



# 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.

# Unemployment Insurance System Modeling

**Total Benefits Paid**



**STATE LAW VARIABLES**

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



**ECONOMIC SCENARIO VARIABLES**

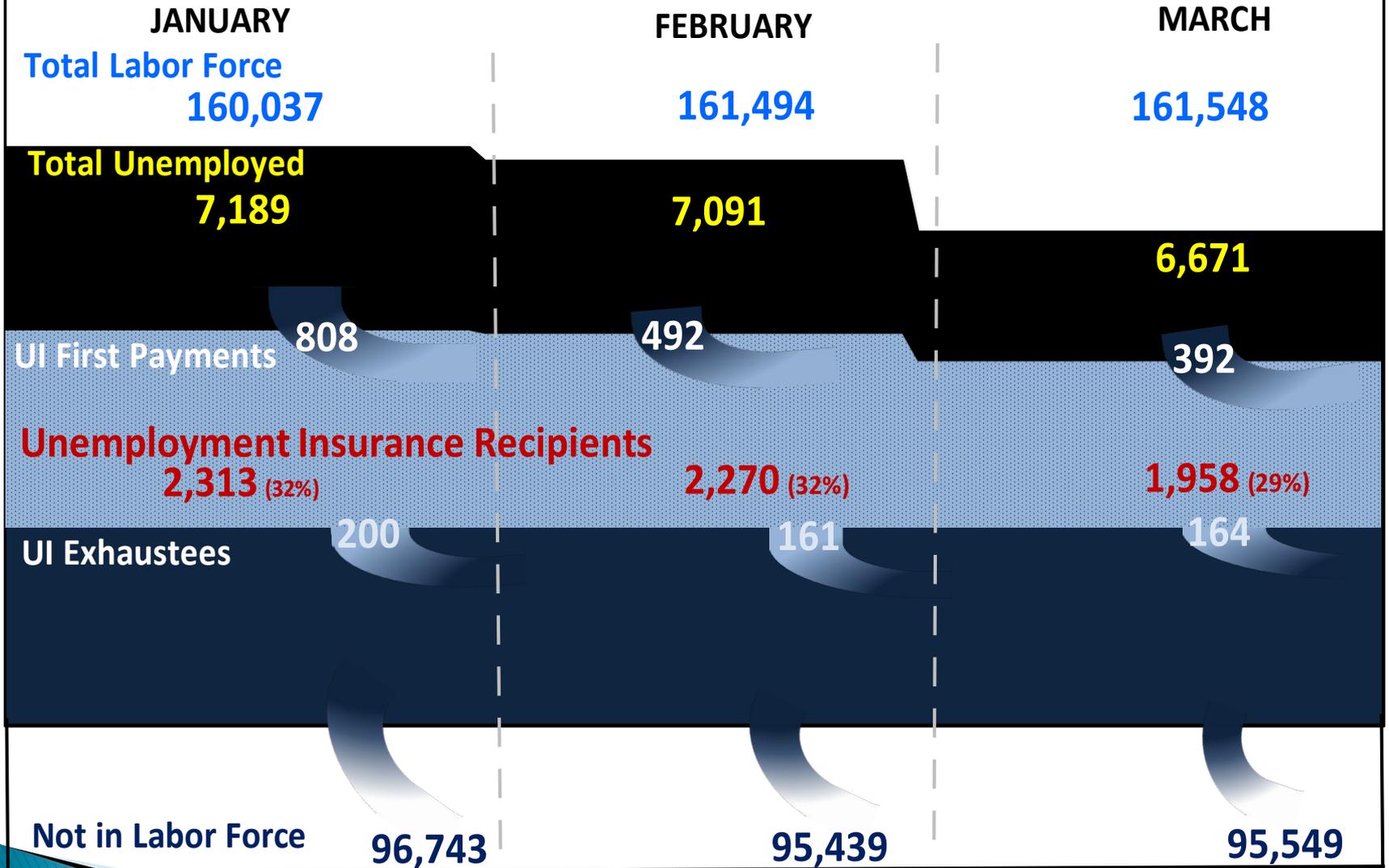
Total Labor Force / Total Unemployment / Average Earnings / Interest Rate

# UI Benefit Modeling

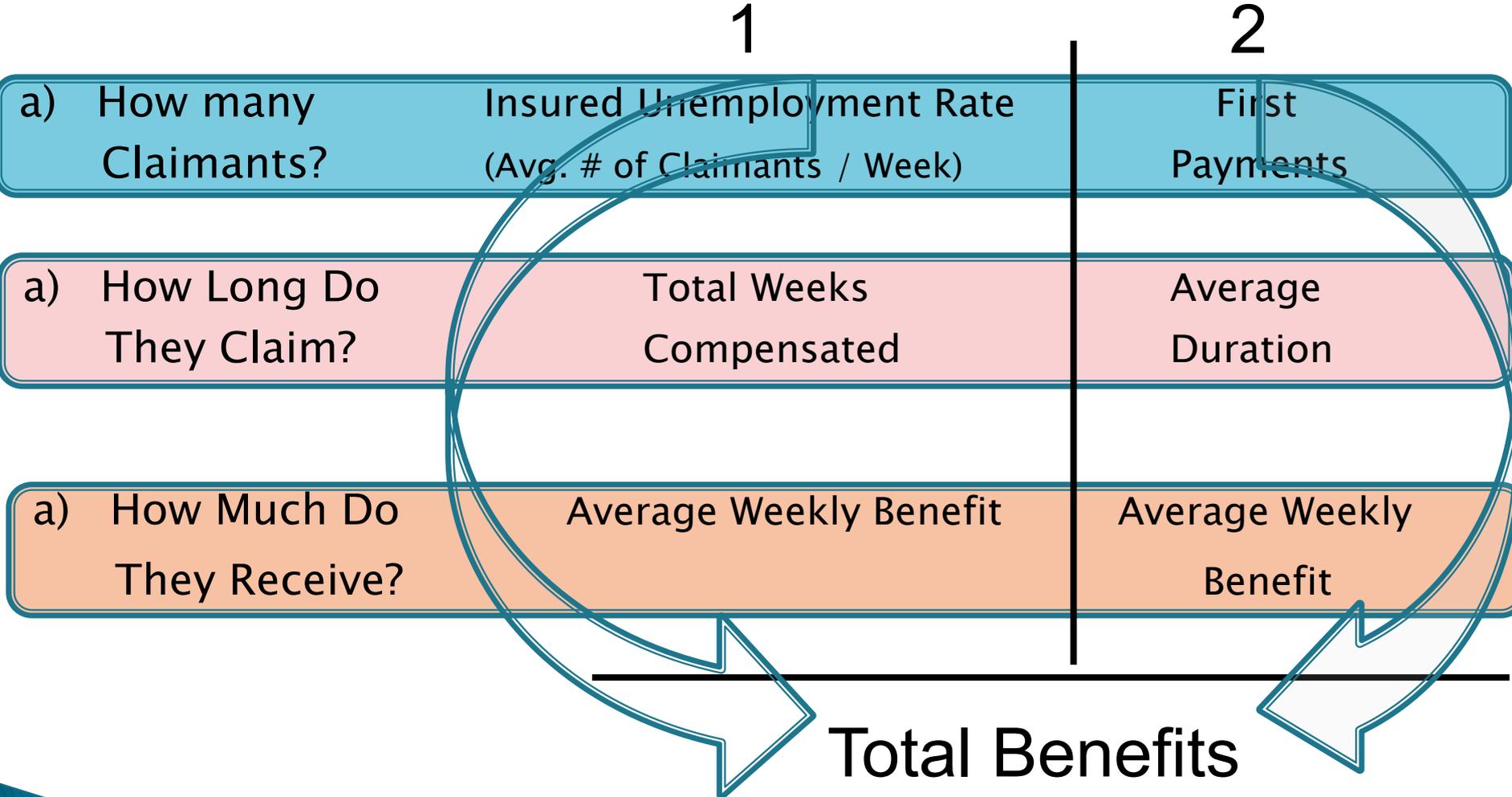
## Answering Three Questions:

1. How Many People are Receiving Benefits?
2. For How Long Do They Receive Benefits?
3. How Much Do They Receive?

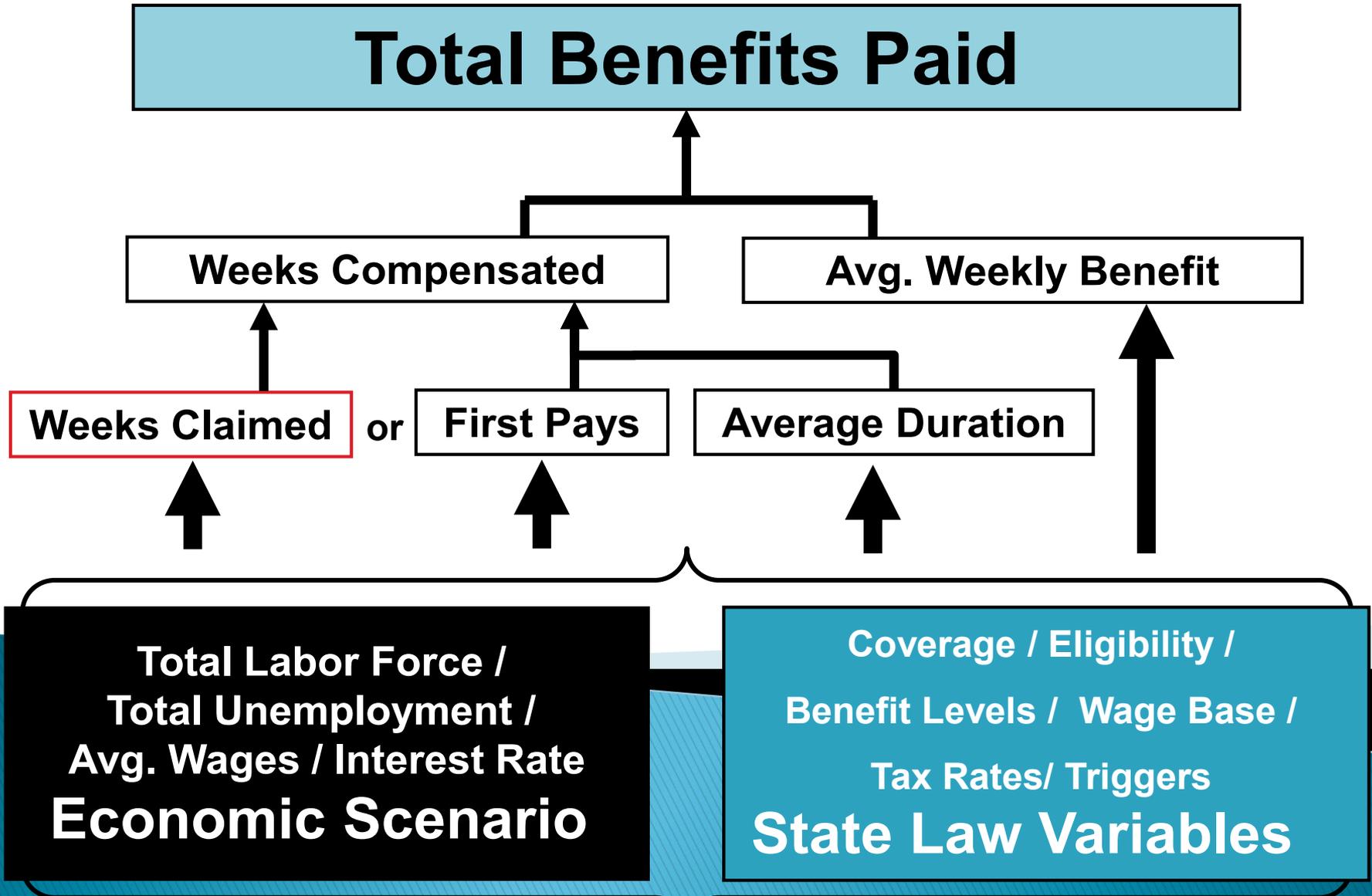
# Unemployment Flow - First Quarter CY2018 (000)



# Two Paths to Calculating Total Benefits



# Unemployment Trust Fund Modelling



# Unemployment Trust Fund Modelling

**Weeks Claimed**

**\* Time Period (Weeks)**

**Insured Unemployment**

**IUR**

**Covered  
Employment**

**TUR**

**Total Labor Force /  
Total Unemployment /  
Avg. Wages / Interest Rate  
Economic Scenario**

**Coverage / Eligibility /  
Benefit Levels / Wage Base /  
Tax Rates/ Triggers  
State Law Variables**





# Estimating Insured Unemployed

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

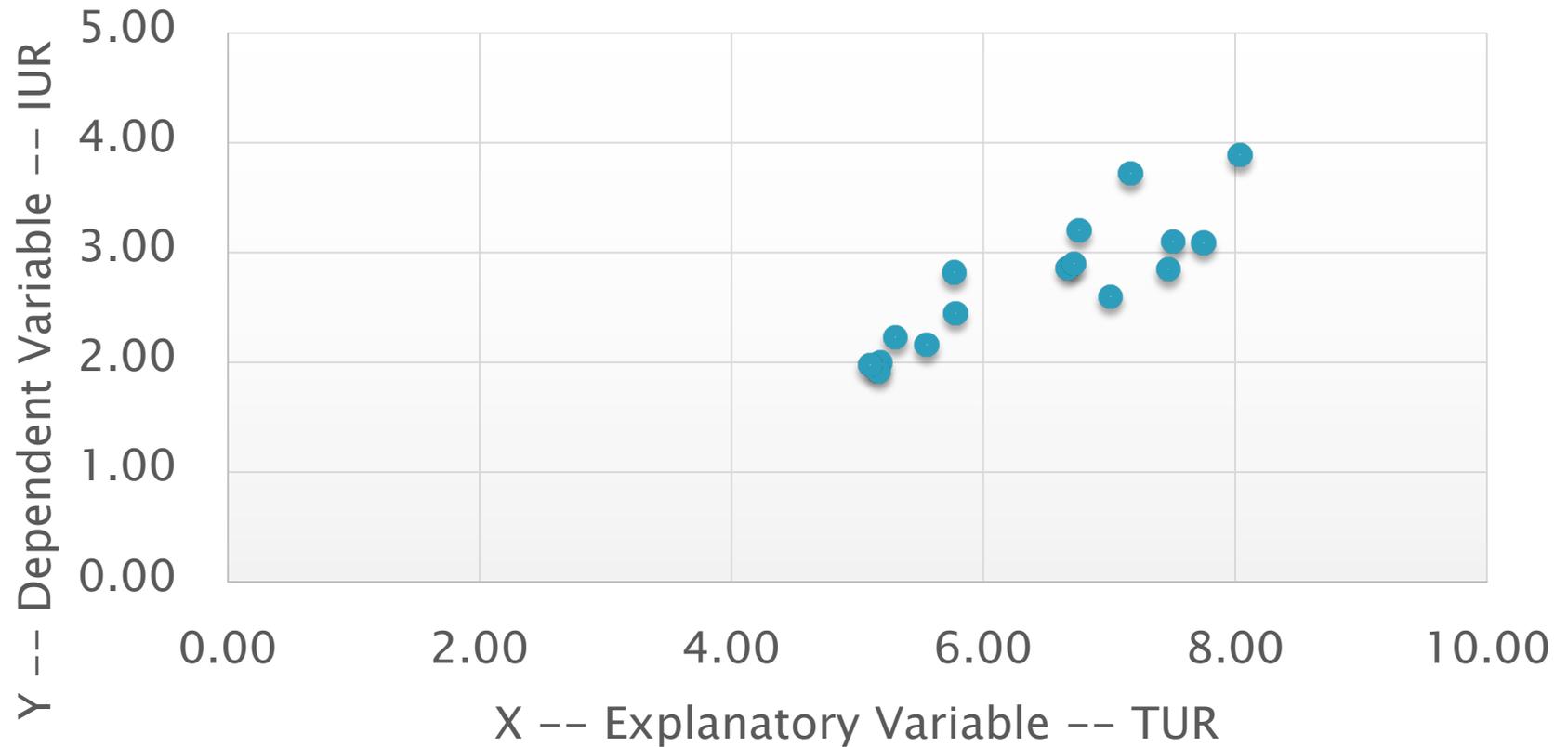
# Time Series UI Data: IUR & TUR

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



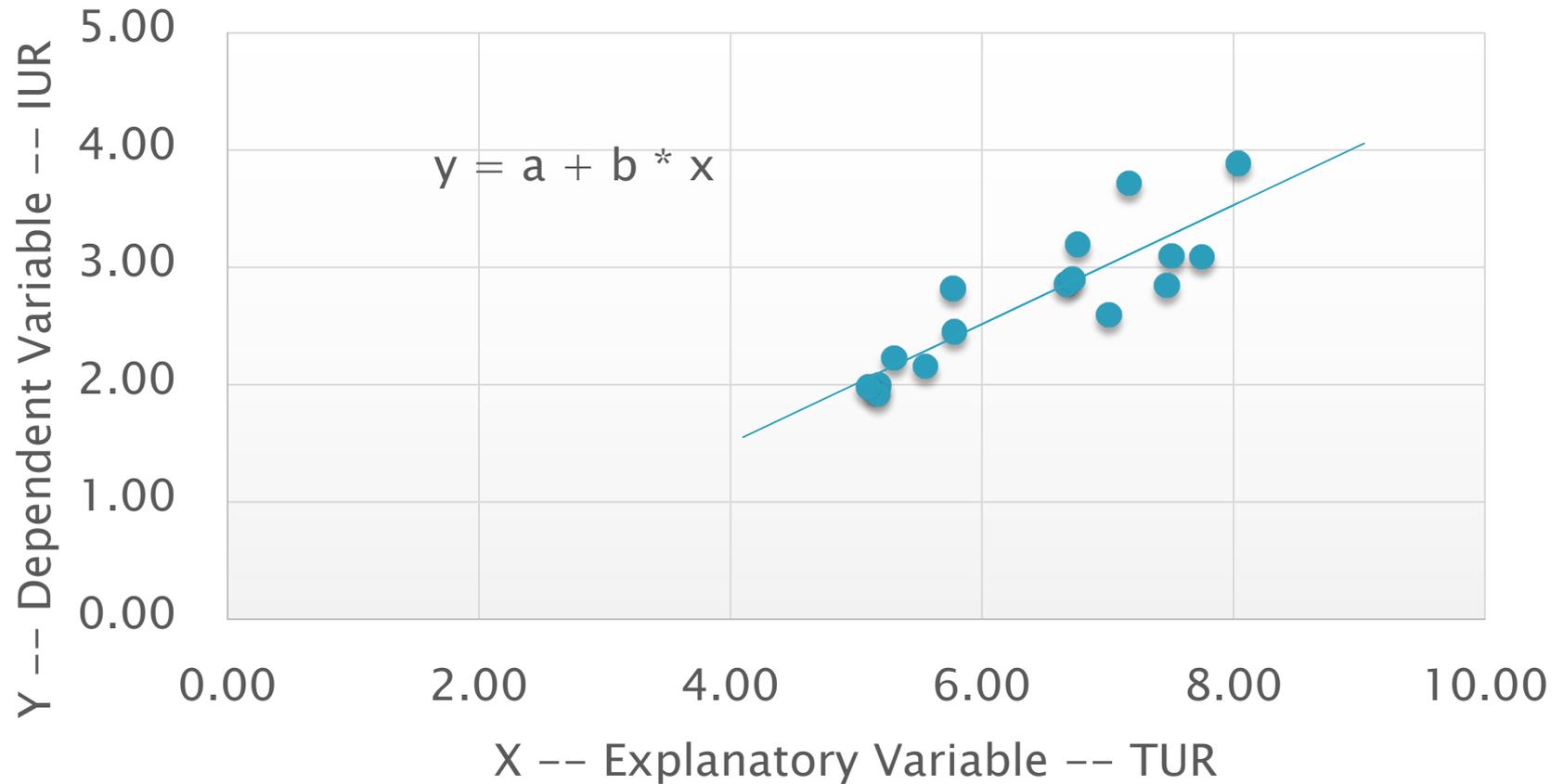
# IUR & TUR Scatter Plot

TUR – IUR Scatter Plot

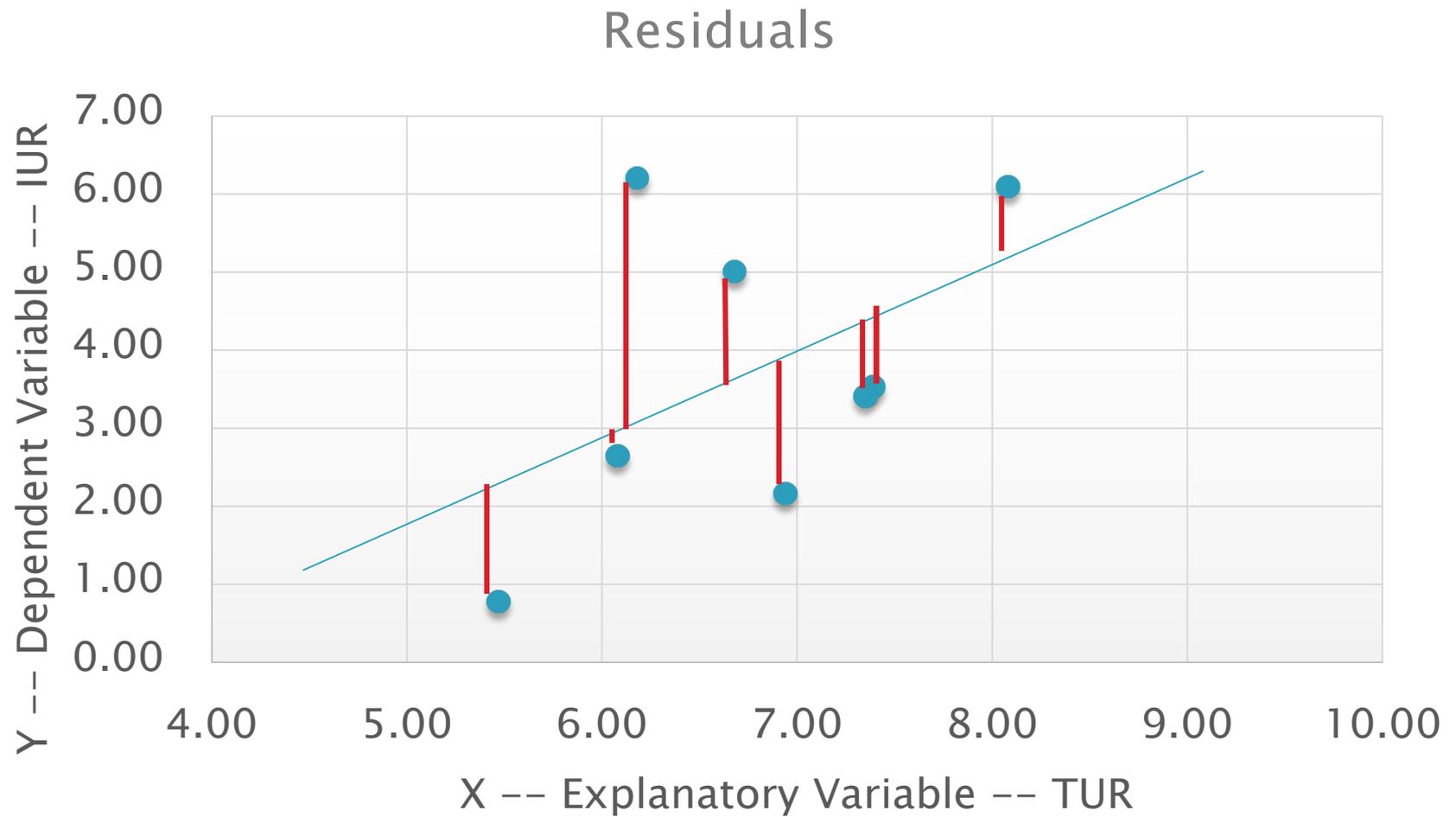


# Regression Line "Fit"

TUR – IUR Scatter Plot w/ Trend

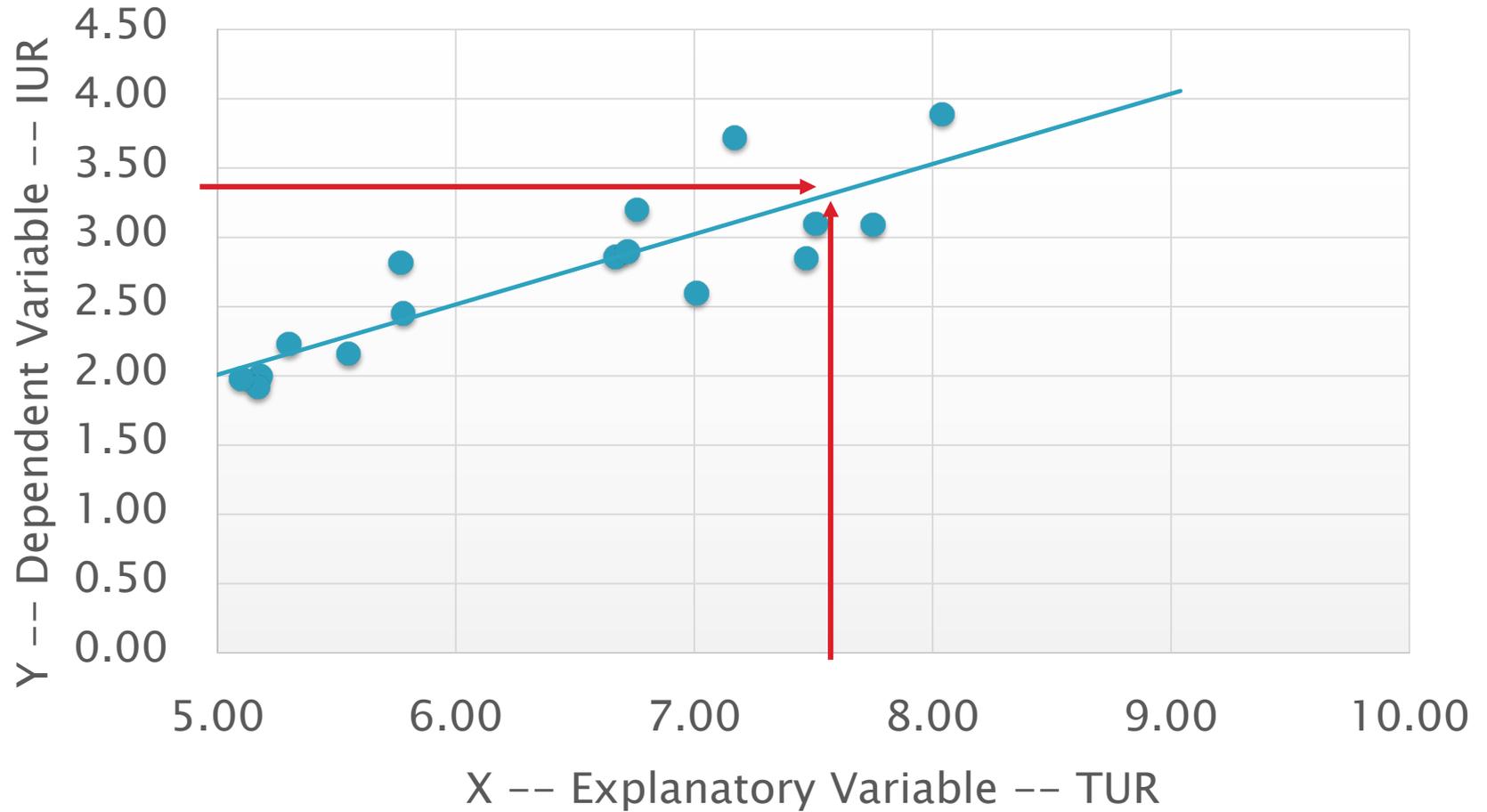


# Line Fit and Residuals



# Predicting IUR

TUR – IUR Scatter Plot w/ Trend





# Regression Equations

▶  $y = a + b * x$

◦ IUR = Intercept + Coefficient(b) \* TUR

▶  $y = a + b1 * x1 + b2 * x2 + \dots + bN * xN$



# 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)**

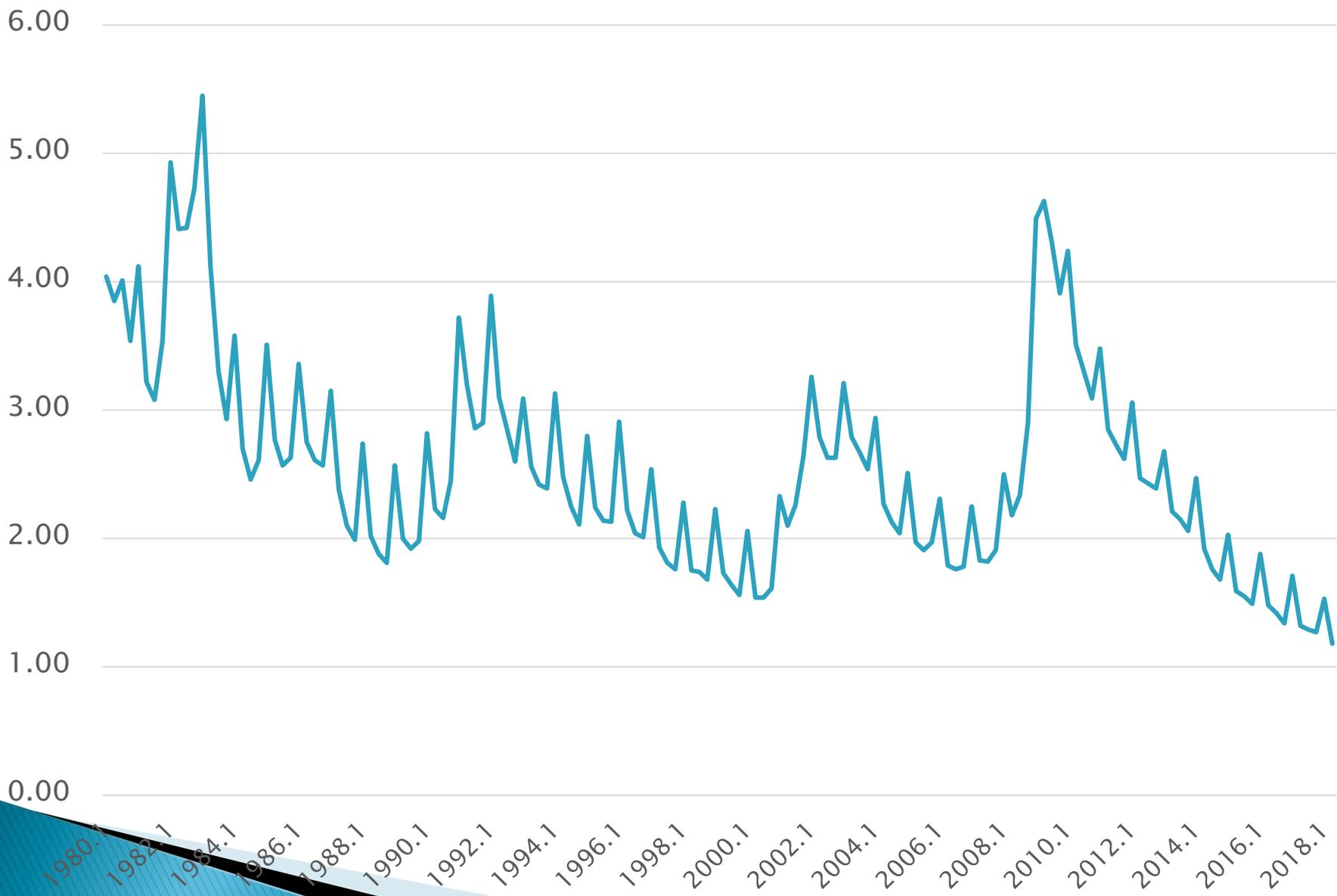


# IUR Regression Data – IUR, TUR, lags/leads, Indicators, etc...

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



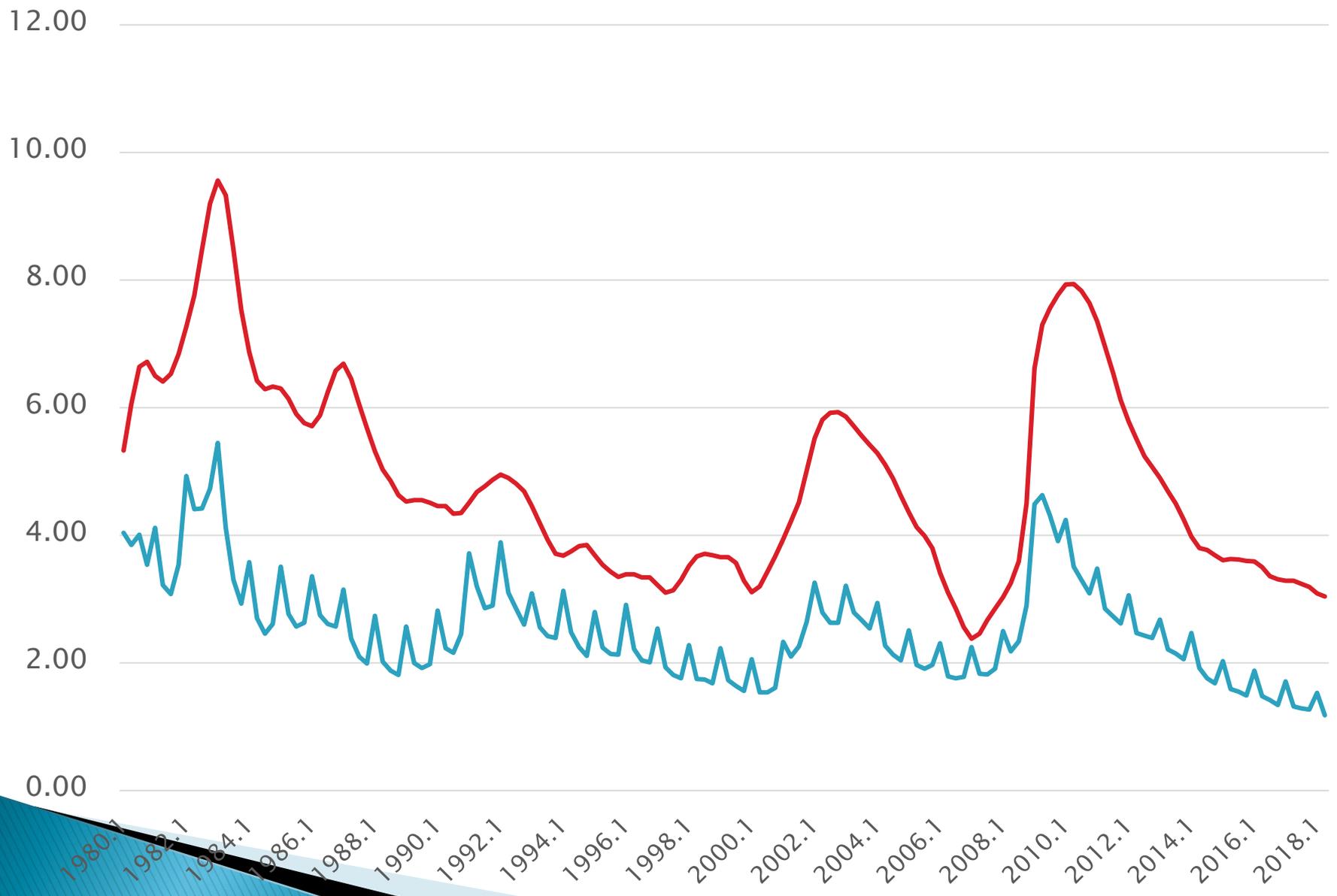
# IUR Not Seasonally Adjusted





IUR Not Seasonally Adjusted

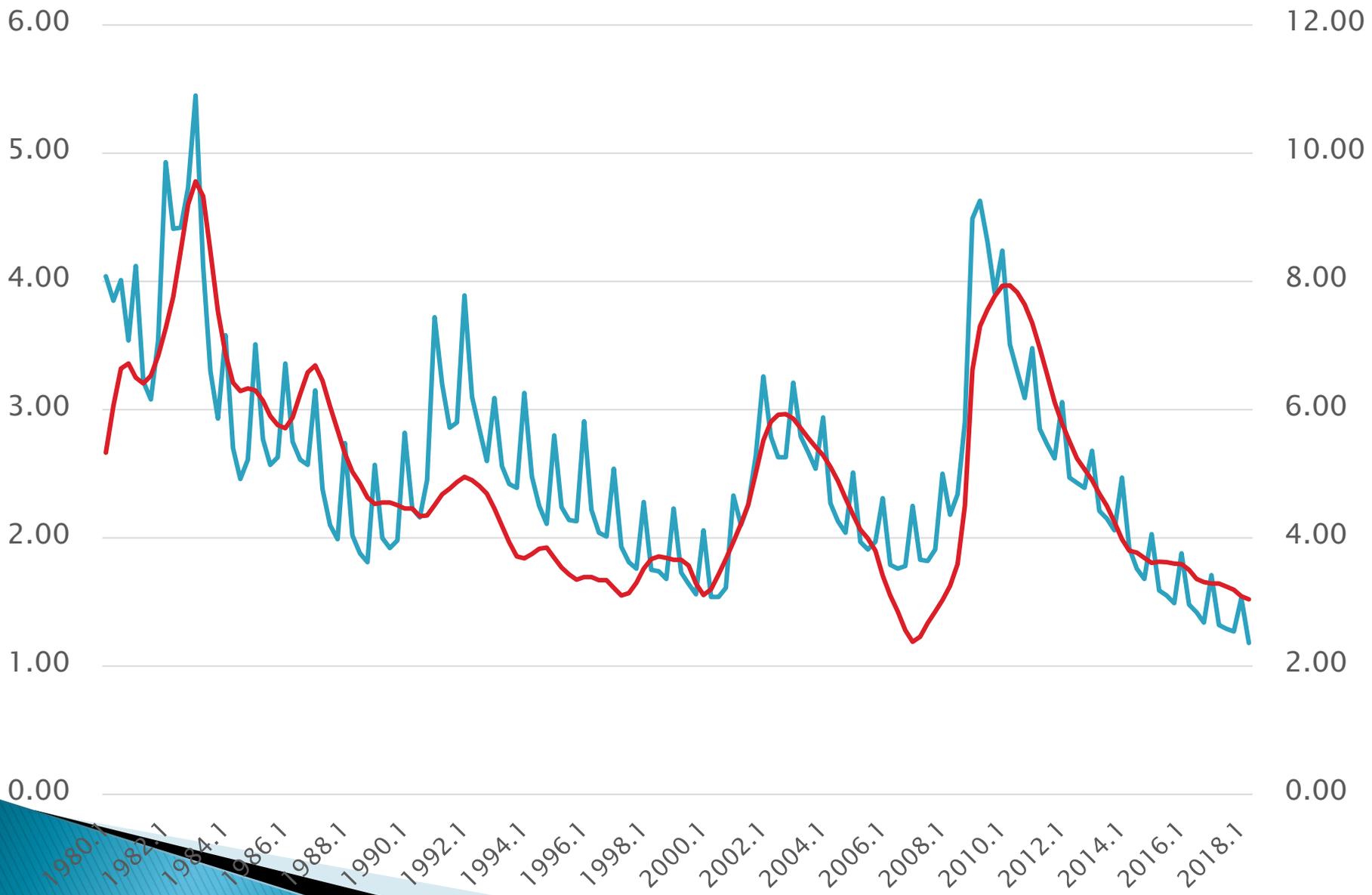
TUR Seasonally Adjusted





IUR Not Seasonally Adjusted

TUR Seasonally Adjusted





# 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:
  - $t \text{ Statistic} = \text{Coefficient} / \text{Standard Error}$
  - $t \text{ Statistic} > 2$  or  $P\text{-value of Coefficient} < 0.05$
  - 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