PRESENTATION ON FORECASTING MODELS

before the Unemployment Insurance Task Force

July 26, 2005

Good afternoon, Distinguished Chairs and Members of the Task Force, my name is Judy Johnson. I work for Employment Security Department as the Unemployment Insurance Program Legislative Coordinator. It is a pleasure to address you today.

I've been asked to describe to you our forecasting models, and explain how we use them to estimate the impacts of changes made in the UI system. My hope is that I can leave you with a better understanding of the value of these tools and that you can share our confidence in their validity and accuracy. I'll also touch on what we've done at Employment Security to improve the data request process as outlined in an email that was sent to you late last week.

I'll start today with why modeling is necessary, an overview of what models do and how they work. Then on to a description of the specific models we have - their purposes, uses and accuracy rates. I'll finish with the improvements we are making in the whole area of modeling and data requests, including our recommendations on assumptions to use on data requests and on the request process itself.

Why is "Modeling" necessary?

But first, let me step back for a moment to remind us why modeling is necessary. It is obviously important to all of us that the Unemployment Insurance system remains solvent, that is, that dollar outlays do not exceed dollar income. It's like your own or your business's bank account. There's always a beginning balance, then dollar inputs like income and interest, then dollar outlays of paying bills or salaries, which result in an ending balance each month or each year. The Trust Fund works exactly the same way.

But how can we project future inputs and future outlays? In your bank account, you have a fairly good idea about what some or most of your income will be, and a concept of what your payouts will be too, with some certainty. And then you can usually estimate other income and other expenses too, based on your historical experiences, your knowledge of your present situation, and to some degree on what's going on around you and your community, and what you see as trends in society. You project all these dollar inputs and dollar outlays so that in the end, you can project what will be left in your bank account - hopefully enough left over for any bad times when you may have more going out than coming in.

We approach our fiduciary responsibility for the UI Trust Fund the same way - we must try to project the future – both *Dollars In* and *Dollars Out*! Just a lot more dollars! Fortunately, we have great tools - including forecasting models, which have proven over the years to be very reliable. For example, since 1985, our projections of the ending balance in the Trust Fund have held true to within two percent of actuals - in other words, a 98% accuracy rate. We're able to do this because using our models, we can accurately project what the *Dollars In* and *Dollars Out* will be, starting with just two forecasted numbers:

- We project *Dollars In* based on the forecast of the total dollar amount of wages employers pay to workers– known as **"*Total Wages*"**. This number comes from the Economic and Revenue Forecast Council.
- We project *Dollars Out* based on a forecast of the number of weeks of unemployment benefits workers will claim – known as **"*Weeks Claimed*"**. This number comes from a time series analysis using historical data.

From these two forecasted numbers (Total Wages and Weeks Claimed), through a series of calculations using historical data, we have been able to accurately project the amount of taxes that will be paid into the Trust Fund and the amount of benefits that will be paid out of it.

- Another factor related to *Dollars In* is the amount of each worker's wages subject to Washington's UI tax, known as the "taxable wage base". Since 1988, using the Forecast Council's "total wages" forecast and our models, we have accurately projected three years in advance the "taxable wage base" with 99.5% accuracy.
- For *Dollars Out*, our forecasts of new claims came in at a 99.1% accuracy rate over the last 33 years. The new claims forecast uses data from January 1, 1971 through September 30, 2004. During that entire period, our models estimates 8.93 million new claims and the actual count was 8.95 million.
- The forecast for weeks claimed for that period was 142.4 million weeks, while the actual was 141.7 million weeks, an accuracy rate of 98.5% over 33 years! We derive *Dollars Out* directly from how many weeks are claimed.

What is a "Model"?

So, you may be asking, "What is the "Model?" It's a collection of formulas and data that uses historical, forecasted, and computed information to predict the future. Models are basically elaborate, computerized simulations of reality that use data from reliable sources and standard statistical analysis methods and lots of algebra to estimate future trends based on historical patterns – to literally forecast what "reality" will look like in the future. Our UI forecasting models consist of millions of pieces of data, some going back as far as 1967. One of our models and some data are stored on a mainframe in Washington, D.C.; others use PC-based applications or are on servers here at the Employment Security Department.

Because models are only simulations of reality, they have limitations. Most presuppose that what happened in the past is likely to happen in the future…and that relationships that existed in the past will continue to exist into the future. When major changes are made in the UI program, the models must be examined and adjusted accordingly. Once adjusted, the models can do a "time series analysis" which looks at a 'series' of historical data to accurately forecast the future trend. For example, when Second Engrossed Senate Bill 6097 changed the calculation for the weekly benefit amount in 2003, we adjusted the model to project what the average weekly benefit amount would be in 2004, which was necessary to be able to project the *Dollars Out* for 2004. After making the adjustments to the models, we projected that the average weekly benefit amount would be $294.12 in 2004. Now in retrospect, the actual amount turned out to be $293.57, a difference of only 55 cents, or 99.8% accurate!

Why do we use models?

In Washington State, historically we've used models to forecast our workload so we knew how many staff we'd need to hire and train to process claims and collect taxes. More recently, we've also used the models to accurately project when we would trigger into and out of the federal program that provides extended benefits to claimants during periods of high unemployment. This allowed us to do the necessary automation and notify the public of these events on time. We've never been mandated to forecast these items, but it's our way of doing business because it's important to manage our administrative funds.

In the past few years, these forecast models were adapted to help the legislature make informed public policy. First and foremost, estimating the solvency of the trust fund, but also to help stakeholders and the legislature make informed decisions on how law changes will affect the system.

How do models work?

Let's take a look at each of three components of a model to better understand how the models work to project the future. The three components of a model are: Inputs, Calculations, and Outputs. The model takes the inputs – or the "what if", applies the calculations, and produces outputs – or the projected "what will be".

- The inputs in our models include historical data, laws, and assumptions (such as the state of the economy, interest rate on the trust fund, etc.). A change in any of these will naturally change the outputs. For example, changing the assumption about the state of the economy from a moderate growth economy to a mild recession will result in a different output for the amount of benefits we will pay out and also the amount of taxes employers will pay in. Changing the law that determines which types of employment are covered by unemployment insurance

will result in different outputs, too, for both the amount of taxes that will come in and benefits that will be paid out of the Trust Fund.

- The types of calculations in our models range from simple formulas to complex statistical analysis methods that are commonly used by the insurance and financial investment industries to determine prices, risks, and strategies. These include regressions, simulations, and time series analysis like ARIMA (the Auto-Regressive Integrated Moving Average), which the Forecast Council also uses and is considered to be the most reliable method of forecasting a seasonal time series.[1]
- Outputs are the end results of all the calculations. Examples are the projected amounts of taxes paid in or benefits paid out, and of course, the most important, the Trust Fund Balance.

As you have probably figured out, having accurate Input elements -or variables- is important to getting accurate Output variables. That's why we use many years of historical wage and claim information, forecasts from the Forecast Council, and base other assumptions on industry-standard calculations. However, some input variables can be changed when running a scenario through our models – these are those "what if"s". When we use the models to provide projections to help stakeholders and legislators make law changes, the types of input variables that we usually need to change in the model are the laws and assumptions; for example, a change to the weekly benefit amount calculation or assuming a mild recession instead of a growth economy. Later I will talk about the key assumptions we recommend for future data requests. Sometimes, we also have to make changes to the historical data. Remember that to predict the future, models use data from the past. Therefore, to project what the future will be like due to a change in the law, we sometimes have to "reconstruct" the historical data to show what it would have been if the proposed law change had been in effect for a number of past years.

[1] Box and Jenkins (1976) Time Series Analysis: Forecasting and Control.

What models do we use?

To determine the *Dollars In* to and *Dollars Out* of the UI Trust Fund and to do most data requests, we use three different models, two existing confidential data sets of actual claimant and employer information, and additional confidential historical data, to help us more accurately estimate the future. The three models complement and corroborate each other – sometimes one provides information another does not; other times each provides the same information so we can cross-check the results. This allows us a high degree of confidence in the outputs the models give us.

I believe committee staff will brief you at a later date about what other states are doing, but one thing I can tell you for certain - we are the ONLY state that provides any in-depth level of projections in response to requests for data. We are the only state that has the capacity, and it's due to the models we use.

Those models are:

- A Benefit Financing Model from the United States Department of Labor
- A Model built by the Urban Institute
- The Washington Employment Security, or ESD Model

First, I'll describe the **Benefit Financing Model**.

The Unemployment Insurance Benefit Financing Model was developed in the late 1970's by the US Department of Labor (DOL). It is customized for each state to reflect our unique experience rating system and state laws. Much of its data is prefilled, aggregated, historical information that states submit on periodic reports to DOL. But the model allows an authorized user to input specific economic assumptions in order to project tax rates, trust fund balances, weeks paid, quarterly contributions, benefit liability, and solvency. It can be used to see how various economic scenarios will impact revenues and outlays; to measure how responsive the system is overall; and to some degree estimate the impact of new state laws and proposals. There are 129 variables in the workload projection program, and 139 variables in the financial forecast program. It can provide quarterly output on its key estimates.

Currently 23 states are using this forecasting model and more states are joining because of solvency troubles they've experienced during the last recession.

How ACCURATE is it, you ask? The Benefit Financing Model has proven to provide extremely accurate output. All major variables (taxable wages, taxes, benefit liability) can be calculated using 99% confidence levels (that is, we can be 99% sure that the outputs we get are not due to random circumstances). The model also ensures integrity by automatically running all regressions and equations and by rejecting any input that appears to be outside a reasonable range!

Next, I'll talk about the **Urban Institute Model**.

Dr. Wayne Vroman, considered the leading expert in UI financing in the United States, contracted with the Washington Legislature in the 1990's to evaluate the state's UI financing system. As a product of that analysis, he developed a simulation analysis model based on 28 years of historical information - from 1967 through 1994. Dr. Vroman coupled that history with provisions reflecting Washington's laws and with projections of important variables through 2005, in order to simulate the outcomes of various economic assumptions. The model has roughly 120 equations that determine UI benefits, taxes, interest income, and year-end trust fund balances. [2]

Each year since 1996, Dr. Vroman's model has been updated by Employment Security by replacing projected information with actuals, incorporating major law changes into the model's formulas, reconstructing the previous years' data to simulate the law changes, and then revalidating the changes made. The model is currently updated through 2004 so it remains a valuable tool that we can confidently use for forecasts through **2009**.

The Urban Institute Model can provide annual output on both benefit liability and benefit payments; while the DOL Model only provides benefit liability, not benefit payments. This is an important difference, because benefit payments reflect all payouts, while benefit liability reflects only the payouts that affect taxable employers. The Urban Institute Model also allows us to monitor the potential of needing Federal Extended Benefits.

In terms of ACCURACY: Past forecasts on major variables have been at 99% confidence levels. And, we were able to project far in advance exactly when we would begin and end an Extended Benefits period during the last recession.

[2] Vroman, W. (1996) An Analysis of Unemployment Insurance Financing in Washington. Washington, D.C.: Urban Institute, pp. 50-53.

Finally, let me describe for you the **Washington ESD Model**.

In the early 1980's, in response to new experience rating laws in Washington that conformed to new federal law, Employment Security research staff developed an additional model to project important variables. The ESD model can estimate consequences of certain policy changes, using historical variables such as employment patterns, wages, unemployment rates, benefits paid, taxes paid, and interest. This model generates annual and quarterly projections of key tax and benefit flows and the trust fund balance. In contrast, the Urban Institute model provides only annual, not quarterly information. Since the ESD Model displays annual and quarterly outputs, it can provide a glimpse of the seasonal nature of Washington's UI system, and allows outputs to be run in fiscal years as well as calendar years; while the other two models only allow outputs in calendar years. This model has 13 variables.

Employment Security research staff have also created two data sets, one with claimant data and one with employer data, that help us use all three Models effectively.

- The first data set is a file of all claimants who applied for unemployment benefits in 2004. This year-long sample has been validated as representative compared to any other year in terms of age, ethnicity, county of residence, language preference and other claimant-specific demographics. This data set is useful for estimating the impacts of different scenarios on claims by using actual claims, but recalculating one or two variables with a new "what if" scenario. For example, since this file contains base year wages for over 187,000 claims, simple computations allow us to estimate what the average weekly benefit amount would be if the benefit amount calculation were changed in state law.

- The second data set is a file of all taxable employers from 1995 to 2004, modified to simulate their tax rates as if the state had been using 40 rate classes since 1995. This is an important data set for estimating average tax rates under the new 40 rate class system - using ten years of simulated historical data to help project future trends. There are over 10 million records used to compile this data set, and it contains industry codes, wages, benefit charges, average tax rates and rate classes, so that we can simulate one year of industry movement among rate classes for any proposed "what if" scenario.

For scenarios not covered by the two existing data sets, ESD Research staff also extracts information from the agency's data warehouse, which contains millions of records of confidential historical data to obtain relevant information needed as input variables. We can access weekly claims, wage files, or benefit charging history in this manner, offering the ability to do, for example, a five-year tax rate projection based on industry.

But just how ACCURATE is the ESD Model? We are confident that this model is accurate because its outputs are always validated and cross-checked with the other two models. Using this model, we came very close to our early projections about benefits paid and taxes due in 2004. We projected total tax contributions of $1.35 billion; the actual was $1.34 billion, a 98.8% accuracy rate.

How do we use the models together?

All three models will do a projection for the trust fund balance, for tax contributions, average tax rate, and benefit liability. But only the Urban Institute and ESD Models can project total benefit payments. All three models can project the average and maximum weekly benefit amounts, weeks claimed and weeks paid, however only the Benefit Financing Model and ESD Model provide information about seasonality, or outputs in quarterly increments, or fiscal year as

well as calendar year outputs, while only the Urban Institute Model can project the start and end dates of Extended Benefit Periods.

Typically, because the ESD Model uses the most detailed data, we run a "what if" scenario with that model, and then validate the outcomes we get by running the same scenario on the Urban Institute and Benefit Financing Models, both of which use aggregated data.

Now let me give you a couple examples of turnaround time and how easy or how difficult a scenario might be to run using the three models and the data sets.

First I'll start with a data request that typically takes just a short time to run.

Changing the calculation of the weekly benefit amount is fairly simple and a short turnaround, even though it does not look simple on the flow chart. Why is it simple, then? Because we already have a dataset of claimants built, so we don't need to create a new data set. We simply change the weekly benefit amount calculation on the base year wages of those 187,000 claims in the existing confidential data set of claimants and then calculate the revised average weekly benefit amount that results. We record the new average weekly benefit amount in all three models; tell the models to process for output; then compare the results each of the models obtained to verify that they match. If they don't match, we check to see why, fix it, then rerun. When they match, as they usually do, we prepare an output document that displays the results in terms of average weekly benefit amounts, benefit payments, benefit liabilities and trust fund balances. Please remember, for changes in the weekly benefit amount, the effect on Tax Rates and Contributions is not reflected in the output sometimes until years after the projection period, because benefit charges never affect the employer's tax rate right away. (see "Claim and Tax Process Timelines" in Task Force notebooks)

A more complex data request with a much longer turnaround is one that requires us to create a new data set in order to analyze a request. One example would be projecting out five years a change in the calculation that sets the taxable wage base. It is more complex because it takes longer and it requires touching more files.

We must first extract confidential wage files from the agency's Data Warehouse: we'd start by creating at least five historical years of wage records on each worker for each employer in each year. With 12 million wage records per year, that's at least 60 million records, so we'd have to run this extract during non-business hours. (Running data extractions against more than 25 million records at a time can take down the agency's entire network. during the day). We must also change the formula in the Urban Institute Model to project five years of taxable wage base. Using the new taxable wage bases, we calculate the total wages and taxable wages for each employer; then convert those figures to aggregated totals. The new ratio of total wages to taxable wages is input into all three models, where regressions are run and the output generated. These outputs are compared. If the outputs do not match, we figure out why, fix it, and then rerun it. If they match, we prepare a document with our findings: taxable wages, taxes collected and trust fund balances.

There are a million iterations between the most simple and the most complex data requests - between the turnaround of "I can have that for you today" and the turnaround of "this one will take at least two weeks!" Generally a simple, short turnaround request will need just one "what-if" variable change, and not require detailed demographic or industry information, and uses existing data. Whereas a complex data request requires more time and planning because it is using more than one "what-if" variable, or calls for details on the industrial or demographic mix, or it requires our staff to build a new data set.

But whether we have the data or need to extract new data sets, it always comes down to inputting the data into the three models to validate and cross-verify each other, and then providing you with the outputs.

What improvements can we make?

The bottom line is this: We know that the models are reliable tools because we've successfully forecasted the solvency of the UI Trust Fund with a high degree of accuracy. Even through law changes that required updating the models, our forecasts of the Trust Fund balance have held true from 1985 through this year. We've been accurately projecting dollars in and dollars out!

If these models are so accurate, then why do errors happen and what do we plan to do about it? Given how standardized these models are, and how few variables are actually input manually, how is it even possible to get errors?

The answer is simple: it is not the models; it is the process and the way the outputs are transferred to the final form in which they're displayed. When data requests are flying furiously during the legislative session, with challenging deadlines, and/or modifications are made to original requests while the original output is still being built, there are bound to be anomalies.

- First, the asker may not get the needed answer because of the way a question is framed.
- Second, the answer may not mean the same thing to the asker as it does to the data preparer.
- Third, the final form in which the output is displayed may not get 100% verified before it is released - sometimes it's as simple as a number transferred incorrectly from a model onto the output spreadsheet.

The agency has worked hard during this interim to try to address all three of these problems and we believe we have solutions in the form of clarification, validation, verification, and automation.

In terms of Clarification: We want everyone to understand the models and how they can be useful and will strive to make sure we have excellent ongoing communication about the models and data requests.

- First, by describing the models, as we are doing today and offering to do in the future. If we all have a common understanding of the accuracy and limitations of our projection models, then we have a better chance of meeting everyone's expectations. As a follow-up to today's presentation, on request, we will hold an in-depth walk-through demonstration of how we use the models, over at Employment Security's office where we can access the actual models and data. This demonstration could take four to eight hours, depending on what the attendees would want and need.

- Second, by defining the terms in a glossary so we use a common language. We've provided a preliminary glossary in your notebooks today, but we'll be adding to that glossary and we're always available to provide more detailed information on specific topics of interest - details such as statutory cites, federal definitions versus the state level, how states vary in law application, or whatever it takes to make these complex processes and terms understandable.

- Third, when we receive data requests, we'll be documenting the questions and the answers in narrative as well as providing output numbers. We started this feature late last session and have continued to refine the entire data request process in the last few weeks and months. We sent the task force a draft Data Request Process late last week describing how we propose to handle requests from the Task Force. We'd like to see better documentation throughout the process and we're also implementing more quality control measures.

- Finally, we'll start describing all the assumptions we are proposing to use to answer data requests. A few days ago, we sent the Task Force a description of the economic and statutory assumptions that would be used for all data requests. But we'd expect any "what if" scenario to contain other unique assumptions, which we would document as a part of our formal response to the question being posed.

In terms of Validation and Verification: We want everyone to be able to trust the models and their output. We are implementing several strategies to accomplish this:

- Obtaining external validation of the models from Dr. Wayne Vroman and from the US Department of Labor. Dr. Vroman is in New Zealand as I speak and therefore unable to be here today. But he wants to personally come out to Washington State at your invitation, to help in any way: with a walk-through of the model; or help with ideas; or to provide any other support that he can to assist the work of this Task Force. We have contracted with him to scrutinize the ESD Model and also to formally validate the updates we've made to his Urban Institute Model (although he has already informally validated the Urban Institute Model updates).

Dr. Vroman is familiar with our new tax structure, and so he'll be reviewing how the new tax structure is modeled to reflect the distribution of employers by rate class since we are now using fixed intervals (instead of an arrayed allocation with a certain percentage of taxable wages in each rate class).

Rob Pavesovich is the US DOL staff responsible for the Benefit Financing Model. We have sent him the distributions prescribed in the manual for the model, and he will be completing an analysis of the inputs and outputs within the next month. (He is busy right now bringing up new models in several states that want to use the model now since they've experienced solvency issues.) Rob will be notifying us of the results of his analysis and we will share that information with the Task Force.

- Second, we will be conducting a closely controlled internal verification of all outputs displayed in a spreadsheet. Besides rigorous proofreading, we will use the auditing function that is built into Excel, which tracks dependencies in formulas, as a cross-check that we've keyed the correct data. This may add minimal time to the turnaround for data requests, but we believe we'll all be more confident of the results.

- Third, we'll be implementing internal procedures to manage future data requests. More attention will be paid to the questions and to our answers! More eyes will review all data request response documents before they are made available to a requestor. While this may take longer to get data requests out, it is certainly worth everyone's time to verify the requests and the responses.

In terms of Automation, we want to be confident that the inputs and outputs are accurate.

- We're looking into ways of locking down the Excel workbook used to display output, in order to minimize operator error.
- Also, we are pursuing the idea of automating the ESD model as much as possible, within limits. We'd base the design on what we think are the most likely "what-if" scenarios. It would be optimum if all the possible 'what if' scenarios could be automated so that the output would be as easy as the touch of a button. But automated forecasting would have limits: if we were to get a "what-if" on an entirely new subject area, this new automation could not be used and we would have to go back to our current processes. Of course we would not want to automate "what ifs" that could raise potential conformity issues. And as we mentioned in our recommended assumptions, there are certain variables that an automated process for modeling just cannot do - such as breaking out the outcomes by employer size. Other than those shortfalls, and even though there will still be unique scenarios that complicate a data request such as unusual start or end timing, or answers at a very detailed industry level, we think this automation could help.

Conclusion

Our vision is to provide high quality information that can inform the public debate about the UI Program. We hope that by describing the models this afternoon, you have a greater understanding of how we develop information and a greater confidence in using the models and their output to help inform your decisions. And the overriding goal is that our models assist policymakers to choose alternatives that maintain solvency in our state's 'bank account', the Unemployment Trust Fund.

Thank you for your time and attention this afternoon to this very complex topic. I am available to take any questions you may have about what I've covered today.