

Lecture Outline

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## 1. The Concept of Elasticity

In the previous chapters we explored the determinants of demand and supply, the concept and principles of market equilibrium, and the role of government in the market economy.

We now turn our attention to the examination of the concept of *elasticity*. Previously, we explored the general response of quantity to changes in price, but we were unable to state how much quantity demanded would change in response to a change in price. *Elasticity* is a measure of the of how one variable (quantity demanded) responds to changes in another variable (price, income).

We can more formally define elasticity as:

*Elasticity measures the proportional responsiveness of one variable with respect to changes in another variable. Let the variable of interest be denoted as  $Y$  with the variable that influences  $Y$  denoted as  $X$ . The elasticity of  $Y$  with respect to  $X$  equals:*

$$e_y = \frac{\frac{\ddot{A} Y}{Y}}{\frac{\ddot{A} X}{X}} \quad (1)$$

## 2. Price Elasticity of Demand

Let us assume that we produce computers and we wish to know how much demand will rise (fall) if we decrease (increase) prices. Since total revenue is dependent upon price and quantity, we can use elasticity to determine the impact of price changes on total revenue. This will allow us to determine what actions to take to increase total revenue, which in turn leads to increase profits.

How do we calculate the price elasticity of demand?

Proceeding from Equation (1), we can write the price elasticity of demand as:

$$e_d = \frac{\ddot{A} Q_d}{Q_d} / \frac{\ddot{A} P}{P} \quad (2)$$

### 2.1 The Problems Associated with Bases and Percentages

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However, this is a problem in calculating elasticity using the formula in Equation 2.

Furthermore, elasticity would differ in absolute value depending upon whether we are increase or decrease price. For example, let us use the following example:

Initial Price for Pentium 400Mhz Computer: \$1250

Initial Quantity: 450,000 per year

Let us assume that we decrease the price to \$1,000 and that quantity increases to 725,000. What is the price elasticity of demand?

$$Ed = \frac{(450000-725000)/(725000)}{(1250-1000)/1250}$$

$$Ed = -0.3793 / 0.2$$

$$Ed = -1.8965$$

That is, for 1% reduction in price, quantity demanded increased by 1.8965%.

Now, let us examine this example in reverse, that is, our initial price is \$1,000 and our initial quantity is 725,000 and we raise price to \$1,250 and quantity declines to 450,000.

$$Ed = \frac{(725000-425000)/(425000)}{(1000-1250)/(1000)}$$

$$Ed = 0.7059 / -0.25$$

$$Ed = -2.8236$$

Thus, we calculate divergent elasticity estimates depending upon the starting point in our example. We can correct this fault by using the **arc elasticity** formula with is based upon the midrange statistic

$$e_d = \left| \frac{(Q_n - Q_o)}{(Q_n + Q_o) / 2} / \frac{(P_n - P_o)}{(P_n + P_o) / 2} \right| \quad (3)$$

where **o** refers to the original price and **n** refers to the new price. Note that we will calculate the price elasticity as the absolute value of the expression, that is, elasticity will always be a positive amount.

We can recalculate the previous example to illustrate that we now receive the same elasticity whether price increases or decreases. **Calculate as an example**

Before we proceed, let's make sure that everyone here understands the concept of elasticity, price elasticity of demand, and how to calculate the price elasticity of demand.

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First, elasticity is merely a measure of how one variable changes in response to a change in another variable. For example, we discussed how quantity demanded changes in response to a change in price. We can also use the elasticity measure for supply, as well as comparing how the quantity demanded of one good changes in response to the change in the price of another good.

Second, we need to use the **arc elasticity** formula to achieve the same elasticity whether price increases or decreases. The arc elasticity formula is represented in Equation 3.

Now, let us calculate an additional examples to illustrate the concepts of arc elasticity and price elasticity of demand.

Example: The Dodge Neon is currently priced at \$9,200. At this price, 560,000 cars were sold from January through June 1998. In July 1998, the price was lowered to \$9,000 and 620,000 were sold. What is the elasticity of the demand curve for Dodge Neon's? Second, what would happen if price was again lowered to \$8,000? Would total revenue increase or decrease?

$$\begin{aligned}
 P_0 &= \$9200 & P_n &= \$9000 \\
 Q_0 &= 560,000 & Q_n &= 620,000 \\
 \\ 
 Ed &= \frac{[(620000-560000)/(620000+560000)/2]}{[(9000-9200)/(9000+9200)/2]} \\
 Ed &= \frac{(60000/590000)}{(-200/9100)} \\
 Ed &= \frac{(0.1017/-0.0222)}{ } \\
 Ed &= -4.581 & &= 4.581
 \end{aligned}$$

That is, for every 1% reduction in price, quantity demanded increased by 4.581%.

Now, at \$9,000 total revenue is equal to \$5,580,000,000. If the price was lowered again to \$8,800, all else remaining equal, this would represent a 2.27% decrease in price (9000-8800/8800). Thus, we would expect quantity demanded to increase 10.399% (4.581 \* 2.27). This would represent an increase of 64,473 cars. At the new price of \$8,800, this would result in total revenue of \$6,023,362,400.

## 2.2 Ranges of Elasticity

Having now discussed the basic calculations for price elasticity of demand and how to interpret the elasticity statistic, we can now formulate some of the basic rules with respect to price elasticity of demand.

In our previous example, a 1% change in price resulted in a greater than 1% change in

quantity demanded. Such a case is termed **price elastic**. More formally,

*Demand is price elastic if the absolute value of the elasticity coefficient is greater than 1.*

Conversely, if a 1% change in price resulted in a less than 1% change in quantity demanded, this type of case would be termed **price inelastic**. More formally,

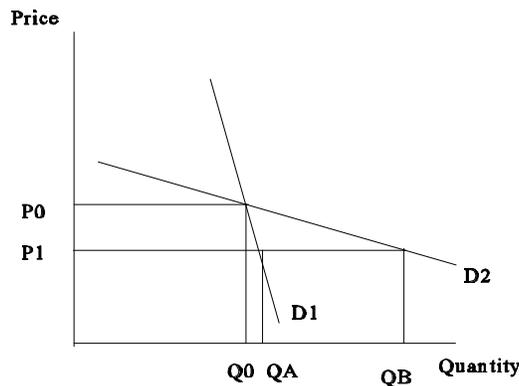
*Demand is price inelastic if the absolute value of the elasticity coefficient is less than 1.*

What does this all mean?

If a good is price elastic, this means that demand is sensitive to changes in price, that is, minor changes in price result in significant changes in demand. If a good is price inelastic, demand is insensitive to changes in price, that is, significant changes in price result in minor changes in demand.

Mercedes, jewelry, and other luxury items are typically price elastic. Basic staples, such as milk, food, and other items are typically price inelastic.

### 2.3 Slope and Elasticity



As illustrated in the above figure, there is a relationship between slope and elasticity. Demand curve D1 illustrates a price inelastic relationship while Demand curve D2 illustrates a price elastic relationship. Generally, if a Demand curve is steeper than 45 degrees, it is price inelastic. If a Demand curve is less than 45 degrees it is price elastic.

## 2.4 Elasticity and Total Revenue

Using the previous discussion and examples, we can formulate the general relationships between price elasticity and total revenue.

Recall that total revenue = price \* quantity

If demand is elastic, this means for 1% decrease (increase) in price, quantity demanded will increase (decrease) by more than 1%. If demand is inelastic, for a 1% decrease (increase) in price, quantity demanded will increase (decrease) by less than 1%.

*Elastic demand:* All else being equal, if price is increased by 1%, total revenue will decline. Conversely, if price is decreased by 1%, then total revenue will increase.

Rationale: Revenue rises/declines because quantity increases/decreases relatively quicker than price.

*Inelastic demand:* All else being equal, if price is increased by 1%, total revenue will increase. Conversely, if price is decreased by 1%, then total revenue will decline.

Rationale: Revenue rises/declines because price increases/decreases relatively quicker than quantity.

## 3. Elastic Demands

We have already discussed the general case of the relationship between elastic demand and total revenue. We now turn to the special case of **perfectly elastic demand**.

A perfectly elastic demand curve has price elasticities of infinity and is horizontal. This is illustrated by demand curve D2 in the figure below.

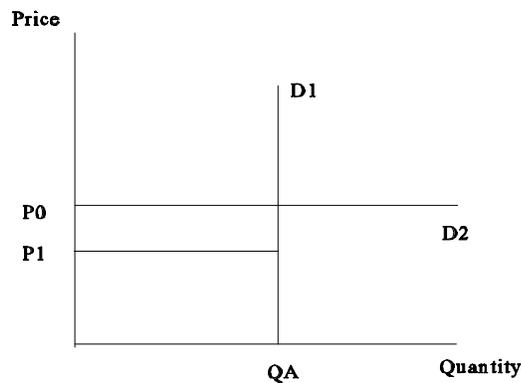
How might a perfectly inelastic demand curve occur? In markets with homogenous products and a large number of sellers, no one seller can influence market price. Agricultural products are an excellent example of this phenomenon.

For example, if the price of a bushel of wheat is set at \$2.50 a bushel, then no one in the market will sell for less than \$2.50. Since no one is able to affect price since everyone is small relative

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to the entire market, no one can sell for more than \$2.50 a bushel. Thus, everyone can sell their entire output for exactly \$2.50 a bushel. The more they can produce, the more they can earn.

*Perfectly elastic demand:* All else being equal, if price is increased at all, total revenue falls to zero. If price is decreased, total revenue declines.



#### 4. Inelastic Demands

We have already discussed the relationship between inelastic demand and total revenue, so we now turn to the special case of **perfectly inelastic demand**.

Perfectly inelastic demand curves would have zero elasticity and be vertical, as illustrated by Demand curve D1 in the figure above.

Inelastic demand curves are non-existent in reality in that total revenue would be solely dependent upon the price charged. However, all products have some upper price limit beyond which individuals just do not have the means to purchase these products, thus, it is infeasible to expect that quantity would never vary even if price neared infinity.

*Perfectly inelastic demand:* All else being equal, if price increased, then total revenue would increase.

#### 4.1 Unitary Elasticity

We have now discussed the various possibilities for elasticity except for the case where price elasticity is equal to 1. When the price elasticity is equal to 1 this is termed **unitary elasticity**.

A unitary elastic demand curve occurs when the elasticity coefficient equals one, so total revenue from the good is unaffected by a change in price.

If a good is unitary elastic, then a 1% increase in price would result in a 1% decrease in demand. Conversely, a 1% decrease in price would result in a 1% increase in demand. In this case, total revenue remains the same regardless of what price is charged.

*Unitary Elasticity: Total revenue is unaffected by changes in price.*

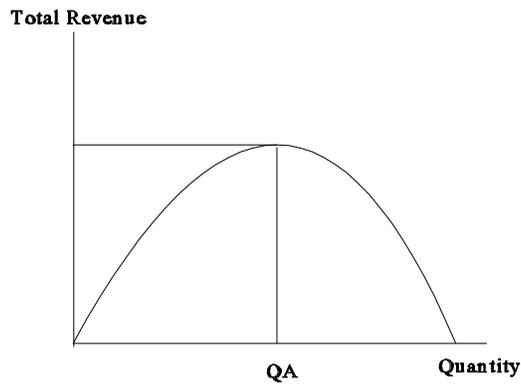
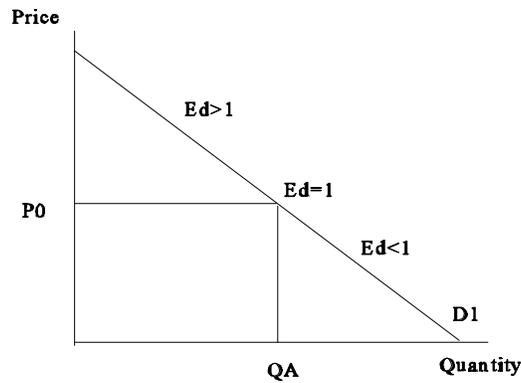
#### 5. Elasticities along a demand curve

To this point, we have acted as if elasticities were constant, that is, each demand curve had a constant price elasticity. We now relax this assumption to examine how price elasticity varies along a demand curve.

As illustrated on the next page, price elasticity varies along the demand curve. When price elasticity is greater than 1, decreases in price lead to increases in total revenue. Total revenue is maximized when price elasticity is equal to 1. When price elasticity is less than 1, further price decreases lead to more significant declines in total revenue.

Thus, the appropriate course of action is to lower price when the price elasticity is greater than 1, to leave price stable when price elasticity is equal to one, and to increase price when the price elasticity is less than 1. Of course, this assumes that you exercise market power in that you can actually influence price.

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## 6. Determinants of Elasticity of Demand Substitutes

What determines whether a good is price inelastic or price elastic? Several factors enter into this analysis, to include whether substitutes are present for the good in question; what proportion of a budget is devoted to the consumption of the good; and what time period is being considered.

### 6.1 Substitutes

As we previously discussed, changes in the price of substitutes can change the demand for a good. If there are good substitutes for the good in question, for example, generic drugs for brand-name drugs, then slight increases in the price of the brand-name drug would likely lead to significant declines in the demand for the brand-name drug. On the other hand, if close substitutes do not exist or are not available, then demand is likely to be more inelastic.

In general, the more substitutes a good has, the elastic the demand is for the good.

## 6.2 Budget Proportion

What percentage of your income you devote to the consumption of a good determines what your price elasticity is for that good. In the aggregate this also holds true.

For those items that require a relatively larger percentage of your income, price changes will invoke a much greater response than for those items which require a smaller percentage of your income. Thus, relatively more expensive goods are likely to be price elastic.

In general, the more income a good requires, the more elastic the demand is for the good

## 6.3 Time

As the time period in question increases, from today to next month to next year, the elasticity for goods also increases. Basically, as the time period increases, your ability to find substitutes also increases.

In general, the greater the time period in question, the more elastic the demand is for the good in question.

## 7. Other Elasticities of Demand

We now turn our discussion to other elasticities of demand and their uses. In this section we will examine two other demand elasticities, the income elasticity of demand and the cross-price elasticity of demand.

### 7.1 Income Elasticity of Demand

The income elasticity of demand measures the responsiveness of a good with respect to change in income. That is, how much quantity demanded will increase (or decrease) in response to a small positive or negative change in income.

More formally, the income elasticity of demand for a good measures the proportional change in the quantity demanded resulting from a given small proportional change in income.

$$e_y = \left| \frac{(Q_n - Q_o)}{(Q_n + Q_o) / 2} / \frac{(Y_n - Y_o)}{(Y_n + Y_o) / 2} \right| \quad (4)$$

Equation 4 illustrates the formula for the income elasticity of demand. Note that we use the midrange formula used to calculate the price elasticity of demand except that the variable in the denominator is income and not price.

What observations can we make about the income elasticity measure. Recall, there are two types of goods: normal and inferior goods. As income rises, the demand for normal goods increases but the demand for inferior goods falls.

Thus, we would expect the demand for luxury items to be income elastic ( $E_y > 1$ ) and basic staples to be income inelastic ( $E_y < 1$ ). Both these types of goods are normal goods. For inferior goods, income elasticity will be negative since the amount demanded of these goods declines as income rises ( $E_y < 0$ ).

Example:	Initial Average Per Capita Income	=	\$21,250
	Initial Demand for Good	=	1.25 million pounds

If average per capita income rises to \$22,500 and the demand for the good rises to 1.45 million pounds. Is the good income elastic or income inelastic?

## 7.2 Cross Price Elasticity

Another important measure of demand elasticity is the measure of cross-price elasticity. This measure captures the change in the quantity demanded of one good in response to changes in the price of another good, for example, if the price of tires increased 50%, how much would the demand for cars decline?

More formally, the cross price elasticity of demand estimates the proportional change in the quantity of one good demanded when the price of another related good is changed.

As illustrated in Equation 5, we examine two goods, X and Z. X is the good that is responsive to changes in the price of Z.

$$e_{xz} = \left| \frac{(Q_{xn} - Q_{xo})}{(Q_{xn} + Q_{xo}) / 2} / \frac{(P_{zn} - P_{zo})}{(P_{zn} + P_{zo}) / 2} \right| \quad (5)$$

In general, if goods are substitutes, then the cross-price elasticity will be positive. IF the goods in question are complements, then the cross-price elasticity will be negative.

This result is quite obvious. If two goods substitute for each other, then as the price of Z increases, consumers will substitute away from Z and demand more of X. If the goods are complements, then an increase in the price of Z will lead to a decline in the quantity demanded of X.

Example:      Initial price of Butter: \$1.25 for 1 lb  
                    Initial quantity of margarine: 2.6 million lbs

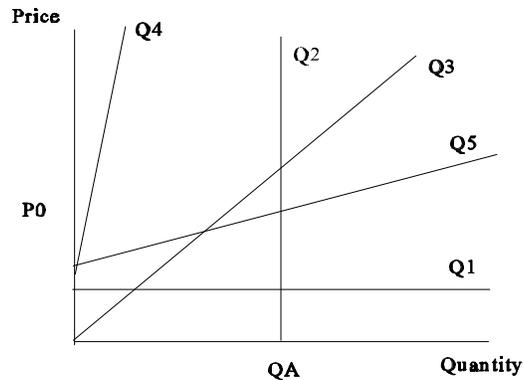
If the price of butter increases to \$1.50 a lb and the quantity demanded of margarine increases to 3.5 million lbs, what is the cross-price elasticity? Is the cross-price elasticity of margarine for butter elastic or inelastic?

## 8. Price Elasticity of Supply

Having discussed the price, income, and cross-price elasticities of demand, we now turn our attention to the other side of the market and the price elasticity of supply. Many of the same principles that we have previously discussed with respect to the demand side of the market apply to the supply side of the market.

Formally, the price elasticity of supply measures the responsiveness of quantity supplied to changes in price. In general, the price elasticity of supply is positive. Equation 6 illustrates that the formula for the price elasticity of supply is the same formula that we previously used for the price elasticity of demand, merely that we now focus on quantity supply rather than quantity demanded.

$$e_s = \left| \frac{(Q_n - Q_o)}{(Q_n + Q_o) / 2} / \frac{(P_n - P_o)}{(P_n + P_o) / 2} \right| \quad (6)$$



In the figure above, we illustrate the possibilities for the price elasticity of supply. Q1 illustrates an **perfectly price elastic** supply ( $E_s = \text{infinity}$ ), where supply is merely dependent upon output. Q2 illustrates a **perfectly price inelastic** supply ( $E_s = 0$ ). Q3 represents a **unitary price elastic** supply ( $E_s = 1$ ). Q4 represents a **price inelastic** supply ( $E_s < 1$ ) and Q5 represents a **price elastic** supply ( $E_s > 1$ ).

## 9. Supply Elasticities and Time

It should be simply noted that as time increases, price elasticity of supply increases. In the very short-run, supply is almost unable to adjust to changes in price and so  $E_s$  is close to zero. As time increases, the supply curve flattens out and  $E_s$  increases.

## 10. Elasticity and Tax Burdens

We now turn our focus toward applying the concepts in the previous section to public policy, that is, how will taxes affect consumers and producers. We can use our measures of elasticity to determine whether a tax will be fully passed on to consumers, fully borne by producers, or shared by consumers and producers alike.

### 10.1 Tax Incidence

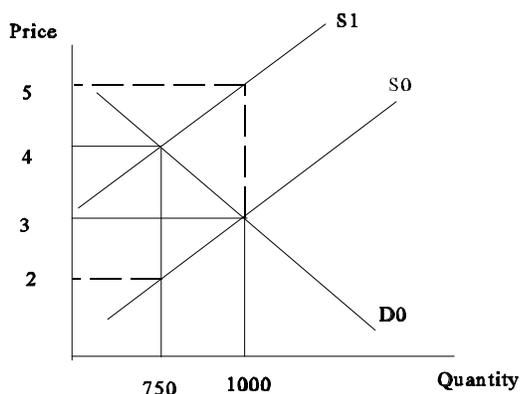
There are two different types of tax incidence. We are primarily used to the **legal incidence** of a tax, that is, who is legally responsible for paying the tax to the government. The personal income tax is the legal responsibility of the individual taxpayer, while the corporate income tax is the responsibility of the corporation.

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However, in economics, we are primarily concerned with the **economic incidence** of a tax, that is, who really pays the tax in question. More formally,

*The economic incidence of taxation (or tax burden) falls on the person who suffers reduced purchasing power because of the tax.*

Thus, if a tax on cigarettes is levied on producers (who must remit the tax to the government) but is fully passed on and paid for by consumer in increased prices, then the economic incidence of the tax is on consumers and not on producers.



In the example above, a \$2 per pack tax is levied on cigarettes. As a result of the tax, supply declines from S0 to S1 as producers must now receive \$5 a pack to produce 1000 million units of cigarettes. The decrease in supply results in an increase in price from \$3 to \$4 and a decline in quantity from 1000 million to 750 million packs. Consumers experience a \$1 per pack increase due to the tax and producers now receive \$2 per pack after tax. In this example, consumers and producers equally share the two dollar tax.

## 10.2 Perfectly Inelastic Supply and Perfectly Inelastic Demand

If supply is perfectly inelastic (vertical), then the economic incidence of a tax is fully borne by the supplier. If demand is perfectly inelastic (vertical), then the economic incidence of a tax is fully borne by the consumer.

## 10.3 Inelastic Supply and Inelastic Demand

If supply is relatively inelastic as compared to demand, then the burden of a tax will be borne

primarily by suppliers. Conversely, if demand is relatively inelastic as compared to supply, then the burden of a tax will be primarily borne by consumers.

#### 10.4 Perfectly Elastic Supply and Perfectly Elastic Demand

If supply is perfectly elastic, then the consumer bear the full burden of a tax. If demand is perfectly elastic, then producers bear the full burden of a tax.

All these cases are relatively easy to demonstrate. **Exercise in class. Proof on board.**

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FEUDALISM: You have two cows. Your lord takes some of the milk.

PURE SOCIALISM: You have two cows. The government takes them and puts them in a barn with everyone else's cows. You have to take care of all the cows. The government gives you as much milk as you need.

BUREAUCRATIC SOCIALISM: You have two cows. The government takes them and puts them in a barn with everyone else's cows. They are cared for by ex-chicken farmers. You have to take care of the chickens the government took from the chicken farmers. The government gives you as much milk and as many eggs as the regulations say you should need.

FASCISM: You have two cows. The government takes both, hires you to take care of them, and sells you the milk.

PURE COMMUNISM: You have two cows. Your neighbors help you take care of them, and you all share the milk.

RUSSIAN COMMUNISM: You have two cows. You have to take care of them, but the government takes all the milk.

DICTATORSHIP: You have two cows. The government takes both and shoots you.

SINGAPORE DEMOCRACY: You have two cows. The government fines you for keeping two unlicensed animals in an apartment.

MILITARIANISM: You have two cows. The government takes both and drafts you.

PURE DEMOCRACY: You have two cows. Your neighbors decide who gets the milk.

REPRESENTATIVE DEMOCRACY: You have two cows. Your neighbors pick someone to tell you who gets the milk.

AMERICAN DEMOCRACY: The government promises to give you two cows if you vote for it. After the election, the president is impeached for speculating in cow futures. The press dubs the affair "Cowgate".

BRITISH DEMOCRACY: You have two cows. You feed them sheep's brains and they go mad. The government doesn't do anything.

BUREAUCRACY: You have two cows. At first the government regulates what you can feed them and when you can milk them. Then it pays you not to milk them. After that it takes both, shoots one, milks the other and pours the milk down the drain. Then it requires you to fill out forms accounting for the missing cows.

ANARCHY: You have two cows. Either you sell the milk at a fair price or your neighbors kill you and take the cows.

CAPITALISM: You have two cows. You sell one and buy a bull.

HONG KONG CAPITALISM: You have two cows. You sell three of them to your publicly listed company, using letters of credit opened by your brother-in-law at the bank, then execute a debt/equity swap with associated general offer so that you get all four cows back, with a tax deduction for keeping five cows. The milk rights of six cows are transferred via a Panamanian intermediary to a Cayman Islands company secretly owned by the majority shareholder, who sells the rights to all seven cows' milk back to the listed company. The annual report says that the company owns eight cows, with an option on one more. Meanwhile, you kill the two cows because the Feng Shui is bad.

ENVIRONMENTALISM: You have two cows. The government bans you from milking or killing them.

TOTALITARIANISM: You have two cows. The government takes them and denies they ever existed. Milk is banned.

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**POLITICAL CORRECTNESS:** You are associated with (the concept of "ownership" is a symbol of the phallo-centric, war-mongering, intolerant past) two differently-aged (but no less valuable to society) bovines of non-specified gender.

**COUNTER CULTURE:** Wow, dude, there's like... these two cows, man. You got to have some of this milk. Far out! Awesome!

**SURREALISM:** You have two giraffes. The government requires you to take harmonica lessons.

**JAPANESE DEMOCRACY:** You have two cows. You give the milk to gangsters so they don't ask any awkward questions about who you're giving the milk to.

**EUROPEAN FEDERALISM:** You have two cows which cost too much money to care for because everybody is buying milk imported from some cheap east-European country and would never pay the fortune you'd have to ask for your cows' milk. So you apply for financial aid from the European Union to subsidize your cows and are granted enough subsidies. You then sell your milk at the former elevated price to some government-owned distributor which then dumps your milk onto the market at east-European prices to make Europe competitive. You spend the money you got as a subsidy on two new cows and then go on a demonstration to Brussels complaining that the European farm-policy is going drive you out of your job.

**+EASTERN EUROPEAN DEMOCRACY:** You have two cows. You sell the milk (diluted with some water) at a high price to the neighbors or to anyone at the open-air market. If somebody asks for receipt, you charge for a two times higher price, so nobody will request an invoice. For concerned families with small babies you claim that the milk is "bio", though you collect the grass for feeding at the side of the highway and you keep the milk in plastic barrels used previously as containers of dangerous chemicals. Later, your neighbor or anybody from town will steal the cows and will buy their meat for a high price, and if you ask for a receipt, you will be charged for a two times higher price.

**+FINNISH SOCIALISM:** You have two cows. Soon you have to kill one of them because in the Netherlands there is an overproduction of milk and the European Union rules say so. When you do so, you realize that it was not necessary, only the system was too slow in getting you the up-to-date news. From the stress, you get an ulcer in your stomach so you go to a doctor. The doctor realizes that this ulcer is a serious one, so you need an urgent treatment. Therefore, you soon get a call to the local hospital. The call's date is for 3 months later, because there is a queue with more urgent cases. Then your ulcer becomes even more serious because you remember that 40 percent of your income is taken for social tax.