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UNEMPLOYMENT INSURANCE SIMULATION MODEL (UISIM)

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Unemployment is a pressing problem in many parts of the world. It has become increasingly recognized that the process of growth in market economies requires intense labor reallocations, with 20 to 30 percent of jobs being created or destroyed every year. Thus even in well-functioning economies the displacement of workers and ensuing unemployment can be a severe problem. Unemployment problems are exacerbated by macroeconomic crises and increased globalization, which seems to expose more workers to the risk of job loss.

It is therefore not surprising that the task of helping the unemployed has gained importance and attracted the interest of policymakers. Because job loss entails the loss of income, providing effective income support—while ensuring appropriate work incentives and facilitating access to jobs—is a prime concern and a necessary component of assistance to the unemployed.

UISIM is a model that the Human Development Network at the World Bank expressly developed to assist client countries in making projections of unemployment insurance (UI) benefit costs, contributions, and trust fund balances.[1] The model assesses the financial status of existing UI schemes under different economic scenarios and conducts financial projections of newly developed UI programs under alternative settings.

The current version of UISIM has been piloted in three countries, Bosnia and Herzegovina, Turkey and China. The model is user-friendly, can be adjusted to fit the UI system of almost any country, and is powerful enough to provide accurate estimates for numerous variables of interest. Deliberately preserving similarities to PROST, the World Bank's pension simulation model,[2] UISIM brings numerous advantages over the plain spreadsheet models built to simulate an unemployment insurance system.

This note describes the key features of the UISIM model—how the model is structured, what data inputs are needed, and what outputs the model generates (the model comes with user's and technical manuals, which provide detailed information about how to operate the model and how it calculates the outputs).[3] For illustrative purposes, the note also presents an example where the model is used to generate simulations for a country-wide UI system. The appendix to the note describes typical data sources and provides a detailed description of requisite data.

[1] Unemployment assistance programs can also be handled by the program.

[2] PROST (Pension Reform Option Simulation Toolkit) has gained worldwide currency and is one of the foremost models of pension reform options in developing countries. It too was developed by the Human Development Network of World Bank.

[3] Unemployment Insurance Simulation Model (UISIM): User's Manual, Human Development Network, World Bank, December 2004; Unemployment Insurance Simulation Model (UISIM): Technical Manual, Human Development Network, World Bank, August 2004.

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Description of the Model

The UISIM model asks the user to complete the base period input data sheets in an Excel workbook, and then performs calculations to produce output tables and charts. The model projects the primary variables of interest—the UI system's revenues, expenditures, and trust fund balances. Written in Visual Basic and C++ compiler and with the interface in Microsoft Excel, the model can be run on most new computers and requires 10 to 30 seconds to compute the results. Below we describe the objectives and key features of the model, as well as the data required for and the outputs generated by the model.

Objective and key features

Objective. The objective of UISIM is to calculate—simulate—expenditures and revenues of the unemployment insurance system. The model supports the following key types of simulations:

- Introduction of the UI system, allowing comparison of alternative scenarios under different design parameters.
- Modifications of the parameters of the UI system, such as changes in initial UI eligibility, length of potential eligibility, benefit level—including minimum and maximum benefits, and indexation of UI benefits.
- Changes in financing related to coverage of the UI system and compliance with payments of contributions.
- Impact of labor market changes created by macroeconomic shocks and cycles on the performance of the UI system.

Key features. To be able to simulate the financial performance of the UI system while retaining a simple model structure and ease of data input, the following principles and features were adhered to:

- UISIM is an accounting model: UI benefits are computed as the number of recipients times the level of benefits, and similarly, UI revenues are computed as the number of contributors times the amount of contributions paid. The model thus does not attempt to model the behavior of individuals (for example, if a larger economy-wide unemployment rate is anticipated, the model does not adjust the probability of exiting unemployment).
- The model inputs and outputs can be disaggregated by age and gender.
- The basic period of observation is one month, and the time horizon is unlimited.

Data requirements

UISIM uses the following two types of data (Figure 1):

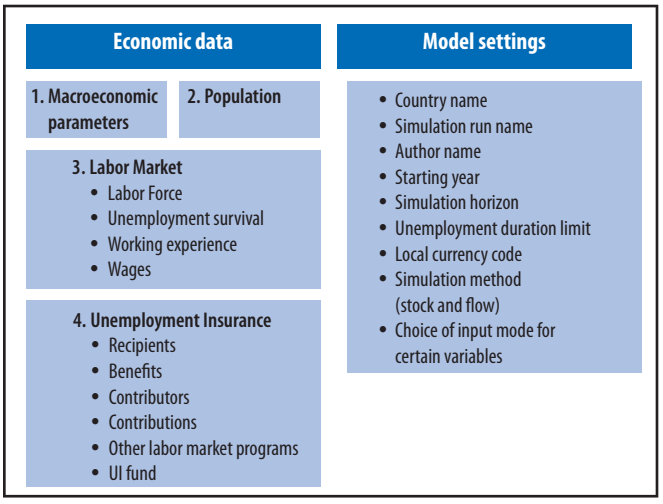
- Economic data
  - Macroeconomic parameters
  - Population and/or labor market data
  - Data about the UI system
- Model settings: modeling and simulation choices (such as assumptions about the probability of exiting unemployment and the simulation horizon).

The input of economic data is flexible and allows entering as many details as the user wants to provide, or, alternatively, very few key data items (such as total employment and unemployment, average wage) to enable "quick and dirty" simulations (thus relying upon default values provided by the model itself).

Methodology and Output

Once the input requirements are satisfied, the model follows a simple algorithm to produce the output. Below

Figure 1: UISIM Input Structure



we outline the algorithm and list the output generated by UISIM.

Algorithm

The user needs to specify time and duration frames for the model. The simulation time frame is defined by the base-year (e.g., 2008) and the simulation horizon y_0 (e.g., five years, in this case the simulation end-year would be 2012). The basic time unit of UISIM is a month and the simulation runs from January of the base-year until December of the end-year. The outline of the algorithm used in UISIM is presented below.

Step 1: ***Calculate smoothly varying monthly values of macroeconomic parameters***

Step 2: ***Project population to each year of the simulation horizon***

Step 3: ***Determine the initial conditions (i.e., the state in January of the base-year)***

Loop the following steps for each month of the simulation:

Step 4: ***Calculate wages***
Wages are calculated based on an inputted earnings profile, which specifies the ratio between the average wage of the specific cohort and the average wage of a 20 year old male. Over the simulation period, wage growth is updated using the assumed inflation rate and the real wage growth rate. The economy-wide average wage is calculated by aggregating cohort wages weighted by their employment share.

Step 5: ***Calculate contributions and benefits***
Benefits and contributions are calculated in a similar manner. For example, benefits can be either flat or variable, or a combination of these. The flat benefits can be entered either in local currency, as a share of economy-wide average wage or as a share of the reference wage. Variable benefits are inputted as a percentage of the wage that the recipient earned in the last month of employment. Variable benefits are limited by minimum and maximum benefits, which are—as is the case of flat benefits—inputted either in local currency or as a share of economy-wide average or reference wage.

Step 6: ***Calculate survival functions***
The duration of receipt of UI benefits is a crucial determinant of UI expenditures. The UISIM model assumes that the survival in (covered) unemployment—and, equivalently, the hazard of leaving it—is governed by a survival/hazard function. The functional forms of the duration models used are either a simple exponential function or a Weibull function. The user can choose either to model both recipients and non-recipients with one of these survival functions or to model non-recipients this way. In the latter case, the survival function of the recipients is specified through behavioral parameters (by modifying the hazard of exit of the non-recipients).

Step 7: ***Calculate new distribution of unemployed***
To calculate unemployment, first the number of unemployed in each of the gender and age groups is determined; the survival functions are then used to distribute the recipients and non-recipients according to the duration of their stay in unemployment. At any specified date, the user can switch to a flow method where unemployment is regulated by the inflow into unemployment and survival functions.

Step 8: ***Update labor market tables***

Step 9: ***Calculate finances of the UI fund***

Outputs

UISIM generates a series of output tables and charts, providing monthly or yearly data for the simulation period. Key variables appearing in the output tables and charts are:

- Number of recipients
- Total revenues (absolute value, share of GDP)
- Total benefits (absolute value, share of GDP)
- Contribution rate required to match current revenues and benefits

- UI fund reserves (number of months that the current level of benefits could be supported from the reserves alone).

Putting UISIM to Use: An Example of UI System Simulations

For illustrative purposes, plausible UI simulation scenarios for *Country X* are presented below, and simulation results discussed. Of particular interest are setting the simulation scenarios, by contrasting various policy scenarios with the baseline scenario, and presenting the model's outputs.

Simulation scenarios

Note that it is assumed that the UI program of *Country X* has been running a surplus and has accumulated large reserves. All scenarios below assume 2004 to be historical data input (usually the last year when historic data are available), and thus the simulations—based on assumed future values of input variables—to start in January 2005. The simulation period is five years. We distinguish the following scenarios:

Baseline scenario: This scenario assumes historical values to prevail in the indefinite future. In particular, it assumes that the following key characteristics and parameters remain at their 2004 levels (average 2004 values for flows and December 2004 values for stocks):

- Level and duration of benefits, as well as eligibility conditions for their receipt
- Number, age, and gender structure of the benefit recipients
- Distribution by the length of stay in unemployment of benefit recipients
- Number and structure of contributors by age and gender, as well as their wage structure
- Contribution rates.

Alternative scenarios: To examine changes that would occur if some of the key labor market characteristics and UI parameters change, the model is simulated assuming alternative developments. These developments reflect contemplated changes of the UI system as well as changes in baseline circumstances, which allow evaluating the long-term sustainability of the system. Note that under the alternative scenarios, only one parameter is modified while the others retain their baseline values (the exception is the "combined reform" scenario, where—as the name suggests—several UI parameters are allowed to change simultaneously). The following scenarios are distinguished:

- **Increase of benefits scenario**, where the level of benefits increases from the current A to B percent replacement level (a change of flat rates also can be modeled). An increase of the replacement level from 50 to 70 percent is assumed below.
- **Increase of duration scenario**, where the potential duration of benefits is increased by XX percent, from the current maximum potential duration of YY to ZZ months. An increase of the potential duration from 10 to 20 months is assumed below.
- **Easing of eligibility scenario**, where the inflow into the receipt of UI benefits is doubled and remains at that level indefinitely.
- **Combined reform scenario**, where the above three modifications take effect simultaneously.
- **Reduction of contribution rate scenario**, where the contribution rate is reduced XX times (from the current YY to ZZ percent). The reduction of the contribution rate from 4 to 1 percent is assumed below.
- **Economic shock scenario**, where the inflow into unemployment and the receipt of UI benefits are tripled over a three-year period (from January 2005 till December 2007), returning to the original baseline level thereafter.

Simulation results

Below we present the evolution of the key UI system variables for the 2004–2009 period as predicted by our simulation model. The output variables are as follows:

- Contribution rate required (expressed as the percentage of the current contribution rate): the rate that would equate current revenues with current expenditures.
- The index of benefits affordable: the level of benefits (expressed as the percentage of current expenditures) that could be supported by current revenues (for example, the index of affordability of 1000 percent means that current revenues could finance a tenfold increase of expenditures).

- The index of UI fund reserves, showing the number of months for which the current level of benefits could be paid by the reserve fund alone (calculated as the reserves divided by current monthly expenditures).
- Number of recipients of UI benefits.
- Average level of UI benefits (in national currency units).
- Average duration of receipt of UI benefits (in months; calculated as the average duration of receipt for those recipients whose benefits cease in a particular month).
- Share of UI benefits in GDP.

The simulation results summarizing the financial performance of the UI system are presented in Figure 2, showing: the required contribution rate; benefits affordable under the current contribution rate; and the capacity of reserves to finance the current level of expenditures.

The simulations show that the required contribution rate (that is, the one that equates current expenditures under different scenarios with current revenues) is below 25 percent of its current rate for all single change scenarios, which increase the generosity and/or ease the access to benefits, and that it increases to a maximum of 37 percent under the combined reform scenario. Under the shock scenario, the required contribution rate peaks at 41 percent of its current rate. Of course, a drastic, fourfold reduction of the contribution rate under the reduced contribution rate scenario brings the required contribution rate much higher, to 82 percent—even so, such a reduction of the contribution rate still generates current surplus to the fund. A similar picture of comfortable excess revenues over expenditures emerges from the simulations of the benefits affordable under the current contribution rate and from the simulations of the UI fund reserves.

To better understand the evolution of expenditures, it is instructive to examine other simulation outcomes, in particular the number of recipients, the level of benefits, the average duration of receipt of UI benefits, and benefit expenditures as a share of GDP (Figure 3).

Except under the reduction of contributions scenario, the number of recipients increases under all other scenarios. The average level of UI benefits changes only under the increase of benefit level and the combined reform scenarios. Similarly, the average duration of receipt of UI benefits increases under the increase of duration and the combined reform scenarios (adjustment paths are quite complex, reflecting changes of inflow into recipiency following the change), but not under other scenarios. Another look at the simulation results is provided by the evolution of benefit expenditures as a share of GDP. Under the baseline scenario,

Figure 2: Simulated financial performance of the UI system for *Country X*

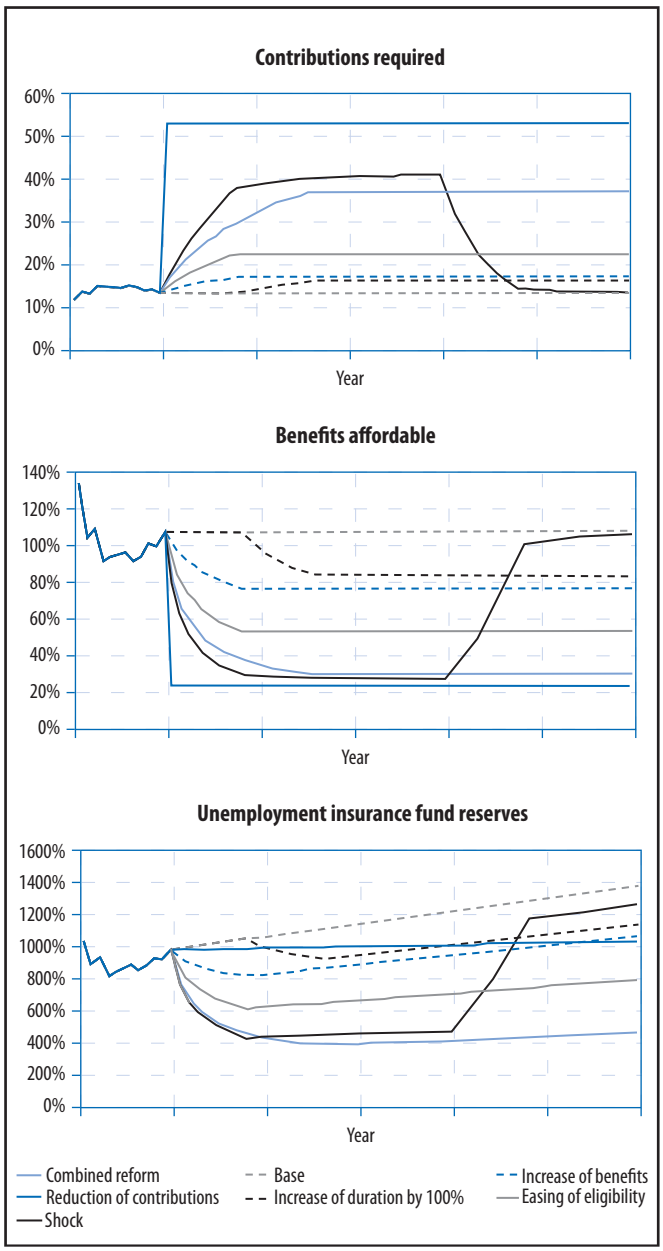
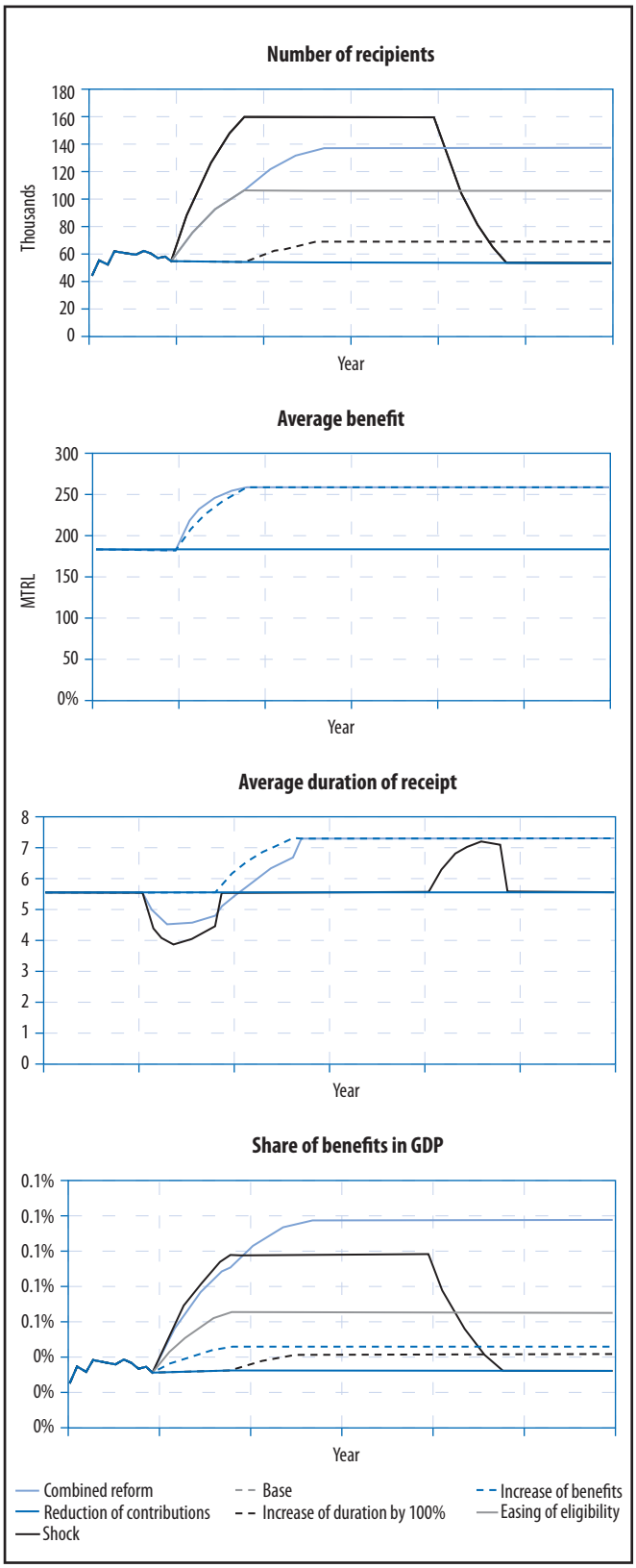


Figure 3: Select simulated outputs of the UI system for *Country X*



these expenditures remain constant at 0.05 percent of GDP. Under alternative scenarios, this share increases above its value in the baseline scenario. Its highest value —0.14 percent of GDP—is reached under the combined reform scenario 20 months after the start of the reform, and stays at that level thereafter.

Logistical Information

The model has been developed and is managed by the Social Protection Unit of the Human Development Network at the World Bank. Similar to the PROST model, attending UISIM training is required in order for the software to be released. The contact person is and further information may be obtained from Milan Vodopivec (HDNSP).

Appendix

Description of Data Sources and Definition of Variables

Sources of data

UISIM relies on two main types of data sources: labor market surveys and administrative records. Both sources typically exist in all countries. Labor market surveys provide data about employment, unemployment, and wages. Employment data should preferably include both formal and informal sector workers, although only workers covered by the UI system are taken into account in the sections of the model pertaining to the UI system.

The other key data sources are records from the government agencies administrating the UI (or other social insurance) system, such as National Employment Office and National Pension Fund. These agencies provide data about the participants in the UI system—the number, structure, and wages of workers covered by (and/or complying with) the system, as well as the number and structure of the recipients of unemployment benefits. A National Employment Office also can provide information about the parameters and rules of the UI system.

Definitions of variables

UISIM requires data of specific format as an input to the model. The data refer to the territorial unit corresponding to the unemployment insurance pooling level (usually a country, but also a city or municipality). The reference age category below is 16–60 years; however, this feature may be adapted in the simulation to reflect the respective UI system.

Table 1: Definitions of variables used by UISIM model

Variable name	Definition	Remark
A. Labor Market		
Employment	Number of employed persons, by gender and age (by yearly cohorts, 16–60)	Both workers employed in the formal or informal sector should be included (estimates suffice).
Employment – workers who are actual contributors to the UI fund	Number of actual contributors to UI fund, by gender and age (by yearly cohorts, 16–60)	Actual contributors are workers who are paying UI contributions, and/or whose employers are paying contributions for them. If available, also obtain data for 2004.
Unemployment	Number of unemployed persons, by gender and age (by yearly cohorts, 16–60)	Depending on the availability of data, registered unemployed could be used instead (persons registered as unemployed with Employment Bureaus).
Average duration of unemployment spells of unemployed	Average duration of completed unemployment spells of unemployed, in months by gender and age (by yearly cohorts, 16–60)	Based on completed durations.
Work experience	Average duration of working experience (cumulative period a person was employed at a given age) of unemployment benefit recipients at the time they register with employment bureaus, in years by gender and age (by yearly cohorts, 16–60)	This variable may not be needed, depending on the eligibility conditions for UI benefits.
B. Unemployment Insurance		
Average wage	Average monthly gross wage of employed – actual contributors to UI fund, in local currency, by gender and age (by yearly cohorts, 16-60)	
Minimum wage	Minimum wage in local currency	
Expenditures of UI fund for payment of UI benefits	Expenditures of UI fund, total and breakdown by categories (payment of UI benefits, other expenditures)	
Revenues of UI fund from payment of UI contributions	Total revenues of UI fund obtained from the payment of UI contributions	
Unemployment insurance recipients	Number of unemployment benefit recipients by gender and age (by yearly cohorts, 16–60)	

(continued on next page)

Table 1: Definitions of variables used by UISIM model *(continued)*

Variable name	Definition	Remark
Average duration of receipt of unemployment benefits	Average duration of unemployment spells of unemployment benefit recipients, by gender and age (by yearly cohorts, 16-60)	Based on completed durations (tip: calculate the average duration of unemployment spells of unemployment benefit recipients who exited unemployment in a certain period, preferably a year to avoid cyclical effects).
Other income of UI fund	Other revenues of UI fund (estimate of yearly other revenues)	Main sources may be interest revenues and government subsidies.
C. Other Variables		
Inflation rate	Inflation rate (yearly level)	
Nominal interest rate	Nominal annual interest rate – nominal annul rate of return on UI funds when invested in bonds or other financial instruments	
Gross Domestic Product	Gross Domestic Product (yearly level)	
Population	Number of persons living in the country (or unit of analysis), by age and gender (0-99)