

$u^* = \sqrt{uv}$: The Full-Employment Rate of Unemployment in the United States - Code and Data

This repository contains the code and data accompanying the paper " $u^* = \sqrt{uv}$: The Full-Employment Rate of Unemployment in the United States", written by [Pascal Michaillat](#) and [Emmanuel Saez](#), and published in the Fall 2024 issue of [Brookings Papers on Economic Activity](#).

Raw data

The raw data used by the code to produce the results in the paper are stored as CSV files in the `raw` folder.

- `20210719_cycle_dates_pasted.csv` - US business cycle dates, 1857–2020
 - Source: [NBER \(2023\)](#)
- `CLF160V.csv` - US labor force level, 1948–2024
 - Source: [BLS \(2024a\)](#)
- `CompositeHWI.xlsx` - `Sheet1.csv` - US vacancy rate, 1951–2020
 - Source: [Barnichon \(2010\)](#)
- `figure5.csv` - Dates of structural breaks in the US Beveridge curve, 1951–2019
 - Source: [Michaillat and Saez \(2021a\)](#)
- `figure6.csv` - Elasticity of the US Beveridge curve, 1951–2019
 - Source: [Michaillat and Saez \(2021a\)](#)
- `HistoricalSeries_JME_2020January.csv` - US unemployment and vacancy rates, 1890–2017
 - Source: [Petrosky-Nadeau and Zhang \(2021\)](#)
- `JTSJOL.csv` - US job openings, 2001–2024
 - Source: [BLS \(2024f\)](#)
- `LNU05026642.csv` - US marginally attached workers, 1994–2024
 - Source: [BLS \(2024h\)](#)
- `LNU05026645.csv` - US discouraged workers, 1994–2024
 - Source: [BLS \(2024g\)](#)
- `NROU.csv` - US NRU, 1949–2024
 - Source: [CBO \(2024\)](#)
- `NROUST.csv` - US short-term NRU, 1949–2021
 - Source: [CBO \(2021\)](#)
- `U4RATE.csv` - US U4 unemployment rate, 1994–2024
 - Source: [BLS \(2024i\)](#)
- `U5RATE.csv` - US U5 unemployment rate, 1994–2024
 - Source: [BLS \(2024j\)](#)
- `UNRATE.csv` - US unemployment (U3) rate, 1948–2024
 - Source: [BLS \(2024k\)](#)
- `ustar.csv` - US NAIRU, 1960–2023
 - Source: [Crump, Eusepi, Giannoni, and Sahin \(2024\)](#)

Code

The results in the paper are obtained using MATLAB. The MATLAB code is placed in the `code` folder.

Main script

The main script, `main.m`, orchestrates the production of the results in the paper:

- The script produces the 30 figures presented in the paper. The script generates each figure in a figure window and saves the figures as PDF files. The script saves the data used to generate each figure in CSV files.
- The script also produces the numerical results associated with each figure. The results are displayed in the command window and saved in Markdown files.

Formatting script

Before the computations begin, the main script calls the script `formatFigure.m` to preformat figures and predefine figure properties.

Production scripts

The main script then produces the individual figures using a collection of scripts:

- `figure1A.m` - Produce panel A of figure 1
- `figure1B.m` - Produce panel B of figure 1
- `figure2.m` - Produce panels A, B, C, D, E, and F of figure 2
- `figure3A.m` - Produce panel A of figure 3
- `figure3B.m` - Produce panel B of figure 3
- `figure4A.m` - Produce panel A of figure 4
- `figure4B.m` - Produce panel B of figure 4
- `figure5A.m` - Produce panel A of figure 5
- `figure5B.m` - Produce panel B of figure 5
- `figure6A.m` - Produce panel A of figure 6
- `figure6B.m` - Produce panel B of figure 6
- `figure7A.m` - Produce panel A of figure 7
- `figure7B.m` - Produce panel B of figure 7
- `figure8A.m` - Produce panel A of figure 8
- `figure8B.m` - Produce panel B of figure 8
- `figure9A.m` - Produce panel A of figure 9
- `figure9B.m` - Produce panel B of figure 9
- `figure10.m` - Produce figure 10
- `figure11.m` - Produce figure 11
- `figure12.m` - Produce figure 12
- `figure13A.m` - Produce panel A of figure 13
- `figure13B.m` - Produce panel B of figure 13
- `figure14A.m` - Produce panel A of figure 14
- `figure14B.m` - Produce panel B of figure 14
- `figure15.m` - Produce figure 15

The scripts display the figures in MATLAB figure windows, save each figure as a PDF file, and save the underlying data as CSV files. The scripts also produce the numerical results associated with the figures. The results are displayed in the MATLAB command window and saved in Markdown files.

Helper functions

The production scripts rely on a collection of helper functions:

- `getBreak` - Return dates of structural breaks of the US Beveridge curve, 1951–2019
- `getData345` - Return US U3, U4, U5 unemployment rates, 1994–2024
- `getElasticity` - Return elasticity of the US Beveridge curve, 1951–2019
- `getNairu` - Return US NAIRU, 1960–2023
- `getNru` - Return US NRU, 1949–2024
- `getNrust` - Return US short-term NRU, 1949–2021
- `getRecession.m` - Return US recession dates, 1930–2024
- `getRecession345` - Return US recession dates, 1994–2024
- `getRecessionDepression.m` - Return US recession dates, 1930–1950
- `getRecessionPandemic.m` - Return US recession dates, 2020–2024
- `getRecessionPostwar.m` - Return US recession dates, 1951–2019
- `getUnemployment.m` - Return US unemployment rate, 1930–2024
- `getUnemploymentDepression.m` - Return US unemployment rate, 1930–1950
- `getUnemploymentJolts.m` - Return US unemployment rate, 2001–2024
- `getUnemploymentPandemic.m` - Return US unemployment rate, 2020–2024
- `getUnemploymentPostwar.m` - Return US unemployment rate, 1951–2019
- `getVacancy.m` - Return US vacancy rate, 1930–2024
- `getVacancyDepression.m` - Return US vacancy rate, 1930–2024
- `getVacancyJolts.m` - Return US vacancy rate, 2001–2024
- `getVacancyPandemic.m` - Return US vacancy rate, 2020–2024
- `getVacancyPostwar.m` - Return US vacancy rate, 1951–2019
- `monthly2quarterly.m` - Convert monthly data to quarterly data

Figures

The figures produced by the code are saved as PDF files. The data used to generate each figure are saved as CSV files. And the numerical results associated with each figure are saved in Markdown files. All the files are placed in the `figures` folder, each corresponding to a specific figure in the paper:

- `figure1A.pdf` , `figure1A.csv` , `figure1A.md` - Panel A of figure 1
- `figure1B.pdf` , `figure1B.csv` - Panel B of figure 1
- `figure2A.pdf` , `figure2.csv` - Panel A of figure 2
- `figure2B.pdf` , `figure2.csv` - Panel B of figure 2
- `figure2C.pdf` , `figure2.csv` - Panel C of Figure 2
- `figure2D.pdf` , `figure2.csv` - Panel D of Figure 2
- `figure2E.pdf` , `figure2.csv` - Panel E of Figure 2
- `figure2F.pdf` , `figure2.csv` - Panel F of Figure 2
- `figure3A.pdf` , `figure3A.csv` - Panel A of figure 3
- `figure3B.pdf` , `figure3B.csv` , `figure3B.md` - Panel B of figure 3
- `figure4A.pdf` , `figure4A.csv` , `figure4A.md` - Panel A of figure 4
- `figure4B.pdf` , `figure4B.csv` , `figure4B.md` - Panel B of figure 4
- `figure5A.pdf` , `figure5A.csv` , `figure5A.md` - Panel A of figure 5
- `figure5B.pdf` , `figure5B.csv` , `figure5B.md` - Panel B of figure 5
- `figure6A.pdf` , `figure6A.csv` - Panel A of figure 6
- `figure6B.pdf` , `figure6B.csv` , `figure6B.md` - Panel B of figure 6

- `figure7A.pdf` , `figure7A.csv` , `figure7A.md` - Panel A of figure 7
- `figure7B.pdf` , `figure7B.csv` , `figure7B.md` - Panel B of figure 7
- `figure8A.pdf` , `figure8A.csv` , `figure8A.md` - Panel A of figure 8
- `figure8B.pdf` , `figure8B.csv` , `figure8B.md` - Panel B of figure 8
- `figure9A.pdf` , `figure9A.csv` , `figure9A.md` - Panel A of figure 9
- `figure9B.pdf` , `figure9B.csv` , `figure9B.md` - Panel B of figure 9
- `figure10.pdf` , `figure10.csv` - Figure 10
- `figure11.pdf` , `figure11.csv` , `figure11.md` - Figure 11
- `figure12.pdf` , `figure12.csv` , `figure12.md` - Figure 12
- `figure13A.pdf` , `figure13A.csv` , `figure13A.md` - Panel A of figure 13
- `figure13B.pdf` , `figure13B.csv` , `figure13B.md` - Panel B of figure 13
- `figure14A.pdf` , `figure14A.csv` , `figure14A.md` - Panel A of figure 14
- `figure14B.pdf` , `figure14B.csv` , `figure14B.md` - Panel B of figure 14
- `figure15.pdf` , `figure15.csv` , `figure15.md` - Figure 15

Usage

1. Clone the repository to your local machine by downloading the ZIP file.
2. Open MATLAB and navigate to the `code` folder as the current folder.
3. To generate all figures and numerical results presented in the paper, execute the following command in the MATLAB command window:

```
run('main.m')
```

4. By default, the main script overwrites the files in the `results` folder. To preserve existing results, save a copy of the folder before running the script.

Software

The results were obtained using MATLAB R2024a on an Apple Silicon Mac running macOS Sequoia 15.0. In MATLAB, the Statistics and Machine Learning Toolbox is required to run some of the scripts.