Project 1

November 4th, 2022

- **This work is individual or group restricted**. It is however allowed to exchange opinions with colleagues and clarify doubts with lecturers.
- If the work is carried out in a group (maximum of 3 elements), the group can indicate the **contribution of each element** to the completion of 100 % of the report.
- The answers should be delivered as a report in **digital format**, using a text editor (and preferably submitted in pdf version). The report language should either be English or Portuguese.
- **Justify properly your answers**. If appropriate provide all intermediate calculations. In your answer insert all the elements that you consider relevant like graphics, code and the results from code or any other element that you consider relevant. The implemented codes must be submitted in a compressed file, within a directory for each problem, for a correct evaluation of the work developed.
- The expected duration is **1 week**; If the work is delivered after this deadline and during the following 1 or 2 days, there will be a penalty.
- The report must be **submitted** for evaluation through the online course (Moodle UPorto).
- **The project report requires an enclosed signed Personal Ethics Statement.**

1 Consumer Price Index: Portugal during the pandemic period

The COVID-19 outbreak is showing economic disruptions, affecting financial and labour markets worldwhile, and in Portugal in particular. Prices shifted significantly as the world entered a period of physical distancing and business closures. The aim of this challenge is to assess the impact of COVID-19 in Portugal.

To that extend, you may consider the Consumer Price Index (CPI) data from Statistics Portugal (INE) - https://ine.pt/. Use the largest possible series (from January 1948 to September 2021) and, you may take the following special categories: total excluding housing, total excluding unprocessed food and energy, total excluding unprocessed food, total excluding energy, unprocessed food, energy, goods and services. If you prefer, CPI data can be obtained from other sources and considering various other categories.

Challenge

You may want to perform your analysis considering the following steps:

1. Get the data on a file with a specific extention.
2. Treat first the data, if nedeed.
3. Make a general overview of the data, exploring the numerical properties of each category.
4. Provide your analysis, highligthing the categories, with information extracted from the data, together with visualization.
5. You may want to zoom your analysis to consider the last 2 years.
6. You may extend your analysis to other data available on the INE website or compare to what happened in other countires.

2 Mundell–Fleming model

> "As a result of awarding the 1999 Nobel Prize for Economics to Robert Mundell, one of his major contributions, the Mundell-Fleming model, has become a focus of attention. Because of the expansion in international trade and the globalization of international finance, many developing and transitional economies in the world are facing the problem of choosing an appropriate exchange rate regime. In light of the improvement in international capital mobility, many small countries are choosing a pegged (fixed) exchange rate system. As pointed out in Mundell (1963) and Fleming (1962), when a small country tries to maintain a fixed exchange rate in a world of perfect capital mobility, money stock becomes endogenous. This result renders the monetary policy completely ineffective as a stabilization policy instrument."
>
> *Extract from: The Mundell-Fleming Model Revisited, Liang-Shing Fan, Chuen-Mei Fan, The American economist, volume 46, issue 1, pp. 42–49*

The Mundell–Fleming model (IS-LM-BP) extends the (closed economy) IS–LM model describing a small open economy. We consider the Mundell-Fleming model with perfect mobility of capital and fixed-exchange rate.

For this challenge you can use the specifications from "Computational Economics: a Concise Introduction", Appendix A: Projects, pp. 180--185 (given bellow) or any other version from another source (cite the references used).

The model

The economies are ruled by:

$$\text{Home economy:} \begin{cases} Y - C - I - G - NX = 0 \\ C - c(Y - T) = \bar{C} \\ T - tY = \bar{T} \\ I + bR = \bar{I} \\ G - gY = \bar{G} \\ M - \overline{P}(kY - hR) = 0 \end{cases}$$

$$\text{Foreign economy:} \begin{cases} Y_F - C_F - I_F - G_F - NX_F = 0 \\ C_F - c_F(Y_F - T_F) = \bar{C}_F \\ T_F - t_F Y_F = \bar{T}_F \\ I_F + b_F R_F = \bar{I}_F \\ G_F - g_F Y_F = \bar{G}_F \\ M_F - \overline{P}_F(k_F Y_F - h_F R_F) = 0 \\ K_F - n_F R_F = \bar{K}_F \\ NX_F + K_F = 0 \end{cases}$$

$$\text{Between economies:} \begin{cases} R = R_F \\ NX = -NX_F \\ NX_F + j_F Y_F = \overline{NX}_F + l_F \frac{\overline{E}\,\overline{P}_E}{\overline{P}} \end{cases}$$

where

- ENDOGENOUS VARIABLES: Y and Y_F are, respectively, the product of the home and foreign country (world); C, C_F the consumption; I, I_F the investment; T, T_F taxes; G, G_F government expenditures; NX, NX_F the net exports; R, R_F the interest rates; M, M_F the money supply; and K_F the capital balance.
- EXOGENOUS VARIABLES: $\overline{E} = 1$ the exchange rate; $\overline{P} = \overline{P}_F = 1$ the price levels; $\overline{C} = 20$, $\overline{C}_F = 200$ autonomous consumption; $\overline{I} = 100$,$\overline{I}_F = 160$ autonomous investment; $\overline{T} = 150$, $\overline{T}_F = 160$ autonomous taxes; $\overline{G} = 100$, $\overline{G}_F = 200$ autonomous government expenditures; $\overline{NX}_F = 10$ the autonomous net exports; $\overline{K}_F = 5$ the autonomous capital balance.
- PARAMETERS related with the sensitivities to variables: $c = 0.45$, $c_F = 0.4$;$b = 15$, $b_F = 20$; $k = 0.5$, $k_F = 0.6$; $h = 20$, $h_F = 25$; $g = 0.1$, $g_F = 0.15$; $t = 0.1$, $t_F = 0.1$; $n_F = 10$; $j_F = 0.1$; $l_F = 2$

Challenge

Implement, analyze and discuss the model. Your work can consider, but it is not restricted to, the following items:

1. Solution for the endogenous variables.
2. ISLM diagram.
3. Perform shocks, analyze the effects and explain the transmission mechanisms.
4. Consider other flavours or possible extensions. Explore them numerically.

3 Life insurance model with reinsurance

In this challenge we will consider a model where a given insurance company has a life insurance with the all the claims being equal. In the insurance industry, in order to spread the risk, insurance companies share some of the risk with other insurance companies that only work with insurance companies (those companies that only insure insurance companies are known as reinsurance companies). The history of reinsurance companies is very old and its use happens because the best way for insurance companies to maximize its profit is to reduce the (ruin) risk.

The fundamental theorem of risk says that in the Cramér-Lundberg model, for $u \geq 0$, u is the initial reserve capital, we have that the expression for the ruin probability of the insurance company is given by

$$\psi(u) = \frac{e^{-Ru}}{\mathbb{E}\left[e^{-Ru} | \tau < \infty\right]}$$

where R is the adjustment coefficient. The goal in this challenge is to evaluate the adjustment coefficient of an insurance company that shares the risk, and naturally the profits, with a reinsurance company.

The equation above is true in the general case. In the particular case of an insurance company with a life insurance where there is a fixed claim in the case that the insured dies during the insurance period. If we consider that the insurance company works with reinsurance, the adjustment coefficient is the only positive root $R = r$ of the following equation

$$e^{\alpha\beta r} - ((1+\theta) - (1+\xi)(1-\alpha))\beta r - 1 = 0$$

where the parameters are

β life insurance claim;

θ safety coefficient of the company, since the premium needs to be higher than the expected value of the claims;

α proportion of the claim payed by the insurance company, that means that in the case of a claim the reinsurance company pays $(1-\alpha)\beta$;

ξ safety coefficient of the reinsurance company, proportion of the premium payed by the insurance company to the reinsurance company.

Notice that the previous equation has a trivial root $r = 0$ and that we are only interested in the only other (positive) root.

Challenge

Consider the following parameters $\alpha = 0.5$, $\beta = 5$, $\theta = 0.2$ and $\xi = 0.3$. The challenge consists in trying the explore the model with the parameters given. Examples of some of the tasks that can among others are:

1. Using the parameters above, determine what is the adjustment coefficient.
2. Considering all the other parameters constant study how does the adjustment coefficient depends on α? Remember that α is the proportion of the claim payed by the insurance company that varies from 0 to 1 :
   a) what happens when $\alpha < \xi$;
   b) what happens when $\alpha \geq \xi$;
   c) plot the resulting function r_α.
3. Proceed with further analysis on the model.