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Philipp Eisenhauer

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# *grmpy* Tutorial

Sebastian Becker

# Introduction

## ***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

$$Y_1 = \delta_1 X_i + U_1$$

$$Y_0 = \delta_0 X + U_0$$

## Choice

$$D = \mathbf{1}\{\Phi(\gamma Z) > u_D\}$$

$$\text{with } u_D = \Phi(V)$$

## Distributional Characteristics

$$\{U_1, U_0, V\} \sim \mathcal{N}(0, \Sigma)$$

$$\Sigma = \begin{bmatrix} \sigma_1^2 & \sigma_{1,0} & \sigma_{1,V} \\ \sigma_{1,0} & \sigma_0^2 & \sigma_{0,V} \\ \sigma_{1,V} & \sigma_{0,V} & \sigma_V^2 \end{bmatrix}$$

# 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
    - ▶  $B^{ATE}, B^{TT}, B^{TUT}$
    - ▶  $B^{MTE}$  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)
  - ▶ Optimizer specifications
  - ▶ Coefficients and covariance parameters, dummy variables ...

## Initialization file

- ▶ [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.fit()*:
  - ▶ 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 new?**



Figure: Replication Carneiro (2011)

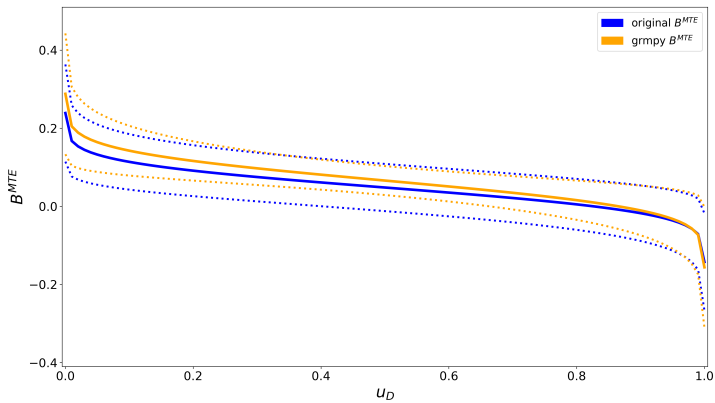
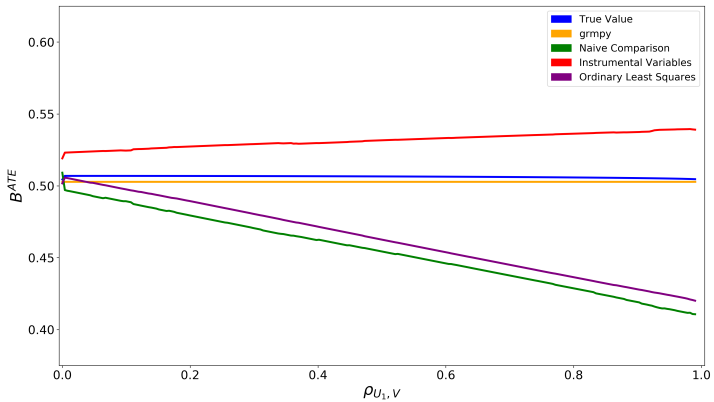


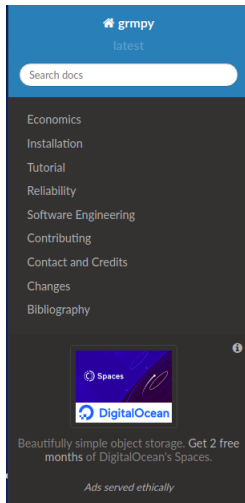
Figure: Performance comparison



## **Implementation of standard errors and adjustments on the output files**

See: [Example](#)

# Online documentation



The sidebar of the grumpy documentation website. It features a blue header with the 'grumpy' logo and 'latest' version indicator. Below is a search bar labeled 'Search docs'. A dark grey menu lists various sections: Economics, Installation, Tutorial, Reliability, Software Engineering, Contributing, Contact and Credits, Changes, and Bibliography. At the bottom, there is a DigitalOcean advertisement for Spaces storage, including the text 'Beautifully simple object storage. Get 2 free months of DigitalOcean's Spaces.' and 'Ads served ethically'.

[Docs](#) » Welcome to grumpy's documentation!

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## Welcome to grumpy's documentation!

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`grumpy` is an open-source Python package for the simulation and estimation of generalized Roy Model (Heckman & Vytlacil, 2005 [11]). It's 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*

Abbring, J. H., & Heckman, J. J. (2007). Econometric evaluation of social programs, part iii: Distributional treatment effects, dynamic treatment effects, dynamic discrete choice, and general equilibrium policy evaluation. In J. J. Heckman & E. E. Leamer (Eds.), *Handbook of econometrics* (Vol. 6, pp. 5145–5303). Amsterdam, Netherlands: Elsevier Science.

- Heckman, J. J., & Vytlačil, E. J. (2007a). Econometric evaluation of social programs, part i: Causal effects, structural models and econometric policy evaluation. In J. J. Heckman & E. E. Leamer (Eds.), *Handbook of econometrics* (Vol. 6B, pp. 4779–4874). Amsterdam, Netherlands: Elsevier Science.
- Heckman, J. J., & Vytlačil, E. J. (2007b). Econometric evaluation of social programs, part ii: Using the marginal treatment effect to organize alternative economic estimators to evaluate social programs and to forecast their effects in new environments. In J. J. Heckman & E. E. Leamer (Eds.), *Handbook*



*of econometrics* (Vol. 6B, pp. 4875–5144). Amsterdam, Netherlands: Elsevier Science.