

# **Monetary Macroeconomics**

## **Lecture 3: Barter and Commodity Money Inflation**

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## Last 2 Lectures

We have shown that fiat money expands the set of attainable allocations in equilibrium.

To show this result in an OLG model we assumed that there is no other way to trade what one has for what one wants. There was only a single consumption good.

Today we will show that

- using fiat money is more efficient than doing barter if the number of goods is high
- using fiat money over a commodity money has also big advantages

## **Chapter 3: What is a Barter Economy?**

In a barter economy goods one has are exchanged for goods one desires.

No particular good is used as medium of exchange.

For a small economy, this does not create any problems. But once there is a big variety of goods it becomes very difficult to trade.

## The Model

An overlapping generations model where agents live for two periods.

There are  $J$  types of consumption goods.

Each person is endowed with  $y$  units of one of these consumption goods when young and nothing when old.

The goods can be stored costlessly over time (*different from last chapter!*).

Each person likes to consume the good one owns when young and a different good when old. However, they do not know which good they will like from the beginning (*there is uncertainty*).

## Trading

People live on a large number of spatially separated islands.

Everyone on an island has the same endowment and tastes.

People from an island (young or old) who want to trade travel in a group to a trading area and are matched at random with another group.

If the groups like each other's goods then they trade. If not, they are matched with other groups.

Exchange is costly because it takes time to search for a suitable trading partner.

Each time a group is matched with another group, everybody in these groups loses  $\alpha$  units of utility.

## Probability of Double Coincidence of Wants

The most direct way of trading is storing some of the endowment when young and trading only when old — because the young do not know yet which good they will like when old.

What is the probability to meet a group that has what you want and that wants what you have?

There would be  $J^2$  combinations of “tastes” if people could also like their own good when old. Since this is not the case, there will be only  $J^2 - J$  possible combinations of “tastes” .

If everyone is equally likely to meet each group, then the probability to meet the right group is only

$$\frac{1}{J^2 - J}$$

which is very low if  $J$  is high.

The average number of attempts before finding a double coincidence of wants is  $J^2 - J$ .



Why?

The number of attempts *before* a success follows geometric distribution. The mean of the geometric distribution is the probability of failure on any single trial divided by the probability of success on any one try:

$$\frac{P[\text{Failure}]}{P[\text{Success}]} = \frac{1 - \frac{1}{J^2 - J}}{\frac{1}{J^2 - J}} = J^2 - J - 1$$

Hence, on average, in the next attempt ( $J^2 - J$ th attempt) there will be a success.

Thus the average search cost under barter will be  $\alpha(J^2 - J)$ .

Let us compare this number with the search cost if there were fiat money in the economy.

## With Fiat Money

Suppose that young people now can trade their goods for fiat money, and then, when old, they can use the fiat money to buy the goods they want.

So people undertake two searches, once when young and once when old. But it is easier to find a trading partner now, since there is no need for double coincidence of wants.

The probability to find an old person who wants to buy your good when you are young is  $\frac{1}{J}$ .

Again the number of failures follows a geometric distribution.  
And the mean is

$$\frac{P[Failure]}{P[Success]} = \frac{1 - \frac{1}{J}}{\frac{1}{J}} = J - 1$$

So on average it takes  $J$  searches for a successful trade.

Since everyone has to do two such searches in his lifetime, the total cost of searching will be  $2\alpha J$ .

When is the average search cost in a barter economy higher than the average search cost when using fiat money?

Cost in Barter  $>$  Cost with Fiat Money

$$\alpha(J^2 - J) > 2\alpha J$$

$$J^2 > 3J$$

$$J > 3$$

When there are more than 3 types of consumption goods in the economy it is more efficient to use fiat money instead of doing barter.

*Note:* This result does *not* depend on the size of  $\alpha$ .

## Result

Using fiat money is more efficient than doing barter if the number of goods is high.

The high number of goods makes double coincidence of wants in a barter economy unlikely whereas fiat money only requires single coincidence of wants.

Hence the average search cost is lower even though the agents have to do their search twice in their lifetime.

*“What consumers and tech companies have essentially been doing is bartering services for personal data”*

“How Big Tech brought back the barter economy” by Gillian Tett, Opinion FT Magazine, April 18, 2018 Gillian Tett

## Commodity Money

There is nothing in the model that says that the medium of exchange has to be fiat money. In fact, it could be also a commodity money — a good with intrinsic value (at least some people derive utility from consuming) that is used as a medium of exchange.

A good example of commodity money is the cigarettes that circulated in the prisoner-of-war camps in WWII. Lacking any type of currency, even the non-smokers accepted cigarettes in trades, thinking that the cigarettes can be used later to bribe guards or to buy other goods.



## A Commodity Money Model

Consider our overlapping generations model from last time.

The population is constant. Each generation has  $N$  people.

There are two goods in this economy:

- One perishable consumption good.
- One storable good called *gold*.

Each person has an endowment of  $y$  of the consumption good when young and no endowment when old.

## Gold

The initial old have  $m_0^g$  units of gold endowment. So that the total amount of gold in the economy is  $M^g = Nm_0^g$ . There is no other source of gold other than this.

Consuming one unit of gold gives utility equivalent to  $\tilde{v}$  units of consumption good. This is the intrinsic value of gold.

## Equilibrium?

There are two possible equilibria in this economy.

- Equilibrium where gold is not consumed, but used in trading.
- Equilibrium where gold is consumed and not used in trading.

## Equilibrium with the Commodity Money

In each period the young consume some part of their endowment and trade the rest in exchange for gold.

Then their budget constraint when young will be

$$c_t^t + v_t^g m_t^g \leq y \quad (1)$$

where  $v_t^g$  is the value of gold in terms of consumption good in period  $t$ .

And when old, they will trade the gold in exchange for consumption good.

$$c_{t+1}^t \leq v_{t+1}^g m_t^g \quad (2)$$

Hence the lifetime budget constraint of an agent born in  $t$  is

$$c_t^t + \frac{v_t^g}{v_{t+1}^g} c_{t+1}^t \leq y \quad (3)$$

## How Do We Find $v_t^g$ s?

Again from the demand=supply condition for gold.

From equation (1) the demand for gold by each young is

$$m_t^g = \frac{y - c_t^t}{v_t^g}$$

So the aggregate demand for gold equals to gold supply

$$M^g = \frac{N(y - c_t^t)}{v_t^g}$$

Thus

$$v_t^g = \frac{N(y - c_t^t)}{M^g}$$

In a stationary economy, the value of gold in each period is

$$v_t^g = \frac{N(y - c_1)}{Mg}$$

So in a stationary economy the value of gold will be constant over time, i.e.  $\frac{v_t^g}{v_{t+1}^g} = 1$  for all  $t$ .

Here the population and the gold supply are constant. Hence the result is analogous to the previous ones where fiat money was introduced.

## Condition to Ensure that Gold is Not Consumed in Equilibrium

To ensure that the entire initial gold stock is used as a medium of exchange, there must be no incentive for any individual to consume gold.

If individuals can obtain greater utility by trading gold for the consumption good, then they will choose not to consume their gold:

$$v_t^g = \frac{N(y - c_1)}{Mg} > \tilde{v}$$



## Equilibrium where Gold is Consumed

When the trading value of gold is less than the utility it can give when consumed (i.e.  $v_t^g < \tilde{v}$ ), then the initial old will choose to consume their gold instead of selling it for some consumption good.

Will they consume all their gold?

No. Only up to the point where the trading value of gold equals gold's intrinsic value ( $\tilde{v}$ ).

The old will consume gold until the gold supply falls to level  $M^{g*}$  such that

$$M^{g*} = \frac{N(y - c_1)}{\tilde{v}}$$

## Is Using a Commodity Money Inefficient?

In a commodity money equilibrium the value of gold will stay constant over time. Hence the life-time budget constraint of the agent, equation (3) becomes

$$c_1 + c_2 \leq y$$

Thus his maximization problem is the same as in the case with fiat money that we covered last time!

Hence from the viewpoint of all future generations using fiat money or commodity money does not matter.

But, it is the *initial old* who would benefit from adoption of fiat money instead of commodity money.

How?

The initial old could use their fiat money holdings to buy consumption good, and they could consume all their holdings of gold which increases their utility!

So the consumption and the utility of initial old are higher in a fiat money economy than in a commodity money economy.

So using commodity money is inefficient!

## **Why is Commodity Money Inefficient?**

Resources that have intrinsic value are tied up in order to provide a medium of exchange.

In the case of a gold standard, precious metal that could be used to make jewelry or aeronautical equipment is used as money and is unavailable for other purposes.

A fiat money system, on the other hand, allows the same trading patterns while freeing up a commodity that is useful for nonmonetary purposes.

## Summary

Barter is inefficient when there are many types of goods in the economy because it requires double coincidence of wants.

A commodity money system is inefficient because resources that have intrinsic value are tied up and cannot be taken full advantage of.

Fiat money is the efficient medium of exchange.

## **More on Fiat Money**

### **Importance of Beliefs**

The intrinsic value of money is less than its value when used in exchange!

What makes money valuable is the beliefs and institutions of the society.

The commonly held belief that currency is accepted in the economy — even though they are useless pieces of paper and metal! — makes people accept and use it.

## Money is a belief system

“The Indian coin that set off millions of messages,” BBC News on 21 February 2018

*“The issue in India is simple: many people don’t seem to believe that the 10 rupee coins are real and, as a result, they are unwilling to accept them. Rumours that the coins are fake - allegedly started in the western state of Gujarat - have now spread across the country. Fourteen different kinds of 10 rupee coins have been issued by the bank between 2009 and 2017, adding to the confusion.”*

## Money is Memory!

Kocherlakota (1998) compares the features of money to the ones of memory.

*“Memory is defined as knowledge on the part of an agent of the full histories of all agents with whom he has had direct or indirect contact in the past.*

*Money is defined as an object that does not enter utility or production functions, and is available in fixed supply.*

*The main proposition is that any allocation that is feasible in an environment with money is also feasible in the same environment with memory. Depending on the environment, the converse may or may not be true.*



*Hence, from a technological point of view, money is equivalent to a primitive form of memory."*

Narayana Kocherlakota (1998), "Money is Memory", Journal of Economic Theory, Vol. 81 No. 2.

Cryptocurrencies (e.g. Bitcoin) are direct applications of the idea that “money is memory”. These currencies record each transaction in a public ledger. Thus there are public records of the full history of transactions, resembling “memory” and giving an overview of the ownership of “money”. There is no central authority!

## Exercise

Consider a fiat money/barter system as described above. There are 100 different types of goods. Each search for a trading partner costs an individual 2 units of utility.

1. What is the probability that a given random encounter between individuals of separate islands will result in a successful barter?
2. What are the average lifetime search costs for an individual who relies strictly on barter?
3. What are the average lifetime search costs for an individual who uses fiat money to trade instead?