Monetary Macroeconomics

Lecture 5:
International Monetary Systems
Price Surprises

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Chapter 5: International Monetary Systems

Questions we would like to answer using our simple OLG model are

- What is the role of fiat money in economies with more than one country and currency?
- How are exchange rates determined?

The Model

Consider an overlapping generations model as before.

There are two countries which have their own currency.

	Country a	Country b
population growth rate	n^a	n^b
fiat money expansion rate	z^a	z^b

There is one type of consumption good that the citizens of both countries like to consume.

There is free trade between countries (no tax, no transportation cost etc.)

If a consumer buys something from the other country, then he has to pay in that country's currency.

In equilibrium if both countries' monies are valued, then the exchange rate should be

$$e_t = \frac{p_t^b}{p_t^a}$$

i.e. what is the value of country a's money in terms of country b's money.

Otherwise, people would not accept one of the currencies for trade anymore.

Flexible Exchange Rates with Currency Controls

Assume that the citizens of each country are permitted to hold over time only the fiat money of their own country.

Note: In the history, this has been the case to protect the national currency's value.

There will be trade between countries but young people will have to save in their own currency, thus they will be affected by the changes in the exchange rate directly!

With currency controls, each country will have its own money demand. So there will be two separate equations for the money markets.

In equilibrium, in country a

$$M_t^a = p_t^a N_t^a (y^a - c_{t,t}^a)$$

Similarly, in country b,

$$M_t^b = p_t^b N_t^b (y^b - c_{t,t}^b)$$

Thus the price levels in each country will be

$$p_t^a = \frac{M_t^a}{N_t^a (y^a - c_{t,t}^a)} \quad \text{and} \quad p_t^b = \frac{M_t^b}{N_t^b (y^b - c_{t,t}^b)}$$

So the exchange rate between the two currencies will be

$$e_t = \frac{p_t^b}{p_t^a} = \frac{\frac{M_t^b}{N_t^b(y^b - c_{t,t}^b)}}{\frac{M_t^a}{N_t^a(y^a - c_{t,t}^a)}}$$

$$= \frac{M_t^b}{M_t^a} \quad \frac{N_t^a(y^a - c_{t,t}^a)}{N_t^b(y^b - c_{t,t}^b)}$$

Here the first term on the right hand side is the relative money supply, and the second term is the relative money demand of these countries.

How Does the Exchange Rate Change Over Time?

$$\frac{e_{t+1}}{e_t} = \frac{\frac{p^b_{t+1}}{p^a_{t+1}}}{\frac{p^b_t}{p^a_t}} = \frac{p^b_{t+1}}{p^b_t}\frac{p^a_t}{p^a_{t+1}}$$

Last time we have shown that in a stationary economy the prices evolve over time according to

$$\frac{p_{t+1}}{p_t} = \frac{z}{n}$$

where z is the money supply expansion rate and n is the population growth rate.

Therefore

$$\frac{e_{t+1}}{e_t} = \frac{p^b_{t+1}}{p^b_t}\frac{p^a_t}{p^a_{t+1}} = \frac{z^b}{n^b}\frac{n^a}{z^a}$$

$$\frac{e_{t+1}}{e_t} = \frac{z^b}{n^b}\frac{n^a}{z^a}$$

If country a's population grows at a faster rate and country b's money stock expands at a faster rate (i.e. $n^a > n^b$ and $z^b > z^a$), then $e_{t+1} > e_t$.

Hence country a's currency appreciates, i.e. its money's value increases (exchange rate here is the value of country a's money in terms of country b's money).

And country b's currency depreciates.

Fixed Exchange Rates

Countries can act together and fix their exchange rate so that

$$\frac{e_{t+1}}{e_t} = 1$$

This implies that

$$\frac{z^b}{n^b}\frac{n^a}{z^a} = 1$$

Hence, say, country a sets its money supply expansion rate at z^a such that

$$z^a = z^b \frac{n^a}{n^b}$$

So if country b inflates its money supply, then country a has to increase its money supply as well to keep the exchange rate fixed.

Country a loses its independence in monetary policy by following a fixed exchange rate policy.

Indeterminacy of the Exchange Rate

Assume that there are no currency controls (i.e. people are free to hold and use any currency they want) and the exchange rate is flexible.

Now people are allowed to hold the currency of either country — we cannot determine the money demand of each country separately!

So we have to set world's money supply equal to world's demand for money.

In terms of the consumption good,

$$\frac{M_t^a}{p_t^a} + \frac{M_t^b}{p_t^b} = N_t^a(y^a - c_{t,t}^a) + N_t^b(y^b - c_{t,t}^b)$$

We have one equation but *two* unknowns, p_t^a and p_t^b!

We can equivalently, substitute $p_t^a = \frac{p_t^b}{e_t}$.

Then

$$e_t\frac{M_t^a}{p_t^b} + \frac{M_t^b}{p_t^b} = N_t^a(y^a - c_{t,t}^a) + N_t^b(y^b - c_{t,t}^b)$$

$$\underbrace{\frac{1}{p_t^b}(e_t M_t^a + M_t^b)}_{\substack{\text{real value of}\\ \text{world's money}\\ \text{supply}}} = \underbrace{N_t^a(y^a - c_{t,t}^a) + N_t^b(y^b - c_{t,t}^b)}_{\substack{\text{aggregate real}\\ \text{demand for money}}}$$

The second term on the left hand side is world's total money supply in terms of country b's currency.

With one equation and two unknowns there are infinitely many solutions!

The exchange rate, $e_t = \frac{p_t^b}{p_t^a}$, is not determined.

Since a nation is no longer restricted to use its own currency, there is no separate money demand for each currency. But then the exchange rate cannot be determined based on the individual money supply and demand for money.

Fluctuations in the Exchange Rate

When people are free to hold and use any currency they want and when the exchange rates are flexible, then the exchange rate will be whatever people believe it should be.

So if these beliefs fluctuate, then so will the exchange rate!

These fluctuations do not need to be tied to fundamental changes in the economy.

For example, after Nixon announced that the US abandoned its efforts to fix the exchange rate in 1971, there were huge fluctuations in the exchange rates that cannot be traced back to changes in the real output, nominal money supply etc. in similar magnitudes.

There are some multinational institutions holding a balanced portfolio of several exchange rates. So they are hedged against the exchange rate fluctuations.

But most individuals who do not hold such a portfolio will be adversely affected by these fluctuations.

Purchasing Power Parity

Recall that in equilibrium if both countries' monies are valued, then the exchange rate should be

$$e_t = \frac{p_t^b}{p_t^a}$$

This is also called purchasing power parity. PPP states that the price of a traded bundle of goods will be the same in every country which engages in trade.

Is this really the case in the data?

Not exactly!

Reasons for failure of PPP: Barriers to trade, non-traded goods, non-traded components of traded goods (e.g. store rents, labor costs, distribution) etc.

Based on PPP reasoning, the British magazine *The Economist* regularly assesses (in a lighthearted way) whether currencies are overvalued or undervalued by comparing BigMac prices and actual exchange rates across countries.

From the Economist, January 10, 2019

https://www.economist.com/news/2019/01/10/the-big-mac-index

Conclusion

In our model the exchange rate is determined based on relative demand and relative supply of different currencies.

However, in the case of flexible exchange rate there is indeterminacy of exchange rate since we cannot isolate the separate demands for each currency. Then the expectations of people on what the exchange rate should be will move the exchange rates.

In the simple OLG model there is nothing that says that each country should have its own currency. On the contrary, having a currency union would eliminate the exchange rate fluctuations and facilitate easier trading.

Chapter 6: Price Surprises

What happens when z is observed with a time delay?

That is, what happens when this period's money growth rate is not observed immediately?

In our previous lectures we had $M_{t+1} = zM_t$, $z > 1$ **known** to the agents.

We will relax this assumption and analyze the model in this lecture.

Relationship Between Inflation and Output?

Time series data for the US during 1948-1969 shows a negative relationship between unemployment and inflation. This negative relationship is called Phillips Curve.

Observing this relationship policymakers thought that they can influence and stimulate employment (and hence output!) by printing money. However, this steady inflation policy did not work.

Time series data for the US between 1970-today shows a **positive** relationship between the same two variables!

Lucas Critique

Just looking at a reduced-form correlation in the data without understanding how the economy works, and doing econometric policy evaluation is not wise, since these reduced-form correlations are subject to change when the government changes its policies and thus the rules under which decision makers operate.

The Lucas Model

Overlapping generations model with fiat money.

The agents live for two periods.

N young agents are born each period. The aggregate population is constant over time.

There is no government spending.

Fiat money stock grows according to the rule

$$M_t = z_t M_{t-1}, \quad z_t > 1$$

and the government gives lump-sum transfers to the old with the new printed money.

$$\Big(1 - \frac{1}{z_t}\Big) M_t = N p_t a_t$$

where a_t is the real value of the transfer to each old.

The country consists of 2 spatially separated islands.

$\frac{2}{3}N$ young are born on one of the islands.

$\frac{1}{3}N$ young are born on the other island.

Which island will have more young population is random.

When agents get old, they are randomly but equally distributed across the islands.

$\frac{1}{2}N$ old are on one of the islands.

$\frac{1}{2}N$ old are on the other island.

Informational Assumption

In any period, the young cannot observe directly the number of young people on their island and do not know the size of the transfers to the old.

That is they will not know if there are few people to produce or if there is a large transfer to the old, when they observe a high demand for their good!

But they understand the probabilities of outcomes important to their welfare. *Rational Expectations*!

Production

The young on island i are endowed with y units of time, which can be used for home production, $c_{1,t}^i$, or for market production, l_t^i (to produce goods to the old in exchange for fiat money).

l_t^i, i.e. labor, will be a function of the current price level on island i, p_t^i.

Budget Constraints

The feasibility with respect to time allocation requires

$$c^t_{1,t} + l^i_t = y$$

And after trade the cash balances will be

$$p^i_t l^i_t = m^i_t$$

Thus for an agent who was born on island i the budget constraint when young is

$$c^i_{1,t} + \frac{m^i_t}{p^i_t} = y$$

And when old the agent "moves" to island j and his budget constraint is

$$c_{2,t}^{i,j} = \frac{m_t^i}{p_{t+1}^j} + a_{t+1}$$

$$\begin{aligned} c_{2,t}^{i,j} &= \frac{p_t^i l_t^i}{p_{t+1}^j} + a_{t+1} \\ &= \left(\frac{p_t^i}{p_{t+1}^j} \right) l_t^i + a_{t+1} \end{aligned}$$

Thus consumption when old depends on where the agent was born and where he ended up when old.

Substitution vs. Income Effect

Assume that the agents' preferences are such that the optimal labor decision, l_t^i, is increasing in the rate of return on their work, $\frac{p_t^i}{p_{t+1}^j}$.

Therefore we are assuming that an increase in the current price of goods, other things being equal, will induce the young to devote more time to market production.

That is the substitution effect is larger than the income effect.

Case 1: $z_t = z$ **for all** t

That is consumers can easily determine the current money stock. There are no surprises!

Feasibility in the money market requires money supply equals money demand on *both* islands.

On island i the money supply is $\frac{M_t}{2}$ since half of the old are there.

$$\frac{M_t}{2} = p_t^i N_t^i l(p_t^i)$$

where $l(p_t^i)$ is the real labor supply, i.e. real demand for fiat money!

Thus the price level will be

$$p_t^i = \frac{\frac{M_t}{2}}{N_t^i l(p_t^i)}$$

Assume island A has more young population at time t. Thus

$$N_t^A = \frac{2}{3}N \quad \text{and} \quad N_t^B = \frac{1}{3}N$$

Then the price levels on the islands will be

$$p_t^A = \frac{\frac{M_t}{2}}{\frac{2}{3}Nl(p_t^A)}$$

and

$$p_t^B = \frac{\frac{M_t}{2}}{\frac{1}{3}Nl(p_t^B)}$$

We see that $p_t^A < p_t^B$. See the proof in the appendix pp 137-138.

That is the price level is high when young population is low, so they observe a high demand for their product.

$$\frac{p_t^i}{p_{t+1}^j} = \frac{\frac{M_t/2}{N^i l(p_t^i)}}{\frac{M_{t+1}/2}{N^j l(p_{t+1}^j)}} = \underbrace{\frac{M_t}{M_{t+1}}}_{\frac{1}{z}} \frac{N^j l(p_{t+1}^j)}{N^i l(p_t^i)}$$

As z increases, the rate of return to work falls, discouraging work, because the money balances earned from labor are "taxed" by the high expansion of the money stock.

Thus we will see lower aggregate output!

We get **negative** correlation between inflation and output — contradicting the Phillips curve.

However, this is consistent with cross-sectional data of several countries!

Case 2: Random Monetary Policy

$$M_t = \{ \begin{matrix} M_{t-1} & \text{with probability } \theta & (z_t = 1) \\ 2M_{t-1} & \text{with probability } 1-\theta & (z_t = 2) \end{matrix} \}$$

Realization of z_t is kept secret, so that the young cannot infer the aggregate money supply in the economy.

Recall that $p_t^i = \frac{M_t/2}{N^i l(p_t^i)} = \frac{z_t M_{t-1}/2}{N^i l(p_t^i)}$

There are 4 possible states:

$N^i = \frac{1}{3}N$ or $\frac{2}{3}N$ and $M_t = 2M_{t-1}$ or M_{t-1}.

Let us find p_t^i for each state.

	$N^i = \frac{2}{3}N$	$N^i = \frac{1}{3}N$
$z_t = 1$	$p_t^a = \frac{M_{t-1}/2}{\frac{2}{3}Nl(p_t^a)}$	$p_t^b = \frac{M_{t-1}/2}{\frac{1}{3}Nl(p_t^b)}$
$z_t = 2$	$p_t^c = \frac{2M_{t-1}/2}{\frac{2}{3}Nl(p_t^c)}$	$p_t^d = \frac{2M_{t-1}/2}{\frac{1}{3}Nl(p_t^d)}$

We observe that

$p_t^b = p_t^c$ and $p_t^b > p_t^a$ and $p_t^c < p_t^d$.

Therefore $p_t^a < p_t^b = p_t^c < p_t^d$.

So if the young face p_t^a (or p_t^d) then they know that they young population is large (or small) and that the money supply stayed unchanged (or doubled).

Therefore $l(p_t^a) < l(p_t^d)$.

However, if the young face p_t^b, then they cannot infer anything about the state of the economy. So they will all produce l^*, where

$$l_t^a = l(p_t^a) < l^* < l(p_t^d) = l_t^d$$

Aggregate Output?

The aggregate output is the sum of the outputs produced on the two islands.

When $z_t = 1$, then the aggregate output will be a weighted average of l_t^a and l^*.

When $z_t = 2$, then the aggregate output will be a weighted average of l^* and l_t^d.

We observe that the output is higher when inflation is high. This **positive** relationship is similar to Phillips curve!

Policy Question

Should the governments fool their citizens to increase output?

There is a limit that the government can fool consumers. With time, consumers will learn and make decisions based on the "reputation" of the government.

Moreover, even if the output is increased through inflation there is a **welfare loss** associated with it which should never be ignored!

Conclusion

We have seen that correlations among macroeconomic variables are subject to change when economic policy changes.

Unexpected inflation can stimulate output, whereas *anticipated* high inflation will decrease incentives to work and result in lower production.

Lesson to be learned: *Correlation does not imply causality!*