

## Why Money? A Micro Analysis of Exchange

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Without money, agents must barter goods they own for goods they want.

### 1. A Barter Economy

*Goods.*

There are  $g = 1, \dots, n$  types of goods.

e.g. Let  $n = 4$ ; call them

(1) *cattle*, (2) *beaver pelts*, (3) *wampum* and (4) *quiche*.

Assumption (*Homogenous and Divisible Goods*). Agents are indifferent between goods of the same type. Goods are divisible.

e.g. Individuals are indifferent between cattle (i.e. one cow and another cow).

*Prices.*

Let  $p_{gk}$  denote the relative price of  $g$  in terms of  $k$ .

In opportunity cost terms:

-buying 1 unit of  $g$  involves selling  $p_{gk}$  units of  $k$ .

*Exercise.* Show that buying 1 unit of  $k$  involves selling  $1/p_{gk}$  units of  $g$ .

*Markets.*

For each price  $p_{gk}$  there corresponds a market denoted  $\text{mkt}_{gk}$ .

Assumption (*Complete Markets*). A complete set of prices and markets exist; i.e.,  $p_{gk}$  exists for all  $g = 1, \dots, n$ , and  $k = 1, \dots, n$ .

*Ex.* Draw the table of relative prices for the e.g.

“*Law of one Price*”.

-Equivalent exchanges take place at the same price.

Assumption (*Zero Transactions Cost*). There are no costs of transacting other than the relative price.

*Claim.* The Law of One Price requires  $p_{gk} = 1/p_{kg}$ .  
Thus,  $p_{gg} = 1$ .

Demonstration: The price  $p_{kg}$  implies that  $1/p_{kg}$  is the price of 1 unit of  $g$  in terms of  $k$ .

*Ex.* Complete the demonstration.

*Exchange Ratios.*

*Ex.* Redraw the table using equilibrium prices.

*Ex.* With  $n$  goods how many distinct relative prices are there? Compare the number of prices when  $n=4$  and  $n=100$ .

*Unit of Account.*

A unit of account values all goods in terms of one type of good.

Thus, with  $n$  goods there are only  $(n-1)$  relative prices to consider.

e.g.  $n = 4$ , then  $(n-1) = 3$   
 $n = 100$ , then  $(n-1) = 99$

Wealth aggregation is easy using a unit of account.

*Ex.* You own  $3c$ ,  $2b$ ,  $5w$  and  $4q$ .  
What is your wealth in terms of wampum?

Any item can be used as a unit of account, even one that doesn't have physical existence. Call it pixels.

*Ex.* If 1  $w$  is counted as 10 pixels, what is your wealth in terms of pixels?

A unit of account is good for accounting purposes. But, is it useful in trading?

*Trade In and Out of Equilibrium.*

Assumption (*Non-Satiation*). Agents always want more of each good.

*Claim.* In equilibrium  $p_{gk} > 0$ .

Demonstration. Suppose not,  $p_{gk} \leq 0$ .

Case  $p_{gk} = 0$ . If  $p_{gk} = 0$ , then buying  $X$  units of  $g$  costs  $X p_{gk} = 0$ . Non-satiation implies that you buy all the units of  $g$  and want more. Hence there is excess demand and  $p_{gk} = 0$  is not an equilibrium price.

Case  $p_{gk} < 0$ .

*Ex.* Show that  $p_{gk} < 0$  cannot be an equilibrium. Thus, if an equilibrium price exists,  $p_{gk} > 0$ .

*Claim.* The Law of One Price requires  $p_{gk} = p_{gi}p_{jk}$ , for any (intermediate) good  $j$ .

Demonstration.  $p_{gi}p_{jk}$  is the price of 1  $g$  in terms of units of good  $k$ , indirectly via a good  $j$ . By the Law of One Price  $p_{gk} = p_{gi}p_{jk}$ .

*Ex.* Find a set of numerical prices that satisfy all the implications of the Law for the e.g.

*Ex.* Suppose  $p_{cb} > p_{cw}p_{wb}$ . Starting with 1 unit of  $b$ , show that you can buy all units  $b$ .

Action	Goods $b$	Goods $w$	Goods $c$
Endowment	1		
Sell $b$ for $w$		$p_{bw}$	
Sell $p_{bw}$ $w$ for $c$		$- p_{bw}$	$p_{wc}p_{bw}$
Sell $p_{wc}p_{bw}$	$p_{cb}p_{wc}p_{bw}$		$- p_{wc}p_{bw}$
Total	$p_{cb}/p_{cw}p_{wb} > 1$	0	0

Repeat until you own all the  $b$ . Excess demand for  $b$  means that this can't be an equilibrium price relationship.

*Ex.* Show that you do the same if  $p_{cb} < p_{cw}p_{wb}$ ?

*Claim.* In equilibrium  $p_{gk} = p_{gi}p_{jk}$ .

Demonstration. If  $p_{cb} < p_{cw}p_{wb}$  or  $p_{cb} > p_{cw}p_{wb}$ , then there is either excess demand or supply for the goods.

By the Law of One Price  $p_{gk} = p_{gj}p_{jk}$ . At these prices, individuals are indifferent between ways of purchasing  $g$ . Thus, there is no excess demand or supply.

*Arbitrage and the No-Arbitrage Pricing Principle.*

What if we had nothing with which to start? Could we still clean up in the above examples?

-Yes, if we could borrow cheaply.

*Short selling*

Borrowing the asset and returning the asset in the future.

Short selling 1  $b$  involves borrowing it and repaying 1  $b$  in the future. (Or, more generally,  $1+\varepsilon$  units  $b$  in the future where  $\varepsilon \geq 0$ ; where  $\varepsilon$  is the “dividend” rate on assets. We assume  $\varepsilon = 0$ , analysis goes through if all assets have the same dividend rate.)

*Ex.* Redo the *Ex* for  $p_{cb} > p_{cw}p_{wb}$ , but starting with nothing but the ability to short sell.

This strategy gets you something for nothing! It is the proverbial “free lunch”.

Formally, this is known in economics as arbitrage (and in business as “pure arbitrage”).

*Arbitrage is:*

But free lunches are supposed to be impossible!

No-Arbitrage Pricing Principle (No-Free Lunch).

A necessary condition for prices to be equilibrium prices is that at those prices arbitrage is impossible.

It is the most powerful pricing principle in economics. (It is used to price assets in Econ 435.)

*Money in a Frictionless Economy.*

In our barter economy, markets are “complete” and there are no impediments, including transactions costs, to trade. This is a “frictionless” economy.

In this frictionless economy:

- An agent with a good to sell can trade for any good directly.
- At equilibrium prices, indirect trade is no cheaper than direct trade.

Under our assumptions, there is no role for a medium of exchange and all goods are equal candidates for being a unit of account.

Suppose  $w$  were the unit of account. Then direct trade can be described in terms of the equivalent indirect trades using  $w$ .

## 2. Economies with Frictions

*Why Money?*

To find a useful role for a medium of exchange at least one of our assumptions must be relaxed:

- complete markets
- zero transaction cost
- divisibility
- homogenous goods

We have also implicitly assumed goods are:

- durable
- recognizable (symmetric information on quality)
- portable

*Incomplete Markets.*

Suppose only markets for quiche exist; i.e. only prices  $p_{gq}$  exist, for all  $g$ .

Quiche would be the medium of exchange and any good could be acquired using quiche money.

e.g. An agent with  $b$  wanting  $c$  would exchange  $b$  for  $q$  and then  $q$  for  $c$ .  
One unit of  $c$  costs  $p_{cq}/p_{bq}$  units  $b$ .

Why might other markets not exist?

- Possibly, because it is costly to set up markets, and historically, only quiche markets emerged.

Of course, we could tell the same story for any of the goods.

*Without Divisibility, Durability, Portability, or Recognizability.*

Quiche has an advantage over cattle and beaver pelts in terms of divisibility and portability, but clearly not durability (without refrigeration).

For large transactions cattle and beaver pelts are clearly better mediums of exchange.

Wampum has an advantage over all of these goods. It is durable, portable, and recognizable and is in small denomination (beads that can strung into necklaces).

Why did wampum and beaver pelts co-exist as media of exchange in Canada?  
- Beaver pelts were like a \$1,000 bill; they were held as an asset and only infrequently exchanged; they kept their value as they were sold in Europe.

*Without Markets and With Search Transactions Costs.*

For many items there are no well-defined markets. Agents have to search for their desired good.

Even if an agent locates a person who has the good they want, there will be no barter if the other agent does not care for the good offered in exchange.

A *double coincidence of wants* exists when both parties are willing and able to trade the other's desired consumption good.

Locating a double coincidence of wants is often tedious. In most encounters there is an absence of the double coincidence of wants.

*Search Money Models.*

Jones (1976) and Kiyotaki and Wright (1989) develop models in which agents randomly encounter each other and show that a medium of exchange can facilitate trade.

- The best commodity money is one that is the most frequently found in the society.
- Paper money that has no value can also improve exchanges.

Wright and Williamson (1994) show that when there is asymmetric information on the quality of goods, money can facilitate exchange because it is of known value.

Engel and Shi (1998, 2001) show that money can improve bargaining outcome and hence facilitate trade.

### 3. Money and Value

#### *Commodity Money.*

Wampum is a commodity money.

*Intrinsic value.* Was wampum intrinsically valuable in use (consumption)?

- It was worn as a necklace. If it was worn as a necklace for jewellery purposes, then it was intrinsically valuable.
- If it was worn as a necklace for convenience then it was not intrinsically valuable.

It is not necessary that commodity money be intrinsically valuable. However, if it is intrinsically valueless, people must believe in it as a medium of exchange for it to be valuable. This is also true of fiat money.

*Value of Commodity Money.*

- Empirically, the average price of a commodity money has been less than or equal to its cost of production. This fits with theory.

Define:  $v_t$  denote the number of goods one unit of money purchases in exchange;  $X_t$  is the cost in terms of goods of creating one unit of money.

*Claim.* In equilibrium,  $v_t \leq X_t$ .

*Ex.* Show that  $v_t > X_t$  violates equilibrium.

*Disadvantages of Commodity Money.*

- The resources put in creating it could have been saved by using fiat money instead.

#### *Fiat Money.*

- Paper money that has been declared legal tender. It can be legally used to pay taxes and debts.
- Intrinsically valueless. If it has value, it is only because of its roles as a medium of exchange and means of settling debts.

Beliefs are essential in determining the value of fiat money.

*Claim.* Suppose there are no taxes or debts to pay. Then rational agents would not give up goods for money unless they thought that they could use the money in the future to buy goods they want.

*Optional Ex.* Prove the claim. (Hint: You have to use a timeline where T is the end of the economy.)

Accepting money is premised on the belief that others will accept it in the future.

The value of money is also based on individuals' beliefs about the government's supply of money. If individuals think that the government will increase the supply in the future, the value of money will go down today (inflation will go up today).

#### *Advantages of Fiat Money*

Increases in the supply of fiat money accrue to the government as revenues, called seigniorage.

- Many governments depend on seigniorage for a large proportion of their revenues.

#### *Disadvantages of Fiat Money*

The ability to generate seigniorage creates an incentive for the government to generate more seigniorage.

- Governments that give in to temptation generate high inflation devaluing the money. This can backfire in hyperinflations where the value of the money falls dramatically so the seigniorage revenues fall.