README

This document describes the replication package that accompanies *Alert the Inert? Switching Costs and Limited Awareness in Retail Electricity Markets* by Luisa Dressler and Stefan Weiergraeber.

Overview

The code in this replication package constructs all tables and figures in the main text and the online appendix from the original data sources using a combination of Python, R, Stata, and MATLAB (using Mex and C code).

The code is structured based on a template for reproducible research projects in Economics by Gaudecker, 2019. The automation is pre-configured by describing the research workflow as a dependent acyclic graph using Waf (https://code.google.com/p/waf/).

In order to replicate all figures and tables referenced in the paper you need to:

- Install all the required software and packages (see *Software Requirements* below). If not already the case, add all executables for Python, R, Stata, and MATLAB to your system path so that waf can access the software from the command line.
- Copy the confidential data files that are not provided as part of this package into `src/original_data`. For information on how to obtain the data files, see *Details on Each Data Source* below.
- Navigate to the root folder of the code repository.
- Configure waf using the command `python waf.py configure`.
- Let waf build the project using the command `python waf.py build`. The file `waf.py` along with the `wscript`-files in each subfolder and the code in folder `.waf` serve as a master file that runs all the programs for data management, analysis, and final formatting in the correct order. In addition, waf will create the corresponding folder structure within a `bld`-folder in the root-directory of the replication package. Details about this setup are provided by Gaudecker (2019). Therefore, you should not run any of the programs manually before running the waf-program. Once the folder structure and the associated project path files in `bld` are created, you can interactively rerun any of the programs contained in this repository and inspect all of its output. When running single files in isolation please set the working directory of your Stata/MATLAB/Python/R executable to `bld` to ensure that the automatically generated absolute path names can be accessed by the programs.

  Note that waf will run independent programs in parallel. On some machines this could lead to an inefficient overuse of hardware and in rare circumstances crash the system. In order to circumvent this, waf can be

instructed to run all files serially by using the `-j1` flag: `python waf.py build -j1`

You should expect the code to run for about 7 days on a modern desktop computer.

Data Availability Statement

Summary of Availability

Most of the data sources are confidential and cannot be made publicly available. We elaborate on the availability of each data set below. The key data (contract-level market shares and consumer surveys) can be obtained by signing a research cooperation and confidentiality statement with VREG, the *Vlaamse reguleringsinstantie voor de elektriciteits- en gasmarkt* (Flemish regulator of the electricity and gas market; website: https://www.vreg.be/nl). Researchers who are interested in obtaining access to the data can contact VREG at https://www.vreg.be/nl/contact.[1]

It can take a few weeks to negotiate data use agreements and gain access to the data, but in our experience VREG is very supportive of academic research. We are happy to assist with any reasonable replication attempts for two years following publication. We provide code comments within the programs in `src/data_management` to provide interested replicators an overview of the structure of each data file.

Details on Each Data Source

We provide a table which lists all the data files used in our analysis below. The code relies on six groups of data:

1. Advertising data (confidential): The files starting with `adv_` have been obtained from Nielsen (2016). We contacted Nielsen through the official contact form on their web page: https://global.nielsen.com/. The files starting with `advertisement` have been obtained in 2016 from UBA (2016), the Belgian association of advertisers. We contacted UBA via their website: https://www.ubabelgium.be/fr/. These files contain monthly advertising expenditure by all energy firms for the different regional markets in Belgium. Since we do not have permission to share these files publicly, we do not include them in this package. We did not pay an access fee for either of the data sets. However, we are allowed to use the data only for this specific research project and had to attest that no other party gains access to the raw data and that the data is not used for any other purpose, in particular, consulting or other for-profit industry studies.

[1] We do not provide a specific contact person in this README, because we obtained all the data in 2016 and the persons responsible for managing data access at both VREG and Nielsen have changed and will most likely change again in the future. In our experience, the quickest way to contact the data providers is via their general contact form.

2. Aggregate industry level statistics (used for online appendix A.1): The files starting with `acer` were obtained from ACER (2020b) and ACER (2020a). The data are available at the following links:

   - https://aegis.acer.europa.eu/chest/dataitems/66/view
   - https://aegis.acer.europa.eu/chest/dataitems/63/view
   - https://aegis.acer.europa.eu/chest/dataitems/217/view

   and are included in this package.

3. Demographic and macro data: The files `CPI_bel.xlsx` (CPI data) and `demo_age.xlsx` (data on the age distribution in Belgium) were obtained from the Belgian statistical office (Statbel, 2017; Statbel, 2016):

   - http://statbel.fgov.be/en/statistics/figures/economy/consumer_price_index/
   - https://bestat.statbel.fgov.be/bestat/crosstable.xhtml?view=c1649c18-ea66-4286-9310-2413e74134f8

   The files `demo_edu.xlsx` (data on education level of the Belgium population, not used in final model specification) and `demo_inc.xlsx` (data on the income distribution in Belgium) were obtained from Eurostat (2016b) and Eurostat (2016a):

   - https://appsso.eurostat.ec.europa.eu/nui/show.do?dataset=edat_lfse_04&lang=en
   - https://appsso.eurostat.ec.europa.eu/nui/show.do?dataset=ilc_di01&lang=en

   The files `internet_demo.xlsx` and `internet.xls` contain data on internet access and internet usage by different demographic groups in Belgium and were obtained from OECD (2018): https://www.oecd.org/sti/broadband/broadband-statistics/. These data can be downloaded freely from the Statbel, Eurostat, and OECD websites, respectively, and are included in this package.

   The file `households_bel.csv` contains information about the population, number of households, and household size in Belgium and Flanders. We obtained this information via Statista, which collected the data from Statbel (2021b), Statbel (2021a), Vlaamse-Confederatie-Bouw (2021b), and Vlaamse-Confederatie-Bouw (2021a):

   - https://www.statista.com/statistics/517196/population-of-belgium-by-region/
   - https://www.statista.com/statistics/518116/number-of-households-in-belgium/

- https://www.statista.com/statistics/811256/number-of-houses-in-belgium-by-region/
- https://www.statista.com/statistics/811203/number-of-apartments-in-belgium-by-region/.

Since these data sets require a Statista subscription, we do not include them in this package. The data can, however, be easily and freely collected from the sources Statbel (2021b), Statbel (2021a), Vlaamse-Confederatie-Bouw (2021b), and Vlaamse-Confederatie-Bouw (2021a) directly.

4. Market share data (partly confidential): The file `data_macro_FL.xlsx` contains monthly market shares on the firm level for 2012-2016. Market shares at the firm level are publicly available as pdfs (VREG, 2017b). We transcribed this information into a spreadsheet. The pdfs can be downloaded from the VREG website. The file names have the following structure: `MARKTGEGEVENS ELEKTRICITEIT YYYY MARKTAANDELEN ACTIEVE LEVERANCIERS`. These data can either be obtained via VREG's data portal or via the following direct links:

   - https://www.vreg.be/sites/default/files/uploads/statistieken/marktaandelen/20120601-e-martkaandeel_maandelijks_netbeheerderds_h_plus_nh-nl.pdf
   - https://www.vreg.be/sites/default/files/uploads/statistieken/marktaandelen/20140108-e-martkaandeel_maandelijks_netbeheerders_h_plus_nh-nl.pdf
   - https://www.vreg.be/sites/default/files/statistieken/marktaandelen/20150113-e-martkaandeel_maandelijks_netbeheerders_h_plus_nh-nl.pdf
   - https://www.vreg.be/sites/default/files/statistieken/marktaandelen/20160112-e-nl-martkaandeel5fmaandelijks5fnetbeheerders5fh5fplus5fnh6.pdf
   - https://www.vreg.be/sites/default/files/statistieken/marktaandelen/20160905-e-nl-martkaandeel5fmaandelijks5fnetbeheerders5fh5fplus5fnh69.pdf.

   For each of these pdfs, we used information from Table 5: *Marktaandelen actieve leveranciers uitgedrukt in totaal aantal jaargelezen, huishoudelijke elektriciteitsafnemers (toegangspunten)*, i.e. market shares of active suppliers expressed as a share of total number of access points per year (household electricity customers).

   This file also includes the number of PCW users that completed the V-test on the PCW in each month during 2012-2016. This variable is confidential and was provided to us by VREG (2017c) after signing a research cooperation and confidentiality statement. We include the file containing only the firm-level market shares. Before replication, the column

Number of page views Price simulator has to be filled with the PCW usage data from VREG.

The file `data_macro_gas_FL.xlsx` contains the analogous data for the retail natural gas market, which is used to compute several variables and statistics as described in the paper. The file `contract_ms_long.xlsx` contains quarterly contract-level market share data for 2012-2016. These data are confidential and were obtained from VREG (2016a) upon signing a research cooperation and confidentiality statement. `ms2011.xlsx` contains the analogous data for 2011.

We obtained the data via email after negotiating access conditions and signing a confidentiality statement. We did not pay an access fee for either of the data sets. However, we are allowed to use the data only for this specific academic research project and had to attest that no other party gains access to the raw data and that the data is not used for any other purpose, in particular, consulting or other for-profit industry studies. Interested replicators can contact VREG via their general contact form https://www.vreg.be/nl/contact.

5. Consumer surveys (confidential): The individual-level consumer surveys are confidential and were provided to us by VREG (2016b) after signing a research cooperation and confidentiality statement. These surveys contain over 100 questions about consumers' demographic information, their electricity supplier choices, and price comparison website usage behavior, as well and their attitudes towards energy markets. We refer interested readers to the code comments in `src/data_management` to get an idea of the structure of the survey files. Surveys for the years 2012 to 2014 were provided in Excel-format. Surveys for the years 2015 and 2016 were provided in Stata format.

   We obtained the data via email after negotiating access conditions and signing a confidentiality statement. We did not pay an access fee for either of the data sets. However, we are allowed to use the data only for this specific academic research project and had to attest that no other party gains access to the raw data and that the data is not used for any other purpose, in particular, consulting or other for-profit industry studies. Interested replicators can contact VREG via their general contact form https://www.vreg.be/nl/contact.

6. Price data: The file `newprices.xlsx` contains price data for retail electricity and gas markets for 2012-2016 for the regions Flanders and Wallonia. These data were obtained from data that are generally not available to the public. Retail prices for both regions (Flanders, Wallonia) come from price sheets that electricity suppliers are required to submit to CREG (Commission de régulation de l'électricité et du gaz), the Belgian Regulator for Electricity and Gas, on a monthly basis for each retail electricity contract that they offer (CREG, 2016). We received this information as

pdfs and transcribed it into a spreadsheet. The prices typically include a monthly subscription fee, the price per kWh of electricity consumed, and additional kWh charges, for example to support the development of renewable energies or cogeneration plants.

Files starting with `wholesale` contain commercial data for spot and future wholesale market prices at the quarter-hour level for electricity. These data were provided to us by CREG and we do not have permission to upload these data either.

We do not have permission to publicly upload any of the price data provided by CREG, but we are happy to provide our complete spreadsheets after you have obtained written permission from CREG to use these data. CREG can be contacted via the following form: https://www.creg.be/fr/formulaire-de-contact. We obtained the data from CREG after negotiating access conditions and signing a confidentiality statement. We did not pay an access fee for either of the data sets. However, we are allowed to use the data only for this specific academic research project and had to attest that no other party gains access to the raw data and that the data is not used for any other purpose, in particular, consulting or other for-profit industry studies.

The file `wholesaleGasPrices.xlsx` contains daily wholesale price data for natural gas at several hubs. These data are publicly available on the ACER (2020b) website (https://aegis.acer.europa.eu/chest/dataitems/217/view) and are included in this package.

`dep_wholesale.csv` contains a firm-specific variable that is constructed to approximate each supplier's sensitivity to wholesale market prices. It is the result from calculating one plus the approximated share of electricity that a supplier needs to purchase, instead of producing itself, to satisfy demand. Observed electricity volumes that each supplier delivered in 2014 in Belgium is available from VREG (2017a): https://www.vreg.be/sites/default/files/statistieken/marktaandelen/20170517-statistiek_marktaandelen_elek_-_geleverd_volume_-_2016.pdf. The estimate of own production uses production capacity by supplier available on the website of Belgium's electricity transmission system operator (ELIA, 2017): http://www.elia.be/en/grid-data/power-generation/generating-facilities. Country-wide capacity factors by energy source are available at the website of the Federation of Belgian Enterprises for Electricity and Gas (FEBEG, 2017): https://www.febeg.be/fr/statistiques-electricite.

The following table summarizes all the data files necessary to build the project.

Data file	Source	Notes	Provided
`acer_markups.xlsx`	ACER		Yes
`acer_price_breakdown.xlsx`	ACER		Yes

Data file	Source	Notes	Provided
adv_nielsen_mly.xlsx	Nielsen	Confidential	No
adv_nielsen_yrly.xlsx	Nielsen	Confidential	No
advertisement_bel.xlsx	UBA	Confidential	No
advertisement_north.xlsx	UBA	Confidential	No
advertisement_south.xlsx	UBA	Confidential	No
advertisement_uba.xlsx	UBA	Confidential	No
CPI_bel.xlsx	Statbel		Yes
demo_age.xlsx	Eurostat		Yes
demo_edu.xlsx	Eurostat		Yes
demo_inc.xlsx	Eurostat		Yes
households_bel.csv	Statista	Subscription	No
internet_demo.xlsx	OECD		Yes
internet.xls	OECD		Yes
dep_wholesale.csv	VREG, Elia, FEBEG		Yes
data_macro_FL.xlsx	VREG	s. description above	(Yes)
data_macro_gas_FL.xlsx	VREG	s. description above	(Yes)
contract_ms_long.xlsx	VREG	Confidential	No
ms2011.xlsx	VREG	Confidential	No
databaseXXXX.xlsx	VREG Surveys 2012-2014	Confidential	No
surveyrawXXXX.dta	VREG Surveys 2015-2016	Confidential	No
newprices.xlsx	CREG	Confidential	No
wholesale_contracts.xlsx	CREG	Confidential	No
wholesale_spot.xlsx	CREG	Confidential	No
wholesaleGasPrices.xlsx	ACER		Yes

Computational Requirements

Software Requirements

In this section, we list all the software that is necessary to build the replication package. The code does not install these packages because we prefer not to interfere with the replicator's computer system. Please install each of the software and required packages manually before running the code.

- Stata (code was last run using version 17)
  - `estout`
- Python (code was last run using Anaconda Python 3.8.5, which should

come with most of the required packages by default.)
  - `matplotlib` 3.3.2
  - `numpy` 1.19.2
  - `pandas` 1.1.3
  - `scipy` 1.5.2
- C compiler for compiling mex-code. We used Apple's clang (version 12.0.0) provided with XCode.
- Matlab (code was last run using Release 2020a)
- R (code was last run using version 4.1.2)
  - `extrafont` (0.17)
  - `ggplot2` (3.3.5)
  - `hrbrthemes` (0.8.0)
  - `lubridate` (1.8.0)
  - `RColorBrewer` (1.1-2)
  - `readxl` (1.3.1)
  - `remotes` (2.4.2)
  - `tidyverse` (1.3.1)
  - `xtable` (1.8-4)

Memory and Runtime Requirements

Summary The code was last run on a **6-core Intel-based iMac with MacOS version 10.15.7**. Computation took approximately 7 days.

Description of Code

- All program files contain an introductory docstring that explains the purpose and content of the respective file.
- All original data source files should be stored in `src/original_data`. The data management code reads all data source files from this location.
- The programs in `src/data_management` clean, reshape, and combine the different data files for both the reduced form regressions and the structural estimation. `src/data_management/wscript` describes the detailed dependency structure and explains which output files are generated by which program. The cleaned data output files are stored in `bld/out/data`.
- The programs in `src/analysis` run the main analysis consisting of reduced form regressions and the structural estimation. `src/analysis/wscript` describes the detailed dependency structure and explains which output files are generated by which program. Most of the estimation output is stored in unformatted form in `bld/out/analysis`. The reduced form regression tables are directly formatted in Stata and are saved in `bld/out/tables`.
- The programs in `src/final` read the estimation output from `bld/out/analysis` and format the final LaTeX-tables for the structural estimation results and the counterfactual results. In addition, the scripts that generate the figures are stored in this folder. `src/final/wscript` describes the detailed dependency structure and explains which out-

put files are generated by which program. The figures are stored in `bld/out/figures`.

- The folder `src/model_specs` contains several configuration files for the estimation, such as optimizer options, and starting values for the parameters that were obtained using an exploratory broad search radius using `src/analysis/ars.m`.
- Note that the file `waf.py` along with the `wscript`-files in each subfolder and the code in folder `.waf` serves as a master file that runs all the programs for data management, analysis, and final formatting in the correct order. In order to build the project, please execute the following:
  1. Navigate to the root folder of the code repository.
  2. Configure waf using the command `python waf.py configure`.
  3. Build the project using the command `python waf.py build`. This step will also create the corresponding folder structure within a `bld`-folder in the root-directory of the replication package. Details about this setup are provided by Gaudecker (2019).
- You should not run any of the programs manually before running the waf-program as described above. Once the folder structure and the associated project path files in `bld` are created on your computer, you can interactively rerun any of the programs contained in this repository and inspect all of its output. When running single files in isolation please set the working directory of your Stata/MATLAB/Python/R executable to `bld` to ensure that the automatically generated absolute path names can be accessed by the programs.

Mapping between Code and Tables and Figures

None of the figures and tables in the main text can be reproduced without obtaining the confidential data described above. Table 2 summarizes for each table and figure which program generates the output. Some of the referenced files in Table 2 only format the output based on analysis results generated by different files in `src/analysis`. For these files, Table 3 lists which analysis files generate the output for the files referenced in Table 2.

Note that there is no code for Figure A.1 and Table A.1. Figure A.1 is not empirical. Table A.1 contains summary statistics that are taken directly from the a summary sheet of the source data file.

Table 2: Mapping of Programs to Figures/Tables

	Output file name	**Program**
Table 1	rf_maintext_aej.tex	src/analysis/reduced_form_evidence_surveys.do, line 252
Table 2	estresults_maintext.tex	src/final/format_est_results.py, line 393
Table 3	cf_full_gmm_2.tex	src/final/format_counterfactuals.py, line 126
Table A.1	In-text numbers	Directly copied from source data file
Table A.2	adspending.tex	src/data_management/reshape_advertisingdata.do, line 187
Table B.1	rfmacro.tex	src/analysis/rf_evidence_macrodata.do, line 98
Table B.2	rf_vtest.tex	src/analysis/reducedform_evidence_surveys.do, line 63
Table B.3	rf_betterchoice.tex	src/analysis/reducedform_evidence_surveys.do, line 213
Table B.4	rf_switching.tex	src/analysis/reducedform_evidence_surveys.do, line 149
Table B.5	rf_ada_evidence.tex	src/analysis/rf_evidence_adv_assumptions.do, line 125
Table B.6	hausman_IV_evidence_2.tex	src/analysis/rf_evidence_macrodata.do, line 192
Table E.1	estresults_hausmancomp.tex	src/final/format_est_results.py, line 570
Table E.2	gof_churn_pcw_2_mod1	src/final/format_model_diagnostics.py, line 313
Table E.3	estresults_1_mod5.tex	src/final/format_est_results.py, line 108
Table E.4	estresults_1_mod6.tex	src/final/format_est_results.py, line 108
Table E.5	copm_est_stats_final.tex	src/final/format_model_diagnostics.py, line 677
Table E.6	comp_contract_val_final.tex	src/final/format_model_diagnostics.py, line 643
Table E.7	ccp_contract_0_1_mod1.tex	src/final/format_model_diagnostics.py, line 405
Table E.8	ccp_contract_200_1_mod1.tex	src/final/format_model_diagnostics.py, line 405
Table F.1	cf_shares_2_mod1.tex	src/final/format_counterfactuals.py, line 422
Table F.2	cf_comp_gmm_2	src/final/format_counterfactuals.py, line 164
Figure 1	pcw_search_costs_2_mod1.pdf	src/final/format_plot_pcw_entrycost.py, line 106
Figure 1	pcw_search_costs_2_mod4.pdf	src/final/format_plot_pcw_entrycost.py, line 106
Figure A.1	vtestcropped.pdf	Not empirical
Figure A.2	plotconvprices.pdf	src/final/plot_prices.py, line 81
Figure A.2	plotgreenprices.pdf	src/final/plot_prices.py, line 117
Figure A.3	plotawarenessswitching.pdf	src/final/plot_awareness_switching.py, line 84
Figure A.4	price_composition_regulated.png	src/data_management/acer_data_check.R, line 184
Figure A.4	price_composition_deregulated.png	src/data_management/acer_data_check.R, line 172
Figure A.5	plot_prices_markups_mwh.pdf	src/final/plot_prices.py, line 245
Figure A.6	markups_time_deregulated.png	src/data_management/acer_data_check.R, line 62
Figure A.6	markups_time_regulated.png	src/data_management/acer_data_check.R, line 72
Figure A.7	retailprices_time_deregulated.png	src/data_management/acer_data_check.R, line 84
Figure A.7	retailprices_time_regulated.png	src/data_management/acer_data_check.R, line 94
Figure A.8	wholesaleprices_time_deregulated.png	src/data_management/acer_data_check.R, line 107
Figure A.8	wholesaleprices_time_regulated.png	src/data_management/acer_data_check.R, line 118
Figure E.1	gof_pcw_churn_2_mod1.pdf	src/final/plot_gof.py, line 103
Figure F.1	plotmsperfectinfo_2_mod1.pdf	src/final/plot_marketshares.py, line 168
Figure F.2	plotmssubsidy_2_mod1.pdf	src/final/plot_marketshares.py, line 126
Figure F.3	plotmsobs.pdf	src/final/plot_marketshares.py, line 67
Figure F.4	cf_pcw_usage_comb_2_mod1.pdf	src/final/format_counterfactuals.py, line 363

Table 3: Mapping of Formatting Programs to Analysis Programs

Formatting program (in `src/final`)	**Analysis program (in `src/analysis`)**
`src/final/format_est_results.py`	`estimate_model.m`
`src/final/format_model_diagnostics.py`	`estimate_model.m`
`src/final/format_counterfactuals.py`	`counterfactuals.m`
`src/final/format_plot_pcw_entrycost.py`	`estimate_model.m`
`src/final/plot_gof.py`	`estimate_model.m`
`src/final/plot_marketshares.py`	`counterfactuals.m`

References

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CREG (2016). *Retail and wholesale prices of Belgian energy suppliers 2012-2016 [dataset]*. Accessed via Commission de régulation de l'électricité et du gaz (CREG) [distributor], 2016-10-04.

ELIA (2017). *Generating facilities [dataset]*. http://www.elia.be/en/grid-data/power-generation/generating-facilities, accessed 2017-02-08.

Eurostat (2016a). *Distribution of income by quantiles - EU-SILC and ECHP surveys [dataset]*. https://appsso.eurostat.ec.europa.eu/nui/show.do?dataset=ilc_di01&lang=en, accessed on 2016-11-29.

– (2016b). *Population by educational attainment level, sex and NUTS 2 regions [dataset]*. https://appsso.eurostat.ec.europa.eu/nui/show.do?dataset=edat_lfse_04&lang=en, accessed on 2016-11-29.

FEBEG (2017). *Statistiques électricité [dataset]*. https://www.febeg.be/fr/statistiques-electricite, accessed 2017-02-08.

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Nielsen (2016). *Advertising expenditures of energy companies in Belgium [dataset]*. Accessed via Nielsen Belgium [distributor], 2016-11-22.

OECD (2018). *Broadband portal [dataset]*. https://www.oecd.org/sti/broadband/broadband-statistics/, accessed on 2018-08-01.

Statbel (2016). *Population par lieu de résidence, nationalité (Belge/non-Belge), état civil, âge et sexe [dataset]*. https://bestat.statbel.fgov.be/bestat/crosstable.xhtml?view=c1649c18-ea66-4286-9310-2413e74134f8, accessed on 2016-11-29.

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– (2021a). *Number of households in Belgium from 2011 to 2021 [dataset]*. Accessed via Statista [distributor], 2021-11-18.

– (2021b). *Population of Belgium from 2009 to 2021, by region [dataset]*. Accessed via Statista [distributor], 2021-11-18.

UBA (2016). *Advertising expenditures of energy companies in Belgium [dataset]*. Accessed via United Brands Association [distributor], 2016-09-29.

Vlaamse-Confederatie-Bouw (2021a). *Total number of apartments in Flanders, Wallonia and the Brussels Capital Region (Belgium) in 2005 and 2017 [dataset]*. Accessed via Statista [distributor], 2021-11-18.

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