HOMEWORK 2

MACROECONOMICS

GROUP J

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PART 1

(a) Compare results from 1 and 3 by describing changes in the simulated economy. Comment on the differences between 2. and 3. Remember: always refer to the situation from base simulation.

The initial condition was introduced as we can see in the below Social Accounting Matrix

	X1	X2	X3	X4	L	K	W1	W2	WG	CONS1	CONS2	CONSG
X1							60	26	20			
X2							15	25	30			
X3							40	40	14			
X4							10	55	10			
L	46	15	64	10								
K	60	55	30	65								
W1										125		
W2											146	
WG												74
CONS1					100	55						
CONS2					35	155						
CONSG										30	44	

Table 1. Social Accounting Matrix of the Model

Here, we do the code for base simulation, for the No change taxes in taxes (Image 1 code, Non-zero tax on capital in production of good 1 (Image 2 Code) and Tax on capital used in all goods (Image 3 Code)

```
225  * Provide a numeraire:
226  FTAX.FX(FAC,SEC) = 0;
227  PFAC.FX("L")=1;
228  *WG.FX=WG0;
```

Image 1. Code for Simulation without Tax

```
225  * Provide a numeraire:
226  FTAX.FX(FAC,SEC) = 0;
227  FTAX.FX("K","X1") = 0.2;
228  PFAC.FX("L")=1;
```

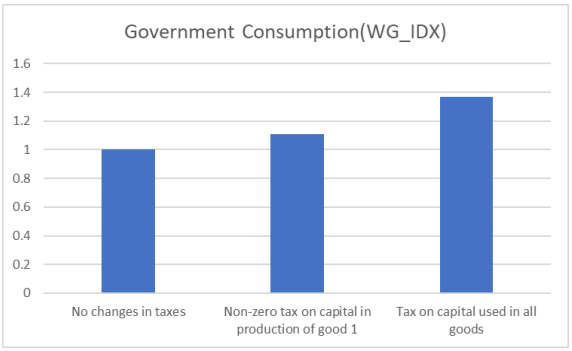
Image 2. Code for Simulation with 20% Tax on production of good 1

```
25  * Provide a numeraire:
26  FTAX.FX(FAC,SEC) = 0;
27  FTAX.FX("K",SEC) = 0.2;
28  PFAC.FX("L")=1;
```

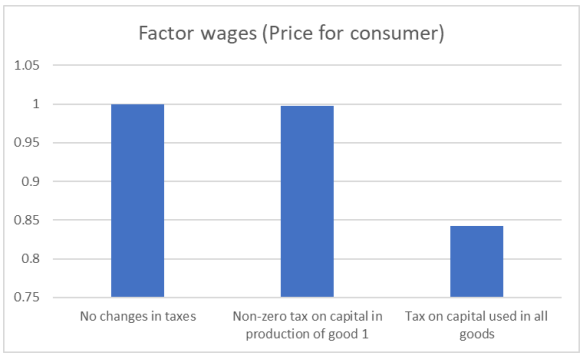
Image 3. Code for Simulation with 20% Tax on Production of All Goods

Parameter		No changes in taxes (Image 1 Code)				Non-zero tax on capital in production of good 1 (Image 2 Code)				Tax on capital used in all goods (Image 3 Code)			
Goods		x1	x2	x3	x4	x1	x2	x3	x4	x1	x2	x3	x4
Consumption	Household 1	1	1	1	1	0.911	1.020	0.999	1.024	0.938	0.936	0.941	0.935
	Household 2	1	1	1	1	0.892	0.999	0.978	1.002	0.866	0.864	0.868	0.863
Output Index		1	1	1	1	0.928	1.067	1.008	1.025	1.002	1.095	0.974	0.940
Output		106.0000	70.0000	94.0000	75.0000	98.3422	74.7077	94.7818	76.8977	106.2308	76.6654	91.6012	70.4989
Factor wages (Price for consumer)		1				0.955				0.842			
Government Consumption (WG_IDX) Index		1				1.109				1.369			
Welfare index		1.000				0.998				1.000			

Table 2. Result of the simulation on a zero tax, non-zero tax in production of good 1 and non-zero tax in production for all goods



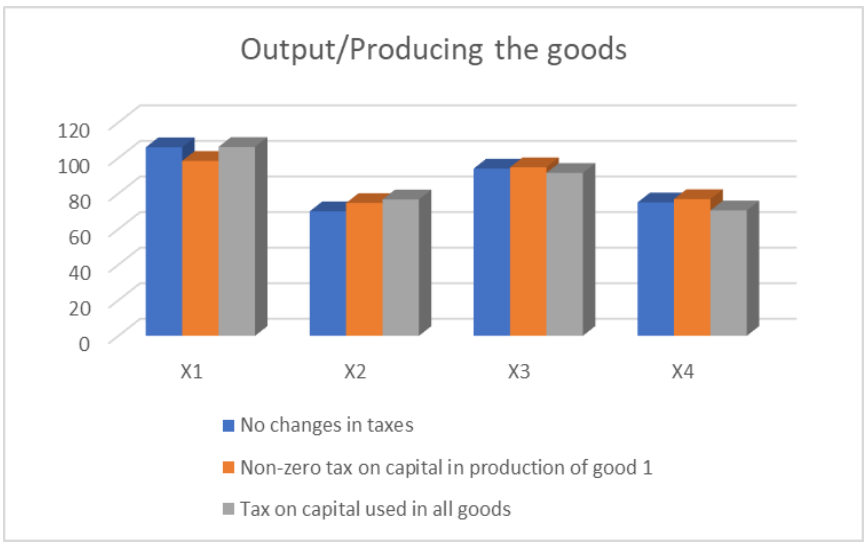
Graph 1. Government Consumption



Graph 2. Factor wages

Interpretation:

If you see in the output parameter, it explains the production of the goods. before and after we put all the taxes, it does not show a big gap between producing the product. The biggest gap before the taxes is 31, and after the tax to all of the goods is 35.7. Therefore, we can assume before and after putting the taxes on all of the goods, the productivity of producing every good is still in good condition.



Furthermore, the price that consumers receive after putting the taxes on all of the goods is 0.842 which means the price that consument need to pay for the goods reduces by around 16 %. Due to the taxes being given to all goods, it causes the rising Government Consumption Index to become 1.369 or increasing 36.9 % for the government spending.

Graph 3. Output/Production of Goods

Of course, increasing the taxes on all goods makes the welfare and consumption of the whole household reduced evenly. Particularly, for household 2, the result is smaller. However, the increasing 36.9 % for the government spending shows the good result because the welfare index remains the same, equalling by 1. It means that the taxes that are given in all of the goods are efficient. Simply, providing the taxes on all goods are in proportion or worth to household utilities and aggregate consumption of the government (welfare index).

(b) How to do the shift between 2 and 3 automatically?

In order to shift the condition from when the 20% tax was applied on capital in production of good 1 to a condition where a tax is applied on capital in production of all goods equally, we should set the government revenue (WG) target at a certain level in the code.

Adjust the tax rate to the government revenue target, we can do this by changing the variable WG into an exogenous variable, thus, in the code we will have WG.FX = 83.304

```
235   WG.FX=83.304;
```

To achieve this government revenue target (WG.FX = 83.304) without adjusting the tax rate manually (in other words, we will be able to shift it automatically). Then, we should declare a new equation that will state that the factor taxes are equal to each other (uniformed):

1) Declare a new variable which is **KTAX (Common Capital Tax Rate)**
2) State an equation that uniform the tax rates for all sectors: **KTAXEQ(SEC)**
3) Finally, write the equation as **KTAXEQ(SEC).. FTAX("K",SEC) =E= KTAX**

Part 2

2. Introduce an exogenous increase of government consumption and comment on the results. Do it in two versions:

(a) With a corresponding increase of government deficit.

In GAMS code, we introduced the government deficit by increasing the government consumption by 50%. It is shown by the below code

```
297  * 1) Increasing government consumption by 50%
298  WG.FX = 1.5*WG0;
```

This condition affects the government savings and the investment which were reduced as shown in the table below.

Treatment	Government Consumption (WG)	Government Savings (GSAV)	Investment (INT
Initial Condition	73.908	0	54.22277
Increase of Government Deficit	111.000	-37.627	17.0718

Table 3. Government Deficit Effects on Economy

It is confirmed by the equation below that there is a linear relation between

$$I = S + T - Tr - G$$

The total investment is equal to the total savings in the economy. Thus, when there is an increase in government consumption (G), the investment will be decreased.

(b) With a corresponding increase of income tax (introduce INC_SHIFT variable)

```
211  MKT_W(HOU)..
212        PW(HOU) * W(HOU) =E= INC(HOU) *  (1-ITAX(HOU)*INC_SHIFT)
213                                                 * (1- SR(HOU));  ;
```

```
230  I_INCG..            INCG =E=  SUM(HOU, INC(HOU) *  ITAX(HOU)*INC_SHIFT)
231                           +   SUM(FAC,  SUM(SEC, FTAX(FAC,SEC) * PFAC(FAC) * BETA(FAC,SEC) * P(SEC) * XS(SEC) / (PFAC(FAC)
232                                                    * (1 + FTAX(FAC,SEC)))));
```

An exogenous increase of government consumption can also be introduced by applying an income tax. In this way, we can insert a new variable called INC_SHIFT and insert it into the equation:

(i) MKT_W (HOU) Demand for aggregate consumption

(ii) I_INCG Income balance (govt)

by applying the tax we will get the result as shown in the table below.

Treatment	Government Consumption	Government Savings	Investment
Initial Condition	73.908	0	54.22277
Application of Tax	111.111	0	46.8027

Table 4. Application of Income Tax Effects on Economy

The application of the Income Tax into the economy shows that there is no change in government saving since the government is not spending their saving anymore but using their revenue from the appplication of this income tax. Thus, there is only a slight decrease in the government investment as shown in the **Table 4**. This it is showing that the application of Income Tax tends to be better than increasing the government consumption.

3. Find out what happens to the economy after three periods after the shock. Focus on investment, capital and GDP changes.

Below, you can see the codes on GAMS to calibrate the procedure in three period to see what happens after three period of the shocks.

```
option nlp = pathnlp ;
SOLVE  SIMPLE USING NLP maximizing TRICK;
NGDP = SUM(SEC, P.L(SEC) * XS.L(SEC));
GDP  = SUM(SEC,  XS.L(SEC));
GDP0 = SUM(SEC, XS0(SEC));
CHANGE_GDP = 100 *(GDP / GDP0 -1);
Display NGDP, GDP, GDP0, CHANGE_GDP;


* Calculate steady state values of depr, growth and interest rate
PARAMETERS
r        rate of return on capital
depr     depreciation                    /0.04/
gp       population growth               /0.00/;
r = SUM(HOU, OMEGA0(HOU, "K")) * (gp + depr) / INV0;

FTAX(FAC,SEC) = 0;
;

* make sure capital accumulates by investment and labor grows as well
* Note that we take into account PREVIOUS period investment
OMEGA0(HOU, "L") = (1 + gp) * OMEGA0(HOU, "L");
OMEGA0(HOU, "K") = (1 - depr) *OMEGA0(HOU, "K")
+ r * INV.L * OMEGA0(HOU, "K") / SUM(HOUSS,OMEGA0(HOUSS, "K"));

option nlp = pathnlp ;
SOLVE  SIMPLE USING NLP maximizing TRICK;

NGDP = SUM(SEC, P.L(SEC) * XS.L(SEC));
GDP  = SUM(SEC,  XS.L(SEC));
GDP0 = SUM(SEC, XS0(SEC));
CHANGE_GDP = 100 *(GDP / GDP0 -1);
Display NGDP, GDP, GDP0, CHANGE_GDP;

* make sure capital accumulates by investment and labor grows as well
* Note that we take into account PREVIOUS period investment
OMEGA0(HOU, "L") = (1 + gp) * OMEGA0(HOU, "L");
OMEGA0(HOU, "K") = (1 - depr) *OMEGA0(HOU, "K")
+ r * INV.L * OMEGA0(HOU, "K") / SUM(HOUSS,OMEGA0(HOUSS, "K"));

option nlp = pathnlp ;
SOLVE  SIMPLE USING NLP maximizing TRICK;

NGDP = SUM(SEC, P.L(SEC) * XS.L(SEC));
GDP  = SUM(SEC,  XS.L(SEC));
GDP0 = SUM(SEC, XS0(SEC));
CHANGE_GDP = 100 *(GDP / GDP0 -1);
Display NGDP, GDP, GDP0, CHANGE_GDP;
```

Parameter	Increase of Government Deficit After Three Periods After The Shock	Increase of Income Tax After Three Periods After The Shock
Investment	12.4519	46.3407
Capital	1.0952	1.0662
Change of GDP	-3.449	-0.701

Table 5. Effects on an Increase of Government Deficit and Income Tax after Three Periods of Shock

Here, as we can see there is a little bit of difference between capital after three periods of the shock. The capital decreased slightly. It is probably because we do not have the input for population growth. So, it remains almost the same.

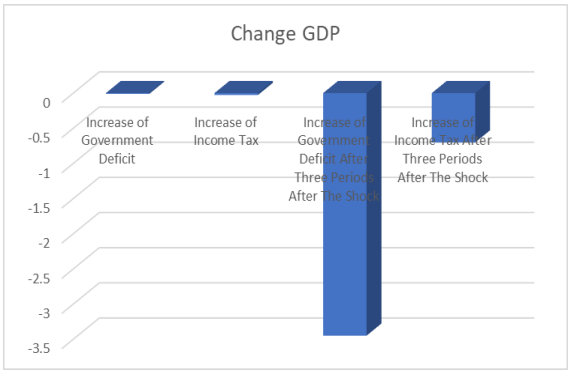
However, there is a big difference in changes of GDP. It is because with the increase of government deficit, we do not put the behavior for government savings at zero before three periods after the shock, in which it will limit the investment. So, it makes the value change over the time, which results -3.449 from -0.011. At the same time, because of the changes of GDP minus, it makes the investment reduce to 12.4519. While, In the Increase of Income Tax, it will mostly remain the same because the behavior for government savings is zero.

4. HOMEWORK (continued):

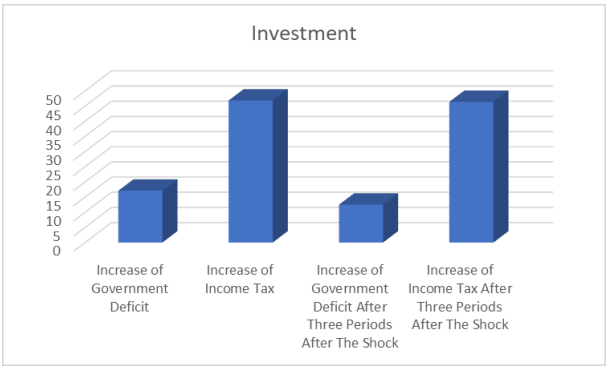
(a) Comment on results of a. and b from previous 2 (Part 2).

Parameter	Increase of Government Deficit				Increase of Income Tax				Increase of Government Deficit After Three Periods After The Shock				Increase of Income Tax After Three Periods After The Shock			
Goods	x1	x2	x3	x4	x1	x2	x3	x4	x1	x2	x3	x4	x1	x2	x3	x4
Price of Final Goods	1.0194	1.0271	1.0109	1.0299	1.0303	1.0423	1.0170	1.0468	1.0528	1.0741	1.0295	1.0820	1.0369	1.0516	1.0207	1.0571
Output	103.6129	83.4808	89.1389	68.7287	102.3115	90.8233	86.437	65.3346	100.3248	79.8261	87.5327	65.4174	101.6529	90.2013	86.0788	64.6473
Price for consumer	1.0205				1.0320				1.0559				1.0390			
Investment	17.0718				46.8027				12.4519				46.3407			
Government Consumption	111.0000				111.0000				111.0000				111.0000			
Government Saving	-37.9183				0				-42.1928				0			
Welfare	216.9109				187.2108				209.6488				185.3626			
Change GDP	-0.011				-0.027				-3.449				-0.701			

Table 6. Result of the simulation of government deficit, income tax in first period and three periods after the shock



Graph 5. Change GDP



Graph 6. Investment

Here, in this case, the government increases the consumption by 50 %. When we see in two versions the increase of government deficit and income tax has the same result by 111.000 from 73.908. However, when we make the difference in treatment for increasing income tax with the setting Government saving become zero, It shows a big difference in investment. It is because the investment is equal to total savings. So, if government savings rise from negative to zero, it makes the value of investment increase, while the government consumption decreases.

Furthermore, for the price consumer and price of final goods, it experiences an increase, although it is not too significant. On the other hand, because of the increase in income tax, the production of all goods tends to decrease. Also, in this case welfare reduces to 187.2108.

In terms of changing GDP, there is no big difference between increase of government deficit and income tax which is -0.011 and -0.027 respectively.

(b) EXTRA CREDIT: Run a tax-replacement scenario: cut the income taxes by 5pp at the same time increasing a tax on capital in production of good 4. Make sure that government consumption remains unchanged. Comment on the results

To run a tax scenario as expected, we need to input the following codes to the simulation on GAMS.

INC_SHIFT.FX	0.95	Cut the income taxes by 5pp
WG.FX	1 * WG0	Government consumption remains unchanged. **(EXOGENOUS)**
GSAV.LO	(-)INF	After WG is fixed with exogenous variable, GSAV set as **(ENDOGENOUS)**
GSAV.UP	(+)INF	
FTAX("K","X4")	0.3	Increasing tax on K in production of good 4. (30% Up)

Table 7. INC_SHIFT codes for GAMS

Parameter	Base				5pp at the same time increasing a tax on capital in production of good			
Goods	x1	x2	x3	x4	x1	x2	x3	x4
Output	106	70	94	75	110,6105	73,8659	96,3718	63,8459
Investment	54,2				61,4687			
Government Consumption	74				74			
Welfare	216,8				208,0641			
Change GDP	0				-0,089			

Table 8. Resul of the Simulation on Applying 5pp & Tax on Capital in Production of Good

Here, we tried to cut income tax to 0.95 with the condition that government consumption remains unchanged and a tax on capital in production of goods 4 by 30%. due to increasing tax in good 4, it makes welfare of the household reduce than the base model. In terms of producing goods, increasing tax in good 4 makes good 4 decrease greatly, while other goods, because they do not have a certain tax, increase little bit. In addition, interestingly, even the GDP lower little bit, the investment increase.