An Overview of
The Unemployment Insurance Revenue Forecasting Model

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The Unemployment Insurance program is a federal-state partnered program. The Revenue Model Package provides state-UI tax revenue forecasts for all states (including the Virgin Islands, Puerto Rico and Washington, DC) and sums the state forecasts to obtain a national forecast. The federal (FUTA) revenues are projected at the national level.

The purpose of this paper is to provide a general overview of the model. The rest of this paper is divided into three sections. Section One provides a list of terms and definitions used throughout the paper. Section Two contains a general introduction to the forecasting model. Section three outlines the specifics of the UI revenue forecasting model. The model consists of seven linked Excel spreadsheets. Each spreadsheet serves a distinct function and each will be covered individually.

Terms and Definitions

The following terms and definitions are used throughout this paper:

Covered Employment (CE)	The number of employees covered by UI reported to the states by employers.
Covered Wages (CWG)	Total wages of all employees covered by UI system, including wages that surpass the Taxable Wage Base.
Taxable Wages (TAXWAG)	Wages paid to Covered Employees that are subject to state UI taxes. Taxable Wages are a function of the Taxable Wage Base and number of Covered Employees in the state.
Average Tax Rate (ATR)	The weighted average tax rate levied on Taxable Wages in the state (or nation).
Liabilities (for deposits)	The amount owed by states based on the projected Average Tax Rate for a calendar year and the Taxable Wages for the same time period.
Deposits	Deposits made by states into their UI Trust Funds; annual revenues generated by state UI taxes (excluding FUTA). Deposits lag liabilities by 3 months.
Benefits (BEN)	UI payments made by states to qualified unemployed individuals. Benefit payments are forecasted separately by the Department of Labor using the Newman model.
Reimbursables (REIMB)	Benefits paid or Contributions received from state and local governments and/or non-profit organizations that are not subject to UI taxes. These organizations reimburse the UI system for any claims made by former employees.
State Share	A state's proportionate share of a particular national variable.
TAXTOT = TAXWAG / CWG	The ratio of Taxable Wages to Covered Wages. The calculation of the projection varies by state depending on whether the state has a fixed or indexed Taxable Wage Base.
Avg. Annual Wage (AAW)	Covered Wages divided by Covered Employment.
Taxable Wage Base (TWB)	The dollar amount of Covered Employees' wage or salary subject to

	UI taxes. May be a fixed dollar amount or an indexed level. Usually indexed TWB is linked to some form of the Annual Average Wage.
Fixed-base state	A state whose TWB is a fixed dollar amount
Indexed state	A state whose TWB is indexed, or linked to some form of the AAW.
Trust Fund Balance (BAL)	The balance in the individual state UI Trust Fund at the end of the Calendar Year (for use in the ATR calculations).
FY TF Balance (FYBAL)	The loan model displays the individual state UI Trust Fund at the end of the Fiscal Year. Also, many states base their ATR calculations on either a FY balance or a balance ending in another month. Each state stores and uses a specific balance depending on its state laws.
Tax Trigger Date	The date based upon which the UI tax schedules and Taxable Wage Bases are determined for the following year. The date used varies by state.
Reserve Ratio (RR)	The ratio of the (FY or CY depending on state) Trust Fund Balance to a one-year lag of (CY) Covered Wages.
Benefit Ratio (BR)	The ratio of (CY) Benefits to (CY) Covered Wages.
Last Historical Year (LHY)	The last complete calendar year in which all of the data needed for the model are available. The term is used as a reference point when discussing time periods needed for different calculations.
First Forecast Year (FFY)	The first year in the 10-year forecast window. Sometimes the first forecast year includes partial available actual data, but it is not used in determining the coefficients for the regression equations.
FUTA	Federal Unemployment Tax Act. The revenues collected under this act fund the federal portion of the UI program.
Reed Act Distribution	Yearly transfers, if certain conditions are met, of excess funds in the federal unemployment accounts to state UI Trust Funds.
ATR, ST Estimate (ESTTR)	Each State provides an independent estimate of their Average Tax Rate on Taxable Wages for the following 1-2 years. These are used, when available for the first and/or second forecast year.

The Revenue Forecasting Model Package

This model generates revenue forecasts for the 53 separate states and then aggregates them to get a national revenue stream. The UI system has flexibility built into it, so that states have a lot of leeway in determining their financing options. For this reason, the approach of using 53 different models allows the user to incorporate each state's specific laws and revenue patterns in determining the forecast.[1]

A simplified flow diagram of the each state model is depicted in Figure 1. The model can be conceptualized as consisting of two distinct parts. The upper portion of the page shows the derivation of state taxable wages (TAXWAG). The lower portion of the page shows the derivation

1 Please refer to O'Leary, pp. 393-416 for a detailed description of state UI flexible financing.

of the Average Tax Rate on taxable wages (ATR). The combination of these two variables yields state deposits, or revenues.

State taxable wage (TAXWAG) forecasts originate from three main sources, represented on the table by the first column of boxes on the upper portion of the page. The first source is the national budget assumptions. These national assumptions establish the growth pattern in covered wages. The second source is recent state collections data. This data leads to calculations of state shares and reimbursement percentages to yield state covered wages. State shares are assumed to remain constant throughout the forecast window. Finally, national and state historical data are used to obtain the regression coefficients for the ratio of taxable to covered wages (TAXTOT). Combining the TAXTOT ratio with state covered wages yields state Taxable Wages (TAXWAG).

The lower portion of figure 1 portrays the second regression equation in the model. To forecast the average tax rate on taxable wages (ATR), the model uses regression analysis to establish the historical relationship between ATR and various lagged independent variables (based on the state's reserve ratio (RR) and benefit ratio (BR)). The model then forecasts the ATR one year into the forecast period. Once the ATR for the first year is determined, the model calculates new values for the lagged independent variables. These values are used to predict the tax rate in the next year of the forecast and the process repeats itself to the end of the 10-year forecast period. Note that Benefits enters the forecast separately. The national Benefits forecast is apportioned across states based on state shares in the latest collections year.

The model is comprised of seven linked Excel spreadsheets: Revenue, Import, USCalc, Taxrate, Output, Loan, and USLoan. Sections that follow discuss these seven linked Excel spreadsheets.

The National UI Forecast: The Revenue Spreadsheet

The Revenue spreadsheet is linked to the other six spreadsheets and provides the formal forecast for state deposits at the national level. This spreadsheet also provides the forecast for FUTA deposits.[2] FUTA collections liabilities are presented in a quarterly format and then summed to annual values at the bottom of the page.

Historical Values: The Import Spreadsheet

All of the Excel spreadsheet links originate at the Import sheet. The primary function of the Import spreadsheet is to house (1) annual and quarterly budget assumptions, (2) historical values of key variables for all states (TWB, AAW, TAXTOT, ATR, BEN, BAL, CWG and CE), and (3) various other elements (REIMB, ESTTR, FUTA estimates) used throughout the model. Historical values are stored on separate pages for each state to facilitate the import process for state forecasts in the Taxrate and Loan spreadsheets. In this manner, the Import spreadsheet simply serves as a reference page for other parts of the model.

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2 For a more detailed discussion of FUTA, please refer to the Appendix to Chapter 8 in O'Leary. (pp.355-361)

The Import spreadsheet also calculates reimbursable percentages for each state. Reimbursables are contributions received or payments made on behalf of state and local governments and/or nonprofit organizations that are not required to remit taxes for state deposit purposes. Rather, these institutions merely reimburse state trust funds for any payments made to former employees. To calculate future payments made to these idled workers and payments received on their behalf, the UI model uses the ratio of Reimbursable Benefits to Total State Benefits (Regular State Benefits plus Reimbursables), and Reimbursable Contributions to Regular State Benefits for the last 3 collections years, and assumes that these ratios remain constant throughout the forecast.

Note that both ratios use benefits as the denominator. This is because by nature reimbursable benefits and contributions are both linked to benefit levels. For example, if a state's total benefit level rises but taxed contributions fall in the same year (not an uncommon phenomenon), the reimbursable contributions would rise with the benefit level increase, rather than fall with the pattern of taxed contributions. The magnitudes of both ratios are relatively small across all states, ranging from one to15 percent of total benefits.

State Forecasts: The USCalc Spreadsheet

The primary purpose of the USCalc spreadsheet is to provide state forecasts for the following variables: CWG, BEN, CE, and Reed Act Distributions[3]. The model forecasts these variables for each state using the US forecast and the assumption that individual state shares remain constant throughout the forecast. The latest state collections data and the US forecast are linked to the Import spreadsheet.

Located separately in the USCalc spreadsheet is the forecast of the Taxable Wage Base, Average Annual Wage and Actual Taxable Wage Base for each state for the period starting two years prior to the forecast period and including the 10-year forecast window. This section (on the Assumptions page, columns L-AA) allows the user to update Taxable Wage Base information based on legislation currently in effect. For fixed-base states, the Taxable Wage Base is filled in for all years and is assumed constant, unless a legislative change is mandated for a future year. For indexed states, a value appears for the last historical year (LHY), the first forecast year (FFY), and, when available, the second forecast year, while future values are left blank. Future values will be calculated in the Taxrate regression spreadsheet based on the state's indexation to AAW.

Regressions and Forecasts: The State Tax Rate Spreadsheet

The Taxrate spreadsheet uses state data from the Import and USCalc spreadsheets to perform two OLS regressions. The first regression derives coefficients for the state TAXTOT forecast (ratio of

[3]A state's share of any Reed Act distributions is based on the state's share of FUTA collections in the latest collections year. The state share is assumed constant over the forecast.

Taxable to Covered Wages). The second regression derives coefficients for the average state tax rate on taxable wages (ATR) forecast. Based on these regressions, the spreadsheet forecasts any remaining pertinent variables as well (BAL, RR, and variations thereof).

The Tax rate spreadsheet contains a separate page for each state. The TAXTOT calculation is dependant on whether a particular state is a fixed-base state or an indexed state. To forecast TAXTOT (and therefore Taxable Wages) for fixed-base states, the model uses a simple linear regression where TBAAW is the sole explanatory variable. TBAAW is equal to the TWB (assumed constant for fixed-base states) divided by the AAW. As expected, the TAXTOT forecast for fixed-base states declines continuously along with TBAAW. For indexed states, the forecasted TAXTOT is simply an average of the historical TAXTOT. This is because the idea behind indexing the TWB is to have the TWB grow at approximately the rate of wage growth, keeping TAXTOT relatively constant.[4]

Using the forecast methodology, the forecasted TAXWAG for fixed-base states is now equal to the following:

(1) $TAXWAG = TAXTOT * CWG = [\alpha + \beta_1(TWB * (CE/CWG)] * CWG$

(2) $TAXWAG = \alpha CWG + (\beta_1(TWB)(CE))$

Therefore, assuming there is no change in TWB, the constant term or β_1, any revisions to the CWG and/or CE forecast will impact TAXWAG.

In the Taxrate spreadsheet, each state model is located on a separate page. Historical values are at the top of the page while forecasted variables appear at the bottom. The historical values are linked to the Import spreadsheet while forecasted values are either calculated from data residing on the page or are linked to the USCalc spreadsheet. (Note: Unless otherwise specified, all variables that appear on these pages are Calendar Year (CY) values.)

The Average Tax Rate (ATR) and Trust Fund Balance (BAL) must be forecast through an incremental process. Using the ATR regression coefficients, the average state tax rate is forecast for one year. Given the ATR, liabilities for deposits are determined. These liabilities, lagged 3 months produce forecasted state deposits. At this point, the next year's values for BAL can be calculated. This calculation takes place in the Loan spreadsheet, and takes into account previous balances, contributions minus benefits (both including reimbursables), Reed Act distributions, and any interest accumulated.[5] The ATR can then be forecasted out another year and the process repeats itself.

Below are examples of relevant explanatory variables for tax rate regressions and their components.

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4 For more information on Taxable Wage Base and its relationship to UI Funding, See pp. 325-334 in O'Leary.

5 All interest rate assumptions used for both loan and trust fund balances are from the national budget assumptions (1st block in figure 1).

Benefit Ratio (BR) = BEN divided by CWG.
Reserve Ratio (RR) = BAL (the month used depending on the state) divided by LCWG.
LBR is a one-year lag of BR. (Variations include L2BR)
LRR is a one-year lag of RR. (Variations include L2RR)
AV5BR is the average of the previous 5 years' BR. (Variations include AV3BR, AV4BR)
AV2RR is the average of the previous 2 years' RR.
RRBR3 = the previous 3-year sum of RR divided by the previous 3-year sum of BR.
TAXTOT is sometimes used as an explanatory variable in the ATR regression.
LTXT is a one-year lag of TAXTOT.

In addition to the variables listed above, many state tax rate regressions contain dummy variables in the model. In general, dummy variables are used to preserve theoretical relationships and increase the predictive power of the explanatory variables. Two types of dummy variables are used throughout the model for selected states.

One frequently used type of dummy variable is a "threshold" dummy, which uses a threshold to identify unusual patterns or levels in a variable. The most often used example in this model is a variable named DNRR. DNRR takes a value of 1 to capture the impact of years (consecutive or intermittent) characterized by very low or negative reserve ratios. When used for a particular state regression, a threshold value is selected and applied to all years to determine the value of DNRR. (During these periods, average state tax rates will often "peak," therefore the usual relationship between LRR or RRBR3 and the ATR will not hold.) Along the same concept, some states use dummy variables for unusual patterns in BR.

The second type dummy variable is a "time period" dummy. These are named DUM in this model. The DUM variable serves two purposes. It removes the impact of outlier observations and captures the impact of recent legislative changes. Typically, DUM will take a value of 1 for consecutive years immediately preceding the forecast period, and will either extend through the forecast period or be turned off, depending on whether the time period is deemed to be a permanent shift or a temporary shock.

It is hypothesized that the explanatory variables should have the following relation to movements in the average state tax rate: LRR(-), LBR(+), AV5BR(+), RRBR3(-), LTXT(-), and TAXTOT(-). Some state equations use Generalized Least Squares (GLS or first-differenced equations) due to serial correlation.[6] It is noted that even if coefficients do not attain the expected sign, it does not imply that the variable should be excluded from the equation. In any case, economic theory should remain the primary motivation for selection of explanatory variables.

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[6]The equations assumed a rho equal to one, which eliminates the intercept term from the equations. This assumption implies an original Durbin-Watson statistic of 0 (pure positive serial correlation), which is unlikely. For these GLS equations, the R^2 statistic should be ignored as it no longer retains its normal interpretation.

A few states are no longer using regression equations to forecast ATR. Instead, schedules are set based on their laws. These schedules still refer to the levels of the independent variables mentioned above (most often, LRR) to determine their position on the set schedule for each year. For these few states, this method had more predictive power than regression equations did.

Additionally, most states add on the cell in a column titled "TXADJ" (column AO) in their ATR forecast. This is an adjustment to their tax rate that happens outside of the regression equation to account for a change in the Taxable Wage Base in a fixed-base state. The TXADJ variable is rarely triggered "on", so it usually is 0. However, if it is triggered on, the ATR will adjust downward by a certain amount depending on the rise in the TWB. The assumption behind this part of the model is that a rise in TWB would be offset somewhat by a fall in the ATR so as not to have a tremendous shock in the revenue stream.

The Output Spreadsheet

The Output spreadsheet lists state and national values for selected variables from the Taxrate spreadsheet. The Output spreadsheet serves as a central location for state output and the summation of state values to national values.

The Loan Spreadsheet

The Loan spreadsheet works in tandem with the Taxrate spreadsheet to generate trust fund balance flows by disaggregating annual benefits and CY liabilities into monthly patterns. The CY liabilities are then lagged by three months to determine actual deposits into the trust fund. This spreadsheet also calculates interest owed on outstanding state loans and interest earned on Trust Fund Balances.

The primary purpose of the model is to track loan activity (including the interest owed on outstanding state loans), but loans are very rare. More frequently, the predicted monthly trust fund balances are used for the calculation in the Taxrate spreadsheet of reserve ratios (RR) for the ATR equations. Each state by law sets its own "tax trigger date", which is the date on which the following year's ATR is calculated. Since the Loan model is set up as a monthly ledger, the balance at the end of each month is available for each state. This allows the state models to use the RR based on the balance as of the "tax trigger date" that is actually in place for each state.

The first page of the spreadsheet has "control" variables with items such as interest rates (linked to the Import spreadsheet) and starting loan balances. The second page contains monthly splits which are derived from historical state data and which allow the annual benefit and deposit numbers to be disaggregated. The model assumes that these monthly splits remain constant for each state throughout the forecast. There is also an output page which summarizes the more important data generated by this part of the model.

The USLoan Spreadsheet

The USLoan spreadsheet simply displays the US aggregate results of the calculations from the Loan model.

References

O'Leary, Christopher J. and Stephen A. Wadner, ed. 1997. *Unemployment Insurance in the United States.* Kalamazoo, MI.