



# *E*conomics of *H*uman *C*apital

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# *grmpy* Tutorial

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# Introduction

## grmpy

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`grmpy` is an open-source Python package for the simulation and estimation of generalized Roy model. Its main purpose is to serve as a teaching tool to promote the conceptual framework provided by the generalized Roy model to illustrate a variety of issues in the econometrics of policy evaluation.

- ▶ ***grmpy*** is ...
  - ▶ ...an open-source Python Package for the simulation and estimation of the generalized Roy model.
  - ▶ ...intended as a useful device to support and improve the understanding of the framework by providing the opportunity to experience the effect of particular specifications directly.

# Setup

## Setup

- ▶ Normal linear-in-parameters version of the generalized Roy model.

Potential Outcomes

$$Y_1 = \beta_1 X + U_1$$

$$Y_0 = \beta_0 X + U_0$$

Cost

$$C = \gamma Z + U_C$$

Observed Outcomes

$$Y = DY_1 + (1 - D)Y_0$$

Choice

$$S = Y_1 - Y_0 - C$$

$$D = I[S > 0]$$

# Features



## Features

- ▶ *grmpy* is currently capable of the following features:
  - ▶ Simulating a dataset based on your own specifications.
  - ▶ Providing some useful information about the simulated dataset for instance:
    - ▶ Distributional outcome characteristics
    - ▶ ATE, TT, TUT
    - ▶ MTE by ventile
  - ▶ Estimating the coefficients of interest given a dataset (of a specific form).

## Install the package

- ▶ OS, Linux : Use the pip install manager (*pip install grmpy*) or download the package via [GitHub](#) and install it manually.
- ▶ Windows: The same procedure as for Linux, OS but you have to verify that the numpy package is already installed on your machine.

## Initialization file

- ▶ The initialization file provides the user with the opportunity to specify all parameters of his/her model, for instance:
  - ▶ Simulation parameters (number of observations, name of the output files)
  - ▶ Estimation parameters (optimization algorithm, start values)
  - ▶ Optimization parameters
  - ▶ Coefficients and covariance parameters, dummy variables...
- ▶ Example
- ▶ for a detailed explanation see: [grmpy-documentation](#)

## Simulation

- ▶ *grmpy.simulate()*:
  - ▶ Input: path of the initialization file.
  - ▶ The function returns a data frame based on your specifications and different output files.
    - ▶ The data set as a pickle and a txt file.
    - ▶ An [Info file](#) that provides the distributional characteristics of the data as well as information about the different treatment effects.

## Estimation

- ▶ *grmpy.estimate()*:
  - ▶ Input: path of the initialization file.
  - ▶ At the moment the estimation process is only capable of two different optimization algorithms:
    - ▶ Broyden Fletcher Goldfarb Shanno (BFGS) algorithm
    - ▶ Powell's conjugate direction method

- ▶ There are two different options for the start values that could be set in the initialization file:
  - ▶ *init*: The estimation process uses the coefficient values specified in the initialization file as the start values for the estimation process.
  - ▶ *auto*: The start values are determined via a simple OLS followed by a Probit regression for the choice indicator.
- ▶ The estimation results are printed to an **output file**

## Test battery

- ▶ We also provide a test battery that includes several tests to ensure that the processes perform as intended.
  - ▶ Property-based testing
  - ▶ Reliability testing
  - ▶ Regression testing

## **What's yet to come?**

- ▶ Partial replication of Carneiro, Heckman, and Vytlacil (2011) (very soon!)
- ▶ Addition of marginal surplus and marginal cost parameters
- ▶ Implementation of polynomial and local instrumental variable estimation
- ▶ Exploration of alternative optimization algorithms to address large estimation tasks



# **Application Example**

# **Additional Information**

# Online documentation

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**grmpy** is an open-source Python package for the simulation and estimation of generalized Roy Model (Heckman & Vytlacil, 2005 [1]). Its main purpose is to serve as a teaching tool to promote the conceptual framework provided by the generalized Roy model which allows to illustrate a variety of issues in the econometrics of policy evaluation.

We build on the following main references:

James J. Heckman and Edward J. Vytlacil. Chapter 70 Econometric Evaluation of Social Programs, Part I: Causal Models, Structural Models and Econometric Policy Evaluation. Handbook of Econometrics, 6, 4779 – 4874, 2007.

James J. Heckman and Edward J. Vytlacil. Chapter 71 Econometric Evaluation of Social Programs, Part II: Using the Marginal Treatment Effect to Organize Alternative Econometric Estimators to Evaluate Social Programs, and to Forecast their Effects in New Environments. Handbook of Econometrics, 6, 4875 – 5143, 2007.

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# Appendix

# *References*

Becker, G. S. (1964). *Human capital* (1st ed.). New York City, NY: Columbia University Press.

Carneiro, P., Heckman, J. J., & Vytlačil, E. J. (2011). Estimating marginal returns to education. *American Economic Review*, 101(6), 2754–2781.