Chapter 5

A Closed-Economy One-Period Macroeconomic Model
In Chapter 4, we studied the microeconomic behavior of a representative consumer and a representative firm.

In this chapter, we will take this microeconomic behavior and build it into a working model of the macro economy. We will also show that the results of this hypothetical economy are socially efficient.
Add in Government

- It purchases consumption goods, $G$, and finances $G$ by taxing the representative consumer $T$.
- Examples of $G$: public goods such as national defense, air traffic control and education.
- Government budget constraint
  $$G = T$$
What we have in our model now?

- Consumption
- Production
- Government
- No international trade, closed economy
• Exogenous variables: $G, z, K$
• Endogenous variables: $C, N^s, N^d, T, Y, w$
• What remains is to show how consistency is obtained in the actions of all economic agents
• Consistency: Given market prices, demand = supply in each market
Figure 5.1 A Model Takes Exogenous Variables and Determines Endogenous Variables
The Competitive Equilibrium

A *Competitive Equilibrium* (CE) is a set of endogenous variables, \( C, N^s, N^d, T, Y, w \) such that, given the exogenous variables \( G, z, K \), the following are satisfied:
• The representative consumer chooses $C$ and $N^s$ to maximize his or her utility subject to his or her budget constraint, given $w$, $T$ and $\pi$.

• The representative firm chooses $N^d$ to maximize the profits, given the real wage $w$.

• The labor market clears. $N^s = N^d$
• The Gov. budget constraint is satisfied.
  \[ G = T \]

• The consumption good market clears.
  \[ Y = C + G \ (\text{Resource Constraint}) \]
Why we have $Y = C + G$ in the economy?

Recall budget constraint: $C = wN_s^s + \pi - T$

We also have profits $\pi = Y - wN_d^d$

Hence $C = wN_s^s + Y - wN_d^d - T$

Notice in equilibrium, we have $N_s^s = N_d^d$, and Gov balanced budget $G = T$

So we get $C = Y - G$
A Graphical Analysis of CE

- Start from production technology
  \[ Y = zF(K, N) \]
- Notice in equilibrium, We have \( N = h-l \)
  \[ Y = zF(K, h-l) \]
- Now because in equilibrium, \( C = Y - G \)
  \[ C = zF(K, h-l) - G \]
• It shows a relationship b/w two goods C and I, given the exogenous variables z, K and G.

• We call it Production Possibilities Frontier (PPF)

• The negative slope of the PPF, called Marginal Rate of Transformation (MRT)

• \( MRT_{I,C} = MP_N = -(\text{slope of the PPF}) \)
Figure 5.2 The Production Function and the Production Possibilities Frontier
• From Chapter 4, we know the profit-maximization decision of the firm is

\[ MP_N = w \]

So in the equilibrium, we must have

\[ MRT_{l,c} = MP_N = w \]

• From Chapter 4, we also know consumer will maximize the utility according to

\[ MRS_{l,c} = w \]
• Hence in competitive equilibrium, we should have

\[ MRT_{l,c} = MRS_{l,c} = MP_N = w \]
Figure 5.3  Competitive Equilibrium
Optimality

• Pareto Optimality (PO)
  Definition: A CE is PO if there is no way to rearrange production or to reallocate goods so that someone is made better off without making someone else worse off.

• Given this definition, we can claim CE is PO in our case. Why?
• Social Planner’s problem

\[ \max U(C, l) \]
\[ s.t. C + G \leq Y = zF(K, h-l) \]

• FOC implies

\[ MRT_{l,c} = MRS_{l,c} = MP_N \]
First Welfare Theorem

• Surprisingly, it is as same as that in CE
• Hence we prove the First Welfare Theorem (FWT): Under certain conditions, a **Competitive Equilibrium is Pareto Optimal** (CE $\Rightarrow$ PO)
Figure 5.4 Pareto Optimality
When does \textit{FWT} fail?

- Externalities
  Because Social $MP \neq$ Private $MP$, or
  Social $MRS \neq$ Private $MRS$.

- Distorting taxes
  e.g. individual income tax
• Now consumer’s problem changes to
  \[ \max U(C, l) \]
  \[ s.t. C = (1 - t)wN^s + \pi - T \]
• Firm’s problem is as same as before
• We have
  \[ MRS_{l,c} = w(1 - t) \neq w = MP_N = MRT_{l,c} \]
• market is not competitive, firm is a price-maker instead of a price-taker. Monopoly power will lead to a underproduction relative to what is social optimal.
Second Welfare Theorem

- Second Welfare Theorem (SWT): Under certain conditions, a PO allocation can be supported as a CE. ($PO \Rightarrow CE$)

- Key point here is to find a price system to support the PO allocation
Figure 5.5 Using the Second Welfare Theorem to Determine a Competitive Equilibrium
Working with the Model: the Effect of $G \uparrow$

• Impact Effect
  – Parallel Downward Shift in $PPF$
  – Pure Income Effect

• Equilibrium Effects
  – Reduced Consumption: $G$ crowds out $C$
  – Reduced Leisure
  – Increased Output
  – Lower Real Wage
• Government Spending a Source of Business Cycles?
  – Government Spending Shocks Wrongly Predict Countercyclical Consumption, $C\uparrow$ while $Y\downarrow$
  – Government Spending Shocks Wrongly Predict Countercyclical Real Wages
  – Therefore G shocks should not appear to be a good candidate as a cause of business cycles
  – But it does very well in explaining what happened during WWII: $Y\uparrow$ while $C\downarrow$
Figure 5.6  Equilibrium Effects of an Increase in Government Spending
Figure 5.7 GDP, Consumption, and Government Expenditures
Working with the Model: the Effect of TFP↑

• Impact Effect
  – Upward Shift in PPF
  – Steeper PPF (Why?)
  – Income and Substitution Effects
Figure 5.8 Increase in Total Factor Productivity
Figure 5.9 Competitive Equilibrium Effects of an Increase in Total Factor Productivity
Figure 5.10 Income and Substitution Effects of an Increase in Total Factor Productivity
• Equilibrium Effects
  – Increased Consumption
  – Leisure and Hours Worked may Rise or Fall
  – Increased Output
  – Higher Real Wage
• Productivity and Long-Run Growth: Facts
  – Consumption Grows over Time
  – Hours Worked Remain about Constant
  – Output Increases over Time
  – Real Wages Rise over Time
• Technological innovation seems consistent with these facts in long run
• Productivity as Source of Business Cycles?
  – Consumption is Procyclical (✓)
  – Cyclical Properties of Hours Worked
    • Procyclical Hours Worked is a Business Cycle Fact
    • Need Strong Substitution Effect to Predict Procyclical Hours
    • Intertemporal Substitution of Leisure
  – Increased Output Defines the Cycle (✓)
  – Procyclical Real Wage Rate (✓)
• Some Macroeconomists hence view TFP shocks as the most important cause of business cycles

• The theory has been called REAL BUSINESS CYCLE theory (RBC)

• Minnesota is the birthplace of RBC, Ed. Prescott won the Nobel Prize in Economics for the contribution to this theory
• But the question still remains: What is behind TFP?
• Changes in TFP could arise because of technological innovation, or changes in weather (Hurricane Katrina), changes in government regulations and changes in the relative price of energy (oil shocks). Anyway they are “real”.
Figure 5.11  Deviations from Trend in Real GDP and the Solow Residual
Figure 5.12  The Relative Price of Energy