# Costain, Nakov and Petit (2021) - Replication codes

This repository includes all the codes required to replicate the results in the paper **"Flattening of the Phillips curve with state-dependent prices and wages"**, by with James Costain (Banco de España), Anton Nakov (ECB and CEPR) and Borja Petit (CUNEF).

The model is solved in two steps. First, we use Fortran to solve for the steady state and to linearize the dynamic system. Then, we use Matlab to implement Klein's complex QZ decomposition solution method and to compute the Impulse Response Functions.

## Structure of the codes

**It is very important that you keep the same structure of folders and subfolders**

### List of folders

| Folder | Description |
|---|---|
| `../compiledfiles/` | This folder contains the `.mod` files produced at compilation |
| `../figures/` | This folder contains the Matlab codes that generate the figures of the paper |
| `../matlab/` | This folder contains a number of Matlab codes that are used to implement Klein's decomposition, and some other auxiliary functions |
| `../tables/` | This folder contains a set of Matlab codes that produce the tables shown in the paper |
| `../textfiles/` | This folder contains text files with data and the solution to the model |

### List of files

| Root | File | Description |
|---|---|---|
| `../` | `dynamics.f90` | This code generates computes the Jacobian of the dynamic system and stores it in `../textfiles/_dyn/Vxy_dyn.txt` where `x` and `y` refer to the specific version solved (see below) |
| | `main.f90` | This code contains the execution of the program |
| | `parameters.f90` | This code contains the parameters of the model as well as some general-purpose functions |
| | `solution.f90` | This code solves the firms' and workers' problems and compute the invariant distribution of prices and wages |
| | `toolkit.f90` | This code contains a set of general-purpose functions and subroutines, including optimization routines used in the code |
| `../figures/` | `fig_2.m` | Generate figure 2 of the paper |
| | `fig_3.m` | Generate figure 3 of the paper |

| | | |
|---|---|---|
| | `fig_4.m` | Generate figure 4 of the paper |
| | `fig_5.m` | Generate figure 5 of the paper |
| | `fig_6.m` | Generate figure 6 of the paper |
| | `fig_7.m` | Generate figure 7 and table 8 of the paper |
| | `fig_8.m` | Generate figure 8 of the paper |
| `../matlab/` | `solve_dyn.m` | This code reads the `.txt` files produced with Fortran and implements the Klein's QZ decomposition to generate the IRFs |
| | `extract_dyn.m` | Given a Jacobian matrix, this code fills the matrices to configure the problem for Klein's QZ decomposition algorithm |
| | `extract_ss.m` | Takes a vector with all the results from the steady-state and fill vectors and matrices |
| | `kleinsolve.m` | This code implements the Klein's QZ decomposition algorithm |
| | `parameters.m` | Defines some parameters that are used in other codes |
| | `plot_irf.m` | Generate the figure with IRFs |
| `../tables/` | `table_4.m` | Generate Table 4 of the paper |
| | `table_5.m` | Generate Table 6 of the paper |
| | `table_7.m` | Generate Table 7 of the paper |
| `../textfiles/` | `calibprams.txt` | Values of the calibrated parameters |
| | `data_pc.mat` | Data used in section 4.2.3 |
| | `data_pdfprices.txt` | Empirical histogram of price changes |
| | `data_pdfwages.txt` | Empirical histogram of wage changes |

## Compilation command

To compile the Fortran codes run the following command:

```
cd [set your own working directory]

gfortran [optional: compilation flags] -J $(pwd)/compiledfiles
toolkit.f90 parameters.f90 solution.f90 dynamics.f90 main.f90 -o lpw
```

You tend to use the following compilation flags:

```
-fopenmp -O3 -ffixed-line-length-150 -fmax-stack-var-size=1000000
```

## Model versions

The different versions of the model, combining different noise parameters and inflation rates, are name according to `Vxy` where `x` refers to the noise parameters and `y` to the inflation rate. In particular:

| Adjustment cost / Inflation rate | 2% | -1% | 0% | 4% | 8% | -2% | 1% |
|---|---|---|---|---|---|---|---|
| Baseline | V10 | V11 | V12 | V13 | V14 | V15 | V16 |
| Semi-flexible prices and sticky wages | V20 | V21 | V22 | V23 | V24 | V25 | V26 |
| Flexible prices and sticky wages | V30 | V31 | V32 | V33 | V34 | V35 | V36 |
| Sticky prices and semi-flexible wages | V40 | V41 | V42 | V43 | V44 | V45 | V46 |
| Sticky prices and flexible wages | V50 | V51 | V52 | V53 | V54 | V55 | V56 |
| Flexible prices and flexible wages | V60 | V61 | V62 | V63 | V64 | V65 | V66 |

This table includes all the versions that can be computed, which are a few more than the ones shown in the paper. In particular, the versions in the second and fourth rows are not in the paper. Beyond this, we allow the inflation rate to take two different extra values to compute the Phillips curve slope presented in the paper. In particular:

| Inflation rate | |
|---|---|
| Inflation rate of 4.63% (US, 1980-2000) | V17 |
| Inflation rate of 2.01% (US, 2000-2020) | V18 |

# Running the codes

The code offers 7 possibilities:

1. Solve only the steady state

   The user is asked to specify which version to solve
2. Solve the steady state and the dynamics

   *The user is asked to specify which version to solve*
3. Calibrate the parameters of the model

   *The user asked which algorithm to use for calibration: Nelder-Mead or a Newton-based algorithm*
4. Solve for different noise parameters

   *The code solves the steady-state and the dynamics for all the combinations of noise parameters and the baseline inflation rate. (Version V10, V20, V30, V40, V50, and V60)*
5. Solve for different inflation rates

   *The code solves the steady-state and the dynamics for all possible inflation rates, and the baseline level of noise parameters. (Versions V10, V11, V12, V13, V14, V15 and V16)*
6. Solve for all possible cases

   *The code solves the steady-state and the dynamics for all possible combinations of noise parameters and inflation rates.*
7. Solve for pre and post inflation rates

   *The code solves the steady-state and the dynamics for an inflation rate of 4.63% (US, 1980-2000) and 2.01% (US, 2000-2020). (Versions V17 and V18)*