ECON 567- Computer Modeling for Policy Analysis

Effect of Devaluation of Currency on Balance of Trade

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Introduction

The project is studying the role of money on the balance of trade based on Tsiang renowned model. Tsiang is using Meade's model to demonstrate the "role that could be played by monetary factors [and therefore] explain how relative prices and income-expenditure adjustments combine to determine the effect of a devaluation". (Tsiang, 1961) Meade studied the effect of devaluation in his model under the assumption of either Keynesian neutral monetary policy or the assumption of internal balance (full employment). Tsiang is using Meade's two countries, two commodities model but omitting all the unnecessary policy variables to make the model more intelligible to the readers. Tsiang model emphasized the facts that a positive trade balance implies a non-spending of income or credit contractions whereas a negative trade balance implies the presence of spending or credit expansion. The project is making use of a CGE model that was devised by professor Tower to demonstrate Tsiang model.

Tower's CGE model describes the behavior of an economy under fixed exchange rate which is examined closely in the first part of the report. Then, the model will be modified to examine the role of money under two different scenarios which are the following:

- Flexible Exchange Rate
- Long Run Flexible Exchange rate

The flexible exchange rate model is built by taking the exchange rate (E) making it endogenous instead of being exogenous while making the Balance of Trade (dT) exogenous. The output of the model (policy matrix) defining the effect of changing the exchange rate on the economy from fixed to flexible will be compared to the output of the original model. The comparison is an attempt to understand the effect of changing an exchange rate regime from fixed to flexible on the balance of trade.

The long run flexible exchange rate model is built by making the Capital (K) endogenous instead of being exogenous while taking money supply (H) out to adjust for the inflexible real return on invested capital (ROIC). The inflexible real ROIC is introduced and calculated assuming the capital of a country is composed of the domestically produced good.

Table 1: Key Notations

Notations		Units
A	Autos Output	Autos
B	Beer Output	Beers
K_A	Capital in America	Machines
K_B	Capital in Britain	Machines
L_A	Labor in America	Workers
L_B	Labor in Britain	Workers
CPI_A	Consumer price index in America	-
CPI_B	Consumer price index in Britain	-
D_A	Absorption of Autos in America	Autos
D_B	Absorption of Beer in Britain	Beers
X_A	America's export of autos	Autos
X_B	Britain's export of beers	Beers
PA_A	Prrice of autos in America	$
PA_B	Prrice of autos in Britain	£
PB_A	Prrice of beer in America	$
PB_B	Prrice of beer in Britain	£
$ABSORP_A$	Money absorption in America	$
$ABSORP_B$	Money absorption in Britain	£
$RealAbsorp_A$	Real absorption in America	Autos
$RealAbsorp_B$	Real absorption in Britain	Beers
W_A	Money wage in America	$
W_B	Money wage in Britain	£
R_A	Money rent in America	$
R_B	Money rent in Britain	£
σ_{uA}	Elasticity of substitution in Absorption in America	-
σ_{uB}	Elasticity of substitution in Absorption in Britain	-
σ_A	Elasticity of substitution in Production in America	-
σ_B	Elasticity of substitution in Production in Britain	-
H_A	Money Supply in America	$
H_B	Money supply in Britain	£
T_A	America's trade balance	$
T_B	Britain's trade balance	£

Notations		Units
μ_A	Sensitivity of the demand for money to the interest rate in America	-
μ_B	Sensitivity of the demand for money to the interest rate in Britain	-
r_a	Interest rate in America	-
r_B	Interest rate in Britain	-
ρ_A	Sensitivity of real absorption to the interest rate in America	-
ρ_B	Sensitivity of real absorption to the interest rate in Britain	-
$\Phi_{A.Autos}$	Share of absorption spent on Autos in America	-
$\Phi_{B.Beers}$	Share of absorption spent on Beers in Britain	-
$\Phi_{A.Beers}$	Share of absorption spent on Beer in America	-
$\Phi_{B.Autos}$	Share of absorption spent on Autos in Britain	-
Θ_{LA}	Labor share in production of autos in America	-
Θ_{LB}	Labor share in production of beers in Britain	-
Θ_{KA}	Capital share in production of autos in America	-
Θ_{KB}	Capital share in production of beers in Britain	-
mpc_A	marginal propensity to absorb (real) out of real income in America	-
mpc_B	marginal propensity to absorb (real) out of real income in Britain	-
E	Exchange rate (1$= ?£)	$/£
$Income_A$	Income of America	$
$Income_B$	Income of Britain	£
$RealIncome_A$	Real Income of America	Autos
$RealIncome_B$	Real Income of Britain	Beers

Equations

1. $\widehat{\mathrm{A}} = (\theta_{KA})\,\widehat{K_A} + (\theta_{LA})\,\widehat{L_A}$
2. $\widehat{\mathrm{B}} = (\theta_{KB})\,\widehat{K_B} + (\theta_{LB})\,\widehat{L_B}$
3. $\widehat{CPI_A} = (\Phi_{A.Autos})\widehat{PA_A} + (\Phi_{A.Beers})\widehat{PB_A}$
4. $\widehat{CPI_B} = (\Phi_{B.Beers})\widehat{PB_B} + (\Phi_{B.Autos})\widehat{PA_B}$
5. $\widehat{D_A} - \widehat{X_B} = (\sigma_{uA})(\,\widehat{PB_A} - \,\widehat{PA_A})$
6. $\widehat{D_B} - \widehat{X_A} = (\sigma_{uB})(\,\widehat{PA_B} - \,\widehat{PB_B})$
7. $\widehat{PA_B} = \,\widehat{PA_A} + \hat{E}$
8. $\widehat{PB_B} = \,\widehat{PB_A} + \hat{E}$
9. $\left(\frac{D_A}{A}\right)\widehat{D_A} + \left(\frac{X_A}{A}\right)\widehat{X_A} = \hat{A}$
10. $\left(\frac{D_B}{B}\right)\widehat{D_B} + \left(\frac{X_B}{B}\right)\widehat{X_B} = \hat{B}$
11. $\widehat{RealAbsorp_A} = \,\widehat{APSORP_A} - \,\widehat{CPI_A}$
12. $\widehat{RealAbsorp_B} = \,\widehat{APSORP_B} - \,\widehat{CPI_B}$
13. $\widehat{K_A} - \widehat{L_A} = (\sigma_A)\left(\widehat{W_A} - \widehat{R_A}\right)$
14. $\widehat{K_B} - \widehat{L_B} = (\sigma_B)(\widehat{W_B} - \widehat{R_B})$
15. $\widehat{H_A} = \,\hat{A} + \,\widehat{PA_A} - (\mu_A)\widehat{r_A}$
16. $\widehat{H_B} = \,\hat{B} + \,\widehat{PB_B} - \,(\mu_B)\widehat{r_B}$
17. $\widehat{RealAbsorp_A} = (mpc_A)\widehat{RealIncome_A} - (\rho_A)\widehat{r_A}$
18. $\widehat{RealAbsorp_B} = (mpc_B)\widehat{RealIncome_B} - (\rho_B)\,\widehat{r_B}$
19. $\widehat{RealIncome_A} = \,\widehat{Income_A} - \,\widehat{CPI_A}$
20. $\widehat{RealIncome_B} = \,\widehat{Income_B} - \widehat{CPI_B}$
21. $\widehat{Income_A} = \,\hat{A} + \widehat{PA_A}$
22. $\widehat{Income_B} = \,\hat{B} + \widehat{PB_B}$
23. $\widehat{Absorp_A} = \Phi_{A.Autos}\left(\widehat{PA_A} + \widehat{D_A}\right) + \Phi_{A.Beer}\left(\widehat{PB_A} + \widehat{X_B}\right)$
24. $\widehat{Absorp_B} = \Phi_{B.Beer}\left(\widehat{PB_B} + \widehat{D_B}\right) + \Phi_{B.Autos}\left(\widehat{PA_B} + \widehat{X_A}\right)$
25. $\widehat{PA_A} = (\theta_{LA})\widehat{W_A} + (\theta_{KA})\widehat{R_A}$
26. $\widehat{PB_B} = (\theta_{LB})\widehat{W_B} + (\theta_{KB})\widehat{R_B}$
27. $dT_A = (PA_A \times X_A)\left(\widehat{PA_A} + \widehat{X_A}\right) - (PB_A \times X_B)\left(\widehat{PB_A} + \widehat{X_B}\right)$
28. $\widehat{ROIC_A} = \,\widehat{R_A} - \widehat{PA_A}$
29. $\widehat{ROIC_B} = \,\widehat{R_B} - \widehat{PB_B}$

Table 2: Initial Values

Parameter	Initial level	Unit
A	100	Autos
B	100	Beers
$\Phi_{A.Autos}$	0.7	-
$\Phi_{B.Beers}$	0.7	-
Θ_{LA}	0.7	-
Θ_{LB}	0.7	-
μ_A	1	-
μ_B	1	-
ρ_A	1	-
ρ_B	1	-
σ_{uA}	1	-
σ_{uB}	1	-
σ_A	1	-
σ_B	1	-
PA_A	1	$
PB_B	1	£
CPI_A	1	-
CPI_B	1	-
E	1	$/£
mpc_A	0.7	-
mpc_B	0.7	-
R_A	1	$
R_B	1	£
W_A	1	$
W_B	1	£

Automatically calculated parameters using initial levels		Unit
$\Phi_{A.Beers}$	0.3	-
$\Phi_{B.Autos}$	0.3	-
Θ_{KA}	0.3	-
Θ_{KB}	0.3	-
$Income_A$	100	$
$Income_B$	100	£
PA_B	1	£
PB_A	1	$
$ABSORP_A$	100	$
ABSORPB	100	£
D_A	70	Autos
D_B	70	Beers
X_A	30	Autos
X_B	30	Beers

In the following analysis, we assume that there are two countries (America and Britain) and two commodities, autos and beers. We further assume that each country produces only one of the commodities and imports the other (America produces autos and Britain produces beers).

Fixed Exchange Rate

Table 3: Policy Matrix for Fixed Exchange Rates

Endogenous Variables	Exogenous Variables						
	K_A^	L_A^	K_B^	L_B^	E^	W_A^	W_B^
A^	0.30	0.70	0.00	0.00	0.00	0.00	0.00
B^	0.00	0.00	0.30	0.70	0.00	0.00	0.00
CPI_A^	-0.21	0.21	-0.09	0.09	-0.30	0.70	0.30
CPI_B^	-0.09	0.09	-0.21	0.21	0.30	0.30	0.70
D_A^	0.30	1.45	0.00	-0.75	0.75	0.75	-0.75
D_B^	0.00	-0.75	0.30	1.45	-0.75	-0.75	0.75
X_A^	0.30	-1.05	0.00	1.75	-1.75	-1.75	1.75
X_B^	0.00	1.75	0.30	-1.05	1.75	1.75	-1.75
PA_A^	-0.30	0.30	0.00	0.00	0.00	1.00	0.00
PA_B^	-0.30	0.30	0.00	0.00	1.00	1.00	0.00
PB_A^	0.00	0.00	-0.30	0.30	-1.00	0.00	1.00
PB_B^	0.00	0.00	-0.30	0.30	0.00	0.00	1.00
$ABSORP_A$^	0.00	1.75	0.00	-0.75	0.75	1.75	-0.75
$ABSORP_B$^	0.00	-0.75	0.00	1.75	-0.75	-0.75	1.75
$RealAbsorp_A$^	0.21	1.54	0.09	-0.84	1.05	1.05	-1.05
$RealAbsorp_B$^	0.09	-0.84	0.21	1.54	-1.05	-1.05	1.05
R_A^	-1.00	1.00	0.00	0.00	0.00	1.00	0.00
R_B^	0.00	0.00	-1.00	1.00	0.00	0.00	1.00
H_A^	0.06	1.99	0.03	-0.78	0.84	1.84	-0.84
H_B^	0.03	-0.78	0.06	1.99	-0.84	-0.84	1.84
dT_A	0.00	-75.00	0.00	75.00	-75.00	-75.00	75.00
r_a^	-0.06	-0.99	-0.03	0.78	-0.84	-0.84	0.84
r_B^	-0.03	0.78	-0.06	-0.99	0.84	0.84	-0.84
$Income_A$^	0.00	1.00	0.00	0.00	0.00	1.00	0.00
$Income_B$^	0.00	0.00	0.00	1.00	0.00	0.00	1.00
$RealIncome_A$^	0.21	0.79	0.09	-0.09	0.30	0.30	-0.30
$RealIncome_B$^	0.09	-0.09	0.21	0.79	-0.30	-0.30	0.30

The policy matrix of the fixed exchange model shows that a **1% increase in the exchange rate (E^= $/£)** will cause the domestic currency (US$) to become more expensive relative to the foreign country currency (GBP£) (Note that America is Country A "domestic" and Britain is Country B "foreign"). The appreciation of the US$ makes the country's exports relatively more expensive, in addition to making foreign imported products relatively cheaper; the domestic price of Beer (foreign good) will go down (**PB_A^ 1 %↓**) while the price of Autos (domestic good)

abroad will go up (**PA_B^ 1% ↑).** Thus, discouraging exports and increasing imports **(X_A^ - 1.75 %↓)** and resulting in a negative balance of trade for domestic country (**dT_A 75 Units ↓).** The numbers of the model are intuitive and corroborates Tsiang findings that devaluation of the currency will result in an increase in terms of trade by providing an alternate simulation (through the appreciation of US$).

Flexible Exchange Rate

Table 4: Policy Matrix for Flexible Exchange Rate

Endogenous Variables	Exogenous Variables						
	K_A^	L_A^	K_B^	L_B^	dT_A	W_A^	W_B^
A^	0.300	0.700	0.000	0.000	0.000	0.000	0.000
B^	0.000	0.000	0.300	0.700	0.000	0.000	0.000
CPI_A^	-0.210	0.510	-0.090	-0.210	0.004	1.000	0.000
CPI_B^	-0.090	-0.210	-0.210	0.510	-0.004	0.000	1.000
D_A^	0.300	0.700	0.000	0.000	-0.010	0.000	0.000
D_B^	0.000	0.000	0.300	0.700	0.010	0.000	0.000
X_A^	0.300	0.700	0.000	0.000	0.023	0.000	0.000
X_B^	0.000	0.000	0.300	0.700	-0.023	0.000	0.000
PA_A^	-0.300	0.300	0.000	0.000	0.000	1.000	0.000
PA_B^	-0.300	-0.700	0.000	1.000	-0.013	0.000	1.000
PB_A^	0.000	1.000	-0.300	-0.700	0.013	1.000	0.000
PB_B^	0.000	0.000	-0.300	0.300	0.000	0.000	1.000
$ABSORP_A$^	0.000	1.000	0.000	0.000	-0.010	1.000	0.000
$ABSORP_B$^	0.000	0.000	0.000	1.000	0.010	0.000	1.000
$RealAbsorp_A$^	0.210	0.490	0.090	0.210	-0.014	0.000	0.000
$RealAbsorp_B$^	0.090	0.210	0.210	0.490	0.014	0.000	0.000
R_A^	-1.000	1.000	0.000	0.000	0.000	1.000	0.000
R_B^	0.000	0.000	-1.000	1.000	0.000	0.000	1.000
H_A^	0.063	1.147	0.027	0.063	-0.011	1.000	0.000
H_B^	0.027	0.063	0.063	1.147	0.011	0.000	1.000
E^	0.000	-1.000	0.000	1.000	-0.013	-1.000	1.000
r_a^	-0.063	-0.147	-0.027	-0.063	0.011	0.000	0.000
r_B^	-0.027	-0.063	-0.063	-0.147	-0.011	0.000	0.000
$Income_A$^	0.000	1.000	0.000	0.000	0.000	1.000	0.000
$Income_B$^	0.000	0.000	0.000	1.000	0.000	0.000	1.000
$RealIncome_A$^	0.210	0.490	0.090	0.210	-0.004	0.000	0.00
$RealIncome_B$^	0.090	0.210	0.210	0.490	0.004	0.000	0.000

The policy matrix of the flexible exchange model shows that a **1 unit increase in the balance of trade (dT_A)** which could be the result of receiving foreign aid or a grant from another country. The positive terms of trade will result in more exports by the US **(X_A^ 0.023 %↑)** which will cause the price of Autos (domestic good) abroad to go down (**PA_B^ 0.013% ↓)** while the domestic price of Beer (foreign good) will go up (**PB_A^ 0.013 %↑)** as Britain is importing more

(X_B^ 0.023 %↓), therefore, the exchange rate will go down by 1% to align with the result of the fixed exchange model.

The fixed and flexible exchange rate regimes show consistent results when the balance of trade is compared against the exchange rate. The relationship between the two variable negative i.e. a devaluation of currency will result in a positive trade balance whereas an appreciation of the

Long Run Analysis

In an attempt to study the effects of a change in the exchange rate in the long run, the capital was made endogenous, allowing for it to change as a result of changes in the other exogenous variables. An important assumption about the composition of capital is made in this case. If the real rental rate is calculated by dividing the nominal rate by the CPI, we get the following:

$$\widehat{\text{RealRental}}_A = \widehat{R_A} - \widehat{CPI_A}$$

$$\widehat{\text{RealRental}}_B = \widehat{R_B} - \widehat{CPI_B}$$

The above equations assume that the capital is composed of the home and foreign goods, since the CPI takes into consideration both goods. However, our assumption here is that the capital is composed of the domestically produced good solemnly. So we will calculate the real rate of return on the invested capital differently.

For the case that the capital is made of the domestic good only, we will calculate the return on invested capital (ROIC) as follows:

$$\widehat{ROIC_A} = \widehat{R_A} - \widehat{PA_A}$$

$$\widehat{ROIC_B} = \widehat{R_B} - \widehat{PB_B}$$

In deriving the two equations, we can see that the CPI will be canceled in the real return on capital investment equation:

$$ROIC = \frac{\frac{R}{CPI}}{\frac{P}{CPI}} = \frac{R}{P}$$

Long-Run Flexible Exchange Rate

Table 5: Policy Matrix for Long Term Fixed Exchange Rate

Endogenous Variables	Exogenous Variables						
	H_A^	L_A^	H_B^	L_B^	dT_A	$ROIC_A$^	$ROIC_B$^
A^	0.00	1.00	0.00	0.00	0.00	-0.43	0.00
B^	0.00	0.00	0.00	1.00	0.00	0.00	-0.43
CPI_A^	1.00	-0.91	0.00	-0.39	0.02	0.39	0.17
CPI_B^	0.00	-0.39	1.00	-0.91	-0.02	0.17	0.39
D_A^	0.00	1.00	0.00	0.00	-0.01	-0.43	0.00
D_B^	0.00	0.00	0.00	1.00	0.01	0.00	-0.43
X_A^	0.00	1.00	0.00	0.00	0.02	-0.43	0.00
X_B^	0.00	0.00	0.00	1.00	-0.02	0.00	-0.43
PA_A^	1.00	-1.21	0.00	-0.09	0.01	0.52	0.04
PA_B^	0.00	-1.09	1.00	-0.21	-0.02	0.47	0.09
PB_A^	1.00	-0.21	0.00	-1.09	0.02	0.09	0.47
PB_B^	0.00	-0.09	1.00	-1.21	-0.01	0.04	0.52
$ABSORP_A$^	1.00	-0.21	0.00	-0.09	0.00	0.09	0.04
$ABSORP_B$^	0.00	-0.09	1.00	-0.21	0.00	0.04	0.09
$RealAbsorp_A$^	0.00	0.70	0.00	0.30	-0.01	-0.30	-0.13
$RealAbsorp_B$^	0.00	0.30	0.00	0.70	0.01	-0.13	-0.30
R_A^	1.00	-1.21	0.00	-0.09	0.01	1.52	0.04
R_B^	0.00	-0.09	1.00	-1.21	-0.01	0.04	1.52
K_A^	0.00	1.00	0.00	0.00	0.00	-1.43	0.00
K_B^	0.00	0.00	0.00	1.00	0.00	0.00	-1.43
E^	-1.00	0.12	1.00	-0.12	-0.04	-0.05	0.05
r_a^	0.00	-0.21	0.00	-0.09	0.01	0.09	0.04
r_B^	0.00	-0.09	0.00	-0.21	-0.01	0.04	0.09
$Income_A$^	1.00	-0.21	0.00	-0.09	0.01	0.09	0.04
$Income_B$^	0.00	-0.09	1.00	-0.21	-0.01	0.04	0.09
$RealIncome_A$^	0.00	0.70	0.00	0.30	0.00	-0.30	-0.13
$RealIncome_B$^	0.00	0.30	0.00	0.70	0.00	-0.13	-0.30
W_A^	1.00	-1.21	0.00	-0.09	0.01	0.09	0.04
W_B^	0.00	-0.09	1.00	-1.21	-0.01	0.04	0.09

The policy matrix show that an increase in the money supply in the US (**H_A^ 1 % ↑)** will not alter any real variable in America but will increase all nominal variables in the country where the change took place i.e. an increase in the money supply in country A will increase all nominal variables in country A(**CPI_A^, PA_A^, PB_A^, R_A^, $Income_A,W_A$^)** by the same percentage, the same treatment will work for an increase in the money supply in Britain (**H_B^ 1 % ↑).** The reason behind not changing the nominal rate is the nature of the model. Because the exchange rate is flexible, it will go down by the same percentage (**E^ ↓)** making all values changes unreal.

It also shows that an increase in the labor supply in the US (**L_A^ 1 % ↑)** will not alter any real variable in America but will change all nominal variables in both countries (**CPI_A^, CPI_B^ PA_A^, PA_B^, PB_A^, PB_B^, R_A^, R_B^, $Income_A$^, $Income_B$^, W_A^, W_B^)**. The increase in the labor supply in Britain (**L_B^ 1 % ↑)** will induce symmetric changes.

The balance of trade rule stating that a decrease in the exchange rate will result in a positive trade balance holds in the long run; a one unit increase in trade balance will decrease exchange rate by 0.04%.

References

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