

# Public Investment and Debt Sustainability in Low-Income Countries

## *Hands-on Session*

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Naivasha, Kenya  
May 19, 2016

# Outline

- ① A brief introduction to Matlab programming
- ② The Debt, Public Investment, and Growth (DIG) Model in practice
  - A Matlab-Excel template
  - Running scenarios
  - Do-it-yourself I

# What you will face...

The screenshot displays the MATLAB R2014b environment. The main window is the script editor, showing a file named `main_script_riskpm_calibration_ECm`. The script contains the following code:

```

1 clear all;
2 clear all;
3 %addpath C:\Users\marto\Desktop\IMF_marto\Diverson\MATLAB\dynare4.4.3\matlab
4
5 %%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%
6 % Includes imperfect capital mobility, no sensitivity to oil wealth, adjustment costs. %
7 %%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%
8
9 %%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%
10 %% parameterization %%
11 %%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%
12 %%% NOTE: Do not change format of 'input.xlsx' excel file.
13
14 [ndata, text, alldata] = xlsread('input.xlsx','1','B2:C37');
15 param_names = char(text);
16 param_values = ndata;
17 [nrows,ncols] = size(ndata);
18 for i = 1:nrows
19     paramname = deblank(param_names(i,:));
20     eval([ paramname ' = param_values(' int2str(i) ')']);
21 end
22
23 %%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%
24 %% Additional parameterization %%
25 %%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%
26
27 g = (1+g_n)*(1+g_a)-1;
28 rho3 = exp(-rho1*dbar)+rho2*dbar; % additional parameter on risk-premium
29 beta = 1/(1+zbar*(psi/rho1^2)*(1-rho3*dbar)+(rho1-rho2));
    
```

The Command Window shows the prompt `>>`. The Workspace window on the right lists various variables and their values, including:

Name	Value
Abar	0.8759
Abaroz	0.9820
AC_k	1002x1 double
AC_s	1002x1 double
aldelta	386x cell
AUX_ENDO_LEAD_22	1002x1 double
beta	0.8879
c	1002x1 double
c_D	0.5995
ca	1002x1 double
ca_D	-0.0060
ca_gdp	1002x1 double
ca_value	-0.0136
cger_ca	1-2.3075e-25914+2.77...
ch	1002x1 double
chvalue	0.5151
coef	1
cost_k	0.2000
cost_s	0.2000
cvalue	0.1695
d	1002x1 double
d_D	0.2223
delta_ca	1-0.5897e-21191+2.22...
dlar	0.3000
delta_k	0.0550
delta_s	0.0550
dvalue	0.3000
e_k	0.8000
e_s	0.7000
nba_ca	304x double
estimation_info	2x1 struct
eta_kvalue	5.0151
eta_svalue	5.7315
fi	1002x1 double
fiogenous_variables	304x double
f	1002x1 double
f_D	-0.2223
f_value	-0.3000
g	0.0458
g_n	0.0279
g_a	0.0174
gamma	1.3333
gov	1002x1 double
gov_D	0.1434
gov_exp_0	0.2807
gov_inv_0	0.1373
gamma	1002x1 double

The File Browser on the left shows the current folder structure, including files like `main_model_riskpm_cal_EC`, `contovnum.m`, `input.xlsx`, `main_model_riskpm_cal_EC.mod`, `main_script_riskpm_calibration_EC.m`, `main_steadystate_riskpm.m`, and `plot_alvar.m`.

## What you will face...

- **Current folder:** Shows the files contained in your current folder.
- **Editor:** Shows a file containing a series of commands (usually with the extension .m). The code written in the Editor can be run by pressing the F5 key or clicking on the green triangle icon in the Editor tab above.
- **Command Window:** Allows you to type in any input (commands with instructions) and shows the output of any requested operation.
- **Workspace:** Stores the objects created by your code (e.g. variables). They can be accessed by double-clicking on their icons or by typing the object's name in the Command Window.

## A few examples of code...

Type the following on your **Command Window**:

```
1 % Creating your first variables
2 x = 4+7;
3 y = x^2;
4
5 % Creating your first matrix
6 M = [x 1/x; y 1];
7 N = M .* eye(2); % is a 2x2 diagonal matrix
8 [rows columns] = size(M);
```

```
1 % Creating your first figure
2 X = randn(30,1);
3 figure
4 plot((1986:2015)',X)
5 title('Kenya''s GDP growth')
6 legend('GDP growth')
7 xlabel('years')
8 ylabel('%')
9 close all;
```

## A few examples of code...

```
1 % Creating your first if statement
2 P = [rand(5,1) rand(5,1)];
3 for i = 1:length(P)
4     if P(i,1)>P(i,2)
5         disp 'Portugal won the football match!'
6     elseif P(i,1)==P(i,2)
7         disp 'Kenya draw against Portugal!'
8     else 'Kenya won the football match!'
9     end
10 end
```

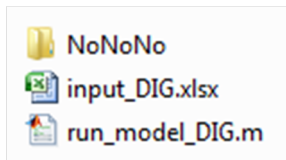
## Setting up the toolboxes

- We need first to install (or better "set path") to Dynare and the CompEcon Toolbox.

```
1 % Create a startup.m file , where you have the path to these toolboxes
2
3 addpath C:\Users\rmarto\Desktop\IMF_rmarto\Diversos\MATLAB\dynare\4.4.3\matlab
4
5 addpath C:\Users\rmarto\Desktop\IMF_rmarto\Diversos\MATLAB\COMPECON\CEtools
```

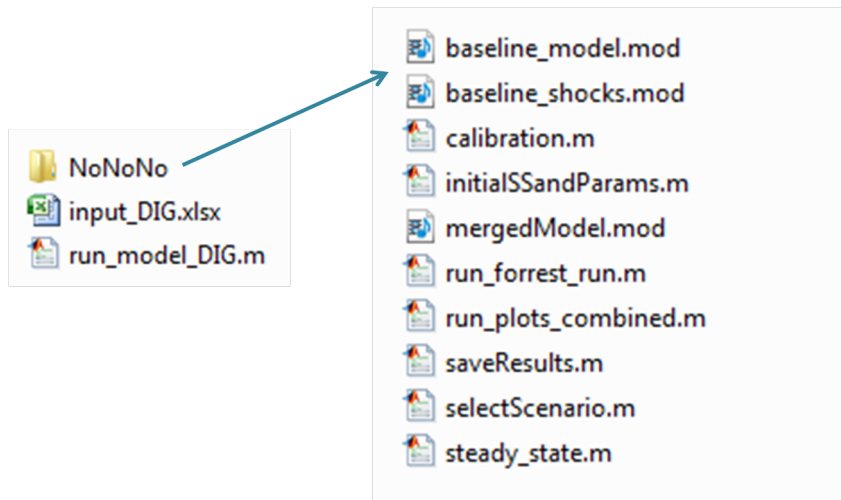
- Then save your startup.m file where you installed Matlab.

## What you have in your DIG Model folder...

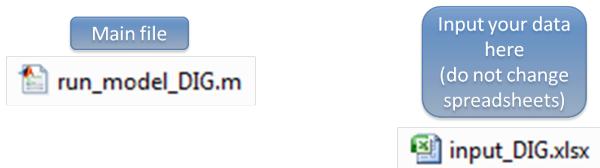




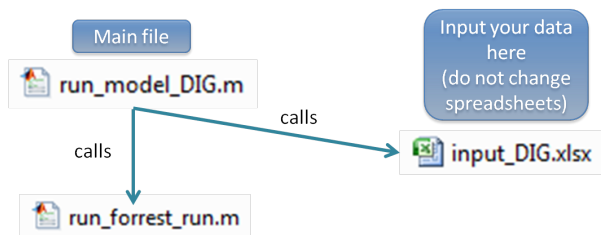
## What you have in your DIG Model folder...



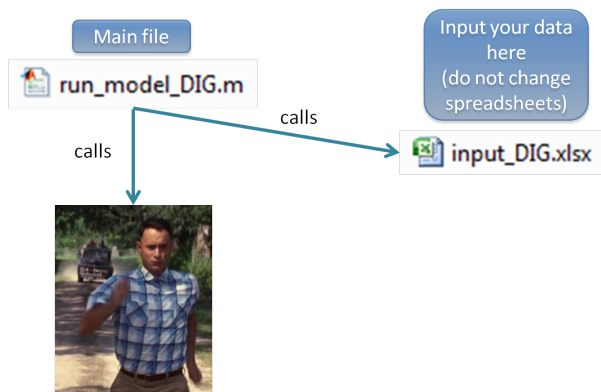
# What you have in your DIG Model folder...



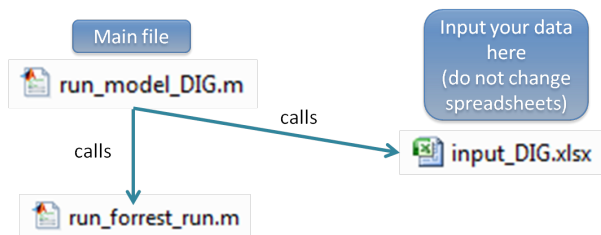
## What you have in your DIG Model folder...



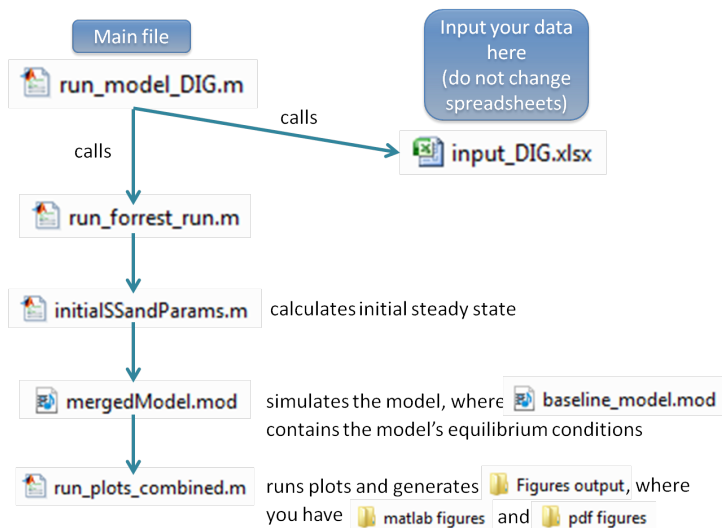
# What you have in your DIG Model folder...



## What you have in your DIG Model folder...



# What you have in your DIG Model folder...



## In Dynare...

- Dynare is a powerful toolbox to solve models in Matlab.
  - `dynare yourfilename.mod noclearall` (`noclearall` keeps the variables in the **Workspace**)

After some magic happens (i.e. Matlab/Dynare routines numerically solved your model), you will find in your **Workspace**:

- The results of your simulation, i.e. the time series for  $y$ ,  $c$ ,  $i$ , ...
- The Matlab structure `M_` containing variable names, parameter values, etc.
- The structure `oo_` containing the simulation output (endogenous variables, steady states, etc.)
- The structure `options_` containing specific options used for the computation (algorithms used, etc.)

You will also find in your **Current folder**:

- A few `m`.files (e.g. `yourfilename.m`), containing the commands solving your model
  - Very useful when you made a mistake in the steady state / initial values for your model

## In Excel...

- **Calibration:** Allows you to define your particular calibration for parameters and initial values.
- **Temporary:** Allows you to specify the path of public investment, grants, concessional debt, or terms of trade shocks for up to 50 periods.
- **Scenario:** Allows you to choose the combination of scenarios you want to run (different financing mechanisms, calibration, and shocks).
- **Graphs:** Allows you to choose what type of graphs you want, what variables to plot, etc.
- **XLSoutput:** Allows you to choose what variables to export to Excel.

**Don't forget to close your Excel file.**



# Calibrate your parameters and initial values

input\_DIG.xlsx - Microsoft Excel

Home Insert Page Layout Formulas Data Review View Developer Add-Ins DM CD Tools IMF Tools

From Access From Web From Text From Other Sources Existing Connections Refresh All Connections Sort Filter Advanced Text to Columns Remove Duplicates Data Validation Consolidate What-If Analysis Group Ungroup Subtotal Show Detail Hide Detail Outline

H1 Scenario 3 - High User Fees

		Parameter Description			Parameters	Scenario 1 - Baseline	Scenario 2 - High Efficiency	Scenario 3 - High User	Scenario 4 -	Scenario 5 -	Scenario 6 -	Scenario 7 -	Scenario 8 -	
Calibration	Sensitivity Analysis	Initial return on infrastructure investment		R_to	25.0%	35.0%	10.0%							
		Efficiency of public infrastructure investment		s	60.0%	100.0%	20.0%							
		Steady state efficiency of public infrastructure investment		s_s	60.0%	100.0%	20.0%							
		User fees for infrastructure services (% of recurrent costs)		fo	50.0%	50.0%	100.0%							
		Consumption tax rate (VAT) ceiling		hbar	75.0%	75.0%	75.0%							
	Country-specific Initial Values	Public infrastructure investment to GDP ratio		izy	6.0%	6.0%	6.0%							
		Consumption tax rate (VAT)		ho	15.0%	15.0%	15.0%							
		Public domestic debt to GDP ratio		share_b	20.0%	20.0%	20.0%							
		Public concessional debt to GDP ratio		share_d	50.0%	50.0%	50.0%							
		Public external commercial debt to GDP ratio		share_dc	0.0%	0.0%	0.0%							
		Grants to GDP ratio		share_grants	5.0%	5.0%	5.0%							
		Oil revenues to GDP ratio		oilro	0.0%	0.0%	0.0%							
		Remittances to GDP ratio		share_remit	4.0%	4.0%	4.0%							
		Private external debt to GDP ratio		share_bstar	0.0%	0.0%	0.0%							
		Real interest rate on public domestic debt		r	10.0%	10.0%	10.0%							
	Real interest rate on public external commercial debt		r_dco	6.0%	6.0%	6.0%								
	Country-specific parameters	Trend per capita growth rate		g	1.5%	1.5%	1.5%							
		Imports to GDP ratio		imp2gdp	30.5%	30.5%	30.5%							
		Value added in NT-sector		VA_n	49.4%	49.4%	49.4%							
		NS/S - labor ratio of Non-Savers(NS) to Savers(S) / $S + a\_ratio * S - 1$		a_ratio	1.5	1.5	1.5							
		Capital's share in value added in the T-sector		alpha_x	40.0%	40.0%	40.0%							
		Capital's share in value added in the NT-sector		alpha_n	55.0%	55.0%	55.0%							
		Cost share of NT-inputs in the production of private capital		alpha_k	50.0%	50.0%	50.0%							
		Cost share of NT-inputs in the production of public capital		alpha_z	50.0%	50.0%	50.0%							
		Capital learning externalities in T-sector		xi_x	0.0%	0.0%	0.0%							
		Capital learning externalities in NT-sector		xi_n	0.0%	0.0%	0.0%							
		Traded T-sector output learning externality		sigma_x	0.0%	0.0%	0.0%							
		Non-traded NT-sector output learning externality		sigma_n	0.0%	0.0%	0.0%							
		Depreciation rate in T-sector		delta_x	5.0%	5.0%	5.0%							

Ready

# Define the path for your exogenous variables (up to 50 periods)

input\_DIG.xlsx - Microsoft Excel

Home Insert Page Layout Formulas Data Review View Developer Add-Ins DM CD Tools IMF Tools

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E41

			Scenario 1 -						Scenario 2 -						Scenario 3 -		
Period	Year	Public Infrastructure Investment (% of Current GDP)	Grants (% of Current GDP)	Concessional Debt (% of Current GDP)	Price of Exported Goods	Price of Imported Consumption	Price of Imported Capital	Public Infrastructure Investment (% of Current GDP)	Grants (% of Current GDP)	Concessional Debt (% of Current GDP)	Price of Exported Goods	Price of Imported Consumption	Price of Imported Capital	Public Infrastructure Investment (% of Current GDP)	Grants (% of Current GDP)	Concessional Debt (% of Current GDP)	Price of Exported Goods
4	2015	5.0	0.4	4.0	0.0	0.0	0.0										
5	2016	7.0	0.4	5.0	0.0	0.0	0.0										
6	2017	7.0	0.4	4.0	0.0	0.0	0.0										
7	2018	6.6	0.4	3.0	0.0	0.0	0.0										
8	2019	5.8	0.4	2.0	0.0	0.0	0.0										
9	2020	5.0	0.4	1.0	0.0	0.0	0.0										
10	2021	4.4	0.4	0.8	0.0	0.0	0.0										
11	2022	4.0	0.4	0.5	0.0	0.0	0.0										
12	2023	3.0	0.2	-1.0	0.0	0.0	0.0										
13	2024	3.0	0.2	-1.0	0.0	0.0	0.0										
14	2025	3.0	0.2	-1.0	0.0	0.0	0.0										
15	2026	3.0	0.2	-1.0	0.0	0.0	0.0										
16	2027	3.0	0.2	-1.0	0.0	0.0	0.0										
17	2028	3.0	0.2	-1.0	0.0	0.0	0.0										
18	2029	3.0	0.2	-1.0	0.0	0.0	0.0										
19	2030	3.0	0.2	-1.0	0.0	0.0	0.0										
20	2031	3.0	0.2	-1.0	0.0	0.0	0.0										
21	2032	3.0	0.2	-1.0	0.0	0.0	0.0										
22	2033	3.0	0.2	-1.0	0.0	0.0	0.0										
23	2034	3.0	0.2	-1.0	0.0	0.0	0.0										
24	2035	3.0	0.2	-1.0	0.0	0.0	0.0										
25	2036	3.0	0.2	-1.0	0.0	0.0	0.0										
26	2037	3.0	0.2	-1.0	0.0	0.0	0.0										
27	2038	3.0	0.2	-1.0	0.0	0.0	0.0										
28	2039	3.0	0.2	-1.0	0.0	0.0	0.0										
29	2040	3.0	0.2	-1.0	0.0	0.0	0.0										
30	2041	3.0	0.2	-1.0	0.0	0.0	0.0										
31	2042	3.0	0.2	0.0	0.0	0.0	0.0										
32	2043	3.0	0.2	0.0	0.0	0.0	0.0										
33	2044	3.0	0.2	0.0	0.0	0.0	0.0										
34	2045	3.0	0.2	0.0	0.0	0.0	0.0										
35	2046																
36	2047																
37	2048																
38	2049																
39	2050																
40	2051																

Temporary shocks

Ready calibration Temporary Permanent Graphs

# Select the scenarios you want to run

The screenshot shows the Microsoft Excel interface with the following data:

	A	B	C	D	E	F	G	H	I	J	K	L	
		<b>Define debt scenarios</b>			<b>Define calibration number</b>		<b>Define calibration name (no blanks or "-" are allowed, only use</b>		<b>Define shock number</b>		<b>Define shock periods</b>		<b>Define shock name</b>
1		Debt scenario 1			Calibration 1	1	CountryA		Temporary shock process 1	1	31	Baseline	
2		Debt scenario 2	exogenous		Calibration 2				Temporary shock process 2	2	20	Aggressive	
3		Debt scenario 3			Calibration 3				Temporary shock process 3				
4													
5													
6													
7													
8													
9													
10													
11	Scenarios	<b>Label</b>	<b>Debt scenarios</b>										
12		exogenous	Public domestic and external commercial debt are constant and concessional debt is constant.										
13		commercial	Public external commercial debt is allowed to cover the fiscal gap.										
14		domestic	Public domestic debt is allowed to cover the fiscal gap.										
15													
16													
17													
18													
19													
20													
21													
22													
23													
24													
25													
26													
27													
28													
29													
30													
31													
32													

At the bottom of the spreadsheet, there is a 'Scenario' dropdown menu with options: Scenario, Calibration, Temporary, Outputs.

# Define your graph options

The screenshot shows the 'Graphs' section of the 'input\_DIG.xlsx' workbook. The data table is as follows:

Graph Description	yes' or 'no' (case sensitive)	Number of periods to plot	Number of rows	Number of columns	Number of variables being plotted	Variable 1	Variable 2	Variable 3	Variable 4	Variable 5	Variable 6
Graph 1. Comparing debt financing scenarios for each calibration set	yes	30	3	3	9	pubingdp	pubeffcapgr	roizpercent	rgdpgroy	privconsg	hpercent
Graph 2. Comparing calibration scenarios for each debt financing opt	yes	20	3	3	5	pubingdp	beffcapgr	rgdpgroy	hpercent	totpubdebt	

Below the table is a list of 'Variables available to graph' with their corresponding 'Label' values:

Variables available to graph	Label
Public Infrastructure Investment (% of GDP)	pubingdp
Public Effective Capital Growth (% dev from SS)	pubeffcapgr
Real GDP Growth (% dev from SS)	rgdp
Real GDP Growth (% YoY)	rgdpgroy
Tradable Output (% dev from SS)	rgdpx
Non-Tradable Output (% dev from SS)	rgdnp
Private Consumption Growth (% dev from SS)	privconsg
Private Investment Growth (% dev from SS)	privinvgr
Private Capital Growth (% dev from SS)	privcapgr
External Private Debt (% of GDP)	extpdebtgdp
Consumption Tax (%)	hpercent
Domestic Public Debt (% of GDP)	domdebtgdp
Concessional Debt (% of GDP)	concddebtgdp
External Public Commercial Debt (% of GDP)	commdebtgdp
Total Public Debt (% of GDP)	totpubdebt
Real Deficit (% of GDP)	rsdef
Current Deficit (% of GDP)	cadef
Real Interest Rate on Domestic Debt (%)	rpercent
Real Interest Rate on External Commercial Debt (%)	rextpercent
Real Exchange Rate (% dev from SS)	rerpercent
Relative Price of NT Goods (%)	relpn
Real Wages (% dev from SS)	rwages
Terms of Trade in Consumption Goods (% dev from SS)	totcons
Terms of Trade in Capital Goods (% dev from SS)	totcap

# Export the path for selected variables

The screenshot shows the Microsoft Excel interface with the following data entered in the spreadsheet:

	A	B	C	D	E	F	G	H	I	J	K	L	M
1		Excel output	yes' or 'no' (case sensitive)	Number of periods to plot	Number of variables being exported	Variable 1	Variable 2	Variable 3	Variable 4	Variable 5	Variable 6	Variable 7	Variable 8
2		Would you like to have the time series of selected variables exported to Excel?	yes	30	10	pubinvgdp	pubeffcapgr	roizpercent	rgdpgryoy	privconsg	hpercent	totpubdbt	cadev
9		Variables available to graph		Label									
10		Public Infrastructure Investment (% of GDP)	pubinvgdp										
11		Public Effective Capital Growth (% dev from SS)	pubeffcapgr										
12		Real GDP Growth (% dev from SS)	rgdp										
13		Real GDP Growth (% YoY)	rgdpgryoy										
14		Tradable Output (% dev from SS)	rgdpx										
15		Non-Tradable Output (% dev from SS)	rgdpxn										
16		Private Consumption Growth (% dev from SS)	privconsg										
17		Private Investment Growth (% dev from SS)	privinvgr										
18		Private Capital Growth (% dev from SS)	privcapgr										
19		Oil Revenues (% of GDP)	oilrevgdp										
20		Grants (% of GDP)	grantsgdp										
21		External Private Debt (% of GDP)	extpdebtgdp										
22		Consumption Tax (%)	hpercent										
23		Domestic Public Debt (% of GDP)	domdebtgdp										
24		Concessional Debt (% of GDP)	concedebtgdp										
25		External Public Commercial Debt (% of GDP)	commdebtgdp										

## And once you are ready, run your model

- Run your Matlab file: Press F5 in the **Editor Window** or type `run_model_DIG` in the **Command Window**.

The screenshot shows the MATLAB R2014b environment. The Editor Window displays the file `run_model_DIG.m` with the following code:

```

1  %% RUN PLOTS
2  % IMF RES-DM, January 2016
3  % Copyright Ricardo Marto
4  % Any questions, please contact rmarto@imf.org.
5
6  %% Disable warnings
7  warning('off','all');
8  %close all;
9
10 %% Useful variables for plots
11
12 startdate = time_line(1);
13 [mmj,nnj] = size(alt_calib);
14 [mjj,njj] = size(alt_exopath);
15 name_calib = name_calib(~cellfun(@isempty, name_calib)); % To remove empty
16 mrk = {'-1','-1','-1','-1','-1','-1','0','0','0','0','0','0'};
17 [graph_max graph_options graph_all] = xlsread('input_DIG.xlsx',4,'C2:W51');

```

The Command Window shows the command `>> ixno` and the output `ixno = 10.2722`. The Run button (F5) in the Editor Window is circled in red.

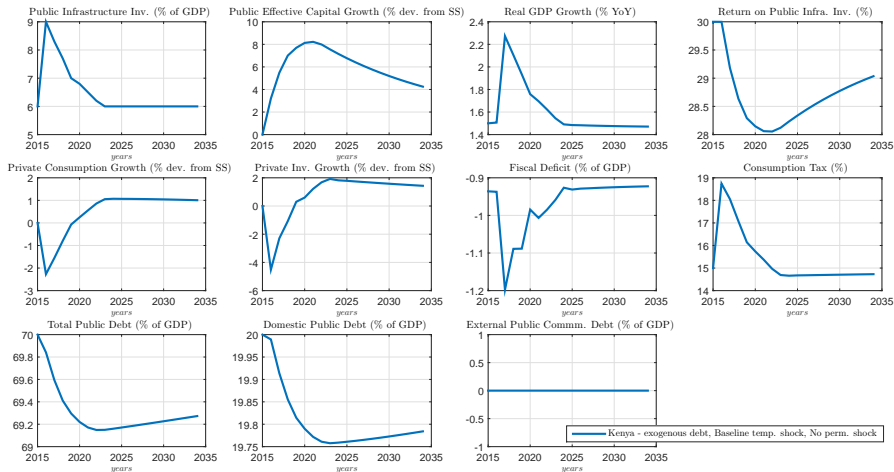
## Example 1.a. Baseline calibration with public investment shock and no debt

Let's run the baseline scenario with an increase in public infrastructure investment.

- In Excel:
  - Keep baseline calibration and shock
  - Debt scenario: exogenous
  - Calibration: 1; and give it a name
  - Temporary shock: 1 for 7 periods, and give it a name
  - Choose graph and variables to plot (pubinvgdp, pubeffcapgr, rgdpgryoy, roizpercent, privconsg, privinvgr, fiscaldef, hpercent, totpubdebt, domdebtgdp, commdebtgdp)
  - Choose same variables to export to excel

# Example 1.a. Baseline calibration with public investment shock and no debt

You should have obtained the following figure:





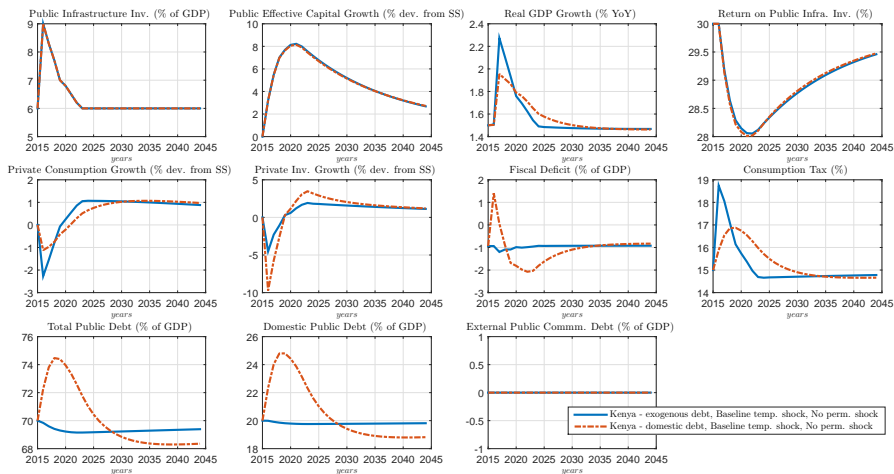
## Example 1.b. Baseline calibration with public investment shock and domestic debt adjustments

Compare the previous example with the same baseline scenario with an increase in public investment but with endogenous domestic debt.

- In Excel:
  - Keep baseline calibration and shock
  - Debt scenario: (i) exogenous and (ii) domestic
  - Calibration: 1; and give it a name
  - Temporary shock: 1 for 7 periods, and give it a name
  - Choose graph and variables to plot (pubinvgdp, pubeffcapgr, rgdpgryoy, roizpercent, privconsg, privinvgr, fiscaldef, hpercent, totpubdebt, domdebtgdp, commdebtgdp)
  - Choose same variables to export to excel

# Example 1.b. Baseline calibration with public investment shock and domestic debt adjustments

You should have obtained the following figure:



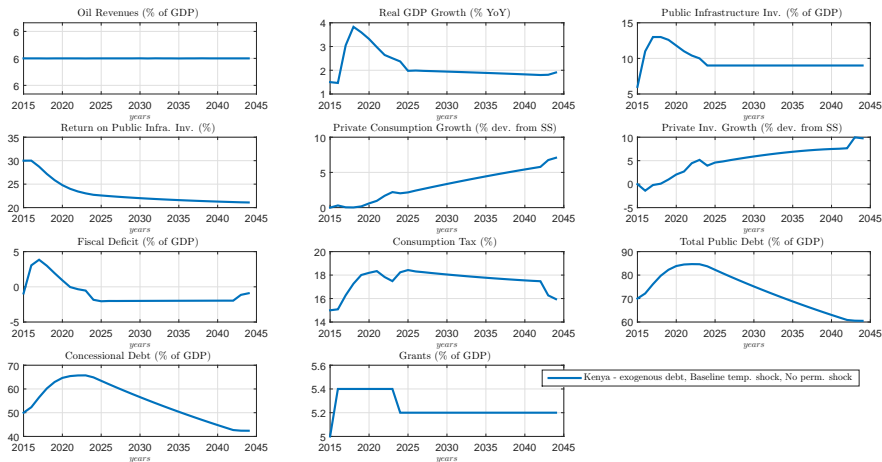
## Example 2.a. Baseline scenario with public investment scaling up and concessional debt

Let's run the baseline scenario with unconstrained consumption tax and exogenous debt (only concessional debt), and with public investment and grants increase.

- In Excel:
  - No need to adjust your calibration and shocks
  - Debt scenario: exogenous
  - Calibration: 1; and give it a name
  - Temporary shock: 2 for 31 periods, and give it a name
  - Choose graph and variables to plot (oilrevgdp, rgdpgryoy, pubinvgdp,roizpercent, privconsg, privinvgr, fiscaldef, hpercent, totpubdebt, concdebtgdp, grantsgdp)
  - Choose same variables to export to excel

## Example 2.a. Baseline scenario with public investment scaling up and concessional debt

You should have obtained the following figure:



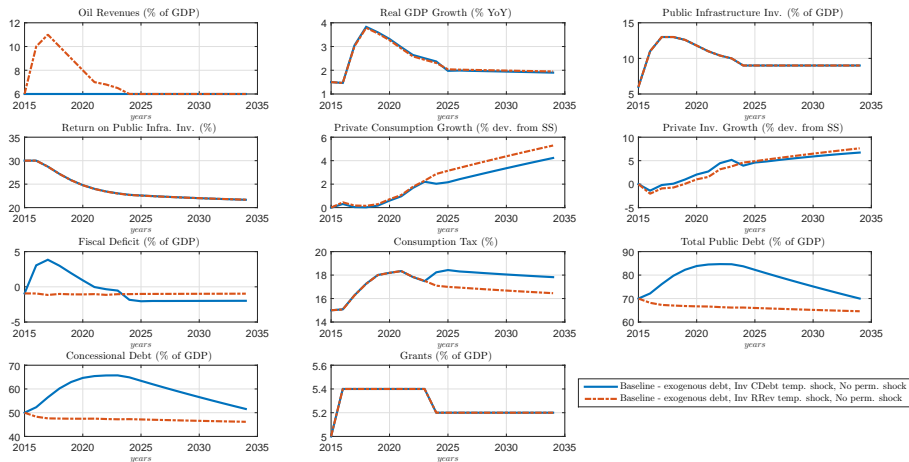
## Example 2.b. Baseline scenario with public investment scaling up and natural resource revenue shock

Compare the previous scenario with unconstrained consumption tax and exogenous debt, and with public investment, natural resource revenue, and grants increase.

- In Excel:
  - No need to adjust your calibration and shocks
  - Debt scenario: exogenous
  - Calibration: 1; and give it a name
  - Temporary shock: 2 and 3, both for 31 periods, and give them names
  - Choose graph and variables to plot (oilrevgdp, rgdpgr, pubinv, roizpercent, privcon, privinv, fiscaldef, hpercent, totpubdebt, concdebtgdp, grantsgdp)
  - Choose same variables to export to excel

## Example 2.b. Baseline scenario with public investment scaling up and natural resource revenue shock

You should have obtained the following figure:



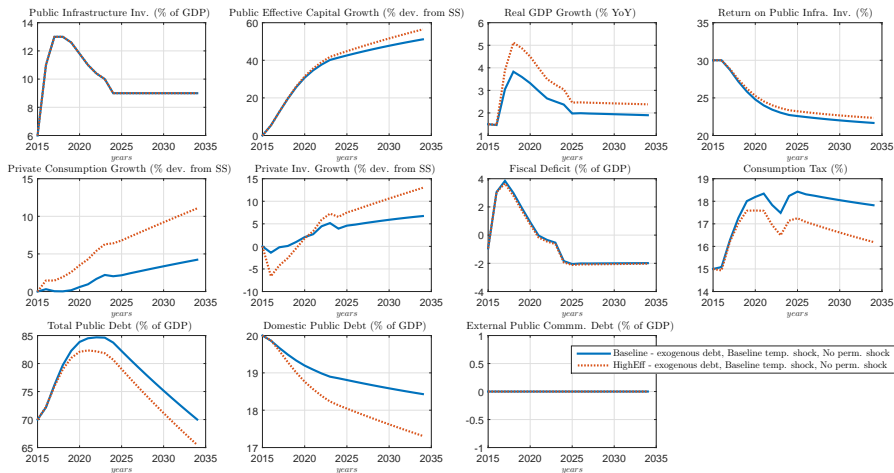
## Example 3.a. Baseline scenario vs. High efficiency scenario

Compare the previous scenario (2.a) with one where efficiency is 100% and same return on public infrastructure (still unconstrained consumption tax and exogenous debt).

- In Excel:
  - Copy/paste calibration 1 in calibration 2 and adjust efficiency
  - No need to adjust your shocks
  - Debt scenario: exogenous
  - Calibration: 1 and 2; give them names
  - Temporary shock: 2 for 31 periods, and give it a name
  - Choose graph and variables to plot (pubinvgdp, pubeffcapgr, rgdpgryoy, roizpercent, privconsg, privinvgr, fiscaldef, hpercent, totpubdebt, domdebtgdp, commdebtgdp)
  - Choose same variables to export to excel

## Example 3.a. Baseline scenario vs. High efficiency scenario

You should have obtained the following figure:





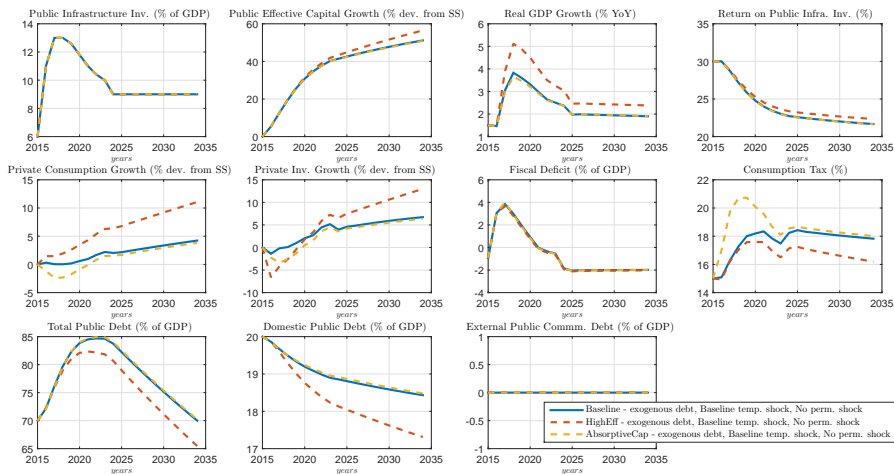
## Example 3.b. Baseline scenario vs. Absorptive capacity constraints

Compare the previous scenario (3.a) with one where absorptive capacity constraints are high (i.e.  $\phi = 5$ ) and same return on public infrastructure (still unconstrained consumption tax and exogenous debt).

- In Excel:
  - Copy/paste calibration 1 in calibration 3 and adjust the severity of absorptive capacity constraints
  - No need to adjust your shocks
  - Debt scenario: exogenous
  - Calibration: 1 and 2; give them names
  - Temporary shock: 2 for 31 periods, and give it a name
  - Choose graph and variables to plot (pubinvgdp, pubeffcapgr, rgdpgryoy, roizpercent, privconsg, privinvgr, fiscaldef, hpercent, totpubdebt, domdebtgdp, commdebtgdp)
  - Choose same variables to export to excel

## Example 3.b. Baseline scenario vs. Absorptive capacity constraints

You should have obtained the following figure:

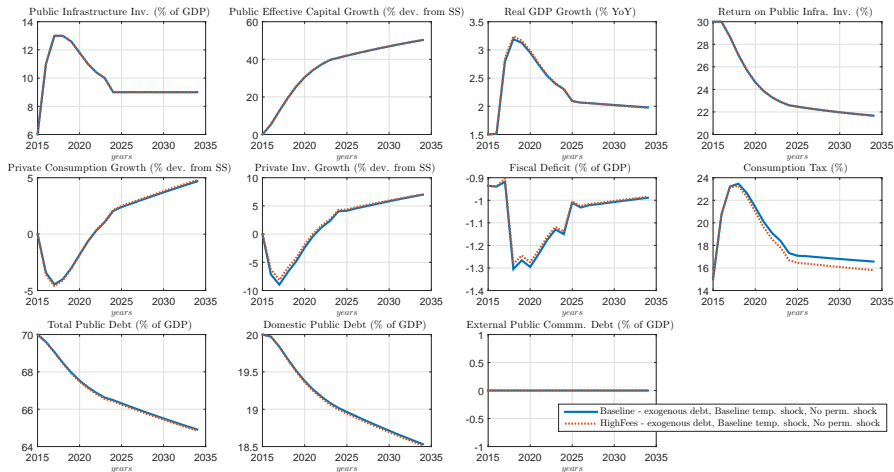


## Exercises

- Run the following scenarios:
  - ① Suppose the government wants to increase user fees for public infrastructure to 100% and intends to finance its public investment plan solely with grants.  
*Simulate your scenarios, comparing this assumption with the baseline calibration.*
  - ② Suppose the government wants to compare the effects of financing their public investment scaling up with either commercial or domestic debt financing (for baseline calibration and unconstrained taxes).  
*Simulate your scenarios, using the exogenous shock processes provided in example 2.a.*
  - ③ Suppose the government wants to compare the effects of financing their public investment scaling up with a cap on the VAT rate at 17% with commercial debt financing (for baseline calibration).  
*Simulate your scenarios, using the exogenous shock processes provided in example 2.a.*
  - ④ Suppose the government expects terms of trade to deteriorate from period 6 to 25, with the price index of exported goods decreasing 10% and of imported consumption and capital goods increasing 20% (with external commercial debt and unconstrained taxes).  
*Simulate your scenarios, using the exogenous shock processes provided in example 2.b.*

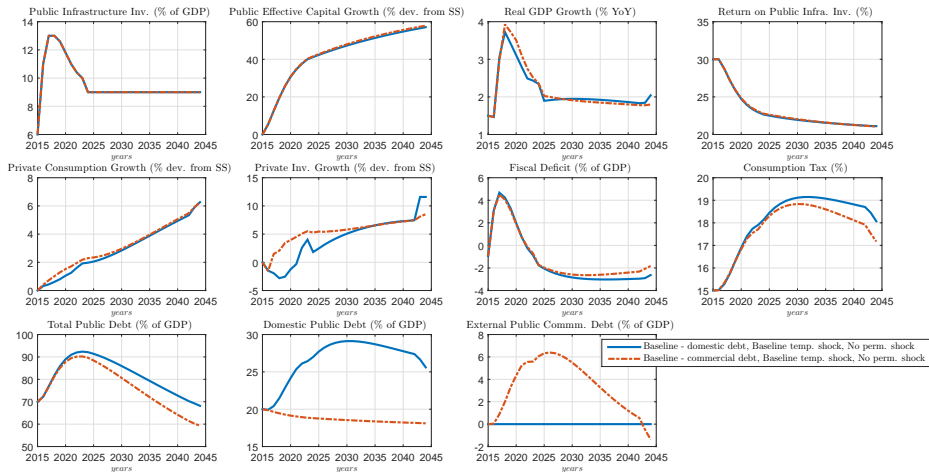
# Exercise 1

You should have obtained the following figure:



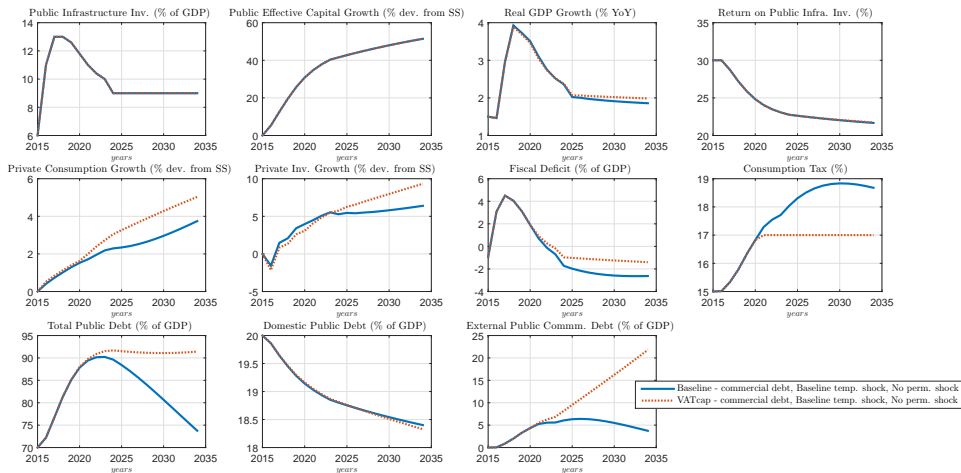
## Exercise 2

You should have obtained the following figure:



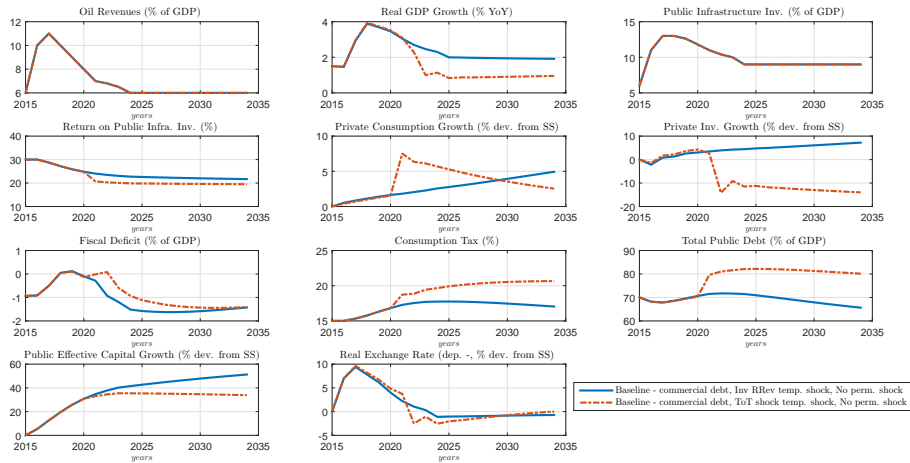
## Exercise 3

You should have obtained the following figure:



## Exercise 4

You should have obtained the following figure:



*Asante sana!*