Introduction to Benefit Cost Estimating with Regression Modeling

UI Benefit Financing Seminar
Division of Fiscal and Actuarial Services
U.S. DOL/ETA/OUI
October 23-26, 2018
UI Benefit Estimation

1. Understanding The Elements That Comprise the Payment of Benefits in Your State.

2. Calculating a Forecast for Total State Benefits.
Total Benefits Paid

STATE LAW VARIABLES
Coverage / Eligibility / Benefit Levels / Wage Base / Tax Rates / Triggers

ECONOMIC SCENARIO VARIABLES
Total Labor Force / Total Unemployment / Average Earnings / Interest Rate
UI Benefit Modeling

Answering Three Questions:

1. How Many People are Receiving Benefits?
2. For How Long Do They Receive Benefits?
3. How Much Do They Receive?
## Unemployment Flow - First Quarter CY2018 (000)

<table>
<thead>
<tr>
<th></th>
<th>JANUARY</th>
<th>FEBRUARY</th>
<th>MARCH</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Total Labor Force</strong></td>
<td>160,037</td>
<td>161,494</td>
<td>161,548</td>
</tr>
<tr>
<td><strong>Total Unemployed</strong></td>
<td>7,189</td>
<td>7,091</td>
<td>6,671</td>
</tr>
<tr>
<td><strong>UI First Payments</strong></td>
<td>808</td>
<td>492</td>
<td>392</td>
</tr>
<tr>
<td><strong>Unemployment Insurance Recipients</strong></td>
<td>2,313 (32%)</td>
<td>2,270 (32%)</td>
<td>1,958 (29%)</td>
</tr>
<tr>
<td><strong>UI Exhaustees</strong></td>
<td>200</td>
<td>161</td>
<td>164</td>
</tr>
<tr>
<td><strong>Not in Labor Force</strong></td>
<td>96,743</td>
<td>95,439</td>
<td>95,549</td>
</tr>
</tbody>
</table>
# Two Paths to Calculating Total Benefits

<table>
<thead>
<tr>
<th>Path 1</th>
<th>Path 2</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>a) How many Claimants?</strong></td>
<td><strong>First Payments</strong></td>
</tr>
<tr>
<td>Insured Unemployment Rate (Avg. # of Claimants / Week)</td>
<td></td>
</tr>
<tr>
<td><strong>a) How Long Do They Claim?</strong></td>
<td><strong>Average Duration</strong></td>
</tr>
<tr>
<td>Total Weeks Compensated</td>
<td></td>
</tr>
<tr>
<td><strong>a) How Much Do They Receive?</strong></td>
<td><strong>Average Weekly Benefit</strong></td>
</tr>
<tr>
<td>Average Weekly Benefit</td>
<td></td>
</tr>
<tr>
<td><strong>Total Benefits</strong></td>
<td></td>
</tr>
</tbody>
</table>
Unemployment Trust Fund Modelling

Total Benefits Paid

Weeks Compensated

Weeks Claimed or First Pays

Avg. Weekly Benefit

Average Duration

Total Labor Force / Total Unemployment / Avg. Wages / Interest Rate

Economic Scenario

Coverage / Eligibility / Benefit Levels / Wage Base / Tax Rates/ Triggers

State Law Variables
Unemployment Trust Fund Modelling

Weeks Claimed

* Time Period (Weeks)

Insured Unemployment

- IUR

- TUR

Covered Employment

Total Labor Force / Total Unemployment / Avg. Wages / Interest Rate

Economic Scenario

Coverage / Eligibility / Benefit Levels / Wage Base / Tax Rates / Triggers

State Law Variables
1) $IUR = f(TUR, \text{other variables})$  
   $IU = IUR \times \text{Covered Employment}$

2) $IU = f(TU, \text{other variables})$

3) $IU/TU = f(TUR, \text{other variables})$  
   $IU = IU/TU \times TU$
Developing Estimating Equations

Regression Modeling

- Method for determining the relationships among two or more variables
- Method for forecasting future values of one variable (dependent), given the values of the other variables (independent)
- *Assumes historical relationships continue in the future
**Time Series UI Data: IUR & TUR**

<table>
<thead>
<tr>
<th>CY</th>
<th>Q</th>
<th>IUR</th>
<th>TUR</th>
</tr>
</thead>
<tbody>
<tr>
<td>2004</td>
<td>1</td>
<td>4.11</td>
<td>5.97</td>
</tr>
<tr>
<td>2004</td>
<td>2</td>
<td>2.27</td>
<td>4.52</td>
</tr>
<tr>
<td>2004</td>
<td>3</td>
<td>1.79</td>
<td>3.92</td>
</tr>
<tr>
<td>2004</td>
<td>4</td>
<td>2.14</td>
<td>3.99</td>
</tr>
<tr>
<td>2005</td>
<td>1</td>
<td>3.31</td>
<td>5.06</td>
</tr>
<tr>
<td>2005</td>
<td>2</td>
<td>1.94</td>
<td>3.6</td>
</tr>
<tr>
<td>2005</td>
<td>3</td>
<td>1.43</td>
<td>3.09</td>
</tr>
<tr>
<td>2005</td>
<td>4</td>
<td>1.68</td>
<td>3.17</td>
</tr>
<tr>
<td>2006</td>
<td>1</td>
<td>2.71</td>
<td>4.17</td>
</tr>
<tr>
<td>2006</td>
<td>2</td>
<td>1.41</td>
<td>2.86</td>
</tr>
<tr>
<td>2006</td>
<td>3</td>
<td>1.06</td>
<td>2.44</td>
</tr>
<tr>
<td>2006</td>
<td>4</td>
<td>1.48</td>
<td>2.46</td>
</tr>
<tr>
<td>2007</td>
<td>1</td>
<td>2.66</td>
<td>3.65</td>
</tr>
<tr>
<td>2007</td>
<td>2</td>
<td>1.43</td>
<td>2.62</td>
</tr>
<tr>
<td>2007</td>
<td>3</td>
<td>1.26</td>
<td>2.56</td>
</tr>
<tr>
<td>2007</td>
<td>4</td>
<td>2.04</td>
<td>3.06</td>
</tr>
</tbody>
</table>
IUR & TUR Scatter Plot

TUR – IUR Scatter Plot

Y -- Dependent Variable -- IUR

X -- Explanatory Variable -- TUR
Regression Line “Fit”

TUR – IUR Scatter Plot w/ Trend

\[ y = a + b \times x \]
Line Fit and Residuals

Residuals

Y -- Dependent Variable -- IUR

X -- Explanatory Variable -- TUR
Predicting IUR

TUR – IUR Scatter Plot w/ Trend

Y -- Dependent Variable -- IUR

X -- Explanatory Variable -- TUR
Regression Equations

- $y = a + b \times x$
  - $IUR = \text{Intercept} + \text{Coefficient}(b) \times \text{TUR}$

- $y = a + b_1 \times x_1 + b_2 \times x_2 + ... + b_N \times x_N$
Regression Steps

1. Identify Potential Explanatory Variables
2. Collect Data (BLS, LMS, UI Program)
3. Plot and Review Data and Relationships
4. Choose a time period
5. Choose specification(s)
   • Add/Drop variables in Stepwise Approach
6. Validate
7. Test forecasts
8. Final model
9. Develop assumptions/scenario
10. Forecast
Identify Explanatory Variables

- Based on knowledge of UI program
  - State program idiosyncrasies
  - State/National Economy & Recessions
  - Seasonality
  - Structural Economic or Programmatic Shifts

- Availability of Data for Regression and Forecasting
  - Historical Period Data &
  - Forecast Period Data
    - Must have or produce projections/assumptions of each variable used in regression equation in order to forecast.
IUR Explanatory Variables

- TUR – Including lags/leads
- Lagged IUR
- Exhaustions
- Extended UI Benefit Availability
- State law/administration variables
- Demographics / changing industries
- Long term unemployed
- Manufacturing Employment
- Unionization
- Job Losers (alternative to unemployed)
## IUR Regression Data – IUR, TUR, lags/leads, Indicators, etc...

<table>
<thead>
<tr>
<th>Year.Qtr</th>
<th>TUR</th>
<th>IUR</th>
<th>TU</th>
<th>IU</th>
<th>...</th>
<th>D1</th>
<th>D2</th>
<th>D3</th>
<th>Recession</th>
</tr>
</thead>
<tbody>
<tr>
<td>1998.3</td>
<td>3.28</td>
<td>1.97</td>
<td>57,666</td>
<td>31,112</td>
<td>...</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>1998.4</td>
<td>2.64</td>
<td>1.73</td>
<td>46,007</td>
<td>27,420</td>
<td>...</td>
<td>0</td>
<td>1</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>1999.1</td>
<td>3.38</td>
<td>2.55</td>
<td>58,598</td>
<td>40,715</td>
<td>...</td>
<td>1</td>
<td>0</td>
<td>1</td>
<td>0</td>
</tr>
<tr>
<td>1999.2</td>
<td>2.98</td>
<td>1.94</td>
<td>52,254</td>
<td>31,050</td>
<td>...</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>1999.3</td>
<td>2.68</td>
<td>1.96</td>
<td>47,438</td>
<td>31,553</td>
<td>...</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>1999.4</td>
<td>2.47</td>
<td>1.63</td>
<td>43,435</td>
<td>26,337</td>
<td>...</td>
<td>0</td>
<td>1</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>2000.1</td>
<td>3.13</td>
<td>2.31</td>
<td>55,011</td>
<td>37,580</td>
<td>...</td>
<td>1</td>
<td>0</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>2000.2</td>
<td>2.40</td>
<td>1.60</td>
<td>42,403</td>
<td>26,147</td>
<td>...</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>1</td>
</tr>
<tr>
<td>2000.3</td>
<td>2.27</td>
<td>1.70</td>
<td>40,250</td>
<td>27,840</td>
<td>...</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>1</td>
</tr>
<tr>
<td>2000.4</td>
<td>1.78</td>
<td>1.58</td>
<td>31,188</td>
<td>25,908</td>
<td>...</td>
<td>0</td>
<td>1</td>
<td>0</td>
<td>1</td>
</tr>
</tbody>
</table>
Choose Time Period

- At least 6 to 8 years
- 10 to 12 years is generally adequate but use discretion to:
  - Include AT LEAST one recession (Consider magnitude and changes in UI relationships)
- Look for state law changes
- Look for other structural changes
Choosing A Specification

- Add/Drop one variable at a time
  - Stepwise approach
    - “Stepwise Model Tracker.xlsx”

- Check:
  - Coefficients
  - Adjusted R–Square
  - Residuals

- Include variables of interest / high importance
Reviewing & Comparing Regression Models

Significance of Individual Variables:
- $\text{t Statistic} = \frac{\text{Coefficient}}{\text{Standard Error}}$
- $\text{t Statistic} > 2$ or P-value of Coefficient $< 0.05$
- Look for correct sign (+/−) & magnitude of coefficient

Adjusted R Square:
- Reflects proportion of variation in dependent variable (TUR) explained by regression line.
- Useful to compare performance across multiple regressions
- Larger Adj. R Square = “better” fit