User Manual for the HPZ Code Package

June 27, 2018

1 Matlab Preparation

The code package runs on Matlab (checked on versions 2015b and 2017a). The user needs to follow the following steps in order to run the code in the MATLAB environment:

- Extract the code package zipped file into a new folder named (for example) HPZ_Code.
- Set the MATLAB path to the HPZ_Code folder:
  - Click on the "set path" option.[1]
  - Choose the "Add Folder with Subfolders" option.
  - Choose the HPZ_Code library.
  - After the files were added to the list, while still marked, click the "Move to Bottom" option.
  - Save and Close.

[1] In the 2010b version the button is under the File tab on the menu bar. In the 2012 version it is an individual button on the MATLAB toolbar. In the 2015b version this button is placed under the Home tab.

2 Start the Program

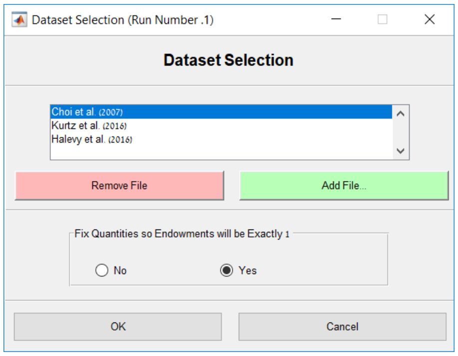
To run the code, the user should write HPZ_Interface on the MATLAB command window. The user interface (HPZ_Interface) includes a sequence of windows. Each window presents the user with questions regarding required operations. After the information is gathered, the "Running Plan" window appears. The user can then choose to insert the parameters for another run of the routine. In this way the user can insert several calculations to a single run of the routine. Once the "Run Now" button is clicked, all the pre-defined calculations are executed in the order of definition. When the routine is done, the results are saved into a file (the results of each run are stored separately) and a popup window is prompted including the path to the result file. The rest of this manual describes the sequence of windows.

3 Dataset Selection Window

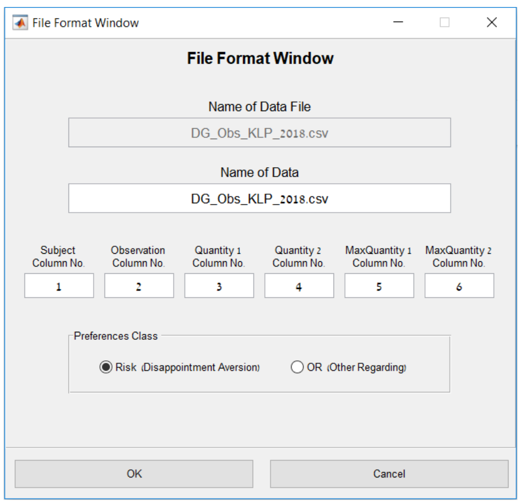
In the Dataset Selection window (see Figure 3.1a) the user is required to choose the dataset for analysis. Currently the datasets that are supported by the code involve either portfolio choice in the context of risk or in the other regarding preferences context.

The user can add a dataset to the list by clicking the "Add File" option. A browser window pops up where the user is asked to choose the new dataset. Then, the File Format window (see Figure 3.1b) appears where the user can edit the dataset name, the preferences class (risk preferences or other regarding preferences) and match the columns in the file to the observation level data required by the software - subject number, observation number, the two quantities and the two maximal quantities (the reciprocal of the prices).

In the Dataset Selection Window the user can also remove a dataset from the list by choosing the dataset and clicking the "Remove File" button. Finally, the user can choose whether to fix the endowments to exactly 1 or leave the data as is. This option might be useful when quantities are rounded in the original data file. In this case, the endowment may equal 1 only approximately



(a) Dataset Selection Window



(b) File Format Window

Figure 3.1: Dataset Selection

and some calculations may be slightly sensitive to these discrepancies.[2] If the user asks to fix the endowment, the quantities are changed accordingly while keeping their ratio constant.

4 Action Selection Window

In the Action Selection window (see Figure 4.1) the user is required to choose one of the following four actions:

[2]An exception is the number of axiom violations that may change considerably.

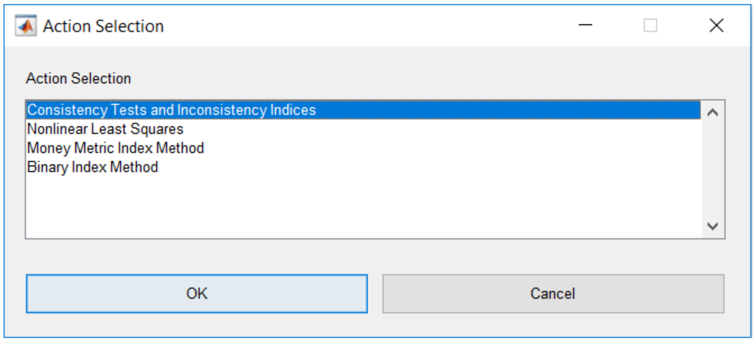


Figure 4.1: Action Selection Window

- Consistency analysis.
- Nonlinear Least Squares recovery.
- Money Metric Index recovery.
- Binary Index recovery.

5 Subjects Selection Window

In the Subjects Selection Window (see Figure 5.1), the user is required to select the analyzed subjects (one or multiple subjects can be chosen). When the choice is made, the sequence of windows continues.

6 Inconsistency Indices Settings Window

The software implements four types of inconsistency indices - number of violations (of some revealed preference axiom), the Afriat index, the Varian index and the Houtman-Maks index (see Appendix B in Halevy et al. (2016) for a detailed description of the algorithms implemented in the package). The inconsistency indices settings window (see Figure 6.1) allows the user the following actions:

- GARP, WARP and SARP violations:

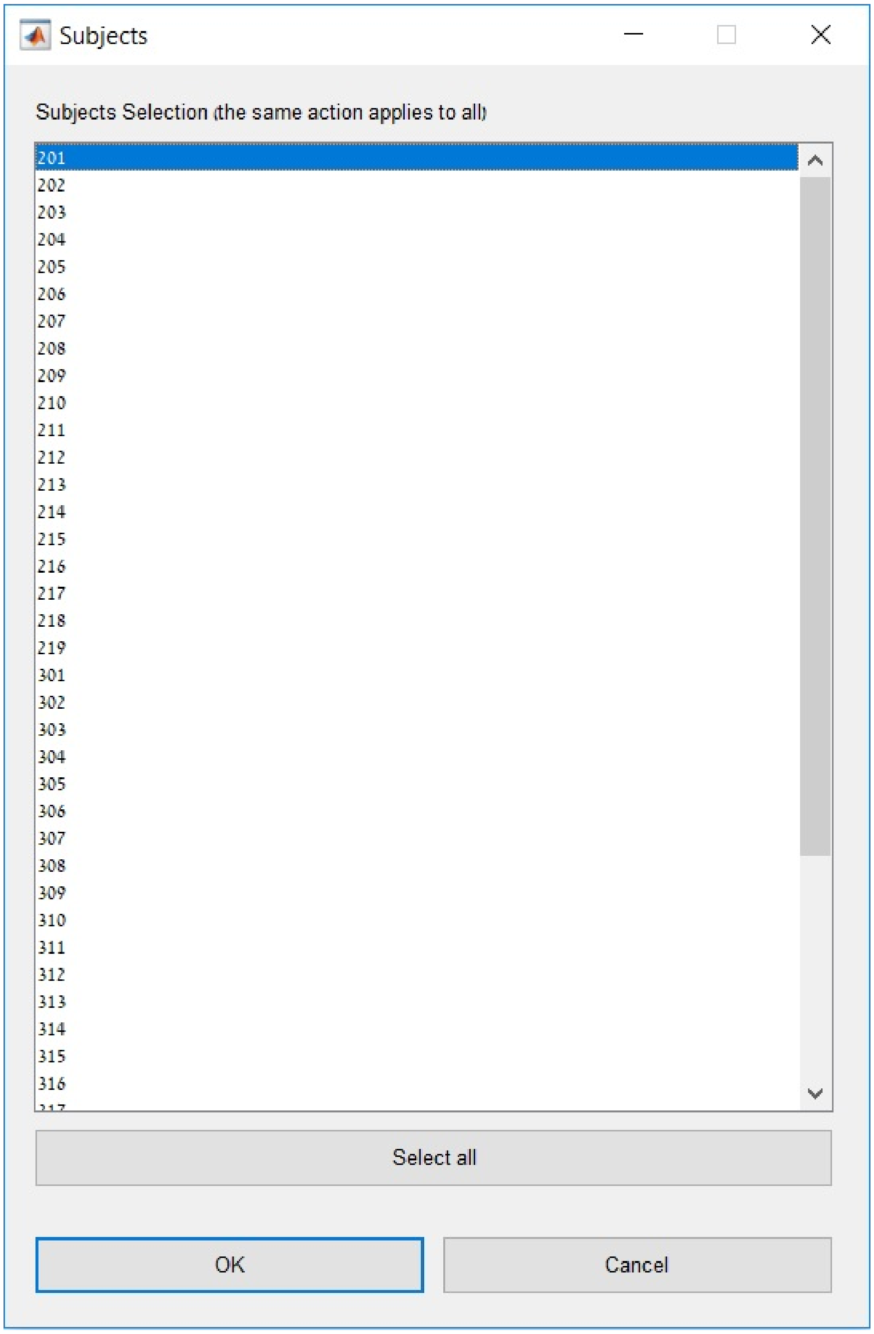


Figure 5.1: Subjects Selection Window

– Calculate: The index is calculated only if YES is checked.

– Residuals: If YES is checked then we compute a residual for each observation. The residual is the number of violations that involve the observation (in-sample) or the number of violations lost if this observation is dropped (out-of-sample calculation). The user can require a calculation of the residual for a specific axiom or for all supported axioms simultaneously.

- Afriat Inconsistency Index:
  - Calculate: The index is calculated only if YES is checked.
  - Residuals: If YES is checked then we compute a residual for each observation - the difference between the index as calculated on the whole dataset and the index as calculated on the dataset when this observation is dropped (out-of-sample calculation).
- Varian Inconsistency Index and Houtman-Maks Inconsistency Index:[3]
  - Calculate: The index is calculated only if YES is checked.
  - Residuals: If YES is checked then we compute a residual for each observation. The residual is the value of this observation in the disaggregated vector that minimizes the index (in-sample) or the difference between the index as calculated on the whole dataset and the index as calculated on the dataset when this observation is dropped (out-of-sample calculation).

When OK is clicked the Running Plan Window pops up.

7 Functional Form Settings Window

The Functional Form Settings window can take two forms depending on the object of choice.

[3] In the results file we specify the algorithm used to calculate the index. In the Houtman-Maks "1" means exact calculation while "0" means approximation. In the Varian "1" means exact calculation, "2" means good-approximation and "3" means not-so-good-approximation

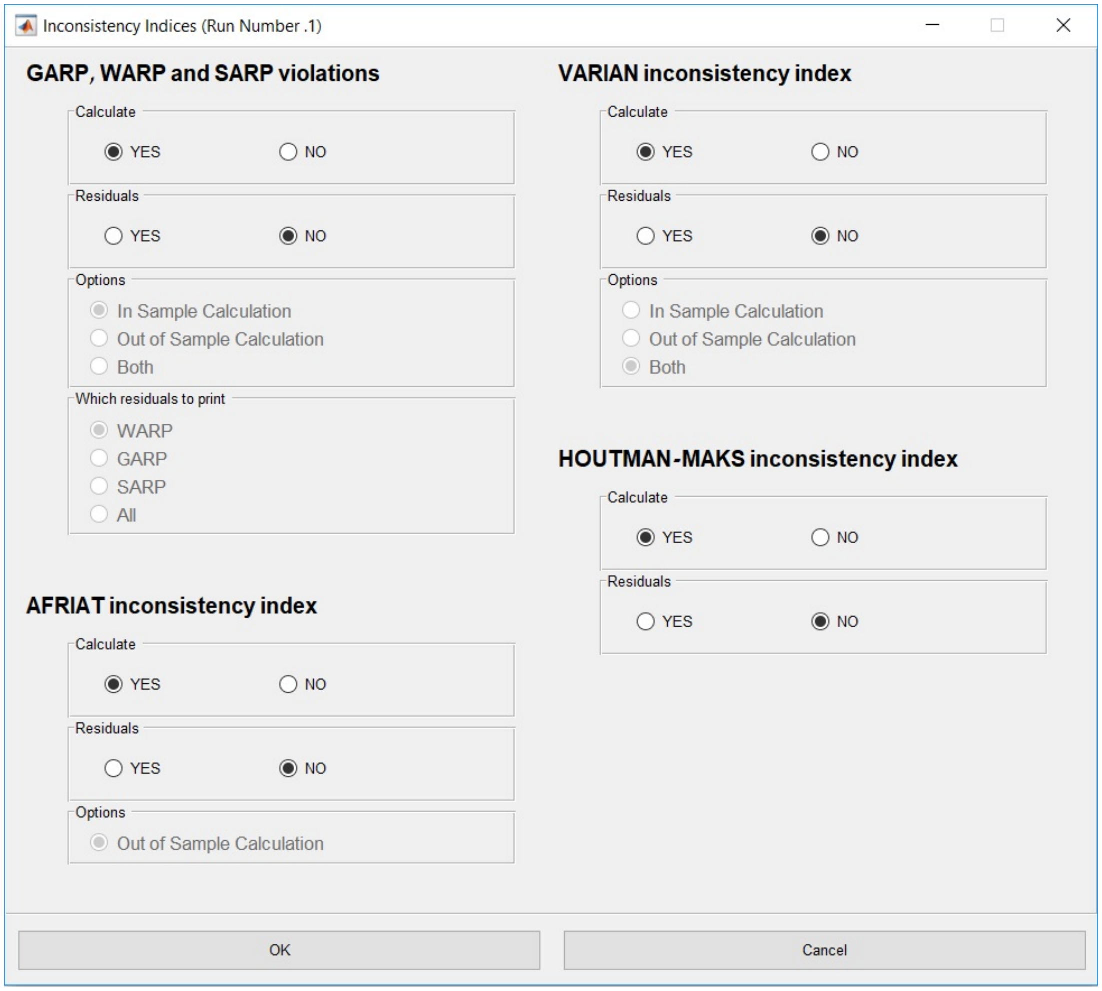


Figure 6.1: Inconsistency Indices Window

7.1 Risk Preferences

First, we describe the window that appears when analyzing a data set collected in an experiment where bundles are portfolios and the goods are Arrow securities (see Figure 7.1). In this window the user is required to address the following issues:

1. **Functional Forms** - Within the Disappointment Aversion framework,

(see Appendix B in Halevy et al. (2016)). Notice that using the not-so-good-approximation for the residuals can lead to unreasonable results (e.g. the normalized out-of-sample index for a residual may be higher than the normalized out-of-sample index for the whole dataset).

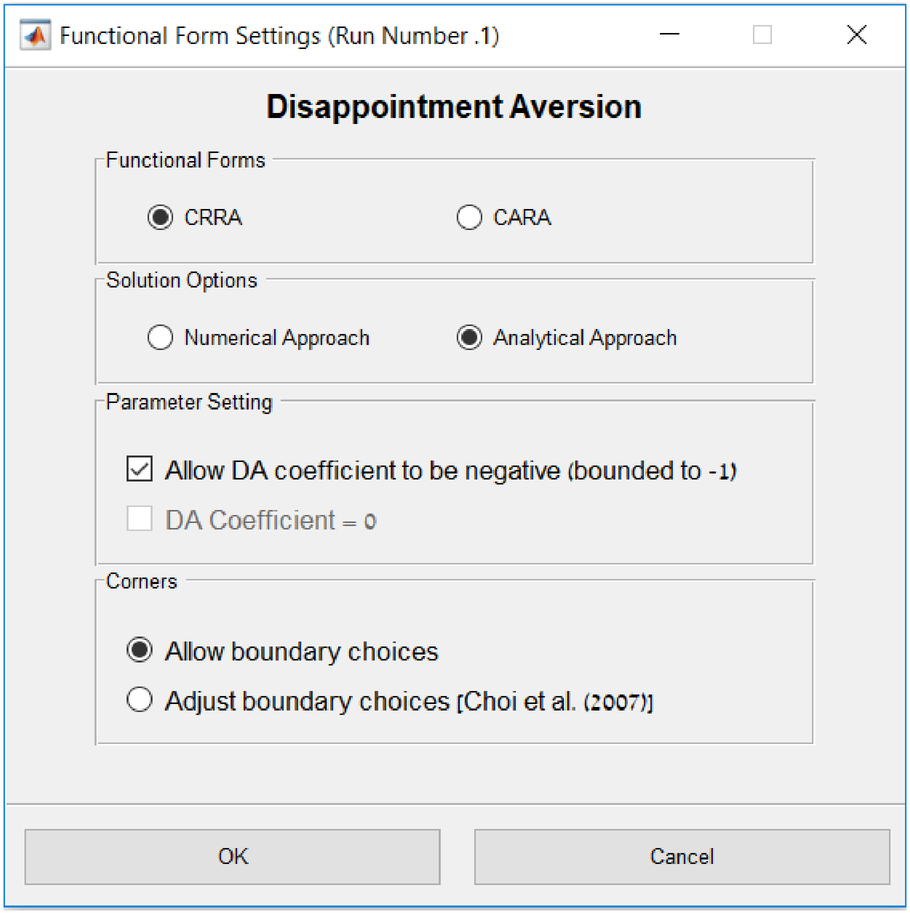


Figure 7.1: Functional Form Settings Window - Risk Preferences

the user must select the functional form of the VNM utility function. The user options are the well known CRRA or CARA.

2. **Solution Options** - The user must choose the computational approach towards basic calculations (optimal choices in the NLLS case and optimal budget line adjustments in the MMI and BI cases). One option is the numeric approach which is based on MATLAB's optimization procedures. The other option is the analytic approach which is based on a pre-calculated first order conditions (the calculations are documented in the file "DA2-analytic.pdf" included in the package). The analytic approach is much faster and therefore recommended for a user that uses

the functional forms provided in the package. The numeric approach may be useful in cases where a new functional form is introduced.

3. **Parameter Setting** - The user has three options here:

   - Checking only the upper box allows for $\beta \geq -1$.
   - Checking only the bottom box fixes β to be zero.
   - Leaving both boxes unchecked restricts β to be non-negative ($\beta \geq 0$).

4. **Corners** - This issue is relevant only to the case where CRRA is the chosen functional form. In this case boundary choices may become problematic, and the user is suggested with two options:

   - Do nothing.
   - Adjust the corner choices so that the dataset will include only internal choices (the method applied follows Choi et al. (2007)).

7.2 Other Regarding Preferences[4]

Next, we describe the window that appears when analyzing a data set collected in an experiment where bundles are token allocations and the goods are tokens for Self and tokens for Other (see Figure 7.2). In this window the user is required to address the following issues:

1. **Functional Forms** - Currently only the CES functional form is implemented.

2. **Solution Options** - See description for the risk preferences case (the calculations of the first order conditions for the analytic approach are documented in the file "CES-analytic.pdf" included in the package).

[4]Currently we add no datasets of other-regarding preferences. A suitable example will be added once the relevant paper will be published.

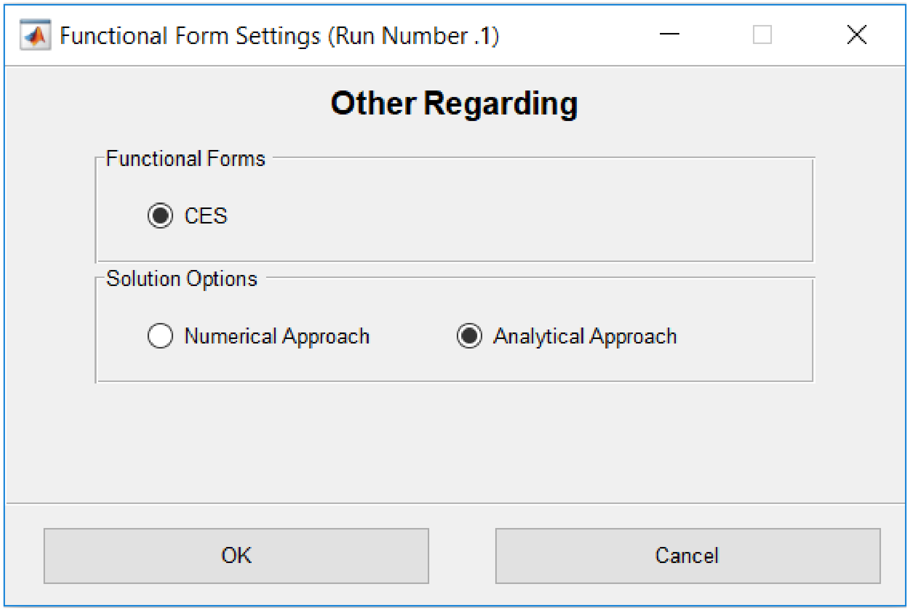


Figure 7.2: Functional Form Settings Window - Other Regarding Preferences

8 Optimization Settings Window

In the Optimization Settings window (see Figure 8.1) the user is required to specify the details of the optimization process on the parameters space. For all three methods the user is required to specify:

- **Number of convergence points** - The main part of the optimization process over the parameters space runs MATLAB's optimization routine multiple times, each time with a different set of initial parameters. The chosen number of convergence points specifies the number of times the optimization process requires the "best" result to be replicated in order to terminate. Hence, the process may terminate either on account of "enough" replications of the "best" result (between 3 and 100 in analytic calculation and between 3 and 30 in numeric calculation) or on account of utilizing the whole set of initial points (100 in analytic calculation and 30 in numeric calculation).

- **Allocated time** - The user has an option to add time limit (in minutes)

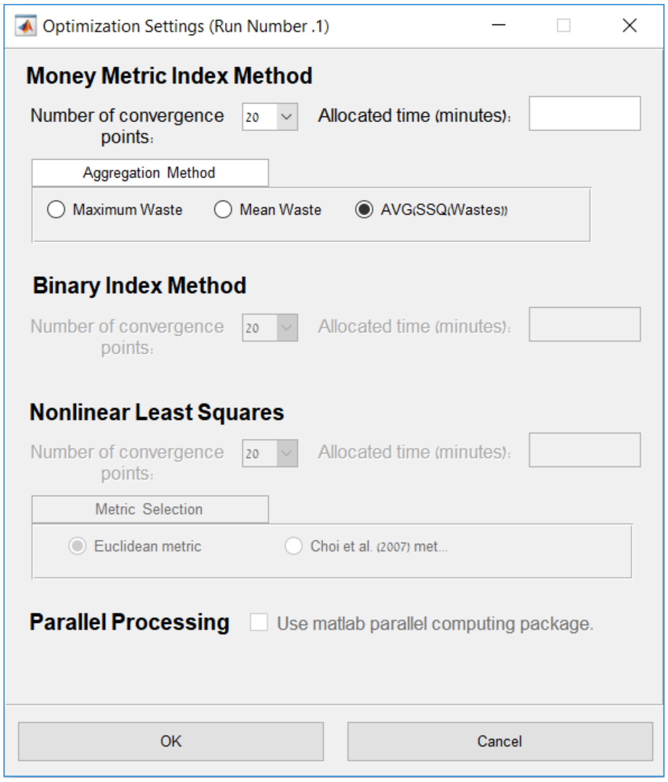


Figure 8.1: Optimization Settings Window

as a third stopping rule for the optimization process. To avoid time limits the user should leave this field empty.

- **Parallel Processing** - If the numerical approach is selected, the user has the option to use the parallel processing package of the MATLAB. This requires to terminate other processes, since it uses all the CPU cores. This option is irrelevant for the analytical approach.

For the Money Metric method, the user is required also to choose the aggregation method:

- **Aggregation Method** - As described in Halevy et al. (2016), the MMI method can aggregate the observation level adjustments using various aggregators. The user's options are (let n be the number of observations and let v^i be the adjustment for the i^{th} observation):

- Maximum Waste - $1 - \min_{i \in \{1,\ldots,n\}} v^i$.
- Mean Waste - $\frac{1}{n} \sum_{i=1}^{n} (1 - v^i)$.
- AVG(SSQ(Wastes)) - $\sqrt{\frac{1}{n} \sum_{i=1}^{n} (1 - v^i)^2}$.

Similarly, for the Non-Linear Least Squares method, the user is required to choose the aggregation method:

- **Aggregation Method** - The NLLS method can aggregate the observation level distances between the predicted bundles and the observed bundles using various aggregators. The user's options are (let n be the number of observations, x^i the observed bundle, $\hat{x^i}$ the predicted bundle and p^i the corresponding price vector):
  - Euclidean Metric - $\min_{\beta,\rho} \sum_{i=1}^{n} \left\| x^i - \arg\max_{x:p^i x \leq p^i x^i} \left(u\left(x;\beta,\rho\right)\right)\right\|$ where $\|\cdot\|$ is the Euclidean norm.
  - Choi et al. (2007) Metric - $\min_{\beta,\rho} \sum_{i=1}^{n} \left(\ln \frac{x_2^i}{x_1^i} - \ln \frac{\hat{x_2^i}}{\hat{x_1^i}} \right)^2$ where $\hat{x^i} = \arg\max_{x:p^i x \leq p^i x^i} \left(u\left(x;\beta,\rho\right)\right)$.

9 Output File Format Window

The Output File Format window (see Figure 9.1) enables the user to partially customize the output file.

- **Select the Values Needed for the Output File** - the value of the chosen loss function always accompanies every set of parameters that is reported in the output file. The user can choose to calculate the value of other loss functions given the reported set of parameters. The optional loss functions are (the chosen criterion is grayed):
  - NLLS value based on Euclidean Metric.
  - NLLS value based on CFGK Metric.
  - MME value based on MAX Waste.

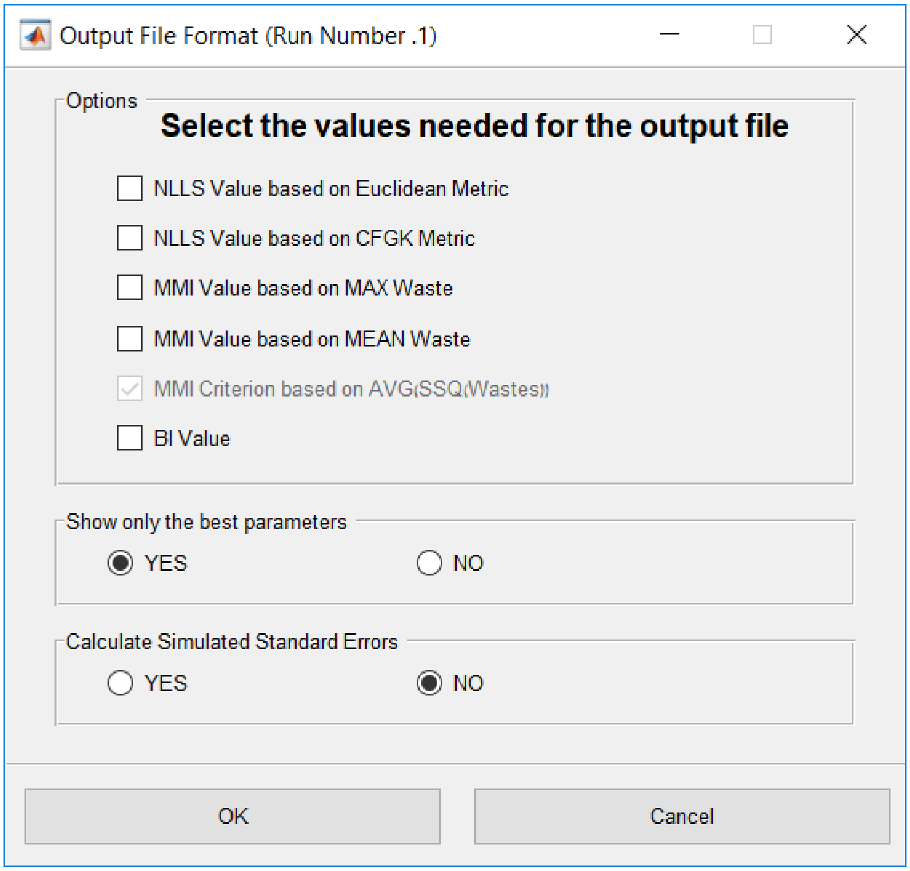


Figure 9.1: Output File Format Window

  - MME value based on MEAN Waste.
  - MME value based on AVG(SSQ(Wastes)).
  - BI Value.

- **Show Only the Best Parameters** - The user can choose the output file to include only the best set of parameters for each subject (by choosing YES) or to include every set of parameters that the code considered as "close" to the optimal set (by choosing NO).

- **Calculate Simulated Standard Errors** - The user can choose to generate a distribution of recovered parameters from 1000 re-samples of the data set. In case YES is chosen, the output file will include, for every

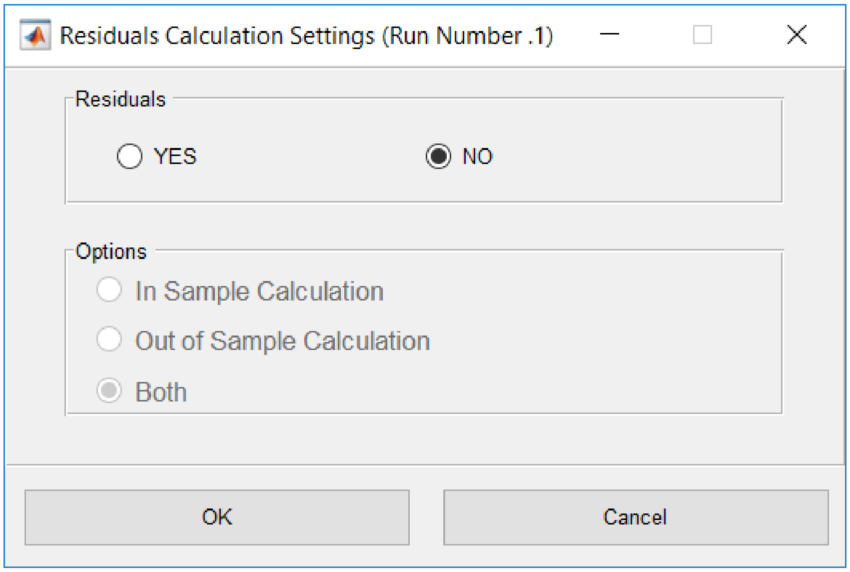


Figure 10.1: Residuals Calculation Settings

subject, the mean, standard deviation, 5% percentile and 95% percentile of this distribution.

10 Residuals Calculation Settings

The final window, the Residuals Calculation Settings (see Figure 10.1), enables the user to generate an additional output file that reports the observation level residuals of the recovered set of parameters in terms of adjustments (in the cases of the MMI and the BI recovery methods) or in terms of Euclidean distance (in the NLLS recovery method case). The In Sample Calculation reports the residuals relative to the set of parameters recovered using the complete sample, while the Out of Sample Calculation reports the residuals relative to the set of parameters recovered when the relevant observation is dropped from the sample (and therefore the Out of Sample Calculation is significantly slower).

To avoid the residuals calculation the user should choose NO in the Residuals frame. Otherwise, the user may choose the type of calculation in the Options frame. When OK is clicked the Running Plan Window pops up.

11 Final Comments

This user manual is meant for users who wish to use the package as is. However the code can be easily altered to support additional functionalities - additional type of preferences, additional functional forms, improved diagnostics, etc. In fact, the code is designed to accommodate some of these additions without the need to be acquainted with the whole package. For advice and support please consult "Code Map and Program Guide.pdf". For any question please contact Dotan Persitz.

References

Choi, Syngjoo, Raymond Fisman, Douglas Gale, and Shachar Kariv, "Consistency and Heterogeneity of Individual Behavior under Uncertainty," *American Economic Review*, December 2007, *97* (5), 1921–1938.

Halevy, Yoram, Dotan Persitz, and Lanny Zrill, "Parametric Recoverability of Preferences," *Working Paper*, 2016.