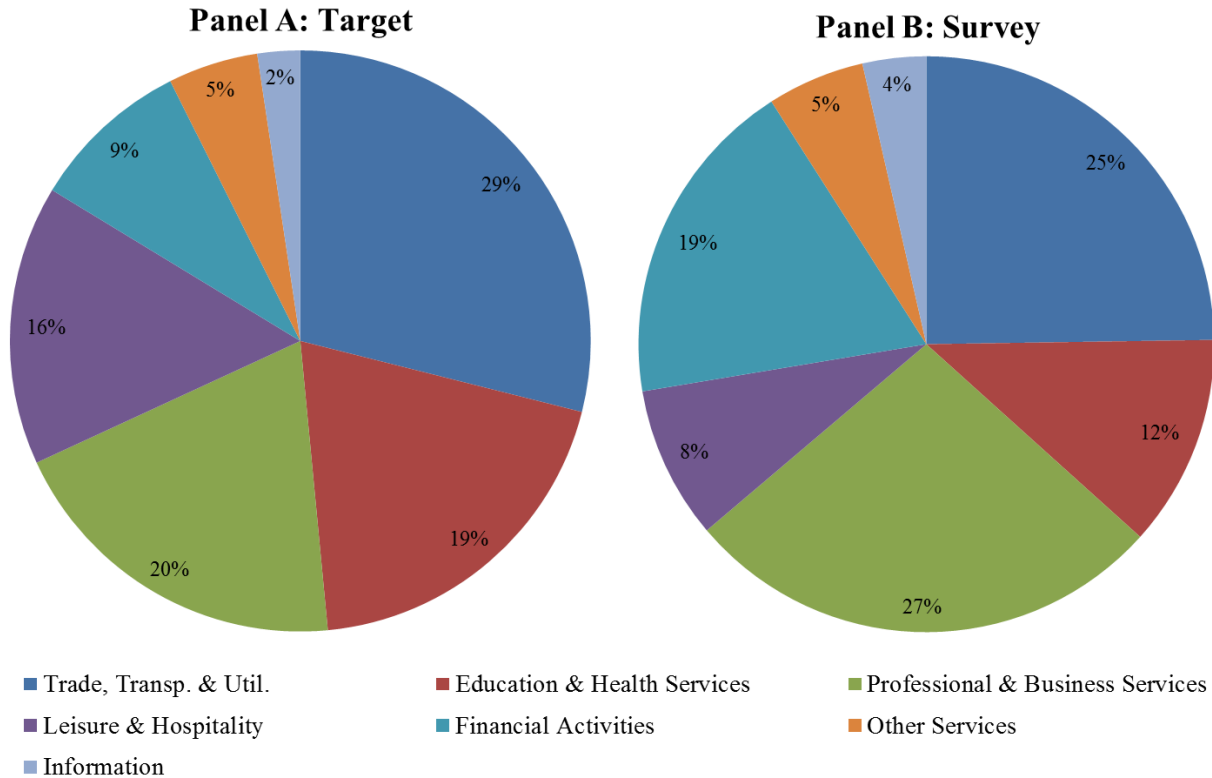
Sample representativeness

TSSOS and TROS were designed to fill a regional data gap. For the surveys to provide consistently reliable indicators of economic conditions in the Texas private services and retail sectors, they 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 target panels for TSSOS and TROS. A breakout of the industry composition is provided at the super-sector level in Figure 1.¹⁰ 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 both TSSOS and TROS panels through recruitment of companies in underrepresented industries.

⁹ A list of the seasonal indexes in TSSOS (for both general services and the retail component) is found on the Dallas Fed website at <https://www.dallasfed.org/research/surveys/tssos/seasonal.aspx>.

¹⁰ There are 55 three-digit NAICS codes represented in the TSSOS panel, so the super sector combinations are presented for brevity.

Figure 1. Desired and Actual Industry Distribution of TSSOS Sample



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

Panel maintenance

Survey participation is voluntary and firms may elect to discontinue involvement over time for a number of reasons including mergers, changing 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 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.¹¹

In order to retain a robust survey panel and ensure representativeness, ongoing recruitment efforts are required in addition to retaining current participants. At the beginning of each year, Dallas Fed economists analyze the representativeness of the existing TSSOS and TROS panels. 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.

Contribution

TSSOS contributes to the existing collection of regional business surveys focusing on the private service-producing sector, while TROS stands out for its focus on consumer spending by tracking the retail and wholesale sectors. The Richmond Fed is the only other Federal Reserve Bank survey to provide a specific breakout for retailers. 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 seven years. Table 1 compares Texas' GDP share and growth with that in the other Federal Reserve Districts undertaking service sector

¹¹ 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.

surveys. Texas accounts for 7.8 percent of total U.S. services output, similar to the Richmond District's, and Texas service sector GDP grew nearly 30 percent from 2010–17, faster than the U.S. overall, which expanded 17.5 percent. The New York District accounts for the largest share of services output, 12.8 percent, but service sector output in that region grew just 11.7 percent over the past seven years, slower than the national average.

Table 1. Private Service Sector GDP in Texas, Federal Reserve Districts

Region	Services GDP, 2017 (Million \$)	Share of U.S. Services GDP, 2017 (percent)	Services GDP Growth 2010-2017 (percent)
Texas	1,042,627	7.8	28.6
Second District ¹	1,710,830	12.8	11.7
Third District ²	1,047,486	7.8	11.1
Fifth District ³	1,213,782	9.1	13.5
U.S.	13,352,130	100	17.5

¹Second District numbers include NY and NJ, a proxy for the New York Fed's survey which comprises NY, northern NJ and Fairfield County, CT.

²Third 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.

³Fifth 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.

Collection period

TSSOS and TROS are 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 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 about half of Federal Open Market Committee meetings, TSSOS is the most recent Fed service sector survey data available.

Measures of service sector activity

TSSOS and TROS include measures of state service and retail 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 and retail sector employment is available from BLS, this data is subject to substantial revision in the months after its initial release, whereas the TSSOS and TROS employment indexes are not. This is also the case with retail sales data from other sources as compared with TROS sales data.

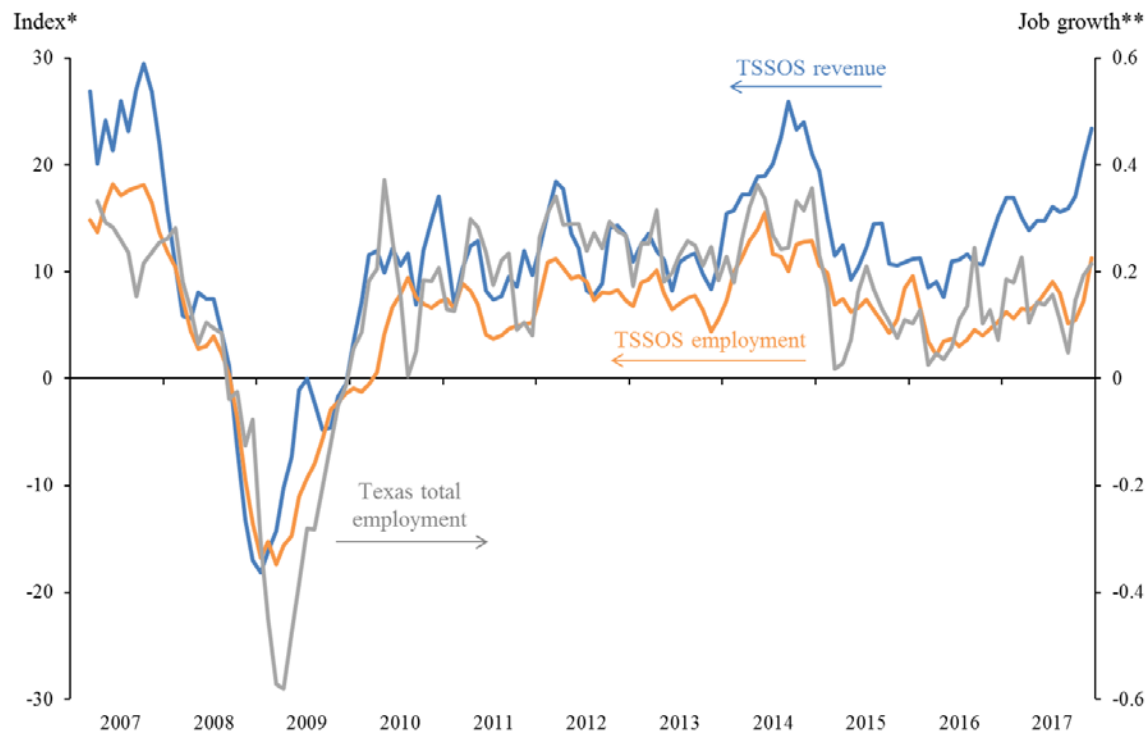
Panel sample characteristics

TSSOS (including its retail and wholesale component, TROS) receives a robust number of responses every month—more than 280—and publishes the number of respondents each month with the report release. This is a greater number of responses than other similar Fed service sector surveys. Not only is it important to have a robust number of responses, but the panel also needs to be aligned with the sector it is trying to measure. The industry distribution of the TSSOS panel is fairly closely aligned with Texas private service sector employment distribution.

Correlation with Regional Indicators

Monthly surveys of regional service activity can provide an early look of current economic conditions before official statistics become available. Figure 2 plots the monthly change in Texas employment against TSSOS revenue and employment indexes.

Figure 2. TSSOS Revenue and Employment Indexes Track Monthly Changes in Texas Employment



*3-month moving average, seasonally adjusted.

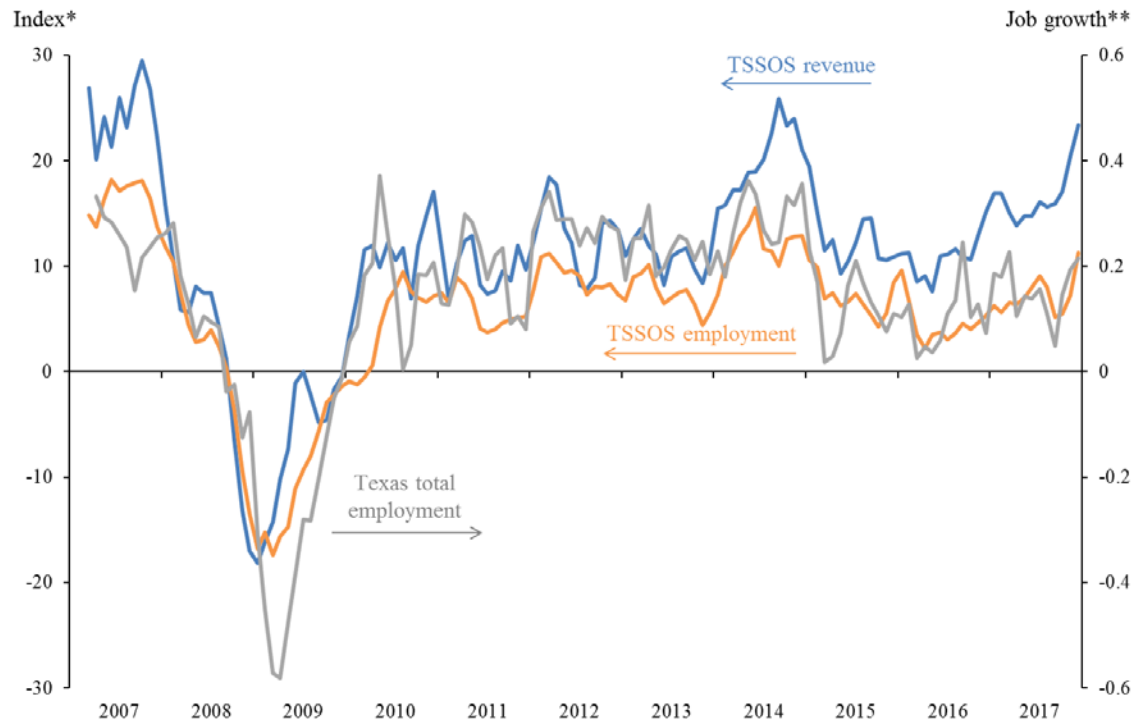
**3-month moving average, month-over-month percent change, seasonally adjusted.

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

The TSSOS diffusion indexes are centered at zero, meaning that values greater than zero are consistent with a rising indicator (in this case revenue or employment). In general, TSSOS indexes do a good job tracking changes in Texas employment growth over the business cycle. Both TSSOS employment and revenue tracked changes in employment during the Great Recession.

TROS sales and employment indexes also exhibit movements similar to monthly changes in Texas employment (**Figure 3**). While the TROS sales and employment indexes are more volatile than the TSSOS revenue and employment indexes, they also tend to be more leading than coincident with regard to employment data. Both TROS indexes turned down before employment in the months leading up to the Great Recession.

Figure 3. TROS Sales and Employment Indexes Track Monthly Changes in Texas Employment



*3-month moving average, seasonally adjusted.

**3-month moving average, month-over-month percent change, seasonally adjusted.

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

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 and Kerr (2014) show that several Texas Manufacturing Outlook Survey indexes successfully explain monthly changes in Texas employment and quarterly changes in state GDP. In order to explore the relationship between the TSSOS indexes and Texas employment, we follow Cañas and Kerr (2014) using the regression equation:

$$\Delta TXEMP_t = \beta_0 + \beta_1 TSSOS_t + u \quad (1)$$

Where ΔTXEMP is the log difference in Texas employment and TSSOS is the index variable in levels. The expected sign of the TSSOS 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. Regression results show that TSSOS indexes successfully explain monthly changes in Texas employment (**Table 2**).

The TSSOS indexes explain between 30 percent and 52 percent of month-to-month variation in Texas employment, as evidenced by the adjusted R^2 values noted in Table 2. All coefficients are statistically significant at the 99 percent level and with the expected sign. According to the regression results, each one-point increase in the TSSOS employment index, for instance, implies a 0.02 percentage point increase in Texas employment growth. As expected, the TSSOS employment index shows the best fit, followed by part-time employment, and revenue.

Table 2 also shows the breakeven point, a value for the TSSOS index that is consistent with no change in the regional indicator (dependent variable). The breakeven point is the negative ratio of the estimated intercept and slope coefficient. Only values above the breakeven point suggest growth for the current month, and only values below the breakeven point suggest a decline.

Breakeven points are subject to uncertainty given that they depend on the coefficients on the intercept and the independent variable in the employment regressions. TSSOS breakeven points range from -13.8 for the general business activity index to 14.6 for the input prices index. The breakeven points for the employment and revenue indexes are the smallest in magnitude, at -1.1 and 1.1, closely matching the zero-center of the indexes.

Table 2. Regression of Texas Employment on TSSOS Indexes

Dependent Variable: Log Change in Texas Employment				
TSSOS Index	Constant (t statistic)	Coefficient (t statistic)	Adjusted R²	Breakeven Point*
Revenue	-0.02 (-0.75)	0.01 (9.88)	0.45	1.1
Employment	0.02 (1.32)	0.02 (11.49)	0.52	-1.1
Part-time Employment	0.11 (7.16)	0.03 (11.09)	0.51	-3.7
Hours Worked	0.09 (5.14)	0.03 (8.91)	0.40	-2.9
Wages and Benefits	-0.17 (-4.27)	0.02 (8.67)	0.38	7.0
Input Prices	-0.21 (-4.03)	0.01 (7.2)	0.30	14.6
Selling Prices	-0.21 (3.95)	0.02 (9.95)	0.46	-3.3
Capital Expenditures	-0.02 (-0.81)	0.02 (8.08)	0.35	1.3
<u>General Business Conditions</u>				
Company Outlook	0.08 (4.62)	0.01 (8.23)	0.36	-6.8
General Business Activity	0.13 (7.82)	0.01 (8.99)	0.40	-13.8

*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: Regressions are based on the estimation period 2007:01 to 2016:12. Texas employment was in log difference.

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 12 lagged values of the change in the manufacturing production index plus the Philadelphia Fed's Business Outlook Survey (BOS) current 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 and Kerr (2014) 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.

Following the steps of previous studies, we regressed monthly changes in Texas employment on its lagged values and TSSOS indexes to test whether the TSSOS indexes provide any information about current employment growth beyond that contained in past values of employment growth. The specification used was as follows:

$$\Delta TXEMPL_t = \beta_0 + \beta_1 TSSOS_t + \sum_{j=1}^k \alpha_j \Delta TXEMPL_{t-j} + u_t \quad (2)$$

The lag length of $k=3$ was chosen following the Akaike Information Criterion (AIC). Table 3 shows the goodness of fit (adjusted R^2) based on regression results of three lagged values of employment growth—the predictive powers of past performance—absent the TSSOS indexes. In addition, Table 3 also shows the adjusted R^2 after adding the TSSOS index to the original specification. When survey indexes are added to the model, the adjusted R^2 rises in all cases, signifying that the TSSOS indexes provide additional explanatory power for Texas employment growth beyond that contained in its past values. The increase in R^2 was 8 basis points on

average. The TSSOS general business activity index performs best after accounting for lagged values of employment growth. Company outlook and employment followed.

Table 3. Regression of Texas Employment on TSSOS Indexes and Lags of the Dependent Variable
Dependent Variable: Log Change in Texas Employment

TSSOS Index (2007:01 to 2016:12)	Coefficient (t statistic)	Adjusted R²
None*		0.44
Revenue	0.01 (5.1)	0.54
Employment	0.02 (5.6)	0.55
Part-Time Employment	0.02 (5.1)	0.54
Hours Worked	0.02 (3.4)	0.48
Wages and Benefits	0.01 (2.8)	0.47
Input Prices	0.01 (3.2)	0.48
Selling Prices	0.01 (3.8)	0.50
Capital Expenditures	0.01 (2.8)	0.47
<u>General Business Conditions</u>		
Company Outlook	0.01 (5.4)	0.55
General Business Activity	0.01 (5.7)	0.56

*Specification includes only three lags of the dependent variable.

NOTE: Regressions are based on the estimation period 2007:01 to 2016:12. Texas employment was in log difference.

In order to explore the relationship between TROS indexes and Texas employment we used the same approach, but substituted TROS indexes for TSSOS as follows:

$$\Delta TXEMP_t = \beta_0 + \beta_1 TROS_t + u \quad (3)$$

Where $\Delta TXEMP$ is the log difference in Texas employment and TROS is the index variable in levels. As in the case of TSSOS, TROS indexes successfully explain monthly changes in Texas employment (**Table 4**).

Table 4. Regression of Texas Employment on TROS Indexes

Dependent Variable: Log Change in Texas Employment				
TROS Index	Constant (t statistic)	Coefficient (t statistic)	Adjusted R²	Breakeven Point*
Sales	0.09 (5.37)	0.01 (9.12)	0.41	-10.4
Employment	0.11 (8.25)	0.01 (12.66)	0.57	-8.1
Part-time Employment	0.18 (11.49)	0.01 (9.76)	0.44	-12.3
Hours Worked	0.17 (11.60)	0.02 (10.72)	0.49	-10.7
Wages and Benefits	0.03 (1.44)	0.01 (8.89)	0.40	-2.1
Input Prices	-0.01 (-0.52)	0.01 (7.36)	0.31	1.6
Selling Prices	0.05 (2.68)	0.01 (9.19)	0.41	-4.7
<u>General Business Conditions</u>				
Company Outlook	0.10 (6.11)	0.01 (7.93)	0.34	-14.0
General Business Activity	0.15 (8.92)	0.01 (8.18)	0.36	-21.9

*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: Regressions are based on the estimation period 2007:01 to 2016:12. Texas employment was in log difference.

TROS indexes explain 31 percent to 57 percent of month-to-month variation in Texas employment, as evidenced by the adjusted R^2 values noted in Table 4. All TROS coefficients are statistically significant at the 99 percent level and have the expected sign. The TROS employment index shows the best fit, followed by hours worked and part-time employment. The breakeven points for input prices and wages and benefits had the smallest magnitude.

In order to test whether TROS indexes provide any information about current employment growth beyond that contained in employment growth's lagged values, we use the following specification:

$$\Delta TXEMPL_t = \beta_0 + \beta_1 TROS_t + \sum_{j=1}^k \alpha_j \Delta TXEMPL_{t-j} + u_t \quad (4)$$

Table 5 shows the goodness of fit (adjusted R^2) based on regressing Texas employment growth on three lags of employment growth with and without TROS indexes. The adjusted R^2 rises in all cases once the TROS index is added, indicating that the TROS indexes provide additional explanatory power for Texas employment. The TROS employment index performs best after accounting for lagged values of employment growth. The sales and hours worked indexes follow.

Table 5. Regression of Texas Employment on TROS Indexes and Lags of the Dependent Variable
Dependent Variable: Log Change in Texas Employment

TROS Index (2007:01 to 2016:12)	Coefficients (t statistic)	Adjusted R²
None*		0.44
Sales	0.01 (5.47)	0.55
Employment	0.01 (6.61)	0.59
Part-Time Employment	0.01 (4.96)	0.53
Hours Worked	0.01 (5.15)	0.54
Wages and Benefits	0.01 (2.98)	0.47
Input Prices	0.004 (3.75)	0.49
Selling Prices	0.01 (4.2)	0.51
<u>General Business Conditions</u>		
Company Outlook	0.004 (5.0)	0.52
General Business Activity	0.004 (5.4)	0.53

*Specification includes only three lags of the dependent variable.

NOTE: Regressions are based on the estimation period 2007:01 to 2016:12. Texas employment was in log difference.

Using TSSOS and TROS Indexes to Forecast Texas Employment Growth

In addition to regression analysis, business survey indexes can 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 and Kerr (2014) find that the TMOS general business activity index is the variable that contributed most to improved accuracy in forecasting Texas employment growth.

In order to evaluate the contribution of the survey indexes in forecasting Texas job growth, we regressed the monthly change in Texas employment on TSSOS and TROS indexes and three lags of Texas employment growth. The forecast evaluation period ran from July 2013 to December 2016. Each month during this period, individual TSSOS and TROS indexes were used to forecast employment growth for that same month. 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 a model with only lags of Texas employment growth. Relative RMSFEs using TSSOS indexes are presented in Table 6, while those using TROS indexes are presented in Table 7. 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.

Table 6. Forecasting Texas Employment Growth Using TSSOS

TSSOS Index	RMSFE
Part-time Employment	0.86
Employment	0.87
Hours Worked	0.94
Selling Prices	0.96
General Business Activity	0.97
Company Outlook	0.97
Capital Expenditure	0.97
Revenue	0.98
Baseline Model	1.00
Input Prices	1.02
Wages and Benefits	1.05

NOTES: A lower relative root mean squared forecast error (RMSFE) indicates better forecasting performance. The baseline model is one lag of Texas employment growth and no TSSOS index. The sample period is January 2007 to December 2016; forecasts run from July 2013 to December 2016. Each entry represents a separate regression and all include three lags of the dependent variable (Texas employment growth). In a more comprehensive forecast analysis where all 81 Texas Business Outlook Surveys indicators were included, TSSOS employment and the TMOS six months ahead hours worked index were the top performers when forecasting Texas employment. Results of this comprehensive analysis are provided upon request.

Table 7. Forecasting Texas Employment Growth Using TROS

TROS Index	RMSFE
Employment	0.85
Hours Worked	0.86
Revenue	0.90
Company Outlook	0.91
Part-time Employment	0.94
General Business Activity	0.94
Inventories	0.95
Wages and Benefits	0.96
Baseline Model	1.00
Selling Prices	1.01
Input Prices	1.06

NOTES: A lower relative root mean squared forecast error (RMSFE) indicates better forecasting performance. The baseline model is one lag of Texas employment growth and no TROS index. The sample period is January 2007 to December 2016; forecasts run from July 2013 to December 2016. Each entry represents a separate regression and all include three lags of the dependent variable (Texas employment growth). In a more comprehensive forecast analysis where all 81 Texas Business Outlook Surveys indicators were included, TSSOS employment and the TMOS six months ahead hours worked index were the top performers when forecasting Texas employment. Results of this comprehensive analysis are provided upon request.

All but two of the TSSOS variables used in the forecast exercise outperformed the baseline model. The part-time employment and employment indexes contributed the most to improve the accuracy of the forecast. Similar to TSSOS index results, when using TROS variables to forecast Texas employment growth, all but two outperformed the baseline model. The employment and hours worked indexes were the best performers.

Summary

The Texas Service Sector Outlook Survey and the Texas Retail Sector Outlook Survey—both monthly Dallas Fed surveys of the state’s service sector—track economic activity in a timely and comprehensive manner. TSSOS and TROS business activity and labor market indexes explain more than half of the variation in Texas employment growth, which is the best official measure of state economic conditions. TSSOS and TROS indexes are available three or more weeks in advance of Texas employment data, which makes the indexes particularly valuable for a timely

analysis of current economic conditions. In addition, TSSOS and TROS indexes are valuable indicators of the Texas business cycle, as they tracked the latest Texas recession very well and were available in real time. Forecasting exercises show that most TSSOS and TROS indexes are useful in forecasting changes in Texas employment.

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Appendix 1.a

Electronic survey form sent to general services survey panelists every month



Texas Service Sector Outlook Survey

Federal Reserve Bank of Dallas

CONFIDENTIAL: Individual responses are kept confidential except for survey comments which may be anonymously published with prior consent of the respondent.

Please complete this survey by marking the circles that best describe your business's activity.

Business Indicators Relating to Your Company's Facilities and Products in Texas:	June vs. May <small>Other than the normal seasonal change</small>			Six months from now <small>Other than the normal seasonal change</small>		
	Increase	No Change	Decrease	Increase	No Change	Decrease
Revenue	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Number of employees	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Number of part-time employees	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Average employee workweek	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Wages and benefits	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Cost for you to provide your services (input prices)	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Selling prices	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Capital expenditures	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
General Business Conditions:						
	Improved	Remained the Same	Worsened	Improved	Remained the Same	Worsened
How has the outlook for your company changed?	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
What is your evaluation of the level of general business activity?	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>

Please feel free to comment on any issues that may be affecting your business. Your comments may be published anonymously and edited to conform to length and style requirements.

Check this box if you prefer we not publish your comments.

Appendix 1.b

Electronic survey form sent to retail and wholesale survey panelists every month



Federal Reserve Bank of Dallas

CONFIDENTIAL: Individual responses are kept confidential except for survey comments which may be anonymously published with prior consent of the respondent.

Please complete this survey by marking the circles that best describe your business's activity.

	June vs. May <small>Other than the normal seasonal change</small>			Six months from now <small>Other than the normal seasonal change</small>		
	Increase	No Change	Decrease	Increase	No Change	Decrease
Business Indicators Relating to Your Facilities and Products						
Retail Activity in Texas:						
Net sales (revenue)	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Number of employees	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Number of part-time employees	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Average employee workweek	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Wages and benefits	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Input prices	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Selling prices	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Capital expenditures	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Inventories	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Companywide Retail Activity:						
Net sales (revenue)	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Internet net sales (revenue)	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
General Business Conditions:						
	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
	Improved	Remained the Same	Worsened	Improved	Remained the Same	Worsened
How has the outlook for your company changed?	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
What is your evaluation of the level of general business activity?	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>

Please feel free to comment on any issues that may be affecting your business. Your comments may be published anonymously and edited to conform to length and style requirements.

Check this box if you prefer we not publish your comments.