MICSIM-4J - A General Microsimulation Model

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User Guide (Version 1.1)

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FFB-Discussionpaper No. 100
December 2015

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MICSIM-4J

MICSIM-4J -
A General Microsimulation Model
User Guide (Version I.I)

Joachim Merz and Lars Rusch*

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MICSIM-4J – A General Microsimulation Model

User Guide (Version 1.1)

Joachim Merz und Lars Rusch

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Abstract

Microsimulation models allow targeted simulations to analyze the impacts of alternative policies, measures, scenarios based on microunits like persons, families, households, firms etc. Meanwhile it is out of question that microsimulation models are a helpful, successful and an imperative instrument for a wide range of policy analyses in the political administration, business area, private and university institutes and consulting groups in general.

Though there is a multitude of microsimulation models nowadays developed and in use, however, in most cases they still need skilled handling and experience or another program system when applied. A general, generic stand-alone and platform independent microsimulation model which provides all necessary simulation tools under a common shield, and which is easy to use for non-expert scholars, is still required.

The overall objective of this paper and of the new MICSIM-4J is to describe and offer such a user-friendly, non-technical and powerful general microsimulation model, to support impact microanalyses for applied research, teaching and consulting. Though the stand-alone MICSIM-4J as a general tool also allows dynamic model building, its focus is on static microsimulation with a powerful module for the adjustment of microdata.

JEL: C80, C81, D10, D30, D31, J20

Keywords: *Stand-alone general microsimulation model, impact analysis of economic and social policies, simulation of microdata, static and dynamic aging, microdata adjustment, information theory*

Zusammenfassung

Mikrosimulationsmodelle erlauben zielorientierte Simulationen, um die Wirkungen alternativer Politiken, Handlungen, Szenarien vorzugsweise auf der Basis von Mikroeinheiten, wie Personen, Familien, Haushalte, Firmen etc., zu untersuchen. Mittlerweile steht es außer Frage, dass Mikrosimulationsmodelle ein hilfreiches, erfolgreiches und zwingendes Instrument für ein breites Spektrum von Politikanalysen in der politischen Administration, im Geschäftsleben, in privaten und universitären Institutionen und Beratungsunternehmen generell sind.

Obwohl heute eine Vielzahl von Mikrosimulationsmodellen entwickelt und im Gebrauch sind, benötigen sie in den meisten Fällen immer noch ein ausgebildetes Vorwissen und Erfahrung in der Anwendung oder ein anderes Programmsystem als Basis. Ein generelles, eigenständiges und Plattform unabhängiges Mikrosimulationsmodell ist gefragt, das alle notwendigen Simulationswerkzeuge unter einem gemeinsamen Dach zur Verfügung stellt, und das leicht für Nichtexperten zu nutzen ist.

Ziel dieser Studie und des neuen MICSIM-4J ist es, ein solches benutzerfreundliches mächtiges generelles Mikrosimulationsmodell nicht-technisch zu beschreiben und zu offerieren, um die Wirkungsanalyse auf der Mikroebene für die angewandte Forschung, Lehre und Beratung zu unterstützen. Obwohl das von anderen Programmsystemen unabhängige MICSIM-4J als ein generelles Werkzeug auch die dynamische Modellierung erlaubt, liegt der Fokus doch auf der statischen Mikrosimulation mit einem mächtigen Modul für die Hochrechnung von Mikrodaten.

JEL: C80, C81, D10, D30, D31, J20

Schlagwörter: *Unabhängiges generelles Mikrosimulationsmodell, Wirkungsanalyse wirtschaftlicher und sozialer Politiken, Simulation von Mikrodaten, statische und dynamische Fortschreibung, Hochrechnung von Mikrodaten, Informationstheorie*

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Content

1 Introduction

The growing societal interest about the individual and its behaviour is asking for microanalyses about the individual situation. Economic and social policy analyses about the individual impacts of alternative policy measures, in particular, are an expression of this interest on the individual. To support microanalyses on a quantitative and empirically based level microsimulation models were developed and increasingly and successfully used for economic and social policy impact analyses. Microsimulation models allow targeted simulations to analyze the impacts of alternative policies, measures, scenarios on an individual level.

In a microsimulation model the focus is on microunits as e.g. persons, families, households, tax units, firms or other disaggregated agents. The microunits are identified by their characteristics such as age, gender or labor force situation of a person, number of children in a family, income and transfers of a household, taxes and deductions of single tax units (if not identical with households), profits, losses, employment situation or specific stock or advertising strategies of a firm or single characteristics of any further individual agent.

Any microsimulation model is systematically changing the individual characteristics either via institutional regulations (individual taxes to be paid caused by a new tax scheme, say) or, more advanced, by behavioural impacts (e.g. changed labor supply with supplied working hours dependent on new taxes, transfers etc.) as the microunit's answer on an introduced new measure.

Meanwhile it is out of question that microsimulation models are a helpful and an imperative instrument for a wide range of policy analyses in the political administration, business area, private and university institutes and consulting groups in general. Based on the microsimulation seminal paper of Orcutt 1957, an early general description of static and dynamic microsimulation developments and applications that far is provided in Merz 1991 followed by quite a number of further developments and publications. Recent surveys are Dekkers, Keegan and O'Donoghue 2014 about new pathways in microsimulation, Tanton 2014 about a review of spatial microsimulation methods, Li and O'Donoghue 2013 about a survey on dynamic microsimulation models, and O'Donoghue 2014 with the Handbook of Microsimulation Modelling. The International Journal of Microsimulation (www.micro simulation.org/ijm) of the International Microsimulation Association (www.ima.org) provides actual information about the state of the art.

Though there is a multitude of microsimulation models nowadays developed and in use, however, in most cases they still need skilled handling of their developers. A general, generic stand alone and platform independent microsimulation model, which provides all necessary simulation tools under a common shield, and which is easy to use for non-expert scholars, is still missing.

Yet, there are some simulation modelling packages which include the necessary functionalities: like LIAM2 (de Menten et al 2014) mainly for discrete time dynamic models, the Statistics Canada's dynamic model MODGEN[1] (Spielauer 2006), the UK model GENESIS (Strassburg & Tracey 2011) and JAMSIM (Mannion et al. 2012) for dynamic discrete-time simulation modelling.

The overall objective of this paper and of the new MICSIM-4J is to describe and offer a user-friendly and powerful general microsimulation model, to support impact microanalyses on a non-technical base for applied research, teaching and consulting. Though MICSIM-4J as a

[1] http://www.statcan.gc.ca/microsimulation/modgen/modgen-eng.htm

general tool also allows dynamic model building, its focus is on static microsimulation with a powerful module for the adjustment of microdata.

At a very general level a microsimulation model requires the handling of microdata (import/export of preferred survey data of individual microunits), the simulation itself (with some modules of behavioural and/or institutional relations), the adjustment or alignment for static and dynamic aging, and some evaluation tools to describe results. Though this sounds easy, however the comprehensive management with a relational data base, which ensures assured operations on a desired selected set of microunits, requires some efforts. In particular, an efficient adjustment of results and microdata in general is a challenging task which is solved in MICSIM-4J by an information theory based nonlinear optimization under restrictions.

The reminder of this paper follows the sketched microsimulation requirements. As a user guide it provides also necessary install and other IT specific procedures and preconditions: chapter two is about the MICSIM-4J philosophy, context and requirements, the following chapters embrace Installing and Start, Projects, Simulation, Adjustment, Evaluation and handling by the SQL-Shell. The Appendix offers an adjustment example.

2 Philosophy, Context and Requirements

MICSIM-4J is based on own long lasting experiences with microsimulation modelling, development and application in research and teaching. These experiences result in the strong belief to have a general microsimulation tool, which should be independent of any programming language and system behind and should allow the concentration on the substantive concern based on a secure data processing. The result was the general purpose microsimulation model called MICSIM written that time in C++ (Merz 1995, 1996).

The MICSIM-4J (and the former MICSIM) philosophy relies on the following objectives:

- Easy and user friendly usage,
- Efficient internal storage and computation,
- Operation over a relational data base system.
- Interaction with focus on the substantive concern.
- Stand alone model, independent of any other statistical package.

Thus, any JAVA or other programming should not be the concern of a user, all technical issues and necessary execution steps should be behind the surface.

To be a microsimulation model general development tool certain requirements have to be achieved and supported:

- Secured data handling by a relational data base system which allows operation on a user-defined selected set of microunits .
- Simulation as modification of the characteristics of micro- and macrounits (parameter variation),
- Adjustment of microdata (before and/or after a specific simulation) to achieve representative totals, (static) aging of microunits,
- Evaluation of the simulation as of a single or as of a multitude of (stochastic or deterministic) simulation runs.

Though the preparation of a suitable microdata base eventually with merging different databases and under consideration of necessary macrodata could be another task, however, other statistical programs are well-suited to deliver proper initial data ready for microsimulation.

A comprehensive discussion of the single requirements of a microsimulation model and a description of MICSIM itself is available in Merz 1995, 1996.

In using the different simulation tools, the MICSIM-4J philosophy above all is

1. *concentration on the substantive level,*
2. *operation by protected programming behind,*
3. *efficient operation by a set-theoretical based approach,*
3. *user-friendly interactive environment.*

At a first glance these principles seem to be a common advertising. But with the background of former larger microsimulation models' programming and handling, each single item is an enormous progress when realized.

3 Installing and Start

MICSIM-4J is a stand alone 64bit Oracle Java (Version >=8) application. Tthe runtime environment is available under https://www.oracle.com/java/; please read and accept the End User License Agreement). MICSIM-4J is platform independent and is running on Windows, Linux and MacOS.

3.1 Installation in Windows Systems

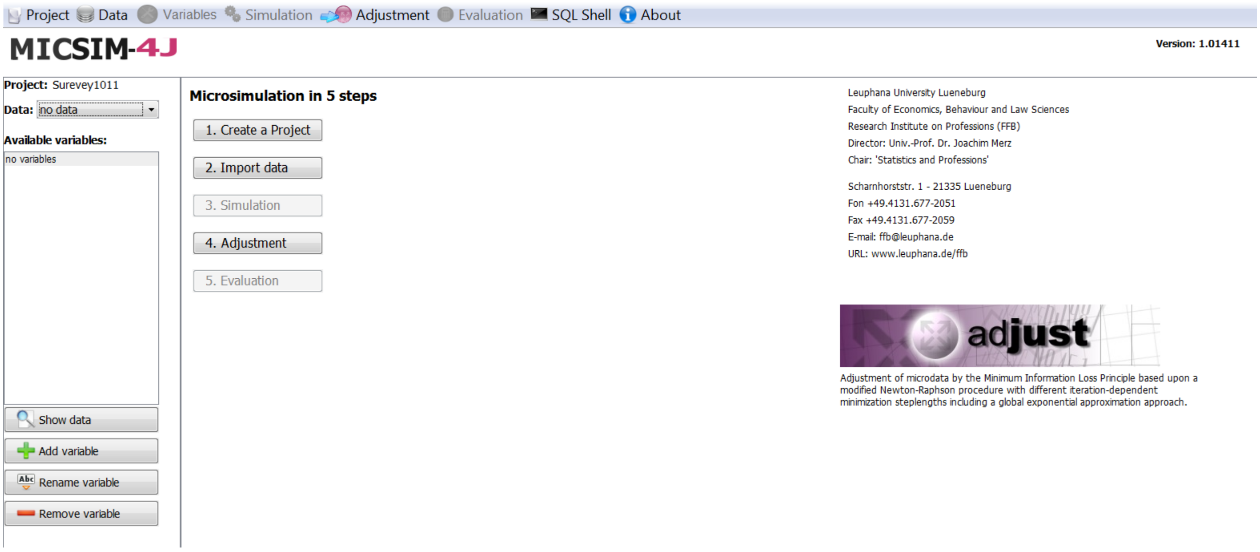
The Windows version can be installed with the provided setup.exe. To be independent of possible administration constraints MICSIM-4J is installed in the *own documents* section. Another way to run MICSIM-4J is to copy the micsim4j-folder to a location with respective user rights and just run the .jar-file MICSIM-4J.

3.2 Installation in Linux- and MacOS-Systems

Copy the micsim4j-folder to a location with user permissions and just run the .jar-file MICSIM-4J.

3.3 Starting MICSIM-4J

MICSIM-4J is started for all systems by double-clicking the micsim4j.jar. For Windows-systems the program can be started from the start menu. The main screen of MICSIM-4J should look like this:



The menu on the top bar shows the link to all single microsimulation tools and microsimulation tasks:

- Project handling, data and variables
- Simulation,
- Adjustment and
- Evaluation.

For advanced users an SQL submenu allows direct access to the underlying relational data base via the SQL query language.

4 Projects

To provide all necessary information of a certain microsimulation application, PROJECTS is gathering all input and output data and log files under a common project name and topic.

4.1 Creating a project

For any dealing with the data under consideration the first thing is to create a project. Open the “Project”-menu and click on “New”. A dialog opens where you can put the name of your project which needs letters as characters.

4.2 Deleting a project

Deleting a project is erasing a project in a similar fashion as creating it.

5 Data

5.1 Importing data

For any working with data it is necessary to import the data into the internal relational database. Go to “Data”-menu and click on “Import”. The data to import needs to be in CSV-format with variable names in the headline (first row) and a unique record (microunit) identifier named “ID”. The delimiter is optional.

1. Select the delimiter which is used in your .csv
2. Click on “Select data file” to open the file handler and select a file.

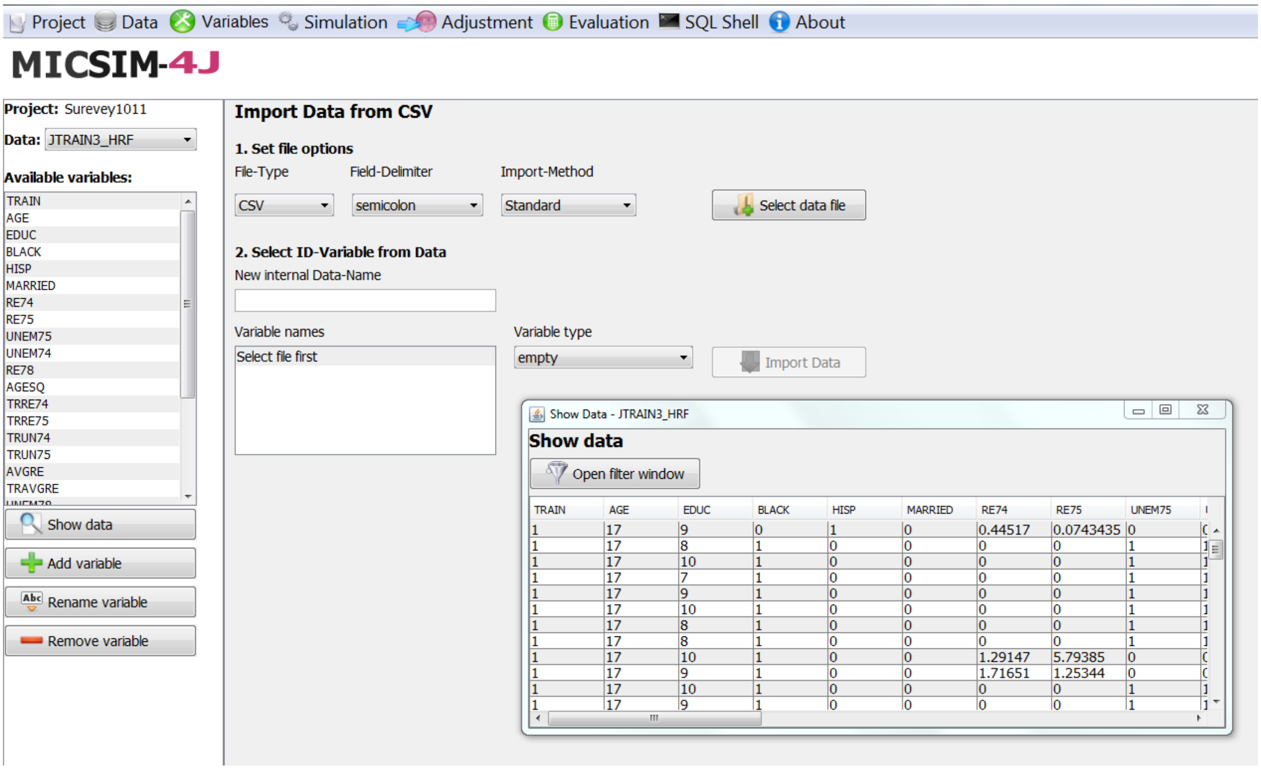
3. Check “New internal Data name”
4. Check variable types
5. Click on “Import Data”

5.2 Show data

To inspect your data the “Data-menu” “Show” will open the data. It is possible to select variables and microunits to show by

- click on “Open filter window”.

There the variables to show and respective conditions in a SQL-like WHERE-clause are available for selection.



5.3 Copy data

In MICSIM4J data can be copied completely or as a part with the following steps:

1. Choose a data-name for a copy from internal data
2. Select the variables to copy
3. Click on “Copy”

5.4 Export data

To export data to a .csv-file

1. Select a delimiter
2. Select the variables to export
3. Click on “Export Data”.

5.5 Delete data

Data can be deleted via the “Delete data” menu item. A dialog opens and data to be deleted can be selected.

5.6 Delete microunits

Microunits can be deleted via the “Delete microunits” menu item. Conditions for microunits to be deleted might be created in a user-friendly SQL-syntax like statement (Example: “age > 60 OR age <20” will delete all respective younger and elder mirounits.

6 Variables

To enhance or to reduce the available variable set of the data various handling procedures are available in MICSIM-4j.

6.1 Add variables from CSV

You may add (merge) a variable from another .csv file to your available data. The merge need an identifier to be selected with the same name in your main data file.

6.2 Add new empty variables

You can create a new variable within your data which is empty so far. This variable might be filled then by the simulation module. The simulation module allows also an independent creation of a new variable as a simulation target variable.

6.3 Delete variables

Unnecessary variables can be deleted. Select data and variables to delete and click on delete. Smaller data files will increase the performance.

6.4 Edit labels

Every variable has a label with a description. This can be edited in that section. After changing the description it is necessary to execute the editing by clicking on “Edit labels”

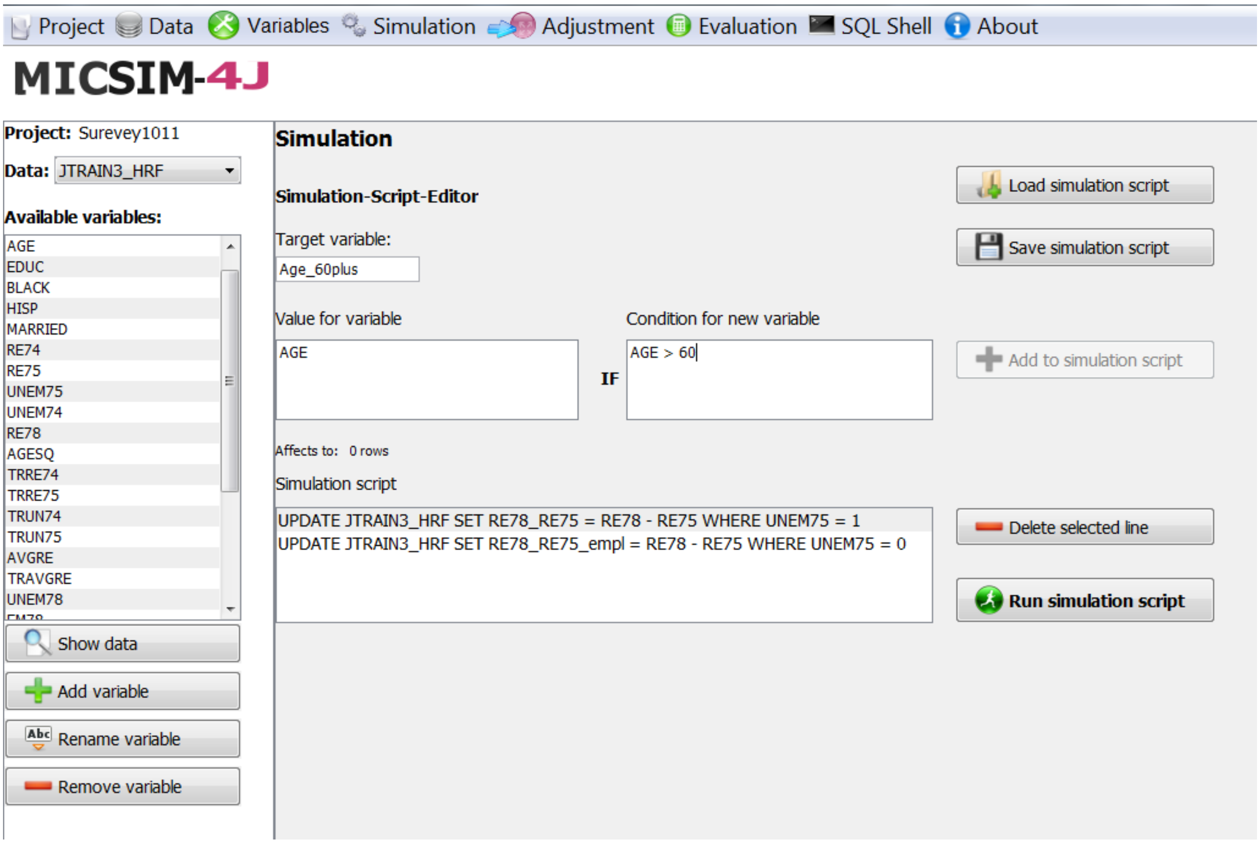
6.5 Rename variables

In some cases variables need to be renamed which is available hereby.

7 Simulation

Simulation is systematic changing parameters of a model which describes different scenarios under investigation. The results are stored in variables which then could be statistically described e.g. with the tools in the EVALUATION module.

As the respective MICSIM-4J screen shows, a certain target variable (to be created or already existing) is filled by a certain expression combined with a desired condition. The condition, in particular, allows operation only according this set of certain microunits (like microunits in a certain tax brackets getting a certain tax rate).



A complex new tax alternative then would be ‘programmed’ condition by condition which can be stored – or is prepared in advance – in a simulation script file also for further use or marginal exchanging certain tax rules.

Not only institutional rules will be handled this way, also behavioural response modelling could be incorporated e.g. by inserting an estimated regression equation.

The virtue of having a simulation script is to develop complex tax systems, say, also independent of MICSIM-4J.

Creating or loading a simulation script is done in a few steps:

1. Drag and drop an existing variable or create a variable in the “Target-variable”-field.
2. Insert a calculation rule for the target-variable.
3. Insert a condition.
4. Click on “Add to simulation script”

If you are prepared so far, save and/or click on “Run simulation script”. If you have new variables as target variables, a dialog window will open to specify the variable type.

8 Adjustment

An essential task when dealing with any microdata is to ensure representativity. Due to many circumstances (non-response, under-reporting, quoted sampling, etc.) almost in any case an available sample is not at random. Then the microunits have to be re-weighted to ensure representativity. Such an individual weighting factor represents the respective number of similar microunits in the population (See Merz 1986 for the structural adjustment in static and dynamic Microsimulation Models).

Beyond that general case, the adjustment (re-weighting, calibration) of microdata is foremost an essential part in microsimulation modelling. Particularly in static microsimulation models appropriate adjustment ((re-) weighting) of a sample is the procedure to extrapolate the underlying sample ('static aging') into the future and/or to update a starting or a resulting file of a dynamic microsimulation run. In addition, alternative margins, total values to be achieved, could serve for sensitivity analyses under different demographic scenarios.

MICSIM-4J provides a powerful module to adjust (grossing-up, (re-)weight) microdata (samples) based on information theory by the minimum information loss (MIL) principle. It is suitable for all cases where the representativity of sample data is required by weighting or reweighting a sample. This module is also available as the stand alone package ADJUST (www.leuphana.de/ffb for a demo and licensed version).

There are two main adjustment tasks and features in MICSIM-4J: a factorial and a simultaneous adjustment.

Factorial adjustment and economic aging

Economic variables, such as certain incomes and expenditures, may have to be inflated (weighted) by an 'economic multiplier' to reach the actual or forecasted situation. Economic aging is thus indexing some money values. An economic multiplier is simply the total sum to be achieved divided by the sample sum of weights. Therefore, this multiplier is one unique factor which is identical for all microunits. Summing up a variable is available in MICSIM-4J in the EVALUATION section and provides the appropriate denominator (the so far sample sum of weights), the nominator is the external information to be achieved.

Simultaneous adjustment and demographic aging

The task of a simultaneous adjustment is to compute single adjustment (weighting) factors but different for every microunit. Such a single adjustment factor then should ensure after aggregation simultaneously all totals (exogeneous control data, margins, restrictions of a sample's year or future totals). The typical setting is to simultaneous achieve totals from different hierarchical levels like totals of different household types, family characteristics within a household, and certain personal characteristics like a gender specific age distribution.

MICSIM-4J provides such a simultaneous hierarchical adjustment via information theory, which is briefly described below as far as it is important and helpful to run and understand the ADJUSTMENT module.

8.1 Adjustment by the Minimum Information Loss Principle – A brief description

In general, the problem is to find a n-vector (n=number of microunits) **p** of adjustment factors optimizing an objective function Z(**p**,**q**) - a distance function between the new adjustment factors **p** and already available ones **q** - satisfying the restrictions **Sp** = **r.** **r** is a (stacked) vector (with m characteristics) of totals to be achieved. **S** is a (m,n) sample matrix only of the adjustment characteristics.

The objective function Z(**p**,**q**) should minimize the distance of the new factors compared to eventually available adjustment factors **q** not to loose those already provided information (e.g. by a statistical office).

With respect to information theory our optimization procedure is to minimize the information loss (Minimum Information Loss (MIL) principle) when the provided distribution of the q factors are replaced by the new p factor distribution subject to the totals to be achieved:

(1) $Z(\mathbf{p},\mathbf{q}) = \min_p \{\sum_j p_j \log(p_j/q_j)\} \qquad 0<p_j,q_j<1,\ \sum_j p_j=\sum_j q_j=1,$

subject to

(2) $\mathbf{Sp} = \mathbf{r}$.

The respective Lagrangean generates a nonlinear equation system to be solved by iteration. The new adjustment factors with the m-vector λ, as the solution then can be calculated by

(3) $p_j = q_j \exp(\lambda' \mathbf{s}^j - 1)$,

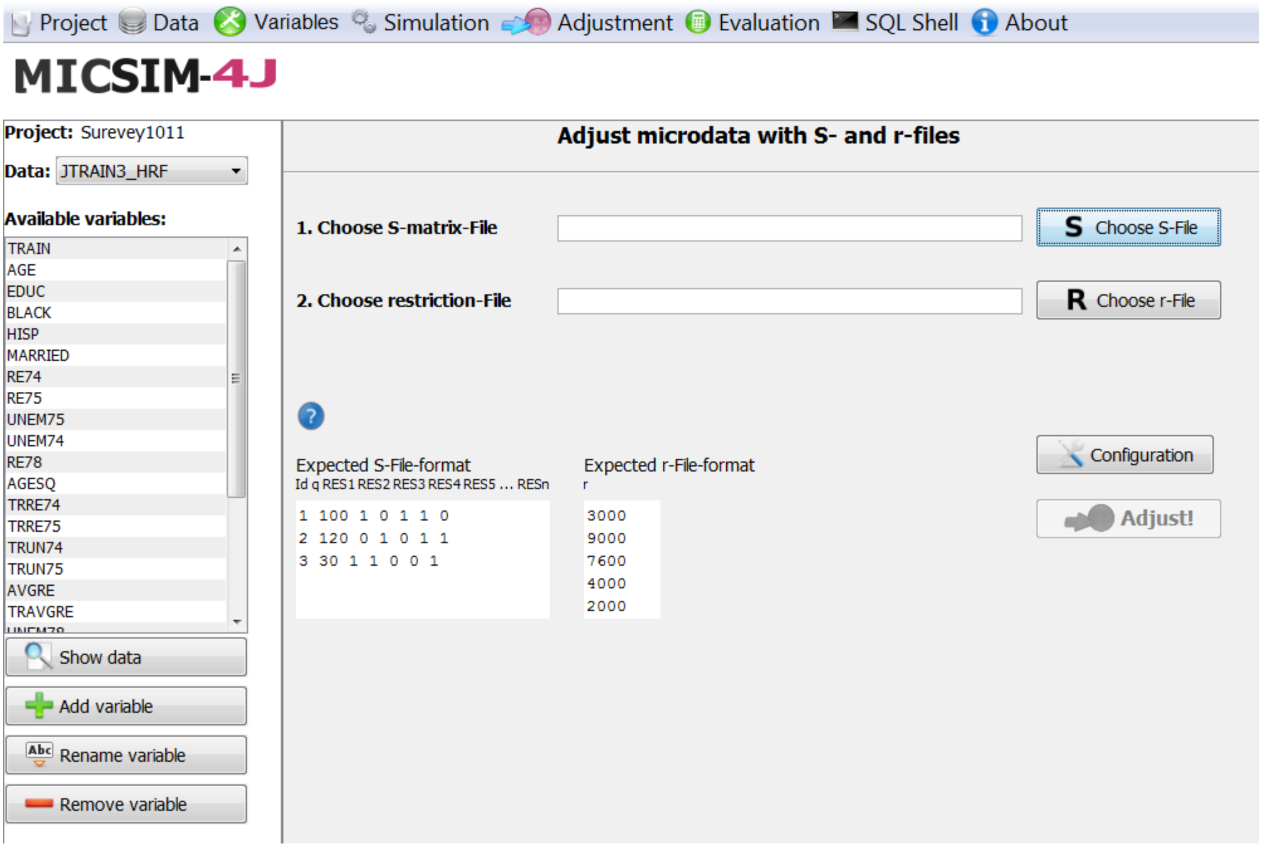
where $\mathbf{s}^j$ are the respective characteristics of the microunit j (j=1,...,n).

Note, regardless of small or very large sample sizes n the solution via λ consists only of m adjustment characteristics which reduces calculations drastically.

A detailed discussion of the methodological adjustment background by the MIL principle and an efficient global exponential approximation is given in Merz (1994, 1983) and realized in the ADJUSTMENT module of MICSIM-4J.

8.2 Adjustment with S- and r-files

Sometimes and with very large datasets it might be more efficient when the sample information matrix **S** is prepared in advance (by SPSS, Stata or any other data handling computer program) before MICSIM-4J and its adjustment is starting.



S-matrix

The **S**-matrix file then contains the transposed **S**-matrix from equation (2) as well as two additional information for each micro unit. Each row in the respective file then represents the adjustment information of a single microunit j with

ID q **S**'(j,i) (i= 1,...,m)

where ID is an identifier, q the individual old weight, and **S**'(j,i), (i = 1,...,m) the row vector of all m adjustment characteristics.

Restrictions

The respective m totals r(i) (i=1,…,m) should be listed in one column of a text file.

Adjustment

With the available sample matrix **S** and its respective **r** vector from respective files then the user might run the adjustment by:

1. Load the **S** and **r** files
2. Run the adjustment by the minimum loss information principle.

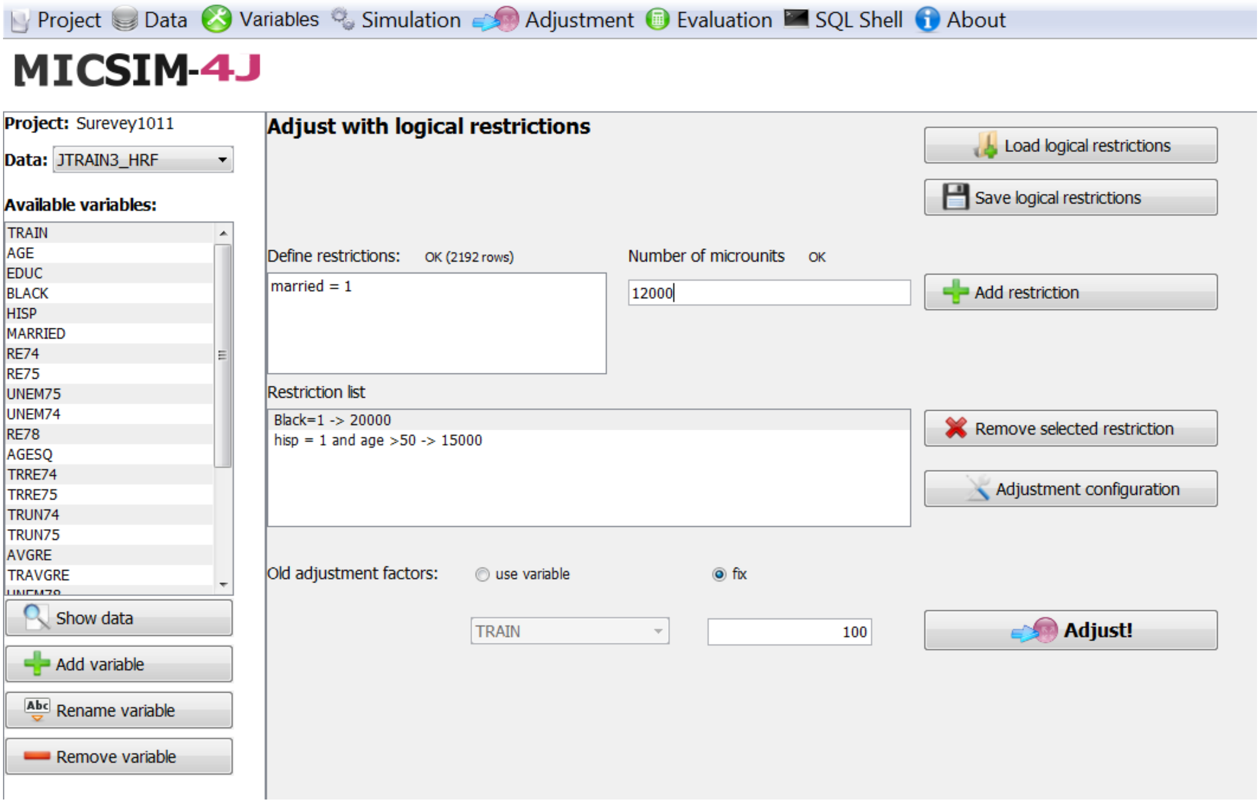
8.3 Adjustment with logical restrictions

Another option is to define only the logical restrictions (i=1,…,m) and to insert the respective total value r_i (i=1,…,m) to be achieved. The **S**-matrix is then created internally by MICSIM-4J and can be stored after the adjustment is done. Thus the user is indeed only concentrated on the logical definition of the restrictions to be achieved, a comfortable situation.

The total logical restrictions then might be saved for further computations.

In particular, sensitivity analysis by different weights via different totals to be achieved can easily be handled based on such a logical restriction file with its totals.

Note: Available adjustment factors **q** and the resulting factors **p** are allowed to be any positive absolute value (not only proportions) like the number of households represented.



Different MICSIM-4J procedures save the **S**-matrix, the **r**-vector, and the adjustment log file. In particular, the computed new adjustment factors **p** then via the respective button can be merged to the data file for further evaluations.

An adjustment example, the re-weighting of US labor market data (National Supported Work (NSW) Demonstration) is given in the Appendix. The adjustment output log file is documented and explained there.

8.4 Adjustment configuration

The adjustment process default parameters might be changed via the respective button. Beyond the maximum number of iterations the convergence criteria abs(z(i)-r(i))<= eps could be changed, where z(i) is the current sum of restriction characteristic i and r(i) is the total to be achieved, i=1,…,m).

The adjustment iteration process to solve the nonlinear equation system uses various pre-defined step-lengths for a fast solution. The first adjustment configuration step-length should be the step-length 1 (one) to incorporate the Newton approach. The other step-lengths are due to the researcher's ideas. The last in line step-length should be the limit of the e-approximation (e.g. 2.5). Whereas all other step-lengths are defined in advance of the entire iterations, the e-approximation step-length is re-calculated in each iteration as an approximation for a final all over step to reach the global minimum of the objective function. For solving the nonlinear equation system each actual iteration then uses that step-length which provides the largest step in direction of the optimal solution. For detailed information about the step-length dependent iteration process see Merz 1994.

8.5 Runtime Error Handling

The underlying adjustment optimization algorithm is very robust and has proved for reaching final convergence based on theoretical reasons and based on numerous applications. If there is any runtime error, then the reason always is the impossibility to invert a needed matrix, i.e. there is at least one linear dependent restriction.

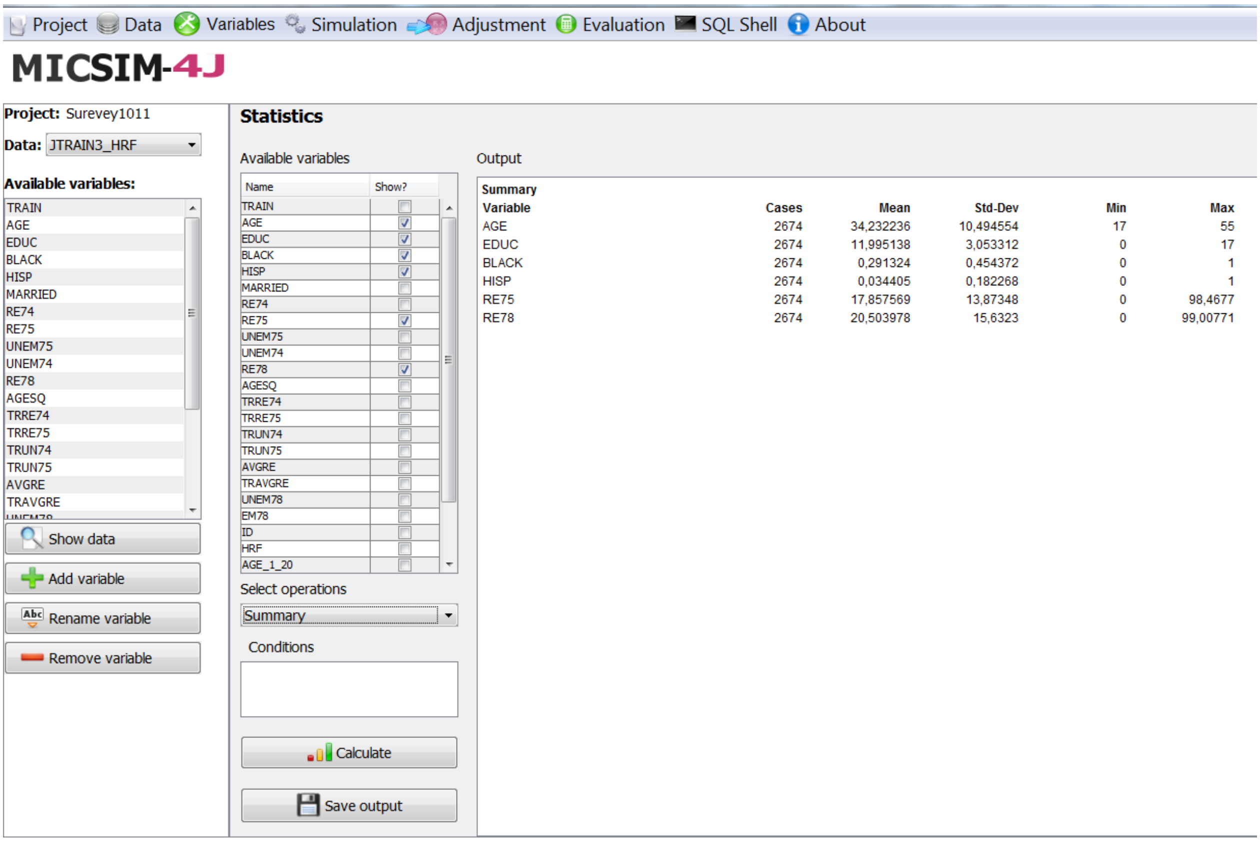
For instance, if the restrictions includes the number of men, women and the total population (possibly indirectly defined by other restrictions), then one of this information is obsolete. Without loss of accuracy skip one of these characteristics and the algorithm will converge (we bet you for one box of fine sparkling wine!).

8.6 ADJUST: a stand-alone package

The adjustment module is also available as the stand-alone program package ADJUST and is meanwhile successfully used in various governmental institutions and private firms (see www.leuphana.de/ffb to download the program, manual and examples).

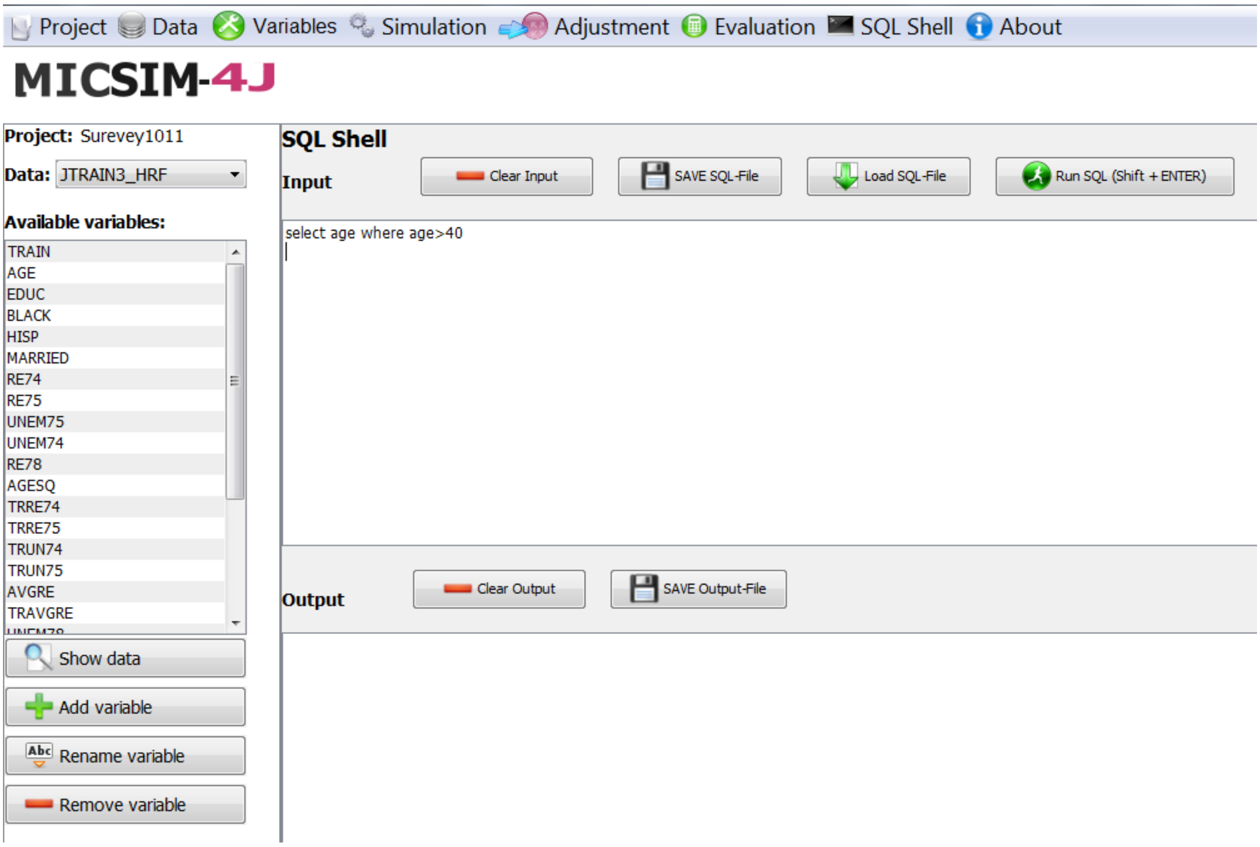
9 Evaluation

The evaluation module contains basic descriptive statistics of chosen variables which might be original ones of the sample under consideration or resulting variables of the simulation process. Though obviously there are a lot of further evaluation procedures, which can be used with other statistical packages after exporting the enhanced data file, by creating further variables of differences between pre-simulation and post-simulation results meaningful first information is provided by the MICSIM-4J evaluation module.



Flexibility of the evaluation is supported by optional conditions. The example screen displays summary statistics of three variables under a certain condition.

10 SQL-Shell



MICSIM-4J operates with a relational database. An experienced user therefore should be able to communicate with the data by the SQL query language.

MICSIM-4J allows single SQL commands, building a batch file of SQL commands, loading a respective batch file and executing the SQL commands.

11 Concluding Remarks

MICSIM-4J is a user-friendly and powerful general microsimulation model, to support impact microanalyses of alternative measures on a non-technical base for applied research, teaching and consulting. We hope it will be helpful for your task and application.

Please, let us know if there are any difficulties or possible improvements in running MICSIM-4J.

Enjoy your work!

Address:

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12 Adjustment example

The following adjustment example with its documentation in the adjustment logfile re-weights US labor market data (jtrain3.dta) about the "National Supported Work (NSW) Demonstration" according to some m=5 fictive totals (**r**). These totals are the margins of the number of persons in respective age groups to be achieved.

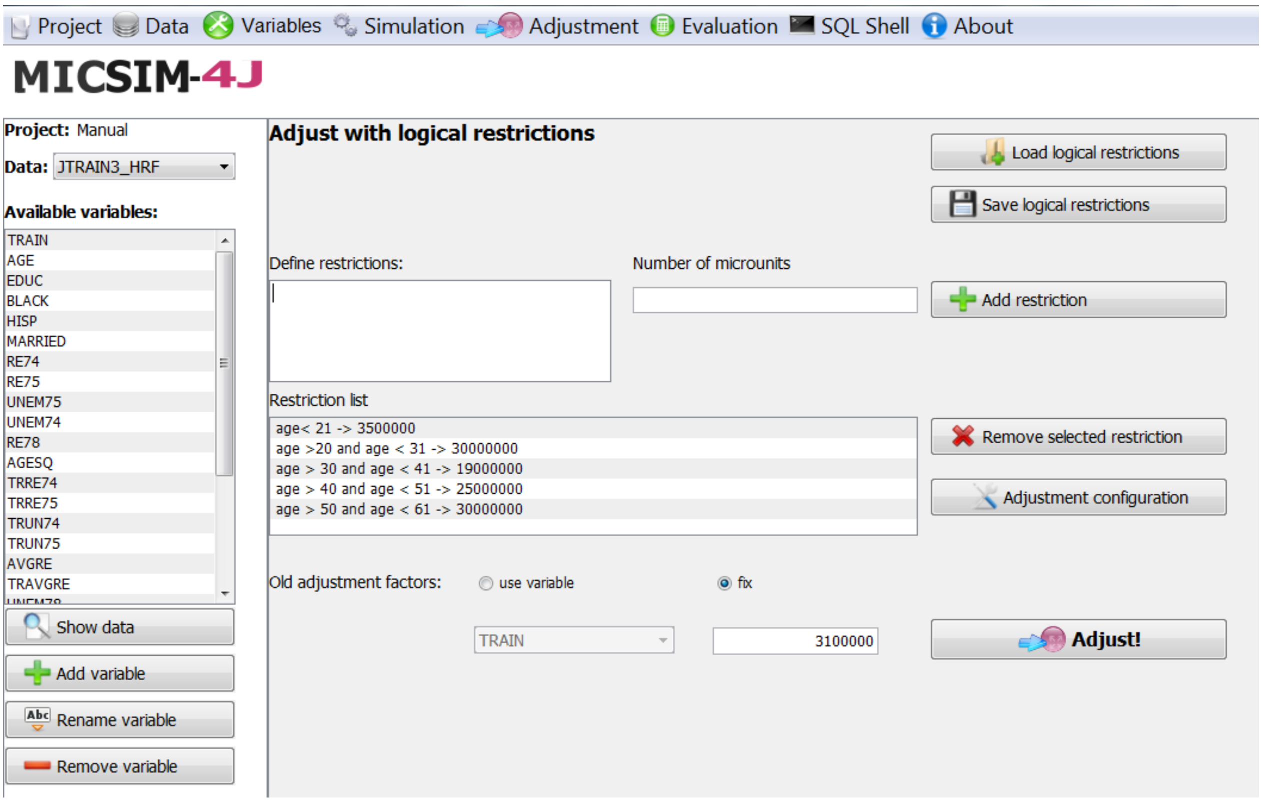
The microdata, which are also the base for varying program evaluation analyses about the success of a trainings program for men with poor labor market histories, can be downloaded from: http://qcpages.qc.cuny.edu/~rvesselinov/statadata/jtrain3.dta.

With this MICSIM-4J adjustment we assume that jtrain3.dta is roughly a 1% sample of the US population. Thus the already given weights (**q**) are about 3,100,000, which are the fictive number of individuals who are represented by the sample members.

The first table shows the differences of the so far weighted sum of age group specific persons to the fictive totals to be achieved. After the successful adjustment with 10 iterations convergence is given and the new adjustment factors **p** yield the desired totals.

Variables in jtrain3.dta:

- train (1 or 0): treatment with a job training program (began two years prior to 1978)
- re78 response: real labor market earnings in 1978
- age
- educ: years of education
- black (1 or 0)
- hispanic (1 or 0)
- maritial status
- re74 and re75: real earnings two years prior to the start of the program etc.



Restrictions (r.dat)

```
 3500000    age 1-20
30000000    age 21-30
19000000    age 31-40
25000000    age 41-50
30000000    age 51-60
```

adjustment logfile

```
adjustment logfile
Adjust Version 1.1.9.1
Sunday, 13-12-15     16:34


Reading restrictions file (r_jtrain3_ages.dat)...
Number of restrictions found: 5

Reading S-Matrix file (S_jtraim3_ages.dat, increased compatibility mode)...
Number of microunits found: 2675
```

I	cases	sum	Z	R	Z-R	(Z-R)/R %
1	138	138.0	427800000.0	3500000.0	424300000.0	12122.9
2	1103	1103.0	3419300000.0	30000000.0	3389300000.0	11297.7
3	595	595.0	1844500000.0	19000000.0	1825500000.0	9607.9
4	607	607.0	1881700000.0	25000000.0	1856700000.0	7426.8
5	232	232.0	719200000.0	30000000.0	689200000.0	2297.3

```
cases : number of microunits in the sample
sum: unweighted sum
Z : sum weighted by old adjustment factors (old weights)
R : restrictions to be achieved

Begin optimization process.

Information shown for each iteration include:
L : position in steplength vector
step : steplength
D²min/D²max : minimum/maximum of D²  (D=Z(I)-R(I))
Imin/Imax : Index I to D²min/D²max
* : next actual step
```

Current Iteration: 0

L	Step	Imin	D²min	Imax	D²max
1	0.50000	1	6.552259e+016	2	4.177569e+018
2	1.00000	1	1.800305e+017	4	3.447335e+018
3 *	2.50000	4	7.069773e+019	1	3.662503e+018

Current Iteration: 1

L	Step	Imin	D²min	Imax	D²max
1	0.50000	1	6.606823e+016	2	4.214925e+018
2 *	1.00000	1	2.407825e+016	2	1.535059e+018
3	2.50000	1	1.045979e+015	2	6.599639e+016

Current Iteration: 2

L	Step	Imin	D²min	Imax	D²max
1	0.50000	1	8.799668e+015	2	5.607378e+017
2 *	1.00000	1	3.155511e+015	2	2.007020e+017
3	1.09275	1	2.600949e+015	2	1.653348e+017

Current Iteration: 3

L	Step	Imin	D²min	Imax	D²max
1	0.50000	1	1.140495e+015	2	7.244845e+016
2 *	1.00000	1	3.912049e+014	2	2.472304e+016
3	1.09010	1	3.199058e+014	2	2.018494e+016

Current Iteration: 4

L	Step	Imin	D²min	Imax	D²max
1	0.50000	1	1.373985e+014	2	8.655783e+015
2 *	1.00000	5	2.206839e+013	2	2.585707e+015
3	1.08341	5	1.174792e+013	2	2.059369e+015

Current Iteration: 5

L	Step	Imin	D²min	Imax	D²max
1	0.50000	5	5.888331e+012	2	8.430049e+014
2 *	1.00000	5	9.249541e+010	2	1.717556e+014
3	1.06822	5	6.508943e+008	2	1.275794e+014

Current Iteration: 6

L	Step	Imin	D²min	Imax	D²max
1	0.50000	5	2.323984e+010	2	4.937224e+013
2 *	1.00000	5	2.313521e+006	2	3.257378e+012
3	1.04053	5	1.140483e+008	2	2.003147e+012

Current Iteration: 7

L	Step	Imin	D²min	Imax	D²max
1	0.50000	5	5.783949e+005	2	8.373940e+011
2 *	1.00000	5	1.486577e-003	2	2.525446e+009
3	1.01065	5	2.610860e+002	2	1.030403e+009

Current Iteration: 8

L	Step	Imin	D²min	Imax	D²max
1	0.50000	5	3.716413e-004	2	6.318893e+008
2 *	1.00000	5	6.417089e-014	2	1.763744e+003
3	1.00043	5	2.815250e-010	2	4.074388e+002

Current Iteration: 9

L	Step	Imin	D²min	Imax	D²max
1	0.50000	5	1.249001e-014	2	4.409364e+002
2	1.00000	5	4.496403e-015	5	4.496403e-015
3 *	1.00000	5	4.496403e-015	5	4.496403e-015

Current Iteration: 10

L	Step	Imin	D²min	Imax	D²max
1	0.50000	5	3.552714e-015	5	3.552714e-015
2	1.00000	5	1.074696e-013	5	1.074696e-013
3 *	1.00000	5	1.074696e-013	5	1.074696e-013

Convergence achieved.

I	cases	sum	Z	R	Z-R	(Z-R)/R %
1	138	138.0	3500000.0	3500000.0	-0.0	-0.0
2	1103	1103.0	30000000.0	30000000.0	-0.0	-0.0
3	595	595.0	19000000.0	19000000.0	-0.0	-0.0
4	607	607.0	25000000.0	25000000.0	-0.0	-0.0
5	232	232.0	30000000.0	30000000.0	0.0	0.0

cases : number of microunits in the sample
Z : sum of old adjustment factors (old weights)
sum: unweighted sum
Z : sum weighted by old adjustment factors (old weights)

Adjustment complete.

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