A Closed-Economy One-Period Macroeconomic Model

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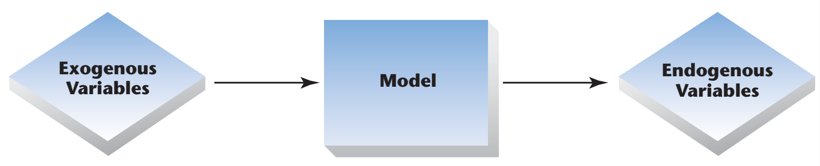
Introduction

- Introduce the government.
- Construct closed-economy one-period macroeconomic model, which has:
    - i representative consumer;
    - ii representative firm;
    - iii government.
- Economic efficiency and Pareto optimality.
- Experiments: Increases in government spending and total factor productivity.
- Consider a distorting tax on wage income and study the Laffer curve.
- Public goods: How large should the government be?

What is a model used for?

- Exogenous variables are determined outside a macroeconomic model.
- Given the exogenous variables, the model determines the endogenous variables.
- In experiments, we are interested in how the endogenous variables change when there are changes in exogenous variables.



The actors

The circular flow

There are three institutional actors in the model

- The representative consumer
- The representative firm
- The government

The consumer's problem

- The representative consumer is the same as in Lecture 8, section "The work-leisure decision".
- His problem is to choose C and l so as to maximize $U(C, l)$ subject to his budget constraint—that is,

$$\max_{C,l} U(C, l) \qquad \text{s.t. } \begin{cases} C = w(h - l) + \pi - T \\ l \leq h \end{cases}$$

The firm's problem

- The representative firm is the same as in Lecture 11.
- Its problem is to choose the labor input N^d so as to maximize profits:

$$\max_{N^d} zF(K, N^d) - wN^d$$

subject to $N^d \geq 0$

The government's problem

- The government wishes to purchase a given quantity of consumption goods, G, and finances these purchases by taxing the representative consumer.
- The government must abide by the government budget constraint:

$$G = T$$

  or government purchases equal taxes, in real terms.
- In practice, governments provide many different goods and services. For now, we are not specific about the public goods nature of government expenditure.
- Introducing the government in this way allows us to study some basic effects of fiscal policy.

Competitive equilibrium

Putting things together

- What remains in constructing our model is to show how consistency is obtained in the actions of all these economic agents.
- By consistency we mean that, given market prices, demand is equal to supply in each market in the economy.
- Such a state of affairs is called a competitive equilibrium.
    - "competitive" refers to the fact that all consumers and firms are price-takers
    - the economy is in "equilibrium" when the actions of all consumers and firms are consistent: When demand equals supply in all markets ('markets clear').

Competitive equilibrium in the model

- In our model economy, there is only one price: w.
- Think of the economy as having only one market, on which labor time is exchanged for consumption goods:
    - consumer supplies labor
    - firm demands labor
- A competitive equilibrium is achieved when, given the exogenous variables G, z, and K, the real wage w is such that, at that wage, the quantity of labor the consumer wishes to supply is equal to the quantity of labor the firm wishes to hire.

Endogenous and exogenous variables

- In the model the exogenous variables are:

G	government spending
z	total factor productivity
K	the capital stock

- The endogenous variables are

C	consumption	N^s	labor supply
Y	aggregate output	N^d	labor demand
T	taxes	w	market real wage
l	leisure	π	profits

Finding the competitive equilibrium

- Representative consumer optimizes given market prices:

$$U_l(C,l) = wU_C(C,l) \tag{1a}$$

$$C = wN^s + \pi - T \tag{1b}$$

$$N^s = h - l \tag{1c}$$

- Representative firm optimizes given market prices.

$$w = zF_{N^d}(K,N^d) \tag{1d}$$

- The labor market clears.

$$N^s = N^d \tag{1e}$$

- The government budget constraint is satisfied:

$$G = T \tag{1f}$$

Counting equations

- Notice that so far we have only 6 equations but there are 8 endogenous variables!
- To identify all the endogenous variables we need 2 more equations.
- They are just the following relationships:

$$Y = zF(K, N^d) \tag{1g}$$

$$\pi = Y - wN^d \tag{1h}$$

Income-expenditure identity

- Starting with the consumer budget constraint (1b):

$$
\begin{aligned}
C &= wN^s + \pi - T \\
&= wN^s + \pi - G && \text{(balanced budget: (1f))} \\
&= wN^s + \left(Y - wN^d\right) - G && \text{(firm's profits: (1h))} \\
&= Y + w\left(N^s - N^d\right) - G && \text{(factoring terms)} \\
&= Y - G && \text{(labor market clears: (1e))}
\end{aligned}
$$

- Then, we obtained the income-expenditure identity:

$$Y = C + G$$

Solving the system of equations

- To solve the model we
  - substitute for w in (1a) using (1d).
  - substitute (1g), (1e) and (1c) in the income-expenditure identity.
- Doing so we end up with a system of two equations in two endogeneous variables (C and l, the only two goods in our model):

$$\begin{aligned} U_l(C,l) &= U_C(C,l)\; zF_2(K,h-l) \\ C+G &= zF(K,h-l) \end{aligned}$$

The competitive equilibrium

We have found the competitive equilibrium:

- Solve last system by substituting C from the second equation into the marginal utilities of the first equation.
- Use C and the income-expenditure identity to get Y.
- Form l and (1c), we get N^s, which equals N^d because (1e).
- Knowing C and l we get the wage w using (1a).
- Knowing N^d and w we get profits π using (1h).
- We already knew that $T = G$.

The social planner

The social planner

Assume that *instead of markets* there is a social planner who:

- controls all resources in the economy.
- is benevolent: her objective is to make the representative consumer as well off as possible.
- does not have to deal with markets: she can simply order the representative firm to hire a given quantity of labor and produce a given quantity of consumption goods.
- has the power to coerce the consumer into supplying the required amount of labor.
- takes G units of consumption goods for the government, and allocates the remainder to the consumer.

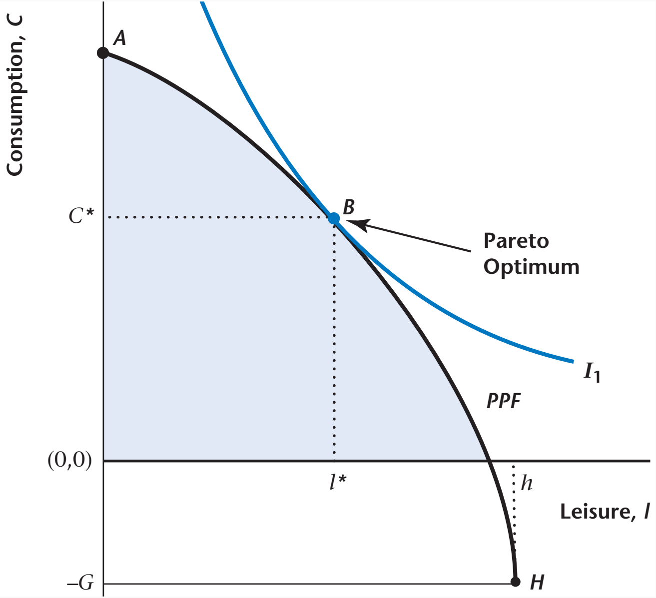
The social planner's problem

- The social planner's problem is to choose C and l, given the technology for converting l into C, to make the representative consumer as well off as possible.
- That is,

$$\max_{C,l} U(C,l) \qquad \text{s.t. } C = zF(K, h-l) - G$$

- The choices of the social planner tell us what, in the best possible circumstances, could be achieved in our model economy.

The production (and consumption) possibilities frontier



Solution to the problem

- Form the Lagrangian:

$$\max_{C,l} U(C,l) + \lambda \left[zF(K, h-l) - G - C \right]$$

- First-order conditions:

$$\begin{aligned} 0 &= U_C - \lambda \\ 0 &= U_l - \lambda z F_2(K, h-l) \end{aligned}$$

- Therefore, solution is characterized by:

$$\begin{aligned} U_l &= U_C \, z F_2(K, h-l) \\ C + G &= zF(K, h-l) \end{aligned}$$

- The solution is identical to the competitive equilibrium we found earlier!

Optimality and welfare

Competitive equilibrium vs. economic efficiency

This connection is important for two reasons:

1. This illustrates how free markets can produce socially optimal outcomes.
2. It's easier to analyze a social optimum than a competitive equilibrium in this model.

Evaluating market outcomes

- An important part of economics is analyzing how markets act to arrange production and consumption activities and asking how this arrangement compares with some ideal or efficient arrangement.
- Typically, the efficiency criterion that economists use in evaluating market outcomes is Pareto optimality.

Pareto optimality

A competitive equilibrium is Pareto optimal 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.

In our model, is the competitive equilibrium Pareto optimal?

- Easy to answer because there is only one representative consumer
- We can focus solely on how production is arranged to make the representative consumer as well off as possible.
- To construct the Pareto optimum here, we introduced the fictitious social planner.
- We found that the allocations from the competitive equilibrium are identical to those by the social planner.
- Therefore, the competitive equilibrium is Pareto optimal.

The welfare theorems

- The first fundamental theorem of welfare economics states that, under certain conditions, a competitive equilibrium is Pareto optimal.
- The second fundamental theorem of welfare economics states that, under certain conditions, a Pareto optimum is a competitive equilibrium.

The ‘invisible hand’

- The idea behind the first welfare theorem goes back at least as far as Adam Smith’s *An Inquiry into the Nature of Causes of the Wealth of Nations* (1776).
- Smith argued that an unfettered market economy composed of self interested consumers and firms could achieve an allocation of resources and goods that was socially efficient, in that an unrestricted market economy would behave as if an “invisible hand” were guiding the actions of individuals toward a state of affairs that was beneficial for all.

The ‘invisible hand’ (2)

“Every individual necessarily labors to render the annual revenue of the society as great as he can…He intends only his own gain, and he is in this, as in many other cases, led by an invisible hand to promote an end which was no part of his intention…By pursuing his own interests, he frequently promotes that of the society more effectually than when he really intends to promote it. I have never known much good done by those who affected to trade for the public good.”

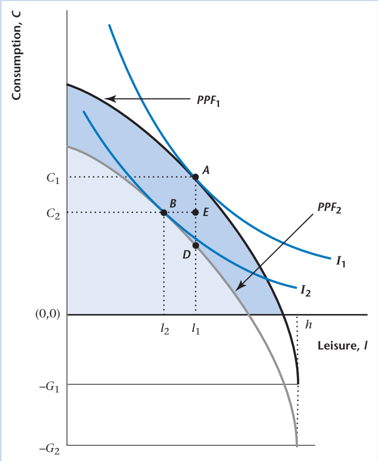
Adam Smith (1776)

Sources of social inefficiencies

- What could cause a competitive equilibrium to fail to be Pareto optimal?
    1. externalities
    2. distorting tax
    3. monopoly power
- Should governments intervene when there are inefficiencies?
    - Sometimes the cost of government regulations, in terms of added waste, outweighs the gains, in terms of correcting private market failures.

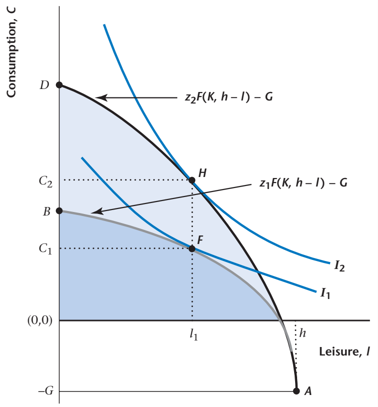
Comparative statics

Equilibrium effects of an increase in government spending



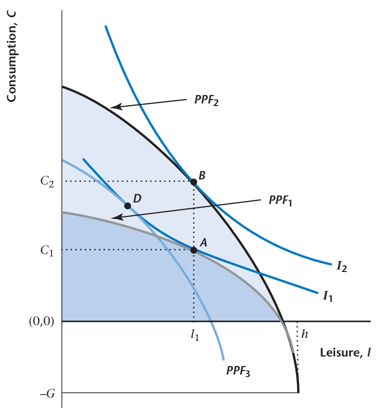
- An increase in G shifts the PPF down by ΔG.
- There are negative income effects on consumption and leisure, so that both C and l fall, and employment rises
- Output (equal to $C + G$) increases.

Equilibrium effects of an increase in total factor productivity



- An increase in z shifts the PPF from AB to AD.
- The C.E. changes from F to H as a result.
- Y and C increase, w increases, and l may rise or fall.
- Because employment is $N = h - l$, employment may rise or fall.

Income and substitution effects of an increase in z



- The increase in z involves a shift from PPF_1 to PPF_2.
- The curve PPF_3 is PPF_2 with the income effect of the increase in z taken out.
- The substitution effect is the movement from A to D,
- The income effect is the movement from D to B.

References

Williamson, Stephen D. (2014). *Macroeconomics*. 5th ed. Pearson.