Lane Transit District Revenue Forecast and Recession Scenario Analysis

By:
Sarah Lindley and Ryan Hendry

Presented to the Department of Economics, University of Oregon
in partial fulfillment of requirements for honors in Economics

Under the supervision of
Professor Timothy A. Duy

and assistance of
Professor William Harbaugh

June 2017

Abstract

The purpose of our research is to predict a forecast of payroll tax revenues for Lane Transit District. Payroll tax constitutes seventy-five percent of LTD's revenue, which we predicted to be closely related to Lane County wages and salaries data from the Bureau of Labor Statistics. This is because payroll tax revenue is collected as a percentage of income paid from employers to employees, so the total amount of tax revenue generated in a given year is directly dependent on the wages and salaries of each individual. Using data from LTD and Bureau of Labor Statistics data on wages and salaries to create a ten-year forecast for LTD's tax revenue. Our original forecast assumes sustained annual economic growth for LTD. To study recession effects, we added the probability of an economic recession within the next few years in terms of a mild, moderate, and severe recession. Thus, we created a forecast that is capable of predicting payroll tax revenues for LTD for ten years that also accounts for the possibility of a recession.

Approved by:_____
Professor Timothy A. Duy Date

Approved by:_____
Professor William Harbaugh Date

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Introduction

One important assumption we make is Oregon's economy tends to follow the national economy in terms of growth indicators and overall growth trends (Pierce, 2010). In many cases, Oregon's growth outpaces national growth when growth is steady. On the other hand, we see that Oregon also tends to suffer more in recession periods when compared to other states and the nation. Based on this relationship, we posit that Oregon consistently follows national trends and business cycles. Further, we posit that Lane County will also follow the same trends as Oregon. This assumption will be addressed and justified in the Methodology section.

Lane County of Oregon uses Lane Transit District, or LTD, as the sole provider of public transportation. While some states have public transportation system that are funded by less economically volatile inputs such as sales tax or consumption tax, LTD is funded through payroll tax. LTD has many revenue sources including passenger fares, payroll tax revenue, and state-in-lieu tax revenue. Payroll tax revenue makes up approximately seventy-five percent of total revenue, while only twenty percent comes from passenger fares. Payroll tax is a tax paid by business or employees and is impacted by factors such as employment and wage growth, which therefore makes payroll tax very sensitive to the same fluctuations of the natural business cycles in the United States. With this information, we assume that changes in wages and salaries in Lane County can be used as an indicator for changes in payroll tax revenue for LTD. Note, however, the tax jurisdiction of LTD is a subset of Lane County (see Figure 20). Unfortunately, we lack a measure of wages and salaries specifically to LTD's tax base. Hence, our measure of payroll encompasses more than the tax jurisdiction of LTD. As long as the two move together systematically, the wages and salaries data can predict the tax base.

Forecasting is the process of using previous trends of variables and their interactions to predict future trends. Economic forecasting is used in many ways for businesses and governments. While businesses forecast trends of an industry, trends of a target market, and sales data, the government can use forecasting to predict future trends of the economy, employment, and income. Forecasting can allow businesses to hold a competitive advantage in an industry and allow government entities to make informed decisions about public policy and budgeting. The specific case studied in this paper is the government funded entity, Lane Transit District. LTD can use our forecast for budgeting analysis to construct expectations of their future revenues to plan expenditures and allowances, create properly funded accounts for general maintenance and upkeep of service vehicles, and to properly budget for a savings reserve for recessionary periods.

Literature Review

The general topic of forecasting and previous research with regards to Lane Transit District has been explored in depth by former University of Oregon students within the last fifteen years. The literature review focuses primarily on the way in which Lane Transit District derives most of its revenue sources (i.e. payroll tax), further explanation of the relationship between Lane County and Oregon trends, and previous forecasts for LTD's revenue.

OEA Methodology

The paper, "The Oregon Economic Model Annual Review of Methodology" (2010) produced by the Oregon Office of Economic Analysis (OEA), explains the economic model that the OEA uses to produce the annual forecast of the Oregon Economy. OEA uses a "regression

forecast model," meaning that because many industries in Oregon are largely dependent upon national conditions, the model uses data from the current and future state of the national economy as well as the current conditions of the Oregon economy to produce a forecast for the Oregon economy. OEA currently uses the national forecast produced annually by IHS Global Insights in the Oregon economic model. OEA uses 38 separate forecasts of relevant Oregon economic variables and IHS's forecast to produce forecasts for Oregon income, employment, and other Oregon economic indicators.

The forecasting technique used by the OEA and the actual forecast OEA produced for Oregon income were used to construct our forecast for Lane Transit District tax revenues. We use a similar technique with respect to OEA's forecast for Oregon income by using it to produce the forecast equation for Lane County salaries and wages.

TriMet Forecast 2016 (Duy)

Duy (2016) created a forecast for the public transportation service in Portland, Trimet. To begin, he analyzed the national economic trends for the United States and compared it to Oregon's statewide trends. Upon finding that Oregon more often outpaced the national growth and related indicators, Duy posited that because Portland accounts for a large population and the biggest economic hub in Oregon, the Portland metropolitan statistical area would follow closely to that of Oregon, which again was accurate. By doing this, he forecasted the revenue for TriMet for five years into the future. We replicated this model because, like LTD's model, TriMet is funded through payroll and state-in-lieu taxes. Therefore we adapted similar assumptions regarding the relationship between county, state, and national incomes.

Ups and Downs: An Analysis of Oregon's Relationship with the National Economy (Michael Pierce), 2010

This paper by Pierce (2010) discusses the way that Oregon's economy relates to the national economy. Pierce finds that while Oregon tends to be in the middle of the fifty states in terms of output, poverty, and education, it tends to grow in the same way that the nation and the other states do. However, he notes that "Oregon is shown to be the 3rd most sensitive state to a shock to fuel prices." (Pierce, p. ii) By simple comparisons, he shows that Oregon has more severe reactions to monetary policy shocks than most states and uses that to explain why Oregon tends to suffer deeper and longer recessions than others. We use the basis that Oregon tracks national growth trends as the basis for our beginning assumptions and use Pierce's information regarding Oregon recessions as a further topic in our research.

Business Cycle Phases in US States (Owyang, Piger, Hall), 2003:

This paper explains the way that certain states and regions follow national trends. There is a trend that states on the east and west coast of the United States are more in sync with national periods of recession and expansion, whereas the middle states are less so. By estimating concordance with national trends, they calculated the percentage of times that each state was following the current national recession or expansion. They found "eleven states were in sync with the national cycle more than 90 percent of the time," (Owyang, Piger and Hall, p. 19), one

of the eleven states being Oregon. Therefore, this paper serves as a reasonable qualification of our leading assumption that Oregon follows the national economy closely.

Lane Transit District Payroll Tax Revenue Analysis (Morris, Walter, Wessinger), 2007:

Morris, Walter, and Wessinger (2007) sought to explain the relationship by which Lane County payroll taxes fund LTD's revenues. While total revenues are a cumulation of passenger fares, federal assistance, payroll taxes, and state-in-lieu taxes, around seventy percent of all revenues are from only payroll and state-in-lieu taxes. This tax revenue data then is dependent on the wages and salaries of the constituents in the tax jurisdiction, Lane County. Thereby, payroll tax revenues are subject to the same fluctuations in short-term growth trends related to wages and salaries. Hence, we used this research for our next assumption that we could use available data from the Bureau of Labor Statistics to forecast for LTD payroll and state-in-lieu tax revenue.

Forecasting Revenues for Lane Transit District: An Econometric Analysis of Lane County Payrolls (Jossis, Penacho), 2010

Using a similar idea to that of Jossis and Penacho (2010), we wanted to further our research question by adding the probability of a recession into our long-term forecast. By doing this, we could account more accurately for future effects of the economy, as any sort of recession leaves the growth economy either constant or decreasing. By using their assumptions with regard to Oregon systematically moving together with the national economy, therefore it is sufficient to

use Lane County wages and salaries to predict LTD's tax base, we created a forecast that will benefit LTD in the short-run and also allow them to update the model as new information comes available or account for a recession at a time increment than proposed.

Why and How to Fund Public Transportation (Arizona PIRG Education Fund), 2009

"Why and How to Fund Public Transportation" by the Arizona PIRG Education Fund analyzes the efficiency and desirability of a sales tax to fund public transportation. This paper finds that fifteen out of twenty-five of the largest transportation services in the US are funded through a sales tax and are the second biggest contributor to revenue for transportation services. A sales tax is an indirect consumption tax and therefore shifts very little within an economic downturn. While sales taxes are typically more politically popular because residents view them to be fairly collected, a sales tax is not able to keep up with the growth of the economy because sales taxes are only collected on purchases of goods but not services, which is a growing sector in the economy. Typically, an indirect consumption tax is seen as more efficient than an income tax and more favorable to the public, but a sales tax is not as efficient of a funding source for public transportation as would be a direct consumption tax.

Data Analysis

Data Sources

The data collected for this research projects comes from three different sources; the Oregon Office of Economic Analysis (referred to as, OEA), the Bureau of Labor Statistics

(referred to as, BLS), and Lane Transit District (referred to as, LTD). All the data collected were originally in terms of dollars. For the comparison aspects of this research paper, the data was converted to annual percentage change using this equation:

$$Percentage\ Change_t = \frac{(\ Variable\ X_t - \ Variable\ X_{t-1}\ )}{Variable\ X_t}$$

The data collected from the OEA is the Oregon income data from 1990 forecasted out to 2026. This dataset is a component of the OEA's economic and revenues forecast for the state of Oregon. The data contains the nominal values of Oregon income from 1990 to 2016, and forecasted values for Oregon income from the years 2017 to 2026 (see Figure 1). Using the equation stated above, this data set was converted to annual percentage change from 1991 to 2026 (see Figure 5).

The second data collected was from the BLS, and it is data on Lane County, Oregon salaries and wages from 1990 to 2016. The BLS is a government agency responsible for gathering statistics on labor markets. The salaries and wages data collected contains information on payrolls paid out by business operating in Lane County. The data set contains nominal values of Lane County salaries and wages from 1990 to 2016 (see Figure 2). Using the equation stated above, this data set was converted to annual percentage change from 1991 to 2016 (see Figure 6).

The third data was collected directly from LTD. This dataset contained the historical revenues LTD earned/received from tax's. The data relevant to this research project was the payroll & self-employment and state in lieu tax revenues (see Figure 3), as well as the applied tax rate for LTD (see Figure 4 'tax rate'). The values of the payroll & self-employment and state in lieu tax revenues are defined as LTD tax revenues for the purpose of simplicity. A drawback

faced in this research project of constructing a forecast for LTD tax revenues is that the LTD tax rate used in constructing the variable, LTD tax base (see Methodology section for explanation of tax base variable) is not the rate applied to the state in lieu tax. There is also switching between the two as government agencies, such as the University of Oregon, becomes recatagorized. For purpose of constructing a better forecast, the LTD tax rate will be applied to the state in lieu and payroll & self-employment tax revenue data, the reasoning behind doing this is that the state in lieu tax revenue is very small relative to the payroll & self-employment tax revenue, and the state in lieu tax data is based upon the salaries and wage of Lane County. The data collected from LTD is from the years 2002 to 2016, and using the annual percentage change equation the values of LTD tax revenue was converted to annual percentage change (see Figure 7).

Explanation of Variables

For the variables used, we needed to define them under a specific name as for use in the call code in the statistical program, RATS. Each of the variables below represents a dataset shown in the Appendix section.

Statistics on Series LEVELSBASE
Annual Data From 2002:01 To 2026:01
Observations 25

Sample Mean 5261521049.485055	Variance 3109842616240029184.000000
Standard Error 1763474586.218931	SE of Sample Mean 352694917.243786
t-Statistic (Mean=0) 14.918052	Signif Level (Mean=0) 0.000000

LEVELSBASE is the variable for the tax base, which we acquired by the equation above. Here we use the LTD data that from 2002-2015 to create the forecasted values through 2026. As seen

before, the data increased continuously and therefore has a very high mean, variance, and standard error.

Statistics on Series LEVELSLC
Annual Data From 1990:01 To 2026:01
Observations 37

Sample Mean 4267487726.403968	Variance 33419092716479749 12.000000
Standard Error 1828088967.104166	SE of Sample Mean 300535974.896021
t-Statistic (Mean=0) 14.199590	Signif Level (Mean=0) 0.000000

LEVELSLC, is the variable of raw data for the Wages and Salaries of Lane County, from the BLS website. There was data available from 1990 to 2015 which we used to forecast until 2026. Again, the trend was upward so the variable has a high mean, variance, and standard error.

Statistics on Series OR
Annual Data From 1990:01 To 2026:01
Observations 37

Sample Mean 78803301189.189194	Variance 14696015900501755822 08.0000
Standard Error 38335383003.827881	SE of Sample Mean 6302298143.792310
t-Statistic (Mean=0) 12.503899	Signif Level (Mean=0) 0.000000

OR, is the variable of raw data for the wages and salaries of the state of Oregon, from the BLS website. Again, data was available from 1990-2015 which we used to forecast through 2026. There is the same upward trend as the two previous variables, which result in a high mean, variance, and standard error.

Statistics on Series OR_CHANGE
Annual Data From 1991:01 To 2026:01
Observations 36

Sample Mean 0.050703	Variance 0.000752
Standard Error 0.027426	SE of Sample Mean 0.004571
t-Statistic (Mean=0) 11.092294	Signif Level (Mean=0) 0.000000

OR_CHANGE, is the variable for percent change of Oregon's Wages and Salaries which was calculated from the variable LEVELSLC, using the percent change formula. Here, the average percent change per year was approximately 5.07% increase in wages and salaries.

Statistics on Series LC_CHANGE
Annual Data From 1991:01 To 2016:01
Observations 26

Sample Mean 0.043063	Variance 0.001586
Standard Error 0.039820	SE of Sample Mean 0.007809
t-Statistic (Mean=0) 5.514242	Signif Level (Mean=0) 0.000010
Skewness -2.095109	Signif Level (Sk=0) 0.000040

LC_CHANGE is the variable for percent change in Lane County Wages and Salaries, calculated from Lane County Wages and Salaries from the BLS website. The average percent change per year is approximately 4.3% increase in wages and salaries.

Statistics on Series BASE_CHANGE
Annual Data From 2003:01 To 2016:01
Observations 14

Sample Mean 0.041322	Variance 0.004035
Standard Error 0.063525	SE of Sample Mean 0.016978
t-Statistic (Mean=0) 2.433921	Signif Level (Mean=0) 0.030109

BASE_CHANGE, is the variable for percent change in tax base, calculated from the LEVELSBASE variable using the percent change formula. The average percent change per year of the tax base of LTD is approximately 4.13%, which is close to LC_CHANGE.

Methodology

The statistical program RATS is the application used for constructing our forecast of the Lane Transit District tax revenue. RATS contains various forecasting capabilities, but the technique of dynamic forecasting was used to construct both the forecast of Lane County salaries and wages and the forecast for Lane Transit District tax base. Dynamic forecasting is the process of forecasting dependent variables that then become explanatory variables in subsequent forecasts. To produce the values for the LTD tax revenue forecast the call code of *LINREG* was used to run the regressions and the call code of *FORECAST* was used to construct the forecasts.

There are a wide variety of forecasting techniques in economics, none of which are flawless. The technique used to forecast Lane Transit District tax revenues is very similar to the technique used by the Oregon Office of Economic Analysis to forecast the state of the Oregon Economy (OEA Methodology). The forecasting technique we used is a regression forecasting model.

Prior to using the regression forecasting model to forecast for LTD tax revenues, the actual values of the LTD tax base must be calculated. In this context, a tax base is the total value of a taxable entity for a specified area. In particular, LTD's tax base is all payrolls of Lane County within the LTD tax district. The payroll tax base of the LTD tax district (LTD tax base) and the salaries and wages of Lane County have a correlation coefficient of 0.97012, which suggests these two variables are highly correlated with one another. Considering the high correlation coefficient, forecasting the variable LTD tax base will produce a more accurate forecast for LTD tax revenues. Using the annual values of the payroll tax revenue and state in

lieu tax revenue data from LTD, the values of Lane County tax base (see Figure 4) are calculated using this equation:

$$Tax\ Base_t = \frac{(Payroll\ Rev_t + State\ in\ Lieu\ Rev_t)}{Tax\ Rate_t}$$

Before constructing any forecasts, relationships had to identified between Oregon income data and salaries and wages data of Lane County, as well as the relationship between salaries and wages data of Lane County and LTD tax base. All variables were converted to their annual percentage change values from the start of the data sets through 2016 (see Figures 6, 7, 8, and 12). The purpose of calculating the annual percentage change, or the growth rate, of the variables is to easily compare and identify the trends between two sets of data.

Once the variables were converted from levels to growth rates, the Oregon income data and the Lane County salaries and wages data were compared in a percentage change chart. With a correlation coefficient of 0.99085 and the visual depiction that Lane County salaries and wages data tracks the Oregon income, it is reasonable to assume that Lane County salaries and wages is predicted by the Oregon income data (see Figure 15). As stated, the correlation coefficient between the Lane County salaries and wages data and the LTD tax base data is 0.97012. Based on the high correlation and the evidence in Figure 17, it is also reasonable to assume that Lane County salaries and wages predicts the values of LTD tax base. Therefore, we next need to test these relationships using regression analysis.

In Stage 1 of the regression forecasting model, Lane County salaries and wages (dependent variable) is linearly regressed on Oregon income (explanatory variable) and a one-year lag of Lane County salaries and wages (explanatory variable), in levels. The purpose of

adding the one-year lagged variable of Lane County salaries and wages is to adjust for the autocorrelation present in the data. This regression yields a model that contains past movements/interactions between Oregon income data and the salaries and wages data for Lane County. Using the regression model above, a dynamic forecast was constructed in RATS for Lane County salaries and wages through the year 2026 (see Figure 9). This forecast uses the already forecasted values of Oregon income to predict subsequent values Lane County salaries and wages forecast.

In Stage 2, Lane County salaries and wages variable will be used as the independent variable in the regression of LTD tax base regressed on Lane County salaries and wages. Using the same dynamic forecasting technique in RATS, this regression model is used to produce a forecast of LTD tax base using the forecasted values of Lane County salaries and wages from Stage 1. The LTD tax revenues forecast can be calculated by applying the annual LTD tax rate to the associated LTD tax base forecast value (see Figure 11).

$$LTD\ Tax\ Reven\quad_i\ (Payroll\ Rev_i + State\ in\ Lieu\ Rev_i) = Tax\ Base_i * Tax\ Rate_i.$$

To account for foreseeable recessions, hypothetical values of recessionary data were implemented to the forecasted value of Oregon income. To implement a recession, we calculated growth rates from previous recessions within the last thirty years and implemented those changes into our Oregon income growth rates during years 2019-2022. The recessionary growth values were calculated based upon the past responses that Oregon income had to different recessionary periods.

For a mild recession, the growth rate of 4.2% was selected based upon various historical slowed growth points in the Oregon, Lane County, and the LTD data sets. In the ending years of each recession studied (1992, 2003, 2013) a percentage growth rate in Oregon income of 4.2% was a common rate among all three recessions. The mild recession of 1990-1992 was our main point of reference: Oregon income didn't drop, but merely stalled for a year, which is how we implemented the hypothetical mild recession.

For a moderate recession, the recession trends of 2000-2003 was used as a template. This recession took the form of a three-year plateau of the growth rates, which is how we constructed our moderate recession. We found that the first year experienced a fall in growth rate at 0.9% and then grew back to 4.2%, which then persisted through the next year before resuming normal growth patterns.

Finally, our severe recession was modeled after the 2008-2010 recession. This recession is unlike the previous two types because rather than a plateau of growth rates, there is an immediate drop to a negative rate, which slowly comes up within three years. The first year has a negative growth rate of -5.3%, climbing back up to non-growth (0.0%) in the second year, and then positive again at 4.2% for the third year (see chart below).

Recession	Year 2019	Year 2020	Year 2021
Mild	**4.2%**	5.3%	4.9%
Moderate	**0.9%**	**4.2%**	4.9%
Severe	**-5.3%**	**0.0%**	**4.2%**

To implement the theoretical recessions to the LTD revenue data set, the growth rates for the forecasted values from 2016-2026 were calculated between each year. In selected years, the forecasted growth values for Oregon income were substituted with theoretical recession values for a mild, moderate, and severe recessions.

Forecast Results

There are three stages to correctly to use the regression forecasting model to construct a forecast for LTD tax revenue. In Stage 1, Lane County salaries and wages is regressed on Oregon income to identify the correlation of the variables. Next, we generate a forecast of Lane County salaries and wages based upon this model. Stage 2 consists of Lane County salaries and wages becoming the independent variable in the regression of LTD tax base regressed on Lane County salaries and wages. Using this regression model, a forecast is generated of LTD tax base. Lastly, Stage 3 we implement recessionary values into Oregon income data. Adding these recessionary values alters the forecast for both Lane County salaries and wages and LTD tax base, ultimately generating a forecast for LTD tax revenue accounting for recessionary shocks.

Prior to Stage 1 in the regression forecasting model, the correlation between the Oregon income data and the Lane County salaries and wages data must be identified. The annual percentage change datasets were used for these variables to depict the growth rates of Oregon income (OR_CHANGE) and Lane County salaries and wages (LC_CHANGE).

Based on Figure 15, the Lane County salaries and wages annual growth data (blue line) looks as though it follows, or is caused by, the trends and movements within the Oregon income annual growth data (black line). Looking at the high correlation between the Oregon income data

and the salaries and wages data of Lane County, there is evidence that there is a relationship that will be tested using a linear regression.

Using regression analysis, we conducted a regression of Lane County salaries and wages on a one-year lagged variable of Lane County salaries and wages and Oregon income. The purpose of including the one year lag of Lane County salaries and wages is that it addresses autocorrelation in the model. This variable is significant at the 5% with a P-value of 0.00494, thus including a lag variable makes the correlation between the Oregon income and Lane County salaries and wages data more precise.

Regression 1:

$$LEVELSLC_t = \beta_O + \beta_1 * OR_t + \beta_2 * LEVELSLC_{t-1} + e_i$$

```
Linear Regression - Estimation by Least Squares
Dependent Variable LEVELSLC
Annual Data From 1990:01 To 2015:01
Usable Observations                         25
Degrees of Freedom                          22
Skipped/Missing (from 26)                    1
Centered R^2                         0.9856797
R-Bar^2                              0.9843779
Uncentered R^2                       0.9991057
Mean of Dependent Variable          3319639934.4
Std Error of Dependent Variable      874452848.1
Standard Error of Estimate           109296546.2
Sum of Squared Residuals             2.62806e+17
Regression F(2,22)                      757.1414
Significance Level of F              0.0000000
Log Likelihood                         -496.6149
Durbin-Watson Statistic                   0.7056

    Variable                      Coeff          Std Error       T-Stat      Signif
*******************************************************************************
1.  Constant                  312822766.533875 91223092.163084      3.42921  0.00239806
2.  OR                               0.028809       0.006478      4.44737  0.00020227
3.  LEVELSLC{1}                      0.412226       0.131957      3.12394  0.00494041
```

Model 1:

$$LEVELSLC_t = 312822766.534 + 0.028809 * OR_t + 0.412226 * LEVELSLC_{t-1}$$

The results of this regression and the regression model suggest that a one dollar increase in the variable representing Oregon income (OR) would result in a 0.028809 dollar increase in the value of Lane County salaries and wages data. After accounting for the lagged impact of the dependent variable, a one dollar increase in last year's value of Lane County salaries and wages data will result in a 0.412226 dollar increase in this year's value of Lane County salaries and wages. Both variables are significant at the 5% level. The R-squared value is 0.9856797, meaning that Oregon income and the previous year's salaries and wages in Lane County explain changes in current Lane county salaries and wages extremely well. Also, the correlation coefficient of 0.99085 shows that the variables are highly correlated. The combination of these factors and because the variable representing Oregon income data contains forecasted values through the year 2026, using the regression forecast model is therefore a valid technique to construct a dynamic forecast for the values of Lane County salaries and wages data through the year 2026.

Using Model 1, we constructed a dynamic forecast (see Figure 16) of Lane County salaries and wages in levels through the year 2026. The actual values of this forecast for Lane County Salaries and Wages can be found in Figure 9 of the Appendix.

As for Stage 2, the dependent variable in Stage 1, Lane County salaries and wages, becomes the independent variable in the following regression: LTD tax base is regressed on Lane County salaries and wages. We use LTD tax base rather than tax revenue because it provides a more accurate representation of the relationship with Lane County salaries and wages. This is because LTD tax revenue contains the changing variable of the tax rate within the data. Furthermore, LTD tax base will have a higher correlation coefficient because Lane County salaries and wages because LTD tax jurisdiction is a subset of Lane County. The annual

percentage change datasets (Figures 8 and 12) were used for the Lane County salaries and wages data (LC_CHANGE) and LTD tax base data (BASE_CHANGE) to show the correlation of the variables.

Based upon Figure 17, the assumption that the LTD tax base (BASE_CHANGE) tracks the Lane County salaries and wages is prevalent with a correlation coefficient of 0.97012. Hence, when Lane County salaries and wages increases, LTD tax base follows the same trend. This provides enough evidence of correlation to run the second regression.

Regression 2:

$$LEVELSBAS_t = \beta_0 + \beta_1 * LEVELSLC_t + e_i$$

```
Linear Regression - Estimation by Least Squares
Dependent Variable LEVELSBASE
Annual Data From 2002:01 To 2015:01
Usable Observations                         14
Degrees of Freedom                          12
Centered R^2                         0.9122776
R-Bar^2                              0.9049675
Uncentered R^2                       0.9986604
Mean of Dependent Variable          3916055105.7
Std Error of Dependent Variable      506073277.3
Standard Error of Estimate           156008979.5
Sum of Squared Residuals             2.92066e+17
Regression F(1,12)                      124.7952
Significance Level of F                0.0000001
Log Likelihood                         -282.9020
Durbin-Watson Statistic                   0.9940

    Variable                        Coeff          Std Error        T-Stat      Signif
*******************************************************************************************
1.  Constant                -598779319.575928 406295324.521200     -1.47375  0.16629095
2.  LEVELSLC                         1.138478         0.101912     11.17118  0.00000011
```

Model 2:

$$LEVELSBASE_t = -598779319.756 + 1.1385 * LEVELSLC_t$$

The results of this regression suggest that there is a high correlation between LTD tax base and Lane County salaries and wages. The model suggests that a one dollar unit increase in

Lane County salaries and wages (LEVELSLC) will result in a 1.1385 dollar unit increase in the LTD tax base (LEVELBASE). The value of 1.1385 is so large because wages grow faster within LTD tax district compared to the county as a whole, which is a result of LTD tax base containing the largest portion of the Lane County economy (namely, Eugene and Springfield). The variable LEVELSLC has a significance value of 0.0000001. In addition, an R-squared value of 0.9122776 shows that Lane County salaries and wages explains the variable for LTD tax base very well. This relationship gives justification to forecast LTD tax base using the forecast of Lane County salaries and wages from Stage 1.

Next, we construct the dynamic forecast for LTD tax base (see Figure 18) through the year 2026. The real values produced via the forecast can be found in Figure 10 in the Appendix.

The LTD tax base forecasted values provide the information necessary to produce a forecast of LTD tax revenues by applying the associated annual LTD tax rate. Using this equation:

$$LTD\ Tax\ Revenue_t = Tax\ Base_t\ (forecasted\ values) * Tax\ Rate_t$$

the values through 2026 can be calculated. These forecasted values for LTD tax revenue and each year's associated tax rate can be found on Figure 11 in the Appendix. These forecasted values contain information from the forecast of Oregon income, forecast of Lane County salaries and wages, and the forecast of LTD tax base. This forecast of LTD tax revenues assumes constant growth for all of the input variables and the future values of LTD tax revenues, but history suggests that sustained growth is nearly impossible. To adjust the forecast to account for recessionary shocks and slowed growth, hypothetical values of recessionary shocks were manually added to the percentage growth values for the forecast of LTD tax revenues.

Recession Results

Figure 14 in the Appendix shows the percentage change values for the forecasted values of LTD tax revenue through 2026. As explained in the Methodology section, the years 2019 to 2021 were selected as application years for the hypothetical recessionary periods to the percentage change dataset for Oregon income forecast. The LTD tax base forecast is predicted by Lane County salaries and wages, which in turn is predicted by Oregon income, so implementing the recession into the Oregon income forecast will result in a trickle-down effect into the LTD tax base forecast, to better emulate realistic recession effects.

To apply the recessionary shocks, the growth values for the years 2019 to 2021 for Oregon income were replaced with the calculated recession rates. Next, the forecast of Lane County salaries and wages and LTD tax base are regenerated in RATS using the Oregon income data with applied recessions. This produces a new forecast for LTD tax revenue with a recession implemented into the data.

As discussed in the Methodology section, a mild recession value of 4.2% is implemented into the Oregon income data for the year 2019 (see Figure 19). For a moderate recession, the recession value of 0.9% replaced the growth value in the year 2019 and the value of 4.2% is used for the year 2020. This moderate recession represents a two-year long recession (see Figure 19). Using the 2008 recession as a template for a severe recession, we use a recession rate of -5.73% for 2019, a non-growth rate (0.0%) for 2020, and 4.2% for the final year in 2021.

Figure 19 represents how recessionary shocks will affect the total dollar value of the LTD tax revenue over time. The mild recession (blue line) only slows the growth rate by a small amount, resulting in the smallest shift downward from the NO_RECESSION line. The moderate

recession has a larger negative effect on tax revenues, shifting the green line further down than the prior recession. The severe recession has the largest effect on tax revenues, causing the revenues to turn negative. However, the three years that a recession takes place isn't the only ramification – there is a long-term persisting effect on growth rates during expansion periods (Owyang, Piger, Hall). This effect causes growth rates to be stifled for recession years and then never recover to where they should have been without a recession (i.e. the counterfactual).

Summary and Conclusions

Overall, we found that our forecasting method will provide Lane Transit District with a very useful estimation of how their revenues will change in the next ten years. With this information, LTD will be able to estimate how much revenue should remain in their reserves for each severity of recession. Also, by simply implementing a recession into our forecast at a given year, we have given LTD the potential to change the forecast as more information becomes available. LTD will also be able to account for fluctuations in demand for public transportation rather than rely on federal government assistance. Also, we calculated each recession in terms of dollars lost by comparing tax revenues of a forecast without a recession to each type of recession (see Figures 21, 22, and 23). This exemplifies the long-term persisting recession effect; revenue growth rates eventually return to normal, but there are significant amounts of dollars lost from the gap in growth rates from each recession.

Moreover, through our research we observed that using payroll and state-in-lieu taxes to fund a public good such as transportation leads to very dangerous and lasting downturns in revenue. As stated by Pierce (2010), Oregon is in the top five states which react more severely to

monetary policy changes and therefore have more severe and drawn-out recession periods. In Oregon, it has been proposed many times to instead use a consumption tax to fund public works rather than an income tax. This follows because in recession years, aggregate income in a county falls as employment decreases and therefore income taxes are subject to the same volatile downward swings. In these same years, residents may slightly lower consumption, but it is always the less affected health indicator in economic downturns. Currently, no state funds public goods, such as transportation, with a direct consumption tax. Cities similar to Eugene, such as Spokane Washington, fund the area's public transportation (Spokane Transit Authority) through a sales tax, which is an indirect consumption tax. This method of funding public goods with an indirect consumption tax can reduce the risk of negative effects resulting from severe recessions (Arizona PIRG Education Fund). Further research would compare the volatility of Spokane Transit Authority's revenue from the sales tax to that of LTD's revenue from income tax.

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Appendix

Figure 1:

Year	Forecasted Values of Oregon Income (dollars)
1990	$27,653,906,000.00
1991	$28,980,447,000.00
1992	$30,906,900,000.00
1993	$32,842,772,000.00
1994	$35,408,538,000.00
1995	$38,340,754,000.00
1996	$41,679,478,000.00
1997	$45,225,579,000.00
1998	$47,926,280,000.00
1999	$50,950,564,000.00
2000	$55,205,663,000.00
2001	$55,728,283,000.00
2002	$55,914,034,000.00
2003	$57,325,280,000.00
2004	$60,575,685,000.00
2005	$64,411,219,000.00
2006	$69,043,132,000.00
2007	$72,760,324,000.00
2008	$73,884,899,000.00
2009	$69,955,678,000.00
2010	$70,948,929,000.00
2011	$74,018,783,000.00
2012	$77,158,018,000.00
2013	$80,178,775,000.00
2014	$85,052,303,000.00
2015	$91,123,876,000.00
2016	$97,619,695,000.00
2017	$103,911,800,000.00
2018	$110,506,975,000.00
2019	$116,913,975,000.00
2020	$123,085,375,000.00
2021	$129,099,275,000.00
2022	$135,246,700,000.00
2023	$141,330,750,000.00
2024	$147,877,300,000.00
2025	$154,863,600,000.00
2026	$162,066,600,000.00

Figure 2:

Year	Lane County Salaries and Wages (dollars)
1990	$1,738,340,741.00
1991	$1,762,122,227.00
1992	$1,864,855,978.00
1993	$1,977,205,587.00
1994	$2,166,278,817.00
1995	$2,302,220,080.00
1996	$2,463,836,704.00
1997	$2,689,432,633.00
1998	$2,870,964,631.00
1999	$3,043,258,761.00
2000	$3,142,044,120.00
2001	$3,189,322,295.00
2002	$3,256,304,820.00
2003	$3,332,555,217.00
2004	$3,551,665,158.00
2005	$3,828,182,459.00
2006	$4,046,773,745.00
2007	$4,235,807,119.00
2008	$4,222,830,118.00
2009	$3,781,740,099.00
2010	$3,776,397,252.00
2011	$3,916,132,115.00
2012	$4,065,500,811.00
2013	$4,238,021,945.00
2014	$4,468,824,995.00
2015	$4,798,720,675.00
2016	$5,103,308,223.78

Figure 3:

Year	LTD Payroll & State in Lieu Tax Revenues (dollars)
2002	$18,284,123.80
2003	$18,416,479.01
2004	$19,455,689.94
2005	$22,550,013.47
2006	$24,165,111.93
2007	$25,044,427.32
2008	$26,354,816.10
2009	$25,103,576.82
2010	$24,560,498.85
2011	$25,379,181.70
2012	$26,424,900.15
2013	$28,409,666.57
2014	$28,936,731.98
2015	$33,275,525.01
2016	$36,698,218.98

Figure 4:

Year	LTD Tax Base (dollars)	Tax Rate
2002	$3,047,353,966.67	0.006
2003	$3,069,413,168.33	0.006
2004	$3,242,614,990.00	0.006
2005	$3,758,335,578.33	0.006
2006	$4,027,518,655.00	0.006
2007	$4,174,071,220.00	0.006
2008	$4,392,469,350.00	0.006
2009	$4,048,964,003.23	0.0062
2010	$3,837,577,945.31	0.0064
2011	$3,904,489,492.31	0.0065
2012	$4,003,772,750.00	0.0066
2013	$4,240,248,741.79	0.0067
2014	$4,255,401,761.76	0.0068
2015	$4,822,539,856.52	0.0069
2016	$5,242,602,711.43	0.007

Figure 5:

Year	Forecasted Oregon Income Percentage Change
1990	
1991	4.7969%
1992	6.6474%
1993	6.2636%
1994	7.8123%
1995	8.2811%
1996	8.7080%
1997	8.5080%
1998	5.9716%
1999	6.3103%
2000	8.3514%
2001	0.9467%
2002	0.3333%
2003	2.5240%
2004	5.6701%
2005	6.3318%
2006	7.1912%
2007	5.3839%
2008	1.5456%
2009	-5.3180%
2010	1.4198%
2011	4.3269%
2012	4.2411%
2013	3.9150%
2014	6.0783%
2015	7.1386%
2016	7.1286%
2017	6.4455%
2018	6.3469%
2019	5.7978%
2020	5.2786%
2021	4.8860%
2022	4.7618%
2023	4.4985%
2024	4.6321%
2025	4.7244%
2026	4.6512%

Figure 6:

Year	Lane County Salaries and Wages Percentage Change
1990	
1991	1.3681%
1992	5.8301%
1993	6.0246%
1994	9.5626%
1995	6.2753%
1996	7.0200%
1997	9.1563%
1998	6.7498%
1999	6.0013%
2000	3.2460%
2001	1.5047%
2002	2.1002%
2003	2.3416%
2004	6.5748%
2005	7.7856%
2006	5.7101%
2007	4.6712%
2008	-0.3064%
2009	-10.4454%
2010	-0.1413%
2011	3.7002%
2012	3.8142%
2013	4.2435%
2014	5.4460%
2015	7.3822%
2016	6.3473%

Figure 7:

Year	LTD Payroll & State in Lieu Tax Revenues Percentage Change
2002	
2003	0.7239%
2004	5.6428%
2005	15.9045%
2006	7.1623%
2007	3.6388%
2008	5.2323%
2009	-4.7477%
2010	-2.1633%
2011	3.3333%
2012	4.1204%
2013	7.5110%
2014	1.8552%
2015	14.9941%
2016	10.2859%

Figure 8:

Year	LTD Tax Base Percentage Change
2002	
2003	0.7239%
2004	5.6428%
2005	15.9045%
2006	7.1623%
2007	3.6388%
2008	5.2323%
2009	-7.8203%
2010	-5.2207%
2011	1.7436%
2012	2.5428%
2013	5.9063%
2014	0.3574%
2015	13.3275%
2016	8.7104%

Figure 9:

Year	Forecasted Values of Lane County Salaries and Wages (dollars)
1990	$1,738,340,741.00
1991	$1,762,122,227.00
1992	$1,864,855,978.00
1993	$1,977,205,587.00
1994	$2,166,278,817.00
1995	$2,302,220,080.00
1996	$2,463,836,704.00
1997	$2,689,432,633.00
1998	$2,870,964,631.00
1999	$3,043,258,761.00
2000	$3,142,044,120.00
2001	$3,189,322,295.00
2002	$3,256,304,820.00
2003	$3,332,555,217.00
2004	$3,551,665,158.00
2005	$3,828,182,459.00
2006	$4,046,773,745.00
2007	$4,235,807,119.00
2008	$4,222,830,118.00
2009	$3,781,740,099.00
2010	$3,776,397,252.00
2011	$3,916,132,115.00
2012	$4,065,500,811.00
2013	$4,238,021,945.00
2014	$4,468,824,995.00
2015	$4,798,720,675.00
2016	$5,103,308,223.78
2017	$5,410,136,529.91
2018	$5,726,619,691.04
2019	$6,041,661,687.58
2020	$6,349,322,188.01
2021	$6,649,402,422.54
2022	$6,950,204,605.87
2023	$7,249,478,621.62
2024	$7,561,446,871.57
2025	$7,891,316,786.94
2026	$8,234,809,146.08

Figure 10:

Year	Forecasted Values of LTD Tax Base (dollars)
2002	$3,047,353,966.67
2003	$3,069,413,168.33
2004	$3,242,614,990.00
2005	$3,758,335,578.33
2006	$4,027,518,655.00
2007	$4,174,071,220.00
2008	$4,392,469,350.00
2009	$4,048,964,003.23
2010	$3,837,577,945.31
2011	$3,904,489,492.31
2012	$4,003,772,750.00
2013	$4,240,248,741.79
2014	$4,255,401,761.76
2015	$4,822,539,856.52
2016	$5,242,602,711.43
2017	$5,560,542,303.72
2018	$5,920,851,432.15
2019	$6,279,519,826.34
2020	$6,629,784,549.32
2021	$6,971,419,306.05
2022	$7,313,875,985.63
2023	$7,654,592,879.99
2024	$8,009,761,881.18
2025	$8,385,311,535.32
2026	$8,776,370,042.51

Figure 11:

Year	Tax Rate	Forecasted Values of LTD Revenue
2002	0.006	$18,284,123.80
2003	0.006	$18,416,479.01
2004	0.006	$19,455,689.94
2005	0.006	$22,550,013.47
2006	0.006	$24,165,111.93
2007	0.006	$25,044,427.32
2008	0.006	$26,354,816.10
2009	0.0062	$25,103,576.82
2010	0.0064	$24,560,498.85
2011	0.0065	$25,379,181.70
2012	0.0066	$26,424,900.15
2013	0.0067	$28,409,666.57
2014	0.0068	$28,936,731.98
2015	0.0069	$33,275,525.01
2016	0.007	$36,698,218.98
2017	0.0071	$39,479,850.36
2018	0.0072	$42,630,130.31
2019	0.0073	$45,840,494.73
2020	0.0074	$49,060,405.66
2021	0.0075	$52,285,644.80
2022	0.0076	$55,585,457.49
2023	0.0077	$58,940,365.18
2024	0.0078	$62,476,142.67
2025	0.0079	$66,243,961.13
2026	0.008	$70,210,960.34

Figure 12:

Year	Forecasted Values of Lane County Salaries and Wages Percentage Change
1991	1.3681%
1992	5.8301%
1993	6.0246%
1994	9.5626%
1995	6.2753%
1996	7.0200%
1997	9.1563%
1998	6.7498%
1999	6.0013%
2000	3.2460%
2001	1.5047%
2002	2.1002%
2003	2.3416%
2004	6.5748%
2005	7.7856%
2006	5.7101%
2007	4.6712%
2008	-0.3064%
2009	-10.4454%
2010	-0.1413%
2011	3.7002%
2012	3.8142%
2013	4.2435%
2014	5.4460%
2015	7.3822%
2016	6.3473%
2017	6.0123%
2018	5.8498%
2019	5.5014%
2020	5.0923%
2021	4.7262%
2022	4.5237%
2023	4.3060%
2024	4.3033%
2025	4.3625%
2026	4.3528%

Figure 13:

Year	Forecasted Values of LTD Tax Base Percentage Change
2003	0.7239%
2004	5.6428%
2005	15.9045%
2006	7.1623%
2007	3.6388%
2008	5.2323%
2009	-7.8203%
2010	-5.2207%
2011	1.7436%
2012	2.5428%
2013	5.9063%
2014	0.3574%
2015	13.3275%
2016	8.7104%
2017	6.0645%
2018	6.4797%
2019	6.0577%
2020	5.5779%
2021	5.1530%
2022	4.9123%
2023	4.6585%
2024	4.6399%
2025	4.6886%
2026	4.6636%

Figure 14:

Year	Forecasted Values of LTD Tax Revenue Percentage Change
2003	0.7239%
2004	5.6428%
2005	15.9045%
2006	7.1623%
2007	3.6388%
2008	5.2323%
2009	-4.7477%
2010	-2.1633%
2011	3.3333%
2012	4.1204%
2013	7.5110%
2014	1.8552%
2015	14.9941%
2016	10.2859%
2017	7.5797%
2018	7.9795%
2019	7.5307%
2020	7.0242%
2021	6.5740%
2022	6.3111%
2023	6.0356%
2024	5.9989%
2025	6.0308%
2026	5.9885%

Figure 15:

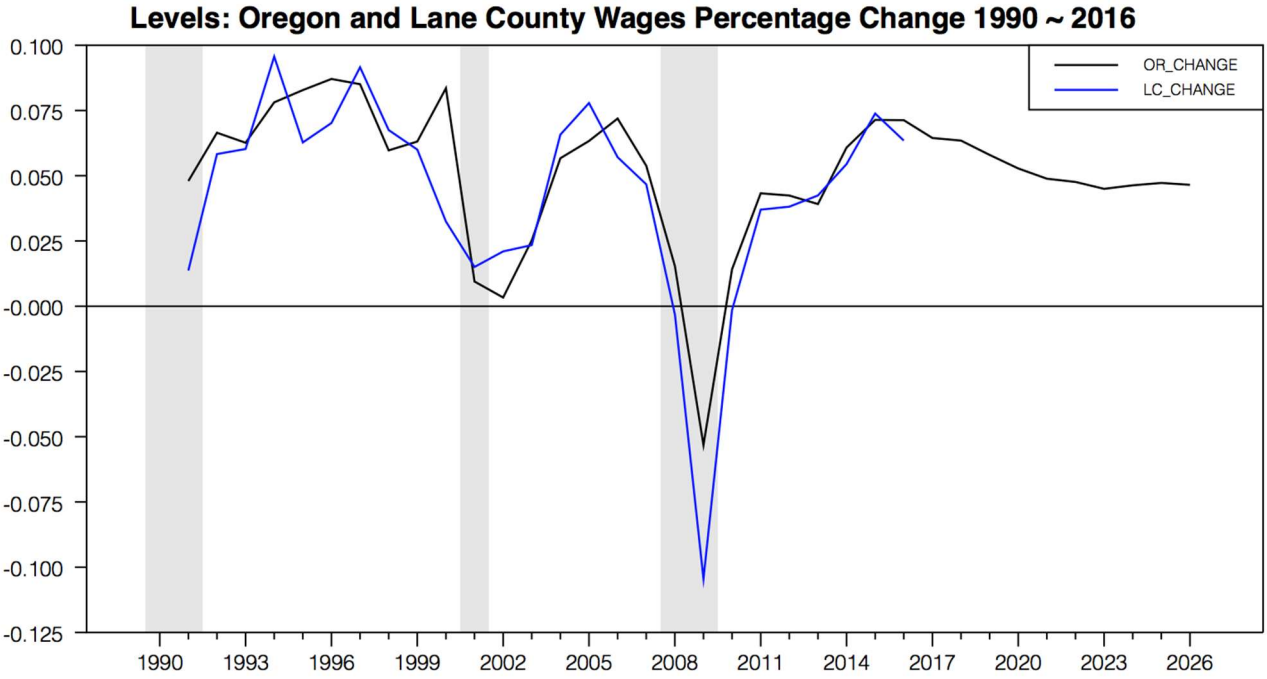

Figure 16:

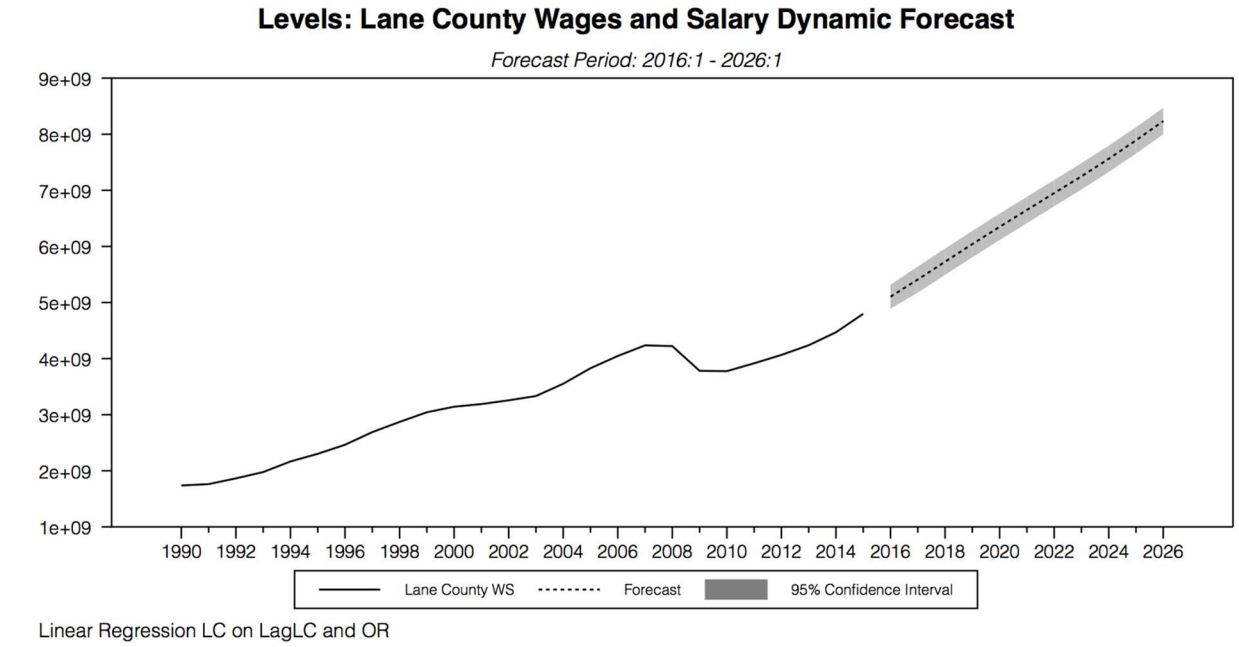

Figure 17:

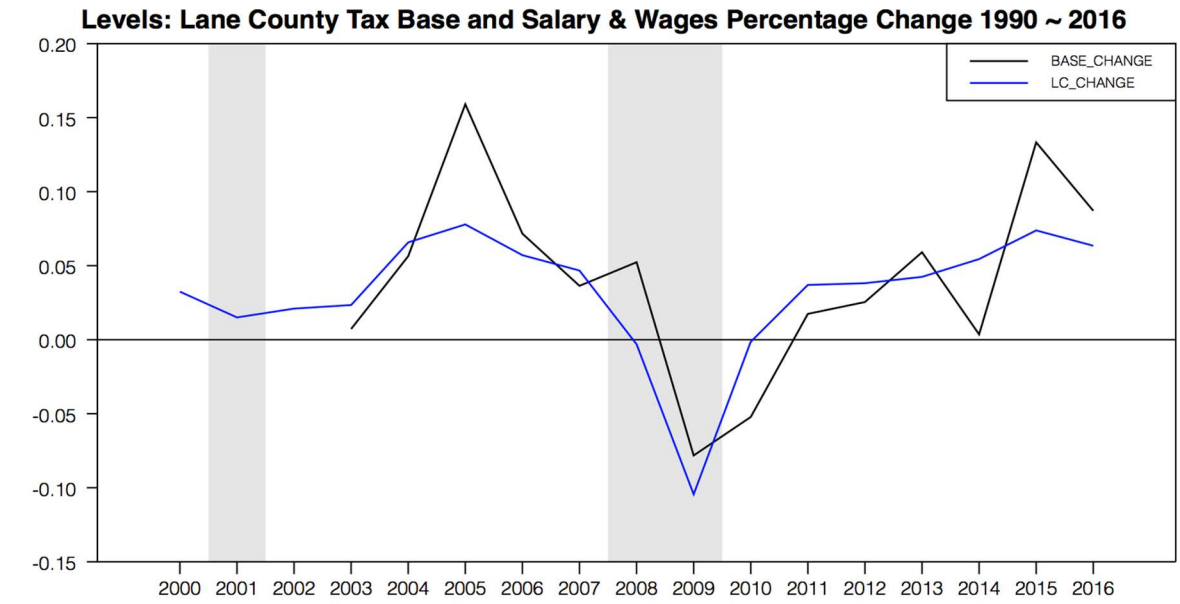

Figure 18:

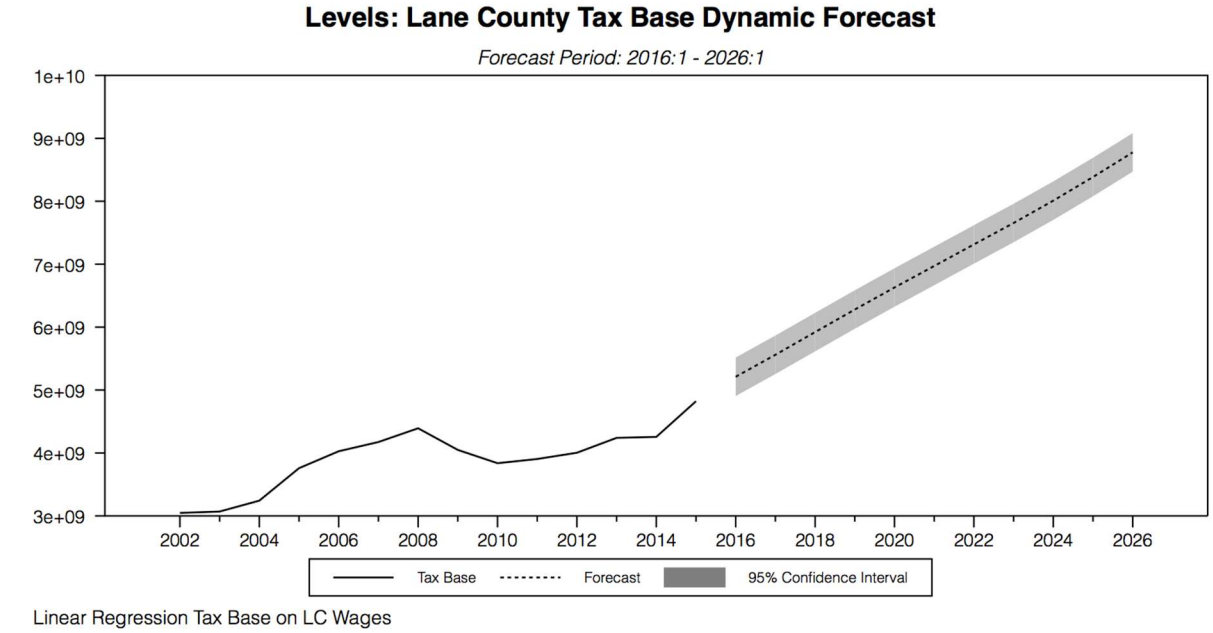

Figure 19:

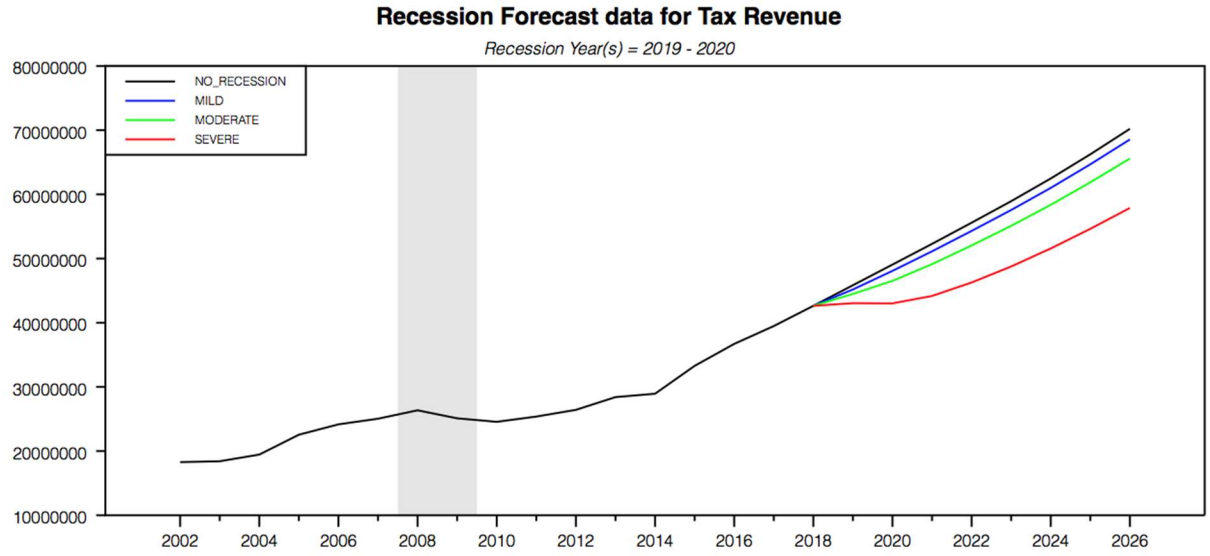
Recession Forecast data for Tax Revenue
Recession Year(s) = 2019 - 2020
NO_RECESSION
MILD
MODERATE
SEVERE
80000000
70000000
60000000
50000000
40000000
30000000
20000000
10000000
2002
2004
2006
2008
2010
2012
2014
2016
2018
2020
2022
2024
2026

Figure 20:

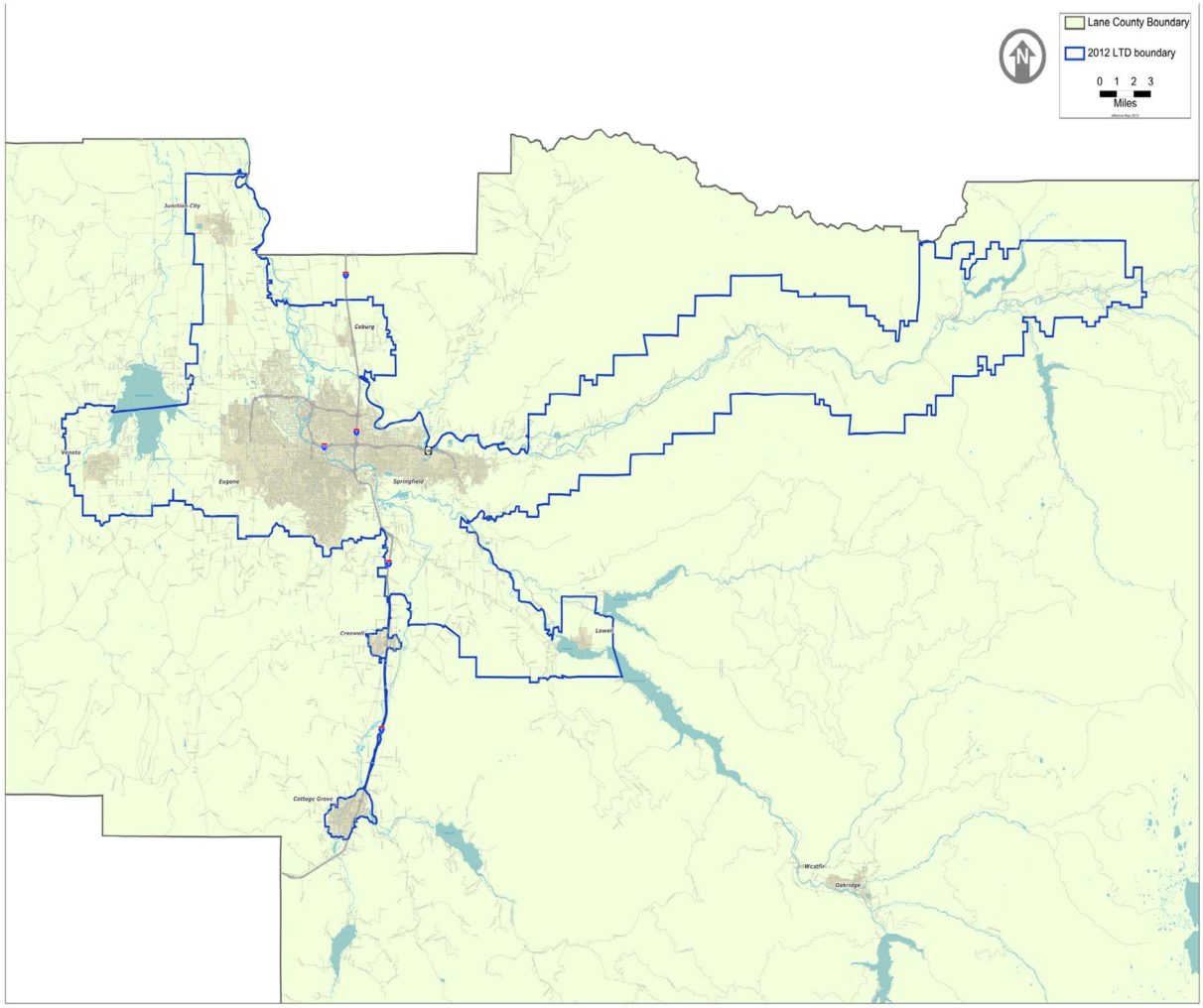
Lane County Boundary
2012 LTD boundary
0 1 2 3
Miles
Junction City
Coburg
Veneta
Eugene
Springfield
Creswell
Lowell
Cottage Grove
Westfir
Oakridge

Figure 21:

Year	Mild Recession Values of LTD Revenue	Dollars Lost due to Recession
2002	$18,284,123.80	$0.00
2003	$18,416,479.01	$0.00
2004	$19,455,689.94	$0.00
2005	$22,550,013.47	$0.00
2006	$24,165,111.93	$0.00
2007	$25,044,427.32	$0.00
2008	$26,354,816.10	$0.00
2009	$25,103,576.82	$0.00
2010	$24,560,498.85	$0.00
2011	$25,379,181.70	$0.00
2012	$26,424,900.15	$0.00
2013	$28,409,666.57	$0.00
2014	$28,936,731.98	$0.00
2015	$33,275,525.01	$0.00
2016	$36,698,218.98	$0.00
2017	$39,479,896.93	-$46.57
2018	$42,630,200.01	-$69.70
2019	$45,417,815.80	$422,678.93
2020	$48,432,662.57	$627,743.10
2021	$51,543,823.49	$741,821.31
2022	$54,766,496.10	$818,961.39
2023	$58,059,338.89	$881,026.28
2024	$61,536,966.69	$939,175.98
2025	$65,245,908.00	$998,053.12
2026	$69,152,182.01	$1,058,778.33

Figure 22:

Year	Moderate Recession Values of LTD Revenue	Dollars Lost due to Recession
2002	$18,284,123.80	$0.00
2003	$18,416,479.01	$0.00
2004	$19,455,689.94	$0.00
2005	$22,550,013.47	$0.00
2006	$24,165,111.93	$0.00
2007	$25,044,427.32	$0.00
2008	$26,354,816.10	$0.00
2009	$25,103,576.82	$0.00
2010	$24,560,498.85	$0.00
2011	$25,379,181.70	$0.00
2012	$26,424,900.15	$0.00
2013	$28,409,666.57	$0.00
2014	$28,936,731.98	$0.00
2015	$33,275,525.01	$0.00
2016	$36,698,218.98	$0.00
2017	$39,479,896.93	-$46.57
2018	$42,630,200.01	-$69.70
2019	$44,544,681.88	$1,295,812.86
2020	$46,844,098.23	$2,216,307.43
2021	$49,579,287.44	$2,706,357.36
2022	$52,564,912.83	$3,020,544.66
2023	$55,677,785.24	$3,262,579.94
2024	$58,992,824.97	$3,483,317.71
2025	$62,540,029.82	$3,703,931.31
2026	$66,280,734.15	$3,930,226.19

Figure 23:

Year	Severe Recession Values of LTD Revenue	Dollars Lost due to Recession
2002	$18,284,123.80	$0.00
2003	$18,416,479.01	$0.00
2004	$19,455,689.94	$0.00
2005	$22,550,013.47	$0.00
2006	$24,165,111.93	$0.00
2007	$25,044,427.32	$0.00
2008	$26,354,816.10	$0.00
2009	$25,103,576.82	$0.00
2010	$24,560,498.85	$0.00
2011	$25,379,181.70	$0.00
2012	$26,424,900.15	$0.00
2013	$28,409,666.57	$0.00
2014	$28,936,731.98	$0.00
2015	$33,275,525.01	$0.00
2016	$36,698,218.98	$0.00
2017	$39,479,896.93	-$46.57
2018	$42,630,200.01	-$69.70
2019	$42,904,248.44	$2,936,246.30
2020	$43,359,078.68	$5,701,326.99
2021	$44,970,683.82	$7,314,960.97
2022	$47,293,067.74	$8,292,389.75
2023	$49,932,701.95	$9,007,663.23
2024	$52,838,221.86	$9,637,920.82
2025	$55,986,991.01	$10,256,970.12
2026	$59,323,737.47	$10,887,222.87