MEcon 8,270 — Spring 2019

International Macroeconomics

# Problem Set 1: EDEIR Model Calibration to Switzerland

March 27, 2019

| | |
|---|---|
| Due date and time: | Wednesday, April 17, at 12pm (prior to the tutorial) |
| Instructor: | Marc-Andreas Muendler |
| E-mail: | marc-andreas.muendler@unisg.ch |
| Teaching Assistant: | David Torun |
| E-mail: | david.torun@unisg.ch |

This problem set asks you to adapt the EDEIR model from Uribe and Schmitt-Grohé (2017) to the economy of Switzerland. The problem set proceeds in three steps: from data construction, to preliminary model simulation for Canada, to model calibration for Switzerland.

Please upload your solutions to this problem set (as a **zip** file) on the respective folder on *StudyNet*. Your zip file should contain your code, your data set, and a pdf file with your written solution. Please create one folder per question (e.g., a folder "Q1 Data Preparation", etc.). Please name the zip file in the following way: PS1_surname_name_19.zip (e.g., PS1_Torun_David_19.zip). After the deadline for submission on Wednesday, April 17, at 12pm (prior to the tutorial), the *StudyNet* folder will automatically close and you will not be able to submit your solutions anymore.

## 1 Data Preparation

Complete the following data preparations and comparisons to the benchmark open economy.

For this question, feel free to use a software package of your choice, including Excel, Stata or Matlab. Most economists would arguably complete this data construction step in Stata. For sample code in Matlab or Stata, please see the files at *StudyNet* or econweb.ucsd.edu/muendler/teach/19s/8270.

The **deliverable product** for this question has *five* components: a report of a single number (the Swiss mean capital share), a report of higher-order moments for statistics in three country-specific tables, a verbal discussion of results and their comparisons, a copy of the prepared data, and a copy of the Stata code (or Matlab code, Excel macro/spreadsheet, or the like).

1. **Obtain** *World Development Indicators* (WDI) data for all available countries over the period 1980–2017 and the following time series, at the *annual* frequency:

   - NY.GDP.PCAP.KN: Real GDP per capita (constant LCU) $y_t$,
   - NE.CON.PRVT.ZS: Households and NPISHs final consumption expenditure (percent of GDP) $\ddot{c}_t$ and compute consumption expenditure per capita $c_t = \ddot{c}_t y_t/100$,
   - NE.GDI.TOTL.ZS: Gross capital formation (percent of GDP) $\ddot{\imath}_t$ and compute investment per capita $i_t = \ddot{\imath}_t y_t/100$,
   - NE.CON.GOVT.ZS: General government final consumption expenditure (percent of GDP) $\ddot{g}_t$ and compute government expenditure per capita $g_t = \ddot{g}_t y_t/100$,
   - NE.IMP.GNFS.ZS: Imports of goods and services (percent of GDP) $\ddot{m}_t$ and compute imports per capita $m_t = \ddot{m}_t y_t/100$,
   - NE.EXP.GNFS.ZS: Exports of goods and services (percent of GDP) $\ddot{x}_t$ and compute exports per capita $x_t = \ddot{x}_t y_t/100$,
   - BN.CAB.XOKA.GD.ZS: Current account balance (percent of GDP) $\ddot{ca}_t$ and compute the current account per capita $ca_t = \ddot{ca}_t y_t/100$.

You may want to visit the WDI download portal datacatalog.worldbank.org/dataset/world-development-indicators. A csv (comma separated values) format might be most useful, as it is understood by most statistical and computational software packages. Drop all countries for which at least one variable fails to have three non-missing values in the period 1980–2017.

2. **Obtain** hours worked per capita $h_t$ data for all available countries over the period 1980–2017 from the Conference Board's Total Economy Database www.conference-board.org/data/economydatabase, using the series *Output, Labor, and Labor Productivity, 1950–2018*. (If you prefer not to set up an account, please download the data from *StudyNet*.) A csv (comma separated values) format might be most useful. Note that $h_t$ is total hours worked per capita, not per worker. Merge the time series for $h_t$ with those from the *World Development Indicators* (WDI) by country and year. As the country variable for the merge, use the ISO-3 code. Drop all countries for which at least one variable fails to have three non-missing values in the period 1980–2017.

3. For Switzerland, **obtain** the capital share in national income for the period 1995–2017 from the Swiss Federal Statistical Office www.bfs.admin.ch/bfs/en/home/statistics. For this purpose, **use** Swiss gross domestic product under the income approach and compute the annual share of compensation of employees (D.1) in gross domestic product (B.1∗b). Note that the capital share is one less the labor share in national income. **Report** the unweighted mean capital share in national income over the full period 1995–2017.

4. **Detrend** the time series from items 1 and 2. See sample codes *data_preparation_example_Q1.do* (Stata) and/or *example_detrending_Q1.m* (Matlab).

   - For real output $y_t$, consumption $c_t$, investment $i_t$, government spending $g_t$ and hours worked $h_t$ per capita, detrend (separately) the natural logarithms using a log-quadratic trend as in section 1.1 of the Uribe and Schmitt-Grohé (2017) textbook. For example, for log real output per capita $\ln y_t$, fit the ordinary-least squares regression $\ln y_t = \beta_0 + \beta_1(t-1980) + \beta_2(t-1980)^2 + \ln y_t^c$, where the residual $\ln y_t^c$ is called the cyclical component and the fitted part is called the secular (or trend) component $\ln y_t^s$. Store the cyclical component of all variables.
   - For the trade-balance-to-output ratio $tb_t/y_t = (x_t - m_t)/y_t$ and the current-account-to-output ratio $ca_t/y_t$ detrend (separately) the levels using a quadratic trend as in section 1.1 of the Uribe and Schmitt-Grohé (2017) textbook. For example, for the current-account-to-output ratio $ca_t/y_t$, fit the ordinary-least squares regression $ca_t/y_t = \beta_0 + \beta_1(t-1980) + \beta_2(t-1980)^2 + \epsilon_t$, where the residual is the cyclical component. Store the cyclical component of all variables.
   - For the level of the trade balance per capita $tb_t = x_t - m_t$ and the level of the current account $ca_t$ per capita, first divide them by the secular component of real output per capita $\exp\{\ln y_t^s\}$, and then detrend (separately) the levels using a quadratic trend as in section 1.1 of the Uribe and Schmitt-Grohé (2017) textbook. For example, for the trade balance per capita $tb_t$, fit the ordinary-least squares regression $tb_t/\exp\{\ln y_t^s\} = \beta_0 + \beta_1(t-1980) + \beta_2(t-1980)^2 + \epsilon_t$, where the residual is the cyclical component. Store the cyclical component of all variables.

5. **Compute** the standard deviation, the serial correlation coefficient, and the correlation coefficient with the *cyclical* component of GDP per capita ($\ln y_t^c$) for (i) Canada, (ii) Switzerland and (iii) either one poor country or one emerging market for the period 1980–2017 using the *cyclical* components of the detrended variables from item 4. **Report** the results in three separate tables, one per country.

6. **Compare** the results from item 5 for (i)–(iii) over the period 1980–2017 to those reported for Canada for the period 1960–2011 in the Uribe and Schmitt-Grohé (2017) textbook, middle panel of Table 4.2, and those in the Mendoza (1991) benchmark paper, left panel of Table 4.2 in the textbook. **What** is the ranking of volatilities in countries (i)–(iii) during the period?

# 2 Simulating the EDEIR model for Canada

Simulate the EDEIR model for the Canadian economy, using the calibrated values from the Uribe and Schmitt-Grohé (2017) textbook.

For this question use Matlab. Most economists would arguably complete this simulation step in Matlab. For sample code in Matlab, similar to that at www.columbia.edu/ mu2166/book by Uribe and Schmitt-Grohé, please see the files at *StudyNet* or econweb.ucsd.edu/muendler/teach/19s/8270. Note that you do *not* need to reprogram or adjust any Matlab file for this question. Matlab files with names that end in "_Q2.m" are used only in question 2.

The **deliverable product** for this question has *one* component: a verbal discussion of the ability of the model to explain observed business cycle patterns in Canada.

1. **Set** the following parameters without a relationship to specific country data for 1980–2017, following Mendoza (1991) (also reported in Table 4.1 of the Uribe and Schmitt-Grohé (2017) textbook):
   - the parameter $\sigma$ (the inverse of the intertemporal elasticity of substitution),
   - the depreciation rate $\delta$,
   - the world interest rate $r^*$,
   - and the subjective discount factor $\beta = 1/(1 + r^*)$.
2. **Set** the following parameters as in Table 4.1 of the Uribe and Schmitt-Grohé (2017) textbook:
   - the capital elasticity $\alpha$ of the Cobb-Douglas production function,
   - the parameter $\omega$, which determines the wage elasticity of labor supply $1/(\omega - 1)$,
   - the parameter $\phi$, which governs capital adjustment costs,
   - the parameter $\psi$, which regulates the sensitivity of the real interest rate to a country's net wealth,
   - the persistence of the technology shock $\rho$, and
   - the volatility of the technology shock $\eta$,

   For this purpose, approximate the equilibrium dynamics up to first order using the Matlab procedure for sections 4.5 and 4.6 of the Uribe and Schmitt-Grohé (2017) textbook.
3. **Compute** the model-implied (theoretical) second moments as in the Uribe and Schmitt-Grohé (2017) textbook, rightmost panel of Table 4.2. **Comment** on the ability of the model to explain observed business cycle patterns in Canada between 1980 and 2017, using the standard deviation, the serial correlation coefficient, and the correlation coefficient with the cyclical component of GDP per capita ($\ln y_t^c$) for Canada from item 5 in question 1 above.

# 3 Calibrating the EDEIR model to Switzerland

Calibrate the EDEIR model of the Uribe and Schmitt-Grohé (2017) textbook to the Swiss economy.

For this question use Matlab. Most economists would arguably complete this simulation step in Matlab. For sample code in Matlab beyond the textbook-provided code (a loop over the steady-state simulation), please see the files at *StudyNet* or econweb.ucsd.edu/muendler/teach/19s/8270. Note that you do need to reprogram or adjust the Matlab files with names that end in "_Q3.m".

The **deliverable product** for this question has *three* components: a copy of your edited Matlab code, a report of five calibrated parameter values, and a verbal discussion of the ability of the model to explain observed business cycle patterns in Switzerland.

1. **Set** the following parameters without a relationship to the Swiss data for 1980–2017, following Mendoza (1991) (also reported in Table 4.1 of the Uribe and Schmitt-Grohé (2017) textbook):
   - the parameter $\sigma$ (the inverse of the intertemporal elasticity of substitution),
   - the depreciation rate $\delta$,
   - the world interest rate $r^*$,
   - and the subjective discount factor $\beta = 1/(1 + r^*)$.
2. **Set** the following parameters to match the first moments of the Swiss data:

- the capital elasticity of the production $\alpha$ to one less the average labor share in national income for Switzerland for the period 1995–2017,
- the composite parameter $\bar{b}/y \equiv -\bar{d}/y$ so that $-\bar{b}/y = \bar{d}/y = (tb/y)/r^*$, where $tb/y$ is the raw ratio (*not* detrended) from the Swiss data for 1980–2017, $r^*$ is as calibrated above and steady-state output remains to be calibrated ($y = [(1-\alpha)\kappa^{\alpha\omega}]^{1/(\omega-1)}$ and $\kappa = [\alpha/(r^* + \delta)]^{1/(1-\alpha)}$), similar to the procedure in section 4.5 of the Uribe and Schmitt-Grohé (2017) textbook.

3. From your answer to item 5 in question 1 above, **use** the following seven higher moments of the Swiss data for 1980–2017 for calibration:

   - the standard deviation of (the cyclical component of) hours worked $h_t$,
   - the standard deviation of (the cyclical component of) investment $i_t$,
   - the serial correlation of (the cyclical component of) investment $i_t$,
   - the standard deviation of (the cyclical component of) the trade-balance-to-output ratio $tb_t/y_t = (x_t - m_t)/y_t$,
   - the serial correlation of (the cyclical component of) the trade-balance-to-output ratio $tb_t/y_t = (x_t - m_t)/y_t$,
   - the standard deviation of (the cyclical component of) output $y_t$, and
   - the serial correlation of (the cyclical component of) output $y_t$.

   **Adjust** the Matlab code that loops over the steady-state simulations and minimizes the deviation of the model-produced seven moments from the empirical seven moments above. In the Matlab iteration routine, **set** and reset the following five parameters to match the preceding seven higher moments:

   - the parameter $\omega$, which determines the wage elasticity of labor supply $1/(\omega - 1)$,
   - the parameter $\phi$, which governs capital adjustment costs,
   - the parameter $\psi$. which regulates the sensitivity of the real interest rate to a country's net wealth,
   - the persistence of the technology shock $\rho$, and
   - the volatility of the technology shock $\eta$.

   For the steady-state computations, approximate the equilibrium dynamics up to first order using the Matlab procedure described in sections 4.5 and 4.6 of the Uribe and Schmitt-Grohé (2017) textbook but feed the calibrated values for the Swiss economy into each iterative call of the steady-state computation. As starting values for the Swiss economy, **use** the Canada-calibrated parameters as in Table 4.1 of the Uribe and Schmitt-Grohé (2017) textbook.

4. **Report** the calibrated parameter values for $\omega$, $\phi$, $\psi$, $\rho$, and $\eta$.

5. **Compute** the model-implied (theoretical) second moments as in the Uribe and Schmitt-Grohé (2017) textbook, rightmost panel of Table 4.2, but now for the calibration to Switzerland.

6. **Comment** on the ability of the model to explain observed business cycle patterns in Switzerland between 1980 and 2017.

# References


**Mendoza, Enrique G.**, "Real Business Cycles in a Small Open Economy," *American Economic Review*, September 1991, *81* (4), 797–818.

**Uribe, Martín and Stephanie Schmitt-Grohé**, *Open economy macroeconomics*, Princeton and Oxford: Princeton University Press, 2017.