DOBRESCU MOTTA

FARAVELLI AND MCWHINNIE

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Dedicated to you, our students.

About this Project

Loretti Isabella Dobrescu and Alberto Motta are multi award-winning academics who have taught introductory economic courses to large and diverse groups of students at UNSW Australia since 2010. Combining their personal experience and rigorous cutting edge research, they show that students struggle to achieve a profound understanding of the economic principles unless they are capable of imagining the interconnected actions of thousands of single individuals within a society. But dry mathematical models are not helpful in stimulating such an ability to imagine what lies behind the equations.

Isabella and Alberto have worked to overcome this challenge by creating the *Playconomics* learning environment, a technology-enabled approach that provides students with a computer-based representation of the economy and challenge them to interact and play with it. This computer-based learning tool also serves to enhance the face-to-face learning experience during classes and tutorials. The early test results on Playconomics in various dimensions of educational outcomes have been exceptionally positive and are consistent with the growing academic literature on gamification and simulations games to which Isabella and Alberto contribute to directly via their research.

About the Authors

Loretti Isabella Dobrescu: Isabella is a Senior Lecturer at the UNSW Australia. She is a microeconometrician and studies issues related to savings and cognition in older age. Her current work examines the main drivers of retirement wealth, from risk attitudes, health and medical spending to social cohesion and bequest motives. Isabella got her PhD from University of Padua (Italy) after spending a few (cold yet very productive!) years in the US studying at Boston University. Together with Alberto, she is the co-creator of Playconomics, the digital analogue of a Micro 101 course. Hobbies: theatre and snorkeling (quite a combination, I know).

Alberto Motta: Alberto is a Senior Lecturer at UNSW Australia. He studied at Boston University and University of Padua where he received his PhD in economics. Alberto's research focuses on developing theoretical models and applying econometric methods to study the types and features of organizational design that are most effective. His current work focuses on designing and evaluating organizational solutions for microfinance institutions, for-profit and not-for profit firms, enforcement agencies and media outlets. Together with Isabella, he is the co-creator of Playconomics. He has had no hobbies since starting working on this project...but he plans to come back big time!

Marco Faravelli: Marco studied at the University of Milan Bicocca and at the University of Edinburgh, where he received his PhD in 2007. He has worked at the University of St Andrews and at the University of Queensland, where he is currently a Senior Lecturer in economics. His research focuses on microeconomics, both from a theoretical and an experimental perspective. He is mainly interested in the application of game theory and experimental economics to topics in public economics and political economy. In his spare time you can find him on the beach in Brunswick Heads.

Stephanie McWhinnie: Stephanie is a Senior Lecturer at the University of Adelaide. She is an applied microeconomist who teaches microeconomics and natural resource and environmental economics. Her research is focussed on fisheries management, primarily on international sharing problems. She got hooked on economics when she studied her BA(Hons) at the University of Otago in New Zealand and after working as a policy analyst she moved to Canada where she completed her PhD at the University of British Columbia in 2006. Other than economics, she loves going to the beach and playing boardgames with her family.

Part I

Opportunity Cost and Comparative Advantage

机会成本 & 相对优势

1
Comparative Advantage and the Basis for Trade

HAVE YOU EVER PAUSED to consider how specialized modern economies are? Think of your normal day. You wake up and (hopefully!) brush your teeth. Wait! You just used a toothbrush. Do you know how to build a toothbrush? How complicated it is to put together all those wonderful little brushes? And what are they made of? We suspect that left to your own devices there would be no toothbrushing at all... But let's go back to your daily routine. You are standing with the toothbrush (which is suddenly looking a bit intimidating) in your hand. You realize it is dark in the bathroom. So, you switch the light on. Wait! Can you produce an electric switch? Would you be able to create its simplest component - plastic? How about producing and storing the electricity itself? And the lightbulb with all the necessary components?

恐吓，威胁

For most of us, the way many things work in our houses is bordering into magic (don't get us started with televisions and Wi-Fi!). Why is that? Well, as we were saying in the beginning, modern societies are very specialized. For example, we — the authors of these notes — are economists by profession, and apart from teaching and writing papers, we don't do much else during the day. One day you may have to decide what you are going to do for a living, and possibly stick to it for most of your life. Isn't that a boring prospect? Wouldn't it be nice for every one to perform different jobs at the same time? Wouldn't that kill monotony?

单调，千篇一律

But as it will turn out, specialization can do great 专门化 things for an economy (and for you too!), even though it might come with its own drawbacks.

1.1 *Your First Model*

We want to show you why specialization can be a great thing. We could try to "talk" you into seeing this point, but we know that a discussion in plain english can be... well, never-ending! Instead we are going to use a *model*. This way you can see our assumptions and our conclusions clearly. Then you can question both our assumptions (if you don't think they are realistic) and our conclusions (if you think they are mathematically wrong). By proceeding this way, we can have a more constructive exchange of ideas. But don't worry! This model is incredibly simple.[1] Here are the assumptions:

Model: A Model is a simplified representation of reality.

1. There are only two possible activities.
2. There are only two individuals. [2]
3. There are no transaction costs 交易成本 when trading (i.e., no negotiation costs, transportation costs, etc) and no other barriers to trade (such as import quotas 进口配额, tariffs 关税, etc.).

[1] It was originally conceived by David Ricardo in 1817 (yes, that long ago!) and some famous economist called it the "magic four numbers" because of its simplicity.

[2] Yes! Two individuals and two activities. That's where the "four numbers" come from.

Figure 1.1: A representation of a simple economy.

1.2 *One Agent Economy*

To begin with, let's take a closer look at one of the agents: meet Alberto!

Alberto lives on a beautiful island that, despite 尽管 being small, has a lot of banana trees and bushes filled with wild rabbits. If Alberto wants to eat, he only needs to collect bananas and/or catch some rabbits. Here we assume that these are the only two *productive activities* 生产活动 that are available for Alberto — collecting bananas or catching rabbits (this is **Assumption 1**). The banana trees that grow on the island are fairly tall so collecting 1 kg of bananas takes 1 hour. Catching 1kg of rabbit is even more

challenging and requires 2 hours. These numbers should give you a sense of his daily *productivity*. Here is why. 生产率

There are only so many hours in a day (24 to be precise!) and Alberto also needs to sleep (let's say for 8 hours), which leaves 16 hours for him to work and have fun. This is what economists call a *time constraint*. 时间约束

If Alberto spends all his available time (16 hours) collecting bananas, at the end of the day he will have (16h x (1kg/1h)=) 16kg of bananas and obviously, 0kg of rabbit. If instead he is only hunting all day long, he will catch (16h x (1kg/2h)=) 8kg of rabbit but will have 0kg of bananas.

These two are extreme scenarios. Alberto can certainly collect bananas *and* catch rabbits throughout the day. For instance, he can spend half of his time collecting bananas and the other half hunting, and at the end of the day, he will bring home 8kg of bananas and 4kg of rabbit. Or he can collect only 4kg of bananas (in 4 hours) and spend all the remaining 12 hours getting 6kg of rabbit.

Now, what do you think we get if we actually plot all possible combinations of bananas and rabbit that Alberto can get in a day working for *all the available hours*? Well, we get the *Production Possibility Curve (PPC)*. The PPC represents all possible combinations of bananas and rabbits that can be produced with Alberto's labour if he works the whole day. Or, more generally, the PPC captures all maximum output possibilities for two (or more) goods, given a set of inputs (or resources — in our case time) if all the available inputs are used.

生产可能性曲线

Production Possibility Curve (PPC): The PPC represents all possible combinations of bananas and rabbits that can be produced with Alberto's labour if he works the whole day. More generally, the PPC captures all maximum output possibilities for two (or more) goods, given a set of inputs (or resources - i.e., time) if inputs are used efficiently.

To build the PPC, we proceed in 4 steps:

1. We must first define the axis: Let's say that we will record the kg of bananas that Alberto collects on the x-axis and the kg of rabbit on the y-axis.

2. Let's draw the two extreme scenarios we talked about before, the ones in which Alberto spends his entire day only collecting bananas or catching rabbits. Note that you are positioning these points either on the x-axis or on the y-axis because one of the goods produced

(rabbits and bananas, respectively) is zero.

3. We also said there is always the possibility for Alberto to perform both productive activities (i.e., collect bananas *and* rabbit) and maybe avoid getting bored, so let's plot also these combinations.

4. What do you notice if you connect all the dots you have on your graph so far? That's right: They form a straight line. This is exactly the PPC we defined above.

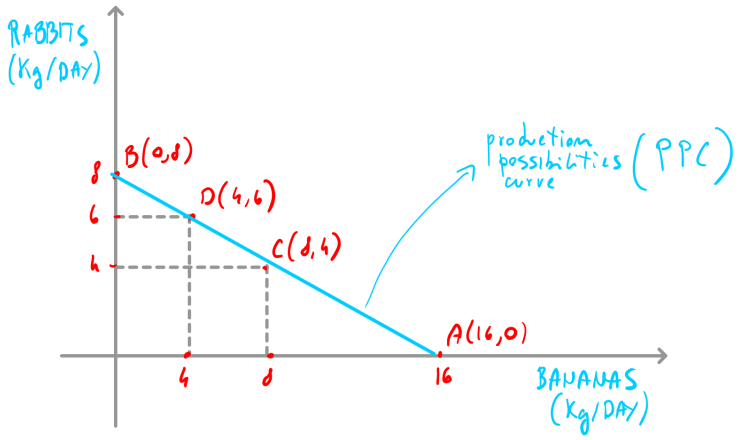


Figure 1.2: A representation of the PPC for one agent.

Figure 1.2 is the graph constructed using the four steps described above. What is each point on the PPC telling you? Each point shows you (on the y-axis) the kg of rabbit you can still catch after spending time collecting a certain amount of bananas (that you can see on the x-axis). If you connect all the points together you get a straight line representing all the combinations of bananas and rabbits that Alberto can produce in one day.

NOW REMEMBER THAT WE said the PPC shows what Alberto can produce if he works *the whole day*, i.e., if all inputs (or resources) are used efficiently and, in our case, no time is wasted. Hence, it is only natural to call the points on the PPC *efficient* points.

But what happens if Alberto hangs around the island losing time? Well, he produces less, right? The points corresponding to this situation are called *inefficient* points

Efficient Production Point: An Efficient Production Point represents a combination of goods (bananas and rabbits) for which currently available resources (Alberto's time) do not allow an increase in the production of one good without a reduction in the production of the other. All the points on the PPC are efficient.

Inefficient Production Point: An Inefficient Production Point represents a combination of goods (bananas and rabbits) for which currently available resources (Alberto's time) allow an increase in the production of one good without a reduction in the production of the other. All the points below and to the left of the PPC are inefficient.

(because inputs — in our case time — are not used efficiently).

Note however that both efficient and inefficient points are *attainable* points, as our agent can reach these points given the resources available to him. 可得到的，可到达的

In contrast, the points to the right and above the PPC are called *unattainable* because no matter what the agent does, he cannot produce the amounts of banana and rabbits denoted by these points. For instance, he cannot produce 4kg of rabbit and 9kg of bananas as he does not have enough time.

So, what happens if Alberto needs to eat 4kg of rabbit and 9kg of bananas when hungry? Is he going to starve if he doesn't manage to produce these goods on his own? To answer this question we need to understand whether the second agent on the island can help Alberto achieve his consumption goal. We are going to present the new agent in the next section.

Attainable Production Point: An Attainable Production Point represents any combination of goods (bananas and rabbits) that can be produced with the currently available resources (Alberto's time). All the points on the PPC or below and to the left of the PPC are attainable.

Unattainable Production Point: An Unattainable Production Point represents any combination of goods (bananas and rabbits) that cannot be produced with the currently available resources (Alberto's time). All the points that lie outside of the PPC are unattainable.

1.3 Two Agents Economy

We are ready to help Alberto reach his preferred consumption of bananas and rabbits. Remember that he needs to eat 4kg of rabbit and 9kg of bananas but he doesn't have the time to produce them by himself (i.e., this point is unattainable for him). Can someone give him a hand and benefit in the process too?

Let's meet Leo. He is our second agent (**Assumption 2**). Like Alberto, Leo can collect bananas or catch rabbits, and also needs to sleep 8 hours per day. But it takes him 4 hours to collect 1kg of bananas and 4 hours to catch 1kg of rabbit. If he works all day, he can only collect (16h x (1kg/4h)=) 4kg of bananas or (16h x (1kg/4h)=) 4kg of rabbit (see Figure 1.3). Leo needs to eat 7kg of bananas to stay in good health. (Note that Leo cannot achieve his consumption target on his own because this allocation is not attainable.)

So, let's go back to the original question. Can Leo help

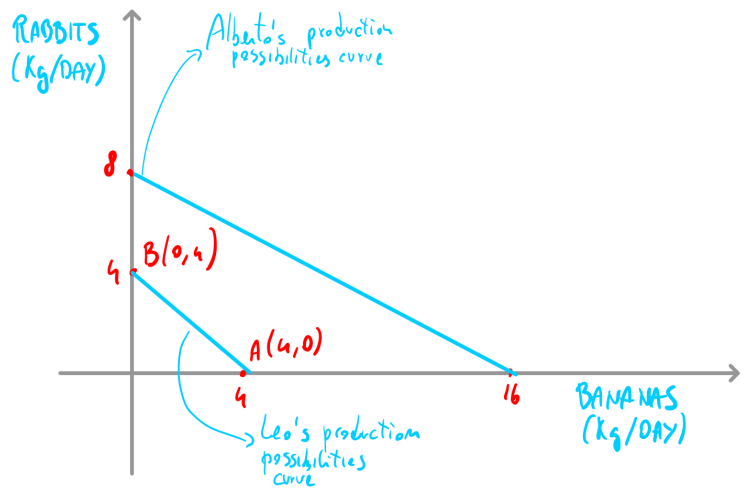


Figure 1.3: A representation of the PPC for two agents.

Alberto achieve his consumption target? Well, a quick look at the Leo's productivities seems to suggest that the answer is no. In fact, the situation seems desperate! Leo is definitely less productive than Alberto and, on top of that, he cannot even achieve his own daily consumption target. How can he find the time to help Alberto if he cannot even provide for himself? Table 1.1 confirms this point by showing the productivities of both agents.

	Time to get	
	1kg of bananas	1kg of rabbit
Alberto	1 hour	2 hours
Leo	4 hours	4 hours

Table 1.1: Productivities of Alberto and Leo expressed in terms of time required.

Note that Alberto is faster both at collecting bananas and at catching rabbits. In other words, in the same amount of time Alberto will get more bananas and rabbits than Leo. In economics, we say that Alberto has an *absolute advantage* in both activities.

绝对优势

Absolute Advantage: An agent (or an economy) has an Absolute Advantage in a productive activity (like collecting bananas or catching rabbits) when he/she can carry on this activity with less resources (for example, less time) than another agent.

Ok, so Alberto is better than Leo in both activities. Does this mean that Alberto does not need Leo at all? We saw that even if Alberto works all day long he won't be able to get the bananas and rabbits he needs in order not to starve, so the solution cannot be that Alberto produces and consumes his own goods. Leo must play a role. And indeed he does, if we look at the problem from a different angle.

So far we have looked at the cost of the different activities in terms of *hours* required to perform them. This is a very misleading way of looking at costs. Let's use a dif-

ferent angle instead, a smarter one. Enter the concept of
机会成本 *opportunity cost*. The opportunity cost of a given action is defined as the value of the next best alternative to that action. In our simple model we have only two alternatives, so the concept is very simple. If you spend time catching rabbits, you are missing out the opportunity to collect bananas. For example, if Alberto spends 2 hours catching rabbits he can get 1kg of rabbit, but at the same time he is missing out the opportunity to spend those 2 hours collecting bananas. If Alberto had spent those 2 hours collection bananas instead, he would have gotten 2kg of them. Then, Alberto's *opportunity cost* of 1kg of rabbit is 2kg of bananas.

Opportunity Cost: The Opportunity Cost of a given action is the value of the next best alternative to that particular action.

The opportunity cost of the different activities can be easily calculated using a graph. To do so, let's go back to the PPC. Remember that Alberto's PPC is a straight line, so its slope (also known as "gradient" or "rate of change") is constant. Calculating the slope is easy for straight lines, as you only have to divide the rise (or the vertical intercept) by the run (or the horizontal intercept). And by doing so, you also get the *opportunity cost* of producing one unit of the good depicted on the x-axis.

For Alberto, the opportunity cost of 1kg of bananas is given by: 8kg of rabbit (vertical intercept) / 16kg of bananas (horizontal intercept) = $\frac{1}{2}$. It means that to get 1kg of bananas Alberto must give up $\frac{1}{2}$kg of rabbit. The opportunity cost of 1kg of rabbit can be simply calculated by taking the inverse of the opportunity cost of 1kg of bananas. Hence, the opportunity cost of catching 1 extra kg of rabbit is 2kg of bananas (the inverse of $\frac{1}{2}$kg). To put it in simple formulas,

$$OC_{bananas} = \frac{loss\ in\ rabbit}{gain\ in\ bananas} \quad or \quad OC_{rabbit} = \frac{loss\ in\ bananas}{gain\ in\ rabbit}$$

Now that we know how to compute the opportunity costs, let's express the productivity table above in opportunity costs terms. See Table 1.2.

A quick look at the table reveals 揭示 that Alberto's opportu-

	Opportunity costs of	
	1kg of bananas	1kg of rabbit
Alberto	0.5kg of rabbit	2kg of bananas
Leo	1kg of rabbit	1kg of bananas

Table 1.2: Productivities expressed in terms of opportunity costs.

nity cost of collecting 1kg of bananas is lower than Leo's. On the other hand, Leo's opportunity cost of catching 1kg of rabbit is lower than Alberto's. Based on these opportunity costs, we conclude that Alberto has a *comparative advantage* at picking bananas, and Leo has a comparative advantage at catching rabbits.

相对优势

Comparative Advantage: An agent (or an economy) has a Comparative Advantage in a productive activity (like collecting bananas or catching rabbits) when he/she has a lower opportunity cost of carrying on that activity than another agent.

Based on these opportunity costs, who should produce what? Well, common sense suggests that the agent with the lowest (opportunity) cost at producing something should go on and produce it. If we follow this rule, Alberto should collect bananas (as his cost of 1kg of bananas is 0.5kg of rabbit, which is lower than 1kg for Leo), while Leo should catch rabbits (as his cost of 1kg of rabbit is 1kg of bananas, compared to 2kg for Alberto). If Alberto and Leo fully specialize this way, the economy (formed by Alberto and Leo) will have 16kg of bananas and 4kg of rabbit. These numbers are presented in Table 1.3 under the *Specialization* section.

As an additional example, consider instead the case where Alberto and Leo would each spend 4 hours catching rabbits and the rest of the time (12 hours) picking bananas. The number of goods produced in this case are presented in Table 1.3 under the *No specialization* section.

	No specialization		Specialization	
	bananas	rabbits	bananas	rabbits
Alberto	12	2	16	0
Leo	3	1	0	4
Total	15	3	16	4

Table 1.3: Gains from specialisation. Both Alberto and Leo are better off when they specialize according to their comparative advantage.

Did you see that coming? The quantities in the first two columns are smaller than what Alberto's and Leo's economy would produce if they were to each specialize. The extra (16-15=)1kg of bananas and (4-3=)1kg of rabbit are what we call *gains from specialization*. The fact that specialization leads to everyone being better off is an important economic principle called the *Principle of Comparative Advantage*.

收益专业化

比较优势原则

Principle of Comparative Advantage: The Principle of Comparative Advantage states that everyone is better off if each agent (or each country) specializes in the activities for which they have a comparative advantage.

1.4 *Trading in a Two-Agent Economy*

So, together, Alberto and Leo produce more when they fully specialize, but how do they get to consume what they need? They obviously trade! The only question is at what price. Given that Alberto specializes in bananas, he

will want to sell some to Leo (who only has rabbits) but what's the price for which Leo is willing to buy Alberto's bananas? It turns out that Leo will want bananas as long as their price is not higher than his opportunity cost of bananas (1kg of rabbit) because otherwise Leo will just collect the bananas himself. Alberto, on the other hand, will be willing to sell bananas at a price no less than his opportunity cost for bananas (0.5kg of rabbit), because the cost of 1kg of bananas for him is 0.5kg of rabbit. If Leo would offer Alberto less than 0.5kg of rabbit for 1kg of bananas, Alberto would be better off getting the 0.5kg of rabbit by himself. So, as long as the price of bananas lies somewhere in between of 0.5 and 1kg of rabbit, both agents will be better off specializing (Alberto in bananas and Leo in rabbits) and then trading.

We are now ready to answer our original question: can Leo help with Alberto's consumption objective (4kg of rabbit and 9kg of bananas) and at the same time reach his own consumption objective (7kg of bananas)? The answer is yes!, provided that Alberto and Leo specialize according to their comparative advantage: Alberto fully *specializes* in bananas (meaning on the activity for which he has a comparative advantage) and produces 16kg of bananas and Leo specializes in catching rabbits and produces 4kg of rabbit. They can then trade, Alberto gives some of his bananas in exchange for rabbits.

To see this point let Alberto offer 7kg of bananas in exchange for 4kg of rabbit — in this case the price of 1kg of bananas is approximately 0.6kg of rabbit, a price acceptable to both parties. If they do so, Alberto obtains 4kg of rabbit and 9kg of bananas, and Leo obtains 7kg of bananas. Magic! They both achieve their consumption targets! By specializing according to their comparative advantage, both Alberto and Leo can achieve their respective goals. This is the magic of specialization, and it shows how powerful the concept of opportunity cost can be when used correctly.

1.5 Economy-wide PPC in a Two-Agent Economy

In this section we are going to derive the Economy-wide PPC in the two agents economy that Alberto and Leo belong to. The simplest way to derive the economy-wide PPC is to follow these steps:

得到

1. Find the total amount of rabbit that Leo and Alberto can produce if they spend all their time catching rabbits. Mark the point corresponding to this amount on the y-axis - see point A in Figure 1.4. Point A represents the following combination: (bananas kg/day, rabbit kg/day) = (0, 12). By construction, this point is on the economy-wide PPC.

2. Now expand production of bananas by 1kg. Who should produce the first kg of bananas? The principle of comparative advantage suggests that Alberto should do it — he has the comparative advantage at producing bananas. We know from the previous sections that Alberto's opportunity cost of producing 1kg of bananas is 1/2kg of rabbit. Hence, the economy is now producing 1kg of bananas and (12kg−1/2kg=) 11.5kg of rabbit. This combination is represented by point B in Figure 1.4. Given that we obtained this point using the principle of comparative advantage, we know that point B is on the economy-wide PPC.

3. Continue to expand production of bananas by using Alberto's labour. At a certain point Alberto will run out of working hours. This will occur when he produces 16kg of bananas — remember that Alberto spends all his available time to produce 16kg of bananas. Point C in Figure 1.4 represents this combinations of rabbit and bananas, where Alberto spends all his time collecting bananas and Leo catching rabbits. Point C then represents the following combination: (bananas kg/day, rabbit kg/day) = (16, 4).

4. If we want to expand the production of bananas beyond 16kg we cannot rely on Alberto's labour anymore

— he ran out of time producing the 16^{th} kg of bananas. If we want more bananas we need to ask Leo. We know from the previous sections that Leo's opportunity cost of producing 1kg of bananas is 1kg of rabbit. If we ask Leo to produce one extra kg of bananas, the economy will be producing 17kg of bananas and (4kg−1kg=) 3kg of rabbit. This combination is represented by point D in Figure 1.4. Given that we obtained this point using the principle of comparative advantage, we know that point D is on the economy-wide PPC.

5. Find the total amount of bananas that Leo and Alberto can produce if they spend all their time collecting bananas. Mark the point corresponding to this amount on the x-axis. See point E in Figure 1.4. Point E represents the following combination: (bananas kg/day, rabbit kg/day) = (20, 0). By construction, this point is on the economy-wide PPC.

6. Connect points A and C with a straight line. Now to do the same for points C and E. Ta-da! You have derived the economy-wide PPC for the two agents economy.

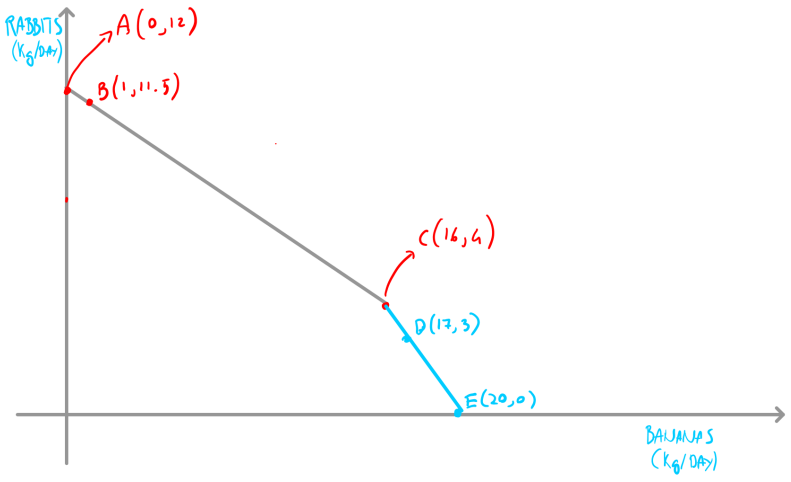


Figure 1.4: A representation of the economy-wide PPC in a two agents economy.

Alberto and Leo together can produce any combination of bananas and rabbit that lies on or below the economy-wide PPC derived above. (Note that to produce a combi-

nation on their economy-wide PPC, they need to use all the time at their disposal, whereas if they produce a combination below and to the left of the economy-wide PPC there is underutilization of resources). 利用不足，未充分利用的

What do you see when you look at the economy-wide PPC in Figure 1.4? Yep, it's not a straight line anymore, but starts looking like a curve that bows out from its origin.

Remember that the slope of the PPC reflects the opportunity cost of 1kg of bananas in terms of forgone rabbits. 放弃 So what does the shape of the economy-wide PPC means in terms of the opportunity cost of bananas in the economy? First note that the slope of the curve is increasing (hence the aspect of a bow): as we increase the quantity of bananas produced, the PPC slope increases, meaning that the opportunity costs of collecting additional bananas (measured in terms of the corresponding loss in rabbits) also rises. Why? This shape is essentially due to the fact that resources are *scarce*. 缺乏的，罕见的

缺乏 Scarcity is one of the fundamental aspects of economics, and of the real world too. In our simple model, time is scarce and so, if the economy needs more bananas, some of the agents who catch rabbits must be sent to pick them. But who should go? Is there an order of who should be sent first? It turns out that there is and it's really common sense: among the agents currently catching rabbits, the agent who is the most productive at collecting bananas should "hit" the bananas first. Meaning, if we need more bananas, we will assign the task to the agent with the lowest opportunity cost at picking bananas in our economy. In our simple example, this agent was Alberto whose opportunity cost was 1/2kg of rabbits. What if society wants more bananas than Alberto can produce in a day? We need to send another agent — Leo, who has a higher opportunity cost (1kg of rabbit) than Alberto. So, as we increase the quantity of bananas produced, we gradually allocate the task to agents with higher and higher opportunity costs. This is

an important economic principle called *low-hanging fruit principle*. 低挂果原则

The Low-Hanging Fruit Principle (or Increasing Opportunity Cost): The Low-Hanging Fruit Principle (or Increasing Opportunity Cost) states that in the process of increasing the production of any good, one first employs those resources with the lowest opportunity cost and only once these are exhausted turn to resources with higher cost.

GIVEN THAT THE ECONOMY-WIDE PPC is closely related to the resources available in the economy, it's easy to understand what are the main factors that drive economic growth and push the PPC of an economy out and to the right. They have to do with resources, and the main resources in the economy are related to capital, labour and technology. So, the PPC gets shifted out if there is: 移出

1. an increase in infrastructures such as factories, equipment, etc., 基础设施
2. an increase in population, and so in labour force, or
3. advancements in knowledge and technology, via education, R&D, IT and communications technologies.

1.6 Trading Between Economies: International Trade

We spent a lot of time figuring out what Alberto and Leo should produce, and then creating the PPC for the multi-agent economy. But the economic welfare of a country 福利 does not depend on what it produces, rather it depends on what it consumes.

Just as the economy-wide PPC shows all possible combinations of two goods that a country can produce, the *Consumption Possibility Curve (CPC)* shows all combinations of the two goods that the agents in the economy can consume. 消费可能性曲线

Consumption Possibility Curve (CPC): The CPC represents all possible combinations of bananas and rabbits that the economy can feasibly consume when it is open to international trade.

So the two curves are similar, but is there an actual relation between them? The answer is only the most frequent one that economists give: Depends! On what? On whether the country is open to international trade or not. Specifically:

Q: Is there an actual relation between PPC and CPC?
A: It depends. On 1 and 2.

1. If a country is a closed economy (doesn't trade internationally), the PPC and the CPC are the same because the agents must consume whatever they produce.

2. If a country is an open economy (trades on the international market), the CPC is usually greater than the PPC because part of what the agents produce can be traded for other goods and services, which relieves the restrictions on consumption.

Given a certain economy-wide PPC, what is the corresponding CPC for that economy?

If the economy is closed, the answer is straightforward: the CPC is identical to the PPC — people consume what they produce and nothing else.

If the economy is open, however, agents can trade (bananas and rabbits) at world price and consume more. To see this, consider first the case where an economy produces a combination represented by point A in Figure 1.5. Also assume that in the international market it is possible to exchange 1kg of bananas for 0.75kg of rabbit. Starting from point A, the economy can sell 1kg of bananas for 0.75kg of rabbit; by doing so it will end up with the a combination of goods represented by point A' in Figure 1.5. If the economy sells 1 more kg of bananas it can reach point A''. By drawing a line that connects points A' and A'', you obtain a straight line that represents all the consumption possibilities available when the economy produces a combination represented by point A.

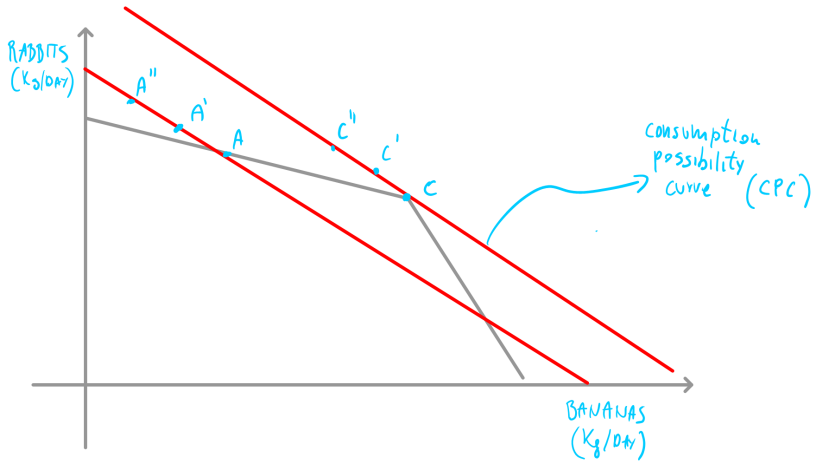


Figure 1.5: A representation of the economy-wide PPC in a two agents economy open to trade.

Can the economy achieve more consumption by pro-

ducing a combination other than A? The answer is yes. Consider point C. Using the same method we used before, construct points C' and C''. Now connect them as you did before. By looking at Figure 1.5 it is easy to see that this new line is above and to the right with respect to the original line connecting points A' and A''. Hence, the economy can consume more by producing the combination represented by point C and then trading along the line $C' - C''$. It is easy to see that producing at point C is indeed guaranteeing the maximum amount of consumption. You can try with different points along the economy-wide PPC and you will find that the resulting consumption opportunities are lower than the ones crossing point C. Having established this, we can conclude that in this example the CPC is represented by the line passing through points C' and C''.

It is important to keep in mind that a change in the international price can change the CPC. For example, assume that in the international market it is possible to exchange 1kg of bananas for 0.2kg of rabbit. Also, suppose that the economy continues to produce the combination of goods represented by C and that the opportunity cost of collecting bananas at point C is 1/2kg of rabbit. In the case, the opportunity cost of collecting bananas for our economy (1/2kg of rabbit) is higher than the opportunity cost of buying them from the international market (0.2kg of rabbit). Hence the economy would be better off producing less bananas and more rabbits. Indeed, you can verify that producing point B guarantees the largest consumption possibilities. The economy should produce only rabbits and then trade with the rest of the world. In this case the CPC is given by line passing through points B' and B''. See Figure 1.6.

Since the PPC is always below the CPC, we can conclude that the consumption opportunities in an open economy are always wider than in a closed one. But is there a particular point on the CPC that gives a specific combination of goods that an economy should consume?

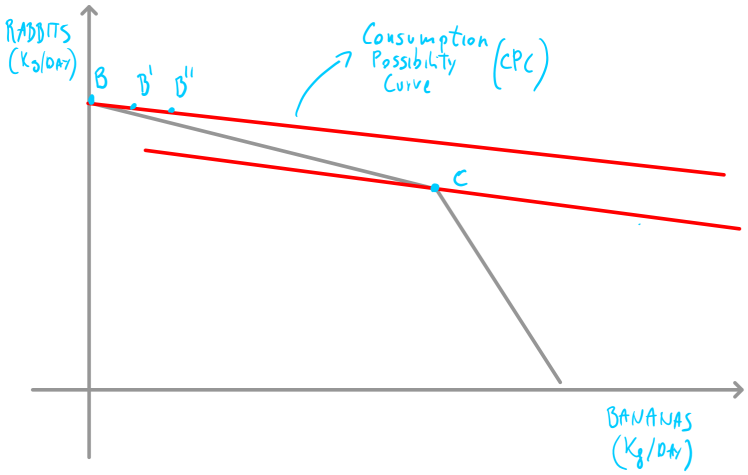


Figure 1.6: A representation of the economy-wide PPC in a two agents economy open to trade.

Again the answer is: It depends! On the needs and wants of the agents (or population), which in economics are called *preferences*. 参数选择

1.7 *Economy-wide PPC in a Many-Agent Economy*

Let's step out of Alberto and Leo's island into the real world, where a real economy has millions of agents, producing and consuming goods. You might be surprised, but everything we have discussed so far still applies! Say that there are a lot more people on the island, carrying the same two productive activities (collecting bananas and catching rabbits). To get the aggregate (economy) 总计 PPC, we start by considering the two extreme scenarios in which all available workers collect bananas *or* catch rabbits. These two situations will give you the x- and y-axis intercepts, respectively. If everybody collects bananas all day long, at the end of the day there will be, say, 80,000kg of bananas. Conversely, if everyone collects rabbits, they will catch 50,000kg of rabbits.

But now remember that we do not have only one agent in the economy, so we cannot link these two points with a straight line and get the PPC. We have millions of agents... So how can we start imagining this curve? Well, with only two agents the PPC started looking like an arc

bowing from its origin. Hence, with millions of agents the PPC will be a *smooth curve that bows from its origin* too. See Figure 1.7.

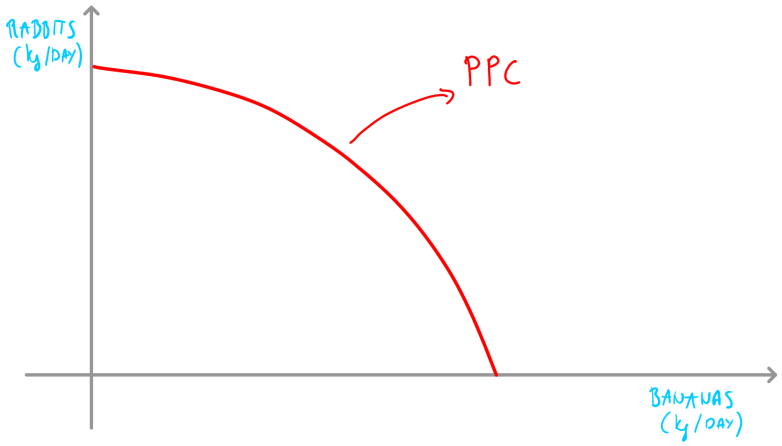


Figure 1.7: A representation of the economy-wide PPC.

Remember that the slope of the PPC reflects the opportunity cost of 1kg of bananas in terms of forgone rabbits. So what does this curvy shape of the PPC means in terms of the opportunity cost of bananas in the economy? First note that the slope of the curve is increasing (hence the aspect of a bow), so as we increase the quantity of bananas produces, the PPC slope increases, meaning that the opportunity costs of collecting additional bananas (measured in terms of the corresponding loss in rabbits) also rises. As in the two-agent case, if we need more bananas, we will assign the task to the agent with the lowest opportunity cost at picking bananas in our economy. What if society wants even more bananas? We need to send another agent. He will have a higher opportunity cost than the first agent, *but* he will also have the lowest opportunity cost among the agents who are catching rabbits. So, as we increase the quantity of bananas produced, we gradually allocate the task to agents with higher and higher opportunity costs. 逐步的，渐渐的

If the PPC is a straight line, the slope (or rate of change) is constant in all the points along the PPC. For an economy with many agents, the PPC is a curve and to get its slope *at a given point* we use the tangent to the curve

at that point. For example consider Figure 1.8. The slope of the PPC at point A is the same as the slope of a line tangent to the PPC at A. But the slope of the PPC at point B (which is the same as the slope of a tangent to the PPC at B) is different than the slope at A — just look at the two tangent lines, they are not parallel, right?

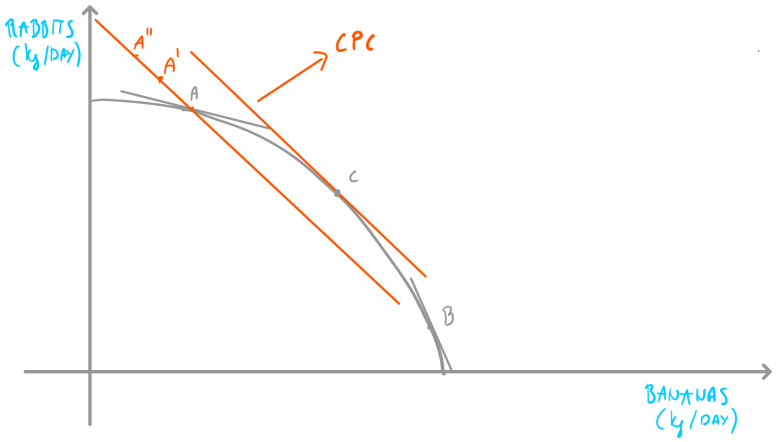


Figure 1.8: Optimal production in the economy-wide PPC with many agents.

Having clarified this, let's go back to the economy-wide PPC in Figure 1.8. To draw the CPC, you need to derive its slope. The slope is determined by the relative prices of bananas and rabbits in the world market. For example, if the country can trade one banana for one rabbit on the international market, the slope of the CPC must be equal to 1 (or to be more precise -1). If the country produces at point A, it can consume any combination of goods on the line connecting A' and A". Is this line the CPC? No! The country can do better than that.

In the example in Figure 1.8, the economy should first produce the combination of goods represented by point C on the PPC (where the opportunity cost of collecting 1kg of bananas equals the opportunity cost of buying it on the international market). Then, they can trade part of the bananas and rabbits in the market to obtain and consume any combination of goods on the CPC, which is given by the tangent to PPC at point C.

1.8 Classic Critiques to the Model

Let's revisit the assumptions we made at the beginning. First, we implicitly assumed that there is no psychological costs from performing only one activity the entire day. However, most people enjoy variety and having to perform the same activity every day can generate significant dissatisfaction.

心理的，精神的

Second, we also assumed away transaction costs connected with trading (i.e., negotiation costs, transportation costs, etc), and we can easily imagine that this is not the case in the real world. We also assumed that there are no import quotas or tariffs, which would limit the gains from specialization by making specialization beyond a certain level pointless.

Third, specializing implies acquiring a lot of expertise in performing a certain activity. This represents a *sunk cost* for a country (a cost incurred at the beginning of an activity that cannot be recovered in any way). But what if the need for the goods or activities in which a country specialized suddenly diminishes? Times are changing and the demand for feature phones (as opposed to smart phones) is not what it used to be. In this case, specialization might come with a risk as the economic (and global) environment is changing.

沉没成本

No import quotas and tariffs

Finally, everything we presented here makes sense economically, but does not takes into account arguments related to preferences (remember those?) or social norms (political, religious, etc.) that might prevent trade.

No change in preferences

REVISION QUESTIONS

Question 1.

a) What is the production possibility curve and what does it reflect?

b) With this in mind, construct a PPC for two products

and label two points, one attainable and one unattainable. Next consider what it means to be on the PPC.

c) Consider two points on the PPC. Now consider a movement along the PPC from one of these points to the next. Look at the initial situation and the final one. What does this movement along the PPC suggests and what economic concept does it illustrate?

d) What will cause the PPC to shift out?

Question 2.

a) Consider the PPC in Figure 1.2 in the textbook. List and explain some of the assumptions behind this PPC.

b) Consider an improvement in technology. There are four scenarios:

1) Alberto can produce more rabbit in one day,

2) Alberto can produce more bananas in one day,

3) Alberto can produce more rabbit and more bananas in one day,

4) Alberto discovered a magic trick and he can now produce as many kg of bananas and rabbit he wants, with no technological limitation.

Show how these technological changes affect the PPC. Use a diagram to aid your explanation.

Question 3.

Consider the PPC for an agent that produces coffee and nuts. Now that agent feels like having a siesta and does not use all the available working hours. How does this affect your PPC? Use a diagram to explain your answer.

Question 4.

In a two-person economy, William can produce 6 watches (if he works only on watches) or 18 boxes per

day (if he works only on boxes), while Kate can produce 8 watches (if she works only on watches) or 12 boxes per day (if she works only on boxes). Which of the following combinations of watches and boxes can be produced by William and Kate if they work together, share their produce and use all the available time in a day?

a) 8 watches and 10 boxes

b) 10 watches and 12 boxes

c) 16 watches and 0 boxes

d) 14 watches and 6 boxes

Question 5.

Assume that there are only two countries in the world and they produce two goods, cars and cotton. The opportunity cost of a car in Country A is 50 units of cotton and the opportunity cost of a car in country B is 300 units of cotton. In this example,

a) country A has a comparative advantage in cotton.

b) country B has a comparative advantage in cotton.

c) country A has an absolute advantage in cotton.

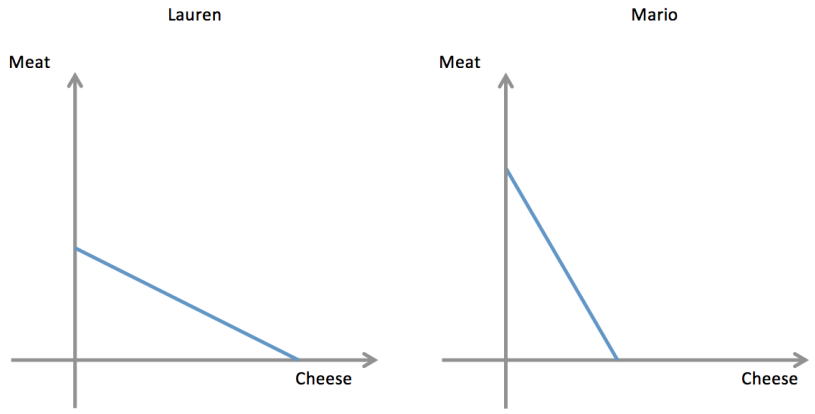
d) country B has an absolute advantage in cotton.

Question 6.

The diagram below represents the production possibilities curves for Mario and Lauren.

Make the following assumptions about the two diagrams:

- Both agents can buy as many units of meat and cheese they want from the international market. The international market price of each good will be between the two agents' opportunity costs of producing that good;
- There are no trade barriers;
- Each agent wants to trade.



Which product should each agent specialise in to maximise its gains to trade?

a) Both Mario and Lauren should produce meat.

b) Lauren should produce cheese and Mario meat.

c) Lauren should produce meat and Mario cheese.

d) Both Mario and Lauren should produce cheese.

Question 7.

The production possibilities curve for Australia is shown in the diagram below:

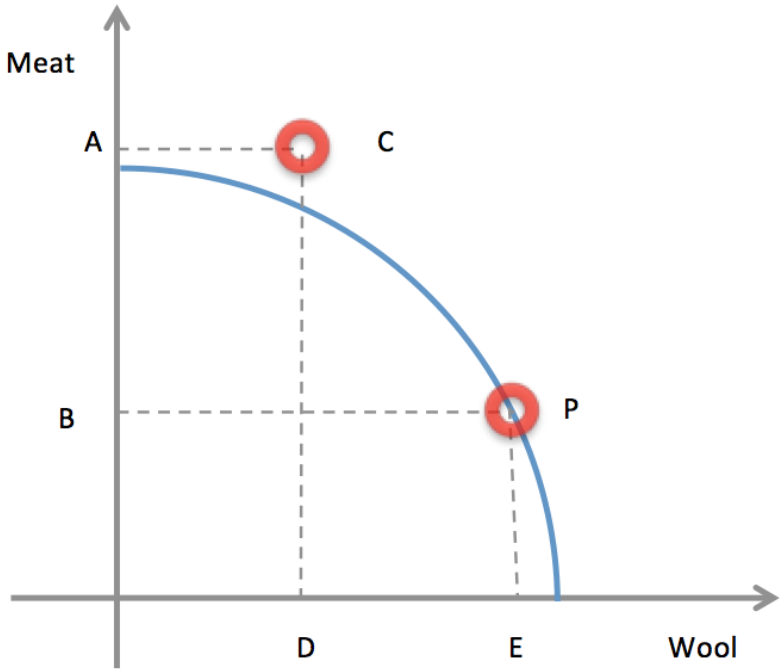
Suppose Australia is currently consuming a combination of goods represented by point C (note this is a point outside Australia's PPC) and is producing a combination of goods represented by point P. If trade can occur freely between Australia and the rest of the world, then Australia must be

a) exporting the amount on the graph denoted by segment DE of wool and importing OB Meat.

b) importing AB meat and exporting OD wool.

c) exporting DE wool and importing AB meat.

d) producing OD wool and OA meat.



Question 8.

What is meant by the term "Opportunity Cost"? Assume that there are many people in the economy, what does it mean to have a "Comparative Advantage"?

Question 9.

a) Assume two people, Jane and Kane, have constant productivities (they can produce cars and computers at a constant rate, irrespective of how many cars and computers they produce). Draw the PPCs for each of these two individuals assuming that:

- Jane has a comparative advantage in car production: the opportunity cost of 1 car is 1/3 computers. Also, Jane can produce a maximum of 3 cars or 1 computer; and
- Kane has a comparative advantage in computer production: the opportunity cost of 1 car is 3 computers. Also, Kane can produce a maximum of 1 car or 3 computers.

b) Assume that the agreed 'price' of a car for these two individuals is one computer and that trade ONLY occurs between these two people. Using the same graph you've constructed in part (a), highlight the consumption possibilities for Jane and Kane. More precisely, highlight the additional bundles which Jane and Kane could potentially consume following this price agreement, i.e. gains from trade.

Question 10.

Consider the "Principle of Comparative Advantage". What is a key requirement to ensure that gains from trade and specialization will arise?

Question 11.

This table shows the output that an identical set of workers can produce per month in China and India.

	Wheat (tonnes)	Rice (tonnes)
China	20	5
India	8	4

For there to be any gains to trade, what is the range of "prices" for a tonne of rice that allows both countries to gain from trade?

Question 12.

Kate goes to see The Prodigy in concert and pays $90 for the ticket plus $20 for a taxi home. On the same night she had two other options: the chance to baby sit and earn $70 and another offer to work in a café to earn $100. Assuming she likes to baby sit as much as she likes working in the café, what is Kate's opportunity cost of going to the concert?

Question 13.

Use the information below to answer the questions below.

	Time to weave rugs	Time to make pots
April	20 minutes	10 minutes
Bert	15 minutes	30 minutes
Colin	20 minutes	60 minutes

a) Who has a comparative advantage in making pots? Who has an absolute advantage in making pots?

b) Suppose that April, Bert and Colin were the only workers on an island and they all worked for 6 hours each. Also assume that April and Colin produce only the goods for which they have a comparative advantage, whereas Bert splits his time such that he spends 3 hours in weaving rugs and 3 hours in making pots. What is the productive capacity of the economy in terms of rugs and pots?

Question 14.

Suppose that a country produces only 2 goods. Using your opportunity cost knowledge explain:

a) Why the slope of the PPC curve reflects the opportunity cost of producing one unit of the product specified on the x-axis.

b) Following from part a), explain how a "bow" shaped (concave to the origin) PPC reflects the "principle of increasing opportunity costs".

c) Explain why the PPC for this economy (with many agents) may be "bow" shaped (concave to the origin). To help you contextualise your answer assume that labour is the only resource required to produce these two products.

Question 15.

Oliver and Nellie produces two products, cloth and wine. The rates of production is summarised in the table below:

	Oliver	Nellie
Cloth (meters)	2 meters per hour	1 meter per hour
Wine (litres)	4 litres per hour	5 litres per hour

a) Re-express this table in terms of input labour requirements i.e. how much time does it take to produce one meter of cloth and one litre of wine.

b) From the above table, find out which person has an absolute advantage in producing cloth and which person has a comparative advantage in producing cloth. Remember to show how you derive the results to reinforce your answer (Hint: For comparative advantage it may be useful to express things in terms of opportunity costs).

c) Using the "principle of comparative advantage", if Nellie decides to specialise in producing a product, which product should she specialise in to ensure that that there are gains from specialisation?

Question 16.

Suppose that Jonathan and Jonathan's sister, Evelyn both produce gold and silver. Now make the following assumptions:

- If Jonathan devotes all his effort to producing gold, he can produce 24 units, if he decides to devote all his effort to producing silver he can produce 12 units. Assume that Jonathan's opportunity cost is constant regardless of the level of production.
- If Evelyn devotes all her effort to producing gold, she can produce 12 units, if she decides devote all her effort to producing silver, she can produce 24 units. Assume that Evelyn's opportunity cost is constant regardless of the level of production.

Using the above information:

a) Define what a PPC is and construct the production possibility curves for Jonathan and Evelyn. Highlight the attainable production combinations.

b) Construct the economy-wide PPC i.e. the aggregate production possibility curve for Jonathan and Evelyn, assuming that the resources will be allocated according to the "low-hanging fruit principle" i.e. assuming that the person with the lower opportunity cost will be used first to produce the good. In your answer you must highlight the attainable production combinations.

Part II

Perfectly Competitive Markets

There is one question that has intrigued economists for a very long time — hundreds of years in fact! Where do prices come from? Think of the price of a loaf of bread from your local store. How is the price of that loaf determined? Some economists were convinced that it had to do with the cost of producing that loaf of bread.[3] Figure out the cost of production (in terms of labor and capital required to produce it) and you will have a pretty clear idea of what the price is going to be. This sounds like a simple and reasonable argument. Having solved the dilemma, should we add some prosciutto to that loaf of bread and head out to lunch? As it turned out, unfortunately, there is a hole in this argument, so our lunch will have to wait. Here is a counter example to show that production costs cannot be the only determinants of prices. Consider a simple sketch made by us. Say we spend a few minutes to do it. The cost of production is clearly low, just the opportunity cost of our time, give or take. Now we might try to sell it. How much do you think we can make out of it? (Here assume that economists are not the best sketch artists...) Do you think we can make a million dollars out of it? Probably not, and this would confirm the hypothesis presented above. But now consider a sketch made by Van Gogh. Now *that* can sell for more than a million, and it probably took only a few minutes to do — and believe us Van Gogh's opportunity cost of time was definitely lower than ours (he died in poverty, not really recognized as the genius he really was until after his death). Unfortunately, the cheap-to-make super-expensive-to-buy sketch by Van Gogh goes plainly against the theory based on production costs. In response to this puzzle, other economists were persuaded that the price of a good was instead determined by how much people wanted it.[4] However, this theory is also not satisfactory. Here is a counter example. Think of the loaf of bread we mentioned in the beginning. Picture yourself in the Dolomites (beautiful mountains in the northern part of Italy). After a long day of trekking you finally arrive

[3] John Stuart Mill (1806-1873) was a British political economist whose research focused on the relation between the value of goods and the costs incurred when manufacturing them.

[4] William Stanley Jevons (1835-1882) and the Marginal Utility theorists (starting with Daniel Bernoulli in 1738) related the value of a good to the idea of maximising utility, proposing the demand for a good as a crucial driver of value.

in a remote refuge with a little store attached to it. If you are suitably hungry you might want to eat that loaf of bread desperately. Your willingness to pay could be enormous, but still that loaf of bread would not cost much more than the same loaf in Sydney's city centre. Hence, the intensity of preference cannot be the only determinant of prices. This story ends with the advent of Alfred Marshall (1842-1924). He came up with the idea that prices are determined both by production costs *and* preferences. His analysis of **demand** (the preference-side of the story) and **supply** (the production costs-side of the market) is at the very heart of this course — and in fact of almost all Microeconomics courses around the world. It is his theory we are going to present in this chapter. You can thank Marshall and eat your sandwich now :)

What is a Market?

Before moving any further, let's clarify the meaning of the word "market". This an elusive term indeed! There are markets that take place in a specific geographic location at a specific time — think of the fish market in Sydney — and others that take place in virtual spaces and there is no time restriction — take eBay for example. Markets frequently disappear; think of the last time you bought a floppy disk, for example. (If you do not know what that is try to imagine something like a CD but really floppy!) And new markets constantly come to life (think of the last time you bought a USB flash drive). If you come up with an new product and there is someone interested in buying it, there you have a brand new market! Now that we have agreed that the concept of markets is indeed elusive, let's try to find a definition that would fit all these different types of economic interactions. A natural definition is the following one: A *market* is the set of all the consumers and suppliers who are willing to buy and sell a given good. This definition is very generic, but it is useful as it encompasses all the examples presented above. What it

Market: The Market for a given good or service is the set of all the consumers and suppliers who are willing to buy and sell that good or service.

says is that markets are essentially made of people. And these people use the market setup to buy or sell a given good at a certain price.

We say that a market has reached its *equilibrium* when the price and the quantity sold of a given good are stable.

Market Equilibrium: Market Equilibrium occurs when the price and the quantity sold of a given good is stable. *Alternatively, Market Equilibrium occurs when the equilibrium price is such that the quantity consumers want today is the same as the quantity suppliers want to sell.*

What is a Perfectly Competitive Market?

In the next 5 chapters, we are going to look at *perfectly competitive markets*. Such markets have the following characteristics:

1. *Consumers and Suppliers are Price-Takers:* when the market reaches a situation where the price is stable, any supplier would lose all her clientele if she were to ask for a higher price (i.e., the consumers would just acquire the good from her competitors) AND any consumer would fail to acquire the good if he were to suggest a lower price (i.e., the suppliers would just serve someone else instead). Of course, the supplier has also no incentive to cut the price (because this would just reduce her profit) and the consumer has no incentive to negotiate an increase in price either. So, in equilibrium both consumers and producers are "stuck" at the prevailing market price and there is no reason for anyone to change their behavior. Put differently, both suppliers and consumers are not willing/able to affect the market price. Hence, they are price-takers. The usual example is the wheat market — a huge international market comprising a large amount of buyers and sellers. It is easy to see that no single farmer can change the market price by changing his production decision, and no single consumer can affect the price by changing her consumption habits. The practical implication of assuming perfect competition is that, in this section, we are going to take the price at which producers sell and consumers buy as given.
2. *Homogeneous Goods:* All suppliers sell exactly the same

product. The wheat market is a good example of a market where every supplier offers the same type of good.

3. *No Externality:* An externality is a *cost* (or a *benefit*) that is incurred by (or accrued to) someone who is not involved in the production or consumption of a certain good. In a market with no externalities, all the production costs and benefits are incurred by the supplier of the good; similarly all the consumption costs and benefits are incurred by the consumer of the good.} A classic example of externality is the pollution resulting from the production of a good. The cost of pollution is often incurred by the general population who had nothing to do with the production of that good.
4. *Goods are Excludable and Rival:* Suppliers can prevent consumers from consuming a certain good (excludability) and, once consumed, that good becomes unavailable to other consumers (rivalry).
5. *Full Information:* The suppliers and the consumers are perfectly informed regarding the characteristics of the good. These characteristics include the quality and the price of a good.
6. *Free Entry and Exit:* Suppliers are free to enter and exit the market.

External Cost: An External Cost is a cost incurred by someone who is not involved in the production / consumption of a given good.

External Benefit: An External Benefit is a benefit accrued to someone who is not involved in the production / consumption of a given good.

2
Supply in a Perfectly Competitive Market

In this chapter we show how to derive the supply curve for a single individual and for a firm.

2.1 Supply Curve for an Individual

Imagine our simple economy described in the previous chapter. Now think of a new member of our society; let's call her Stef. Stef can collect both fish and apples. She can then sell her produce at the harbor for a given price. Say that each unit of fish can be sold at price $P_{fish} = \$0.50$ and each bushel of apples at price $P_{bushel} = \$1.90$. When it comes to fishing, Stef can catch 1 fish in half hour. However, climbing on top of an apple tree to harvest fresh apples is a tiring business and can become more and more tiresome the more climbing one has done. Keeping this in mind, it turns out that Stef correctly anticipates that it is going to take her 1 hour to harvest the first bushel of apples, 1.5 hour to get the second one, 2 hours for the third one and even longer for the fourth one. See Table 2.1 (3^{rd} column).

What is the number of bushels of apples and fish that maximizes Stef's revenues?

In order to answer this question we are going to *think at the margin*. This is an expression often used by economists. It means that we are going to ask ourselves the following question: Should Stef produce one extra fish or one extra bushel of apples? Once this question is answered, we will ask the same question again, and we

Time required to collect apples or catch fish (hours)

Bushels of Apples			Fish		
Units	**Total Time**	**Marginal Time**	**Units**	**Total Time**	**Marginal Time**
1	1	1	1	0.5	0.5
2	2.5	1.5	2	1	0.5
3	4.5	2	3	1.5	0.5
4	7.5	3	4	2	0.5
5	14	6.5	5	2.5	0.5
6	30	16	6	3	0.5

Table 2.1: Stef's productivity.

will continue to do so until Stef depletes all her available working hours. In order to understand how this process works, let's apply it to Stef's example.

Start from a situation where Stef has collected zero of both goods. Should Stef harvest the first bushel of apples? By doing so she would spend 1 hour of her time and she would earn \$1.90. This is referred to as the *marginal benefit* of producing the first bushel.

Marginal Benefit: The Marginal Benefit of producing a certain unit of a given good is the extra benefit accrued by producing that unit.

What is the opportunity cost of that bushel? Well, in that hour Stef could have caught 2 fish, earning her \$1. So the opportunity cost of the first bushel is \$1. This is called the *marginal cost* of producing the first bushel.

Marginal Cost: The Marginal Cost of producing a certain unit of a given good is the extra cost of producing that unit. (Keep in mind here that the relevant cost is the "opportunity cost" and not just the "absolute cost" of producing the good.)

Now we are ready to answer our original question (should Stef harvest the first bushel of apples?) by *thinking at the margin*: we just need to compare the marginal benefit with the marginal cost.

If the marginal benefit is greater than the marginal cost, then Stef should take the action. This is what economists call the *cost-benefit principle*. In this case the cost-benefit principle suggests that Stef should collect the first bushel, the *surplus* being the difference between the marginal benefit and the marginal cost: $\$1.90 - \$1 = \$0.90$.

Cost-Benefit Principle: The Cost-Benefit Principle states that an action should be taken if the marginal benefit is greater than the marginal cost.

Economic Surplus: The Economic Surplus of a certain action is the difference between the marginal benefit and the marginal cost of taking that action.

It is easy to check that the same applies to the second bushel, but not to the third one (i.e., the 2^{nd} bushel brings \$1.90 and costs — in terms of opportunity cost — 3 fish for a total of \$1.50; the 3^{rd} bushel also brings \$1.90 and costs 4 fish for a total of \$2). Hence, Stef should optimally

harvest two bushels and then spend all of the remaining time fishing. In economics we say that the daily *quantity supplied* of apples is 2 bushels.

Quantity Supplied: The Quantity Supplied by a supplier represents the quantity of a given good or service that maximizes the profit of the supplier.

A VERY IMPORTANT CONCEPT in economics is that of *supply curve*. The supply curve represents the relationship between the price of a given good or service and the quantity supplied of that good and service. In order to derive Stef's supply curve for apples we are left with one last task. We need to vary the price of apples and determine how the supply of apples would change with it. Suppose that the price of apples increases to $P_{bushel} = \$2.10$. A quick inspection reveals that the optimal quantity of bushels is now 3 (for the 3^{rd} bushel Stef gets \$2.10 by using 2 hours of her time that could have been spent fishing and earning \$2).

Supply Curve: The Supply Curve represents the relationship between the price of a good or service and the quantity supplied of that good or service.

This tendency for a producer to offer more when the price increases is called the *Law of Supply*. See Figure 2.1.

Law of Supply: The Law of Supply describes the tendency for a producer to offer more of a certain good or service when the price of that good or service increases.

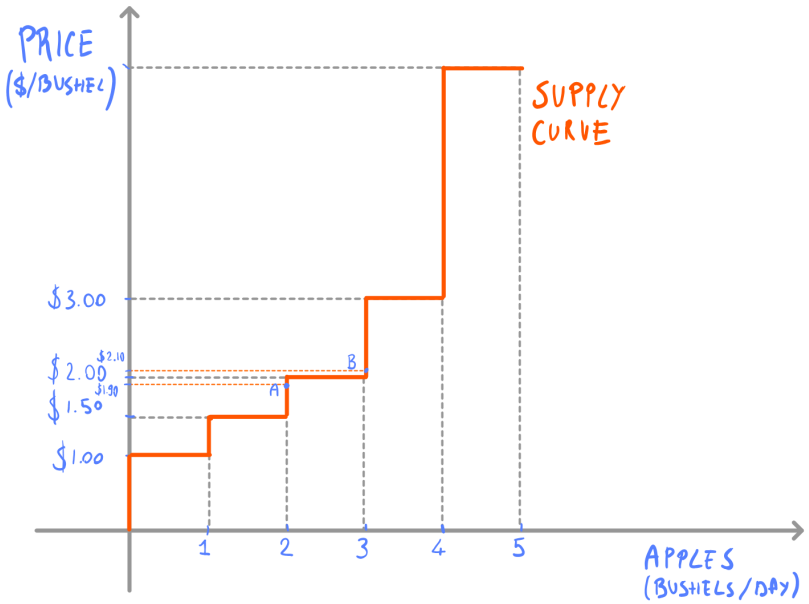


Figure 2.1: Stef's supply curve for the apples market.

The supply curve can be interpreted in two different ways, *horizontally* and *vertically*. The horizontal interpretation is easy: start from a certain price and then use the supply curve to derive how many units of the goods will be supplied at that price. The vertical interpretation is

Horizontal Interpretation (of the Supply Curve): Start from a certain price and find the associated quantity on the supply curve. The quantity you found indicates how many units the producer is willing to supply at that price.

Vertical Interpretation (of the Supply Curve): Start form a certain quantity (say 2 units) and find the associated price on the supply curve. The price you found indicates the minimum amount of money the producer is willing to accept to offer the *marginal* unit (in our example the marginal unit would be the 2^{nd} unit).

more tricky: start from a given quantity, say 2 bushels of apples. Then find the associated price on the supply curve. The price you found can be interpreted as the minimum amount of money the producer is willing to accept to supply the 2^{nd} bushel of apples. In economics we call this *minimum amount* of money the *producer reservation price* for the 2^{nd} bushel of apples.

Producer Reservation Price: Producer Reservation Price denotes the minimum amount of money the producer is willing to accept to offer a certain good or service.

What are the factors that can shift the supply curve — as opposed to a movement along the supply curve caused by a change in $P_{bushel} = \$2.10$? We will discuss this further in the following section.

2.2 *How to Derive the Supply Curve for a Firm*

When we think of suppliers (or entrepreneurs) we often think of firms that need capital and labor (i.e., *factors of production*) to produce their goods. Let's analyze this type of situation. As it will be clear in a second, this analysis is not very different from the one presented in the previous section. The main point of departure is that the entrepreneur needs to pay a *sunk cost* in order to start production.

Sunk Cost: A Sunk Cost is a cost that once paid cannot be recovered.

Think of the sunk cost as a cost that, once paid, cannot be recovered. For example, an entrepreneur might need to take a loan in order to acquire a machinery. Once the loan is initiated, the entrepreneur has to repay a certain amount of money every month and has no ability to affect the repayment due. This is an example of a sunk cost.

The factors of production used by the entrepreneur can be *fixed* or *variable*.

If a *factor of production is fixed*, then the cost associated with it (the *fixed cost*) does not vary with the quantity produced. For example, the machinery described above is a typical fixed factor of production. It does not really matter how much the entrepreneur is producing using that machinery (in fact he might not use the machinery at all), he will still have to pay the monthly repayment all the same. The period of time when at least one factor of

Fixed Factor of Production: If a factor of production is fixed, then the cost associated with it does not vary with the quantity produced.

Fixed Cost: A Fixed Cost is a cost associated with a fixed factor of production.

production is fixed is denoted as the *short run*.

A variable factor of production in our example could be labor. Unlike the loan we mentioned above, the cost associated with a *variable factor of production* (such as labor) tends to vary with the number of units produced (hence *variable cost*). For example, a single employee might be able to produce only a few units of the good, costing the entrepreneur a relatively small amount of money. However, producing more units might require hiring more employees, something that will increase the cost of production.

Short Run: Short Run denotes a period of time during which at least of one factor of production is fixed.

Variable Factor of Production: If a factor of production is variable, then the cost associated with it tends to vary with the number of units produced.

Variable Cost: A Variable Cost is a cost associated with a variable factor of production.

Consider again our entrepreneur. The short run is the period in which he will have to keep his machinery and pay his employees. On the other hand, the *long run* is the period starting from the point in time where he will be effectively free to sell the machinery (and the associated loan) or buy one or more new machineries. In other words, the *long run* is the period in time when all factors of productions are variable.

Long Run: Long Run denotes a period of time during which all factors of production are variable.

It is important to distinguish between short run and long run as the entrepreneur's decision might change depending on the moment in time we are considering.

Let's consider a simple example. The entrepreneur wants to produce a new brand of soft drinks, and assume that he will be able to sell each can of soda he produces for $1.20. Producing this soft drink requires a certain machinery. In order to be able to rent the machinery, he starts a loan, with a daily repayment of $100. He also needs to decide how many employees to hire. Each employee costs the entrepreneur $12 per day. See Table 2.2. The table presents the amount of cans that can be produced as a function of how many employees are employed and it also shows the variable and fixed cost associated with a given amount of cans produced. We assume that the objective of the entrepreneur is to maximize profit.

The question is: What is the optimal number of employees that the entrepreneur should hire to achieve this

purpose? It turns out that a simple way to answer this question is, again, to *think at the margin* – exactly the same approach we used in the previously.

					Average Cost		
Workers	**Quantity**	**Fixed Cost**	**Variable Cost**	**Total Cost**	**Variable**	**Total**	**Marginal Cost**
W	Q	FC	$VC = \$12 \times W$	$TC = VC + FC$	$AVC = \frac{VC}{Q}$	$ATC = \frac{TC}{Q}$	$MC = \frac{\Delta TC}{\Delta Q}$
0	0	\$100	\$0	\$100	–	–	–
1	40	\$100	\$12	\$112	0.30	2.80	0.30
2	90	\$100	\$24	\$124	0.27	1.38	0.24
3	120	\$100	\$36	\$136	0.30	1.13	0.40
4	130	\$100	\$48	\$148	0.34	1.14	1.2
5	135	\$100	\$60	\$160	0.44	1.19	2.40

Table 2.2: Production costs in the presence of a fixed cost.

So, should the entrepreneur hire the first worker? Well, the first worker produces 40 cans. The fixed cost is unchanged: no matter how many employees are hired, the daily loan repayment is constant and equal to \$100. The variable cost increases from 0 (no one is hired) to \$12 (the wage of the first employee). In order to assess the marginal cost of each can produced by the firm we need to compute the change in total cost (ΔTC) when the entrepreneur moves from having no employees to 1 employee. In our example the change in total cost is given by \$12 (the wage of the first employee). We then need to divide this number by the change in the quantity produced. By doing so, we are computing the marginal cost of each single soda that can be produced by the first employee. In our case the marginal cost is \$0.30. We can now compare the marginal cost of the soda can with its marginal revenue. The marginal revenue is the price at which the firm can sell the soda can in the market (in our example \$1.20).

The *cost-benefit principle* suggests that the firm should hire the first employee and produce the first batch of soda because for every single can in that batch the marginal revenue is greater then the marginal cost. Using the same solution method, it is easy to check that the same applies to the second, third and fourth employee, but not to the

fifth one. The reason is that the marginal cost of each soda can produced when a fifth worker is hired ($2.40) is higher than the marginal revenue ($1.20). Hence, our cost-benefit analysis suggests that the entrepreneur should not hire the fifth employee.

Now that we have identified the optimal number of employees, we can make a mental note of the maximum *profit* that the firm can achieve, where *profit* is defined as the difference between the total revenues (TR) and the total costs (TC). In our example, the total revenues (TR) when 4 employees are hired is $156 (=130 x $1.20) and the total cost (TC) is $148. Hence the profit is given $\pi_{production} = TR - TC = \$8$. (You can check that the profit is indeed maximized when the firm hires 4 employees by comparing it to what it would have been with 1, 2, 3 or 5 employees.)

Profit: Profit represents the difference between the total revenues (TR) and the total costs (TC).

The next step is to ask ourselves whether the firm should shut down the operations or produce using the optimal number of employees. So, we need to determine the *shut down condition (short run)*. To do so, we compare $\pi_{production}$ with the payoff that the entrepreneur would achieve by shutting down. Given that the fixed cost needs to be paid even when the firm shuts down, the payoff of the entrepreneur would be $\pi_{shut-down} = -\$100$. Obviously, $\pi_{production} = \$8$ is better than $\pi_{shut-down} = -\$100$, so the firm should continue its production. BUT, what if the firm produces 40 cans (i.e., hires only 1 employee)? In this case, $\pi_{production} = -\$64$, which is still better than $\pi_{shut-down} = -\$100$. This is surprising! The firm should produce even if it is running a loss. The reason for this counterintuitive result is that shutting down would yield an even worse result! Note that whenever $\pi_{shut-down} = \pi_{production}$ the entrepreneur is indifferent between shutting down and continuing operations. Hereafter, we assume that when the entrepreneur is indifferent, she decides to produce.

Shut Down Condition (short run): In the short run, the entrepreneur should shut down production if $\pi_{production} < -FC$. Otherwise, she should hire the optimal number of workers and continue operations.

It is important to notice that our analysis so far has been conducted under the assumption that the en-

trepreneur is facing a fixed cost. In other words, this was a short run analysis. Suppose now we are in the long run and the entrepreneur can decide whether or not to start a new loan to rent the machinery once more (i.e., whether to *exit the market in the long run)*. Clearly there is no sunk cost here. By exiting the industry the entrepreneur gains nothing, but also loses nothing — indeed $\pi_{exit} = 0$. From this follows that the entrepreneur should produce only if the largest profit achievable by doing so is positive. (Note that whenever $\pi_{production} = 0$ the entrepreneur is indifferent between exiting and continuing operations. As mentioned above, we assume the entrepreneur decides to produce when indifferent.)

Exit Condition (long run): In the long run, the entrepreneur should exit the industry if $\pi_{production} < 0$. Otherwise, she should hire the optimal number of workers and continue operations.

2.3 *From a Discrete to a Continuous Model*

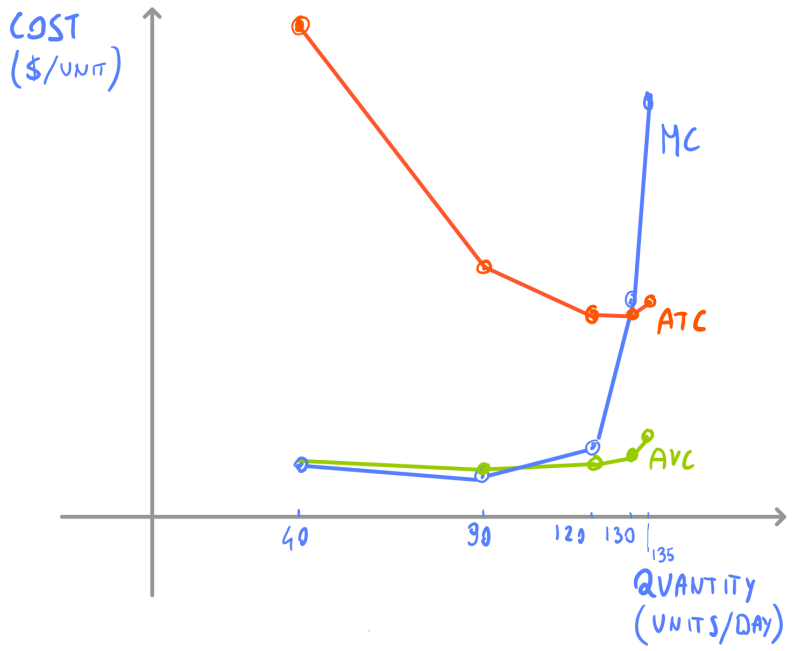


Figure 2.2: A representation of the production costs in a discrete model.

In the previous section we considered a model where the entrepreneur could only hire workers (in whole numbers). This implied that there was a limited set of soda cans that could be produced. If we were to depict the various costs of production in a graph we would obtain a

picture looking like Figure 2.2.

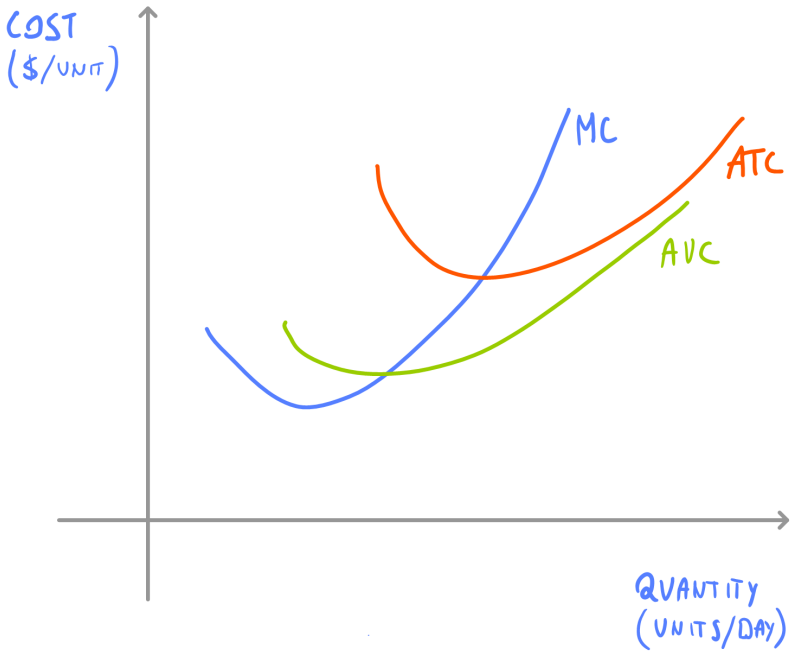


Figure 2.3: A representation of the production costs in a continuous model.

What would happen if the labour supply were much more flexible, and say the employees were hired for as many hours (or even minutes and seconds!) the entrepreneur wants? The resulting graph would be smooth as in Figure 2.3. This graph is useful because it gives you a quick hint on how many units of the good the entrepreneur should produce (just expand the quantity produced until the price line — the marginal revenue — intersects the marginal cost curve), and whether the entrepreneur should shut down (just verify whether the price line is below the minimum point on the Average Variable Cost (AVC) curve — shut down condition in the short run — or the Average Total Cost (ATC) curve — shut down condition in the long run). See the video associated with Figure 2.3 for an example of how optimal production and shut down conditions are derived from the graph.

With a quick glance you can also appreciate other aspects of the productive problem we are considering:

1. The supply curve for a firm can be derived by chang-

ing the price and observe the variation in quantity produced. In the context of the firm, the supply curve is equal to the Marginal Cost (MC) curve only for those values of the MC that are higher than the minimum AVC (in the short run) and higher than the minimum ATC (in the long run). (Remember that the entrepreneur will not produce anything if the price is below these points, in the short and long run respectively.) See the video associated with Figure 2.3 for a visual representation.

2. The MC curve eventually increases with the quantity produced. In other words, the production process is subject to *increasing marginal costs*. This might be due to the fact that adding more employees operating on a fixed amount of machineries translates sooner or later into a productivity decline because, for example, the employees might get in each other's way while operating the equipment.

3. The MC curve cuts the AVC curve and the ATC curve at their minimum points. To figure out the reason, let's use the following analogy. Suppose that the average height of the students in a classroom is 160 cm. Now invite a new student into the classroom. This is the *marginal* student — the extra student we are inviting in. If the marginal student is 150 cm tall, then the *average* height in the classroom will decrease. On the other hand, if the marginal student is 180 cm tall, then the average height in the classroom will increase. The average height won't change only if the marginal student is exactly 160 cm tall. The same intuition applies to the curves in our graph. Remember that the marginal cost is the extra cost associated with the production of the extra unit of the good. If the extra cost is smaller than the average cost, then the average will decrease. On the other hand, if the extra cost is higher than the average cost, then the average will increase. The average remains constant if and only if the marginal cost is equal to the average cost. Hence, the AVC curve and the ATC

curve decrease initially as the *MC* curve is below them. They continue to do so until the point where the *MC* curve touches them. From that point onward, the *MC* curve is above them and so they begin to increase.

4. If you look at Figure 2.3 from the perspective of the long run, the *AVC* curve as depicted in Figure 2.3 should be ignored. In the long run, all costs are variable. For example, the entrepreneur can decide whether or not to start a new loan to rent the machinery. The cost associated with it *does* vary with the quantity produced. If the quantity produced is zero, the cost of the loan is zero. But this is no longer the case if the quantity produced is greater than zero. Hence, the cost of the loan is no longer a fixed cost. For this reason, in our particular example the *AVC* curve would become identical to the *ATC* curve as the entrepreneur moves into the long run.

NOTICE ALSO THAT a change in the market price determines a movement *along* the supply curve, whereas a change in some other factor other than the price that affects *MC* will shift *the entire* supply curve. For instance, it is easy to check that an increase in the cost of inputs (say, the employee's salary) would shift the *MC* curve up because the cost of producing any particular quantity is now higher. Other factors shifting the supply curve could be:

1. *Technology:* More advanced technologies reduce the unit cost of production. By using such technologies, firms can considerably increase the amount of goods they produce (per unit of effort invested).
2. *Input prices:* A change in the price of inputs will affect the productive capacity of a firm/industry, which will be directly reflected in the supply. However, the price changes related to fixed inputs have no effect — except to the change the exit point for the producer.
3. *Expectations:* Expected future price (or future demand)

changes will make suppliers adjust their behavior to take advantage of (or shield themselves from) the new opportunities. If sellers expect the demand for a certain good to go up, for instance, they might hold off the goods with the expectation that next period they will sell them for a higher price.

4. *Changes in pricing for other products:* If a seller is producing two or more goods, and one good experiences a surge in demand (and so, price), the seller will shift (as much as possible) its productive focus to the high demand good. This will affect the supply of all the other goods the seller produces.

5. *Number of suppliers:* The higher the number of suppliers entering a market, the larger the right shift in the aggregate supply curve.

2.4 *Price Elasticity of Supply*

It is also useful to derive a measure of the *responsiveness* of the quantity supplied of a given good to changes in its price. Such a measure is used by governments and firms to have a better understanding of the markets they are interacting with. Of course, there are many ways of measuring this responsiveness. Economists often use the notion of *price elasticity*. To keep things simple, in this textbook we are going to ask you to calculate the elasticity of supply curves that are *straight lines*. This simplifies the calculations as they won't require much calculus!

Price Elasticity of Supply: Price Elasticity of Supply denotes the percentage change in the quantity supplied resulting from a very small percentage change in price.

Take two points, A and B, on a supply curve that is a straight line. Denote by P_A the price at point A and by P_B the price at point B. Also, denote by Q_A the quantity supplied at point A and by Q_B the quantity supplied at point B. Finally, let ΔQ and ΔP capture the change in quantity ($\Delta Q = Q_B - Q_A$) and the change in price ($\Delta P = P_B - P_A$), respectively. Here is the formula for elasticity *at*

point A:

$$Elasticity_A = \frac{\frac{\Delta Q}{Q_A}}{\frac{\Delta P}{P_A}} \tag{2.1}$$

where the percentage change in price ($\frac{\Delta P}{P_A}$) is suitably small (say, for example, $\frac{\Delta P}{P_A} = 1\%$).

Why do economists use this measure? Its most convenient property is that elasticity is a unit-less ratio — it does not depend on the unit of measurement!

Here is a concrete example. Suppose that the per-unit price of pizza increases from \$10 ($P_A = \$10$) to \$10.1 ($P_B = \$10.1$). Then the change in price ($\frac{\Delta P}{P_A}$) is exactly 1% ($\frac{\$0.1}{\$10} = 0.01 = 1\%$). Assume also that, following this 1% change in price, the quantity supplied increases from 1,000 to 1,200 pizzas per day. This implies that the percentage change in quantity ($\frac{\Delta Q}{Q_A}$) is 20% ($\frac{200 pizzas/day}{1{,}000 pizzas/day} = 0.2 = 20\%$). As a result, the price elasticity of supply at point A, calculated as the percentage change in quantity divided by the percentage change in price, is 20.

NOTE THAT THE PRICE elasticity of supply is usually positive. This is due to the fact that price and quantity tend to move in the same direction: when price increases, the quantity supplied increases as well. And when price decreases, the quantity supplied decreases.

This is also known as the *Law of Supply*, which simply states that supply curves tend to be upward sloping. If the supply curve is indeed upward sloping, then the elasticity must be positive.

Law of Supply: Supply curves have the tendency of being upward sloping.

Moreover, the supply is said to be:

(i) *elastic* if the elasticity of supply is greater than 1,

(ii) *unit elastic* if the elasticity of supply is equal to 1,

(iii) *inelastic* if the elasticity of supply is less than 1.

Elastic Supply: Supply is elastic when the price elasticity of supply is greater than 1.

Unit Elastic Supply: Supply is unit elastic when the price elasticity of supply is equal to 1.

Inelastic Supply: Supply is inelastic when the price elasticity of supply is less than 1.

A simple way to compute the price elasticity of supply is by using a graph. Look at Figure 3.3 and take point A

as the initial combination of price and quantity, which are denoted by P_A and Q_A respectively. The formula for elasticity at point A can be rewritten as follows:

$$Elasticity_A = \frac{P_A}{Q_A} \times \frac{1}{slope} \tag{2.2}$$

where the term *slope* indicates the gradient of the supply curve.[1] Given that the supply curve represented in Figure 2.4 is a straight line, the slope will be the same in every point on the curve. However, the elasticity will not be the same. Take for example point B in Figure 2.4. The elasticity at that point is $4/3$ and it is different from the elasticity at point A, which is $3/2$.

[1] It is easy to see that 2.2 is just a rearranged version of equation 2.1. To see this, note that $slope = \frac{\Delta P}{\Delta Q}$ (slope=rise/run, remember?).

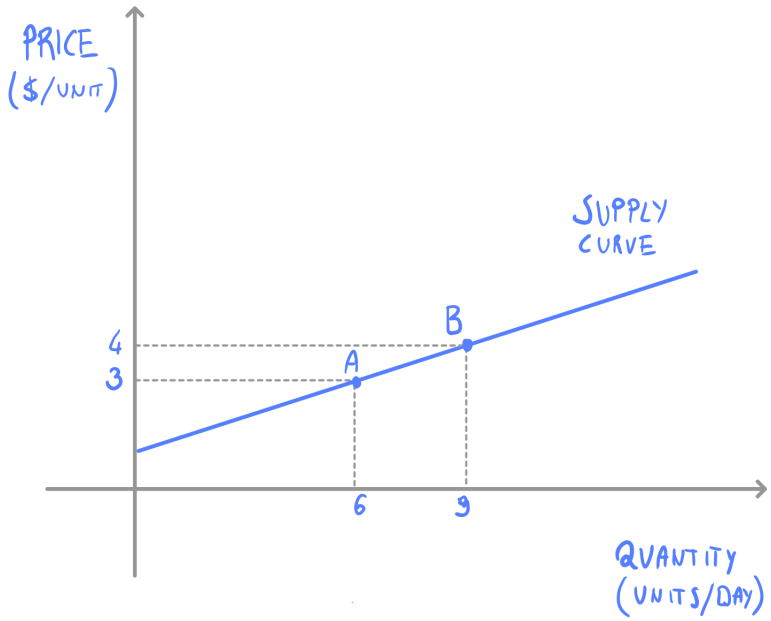


Figure 2.4: A simple way of computing elasticity using a graph.

2.5 *Determinants of Price Elasticity of Supply*

What are the factors that make supply more or less elastic? In order to answer this question, we need to understand what affects the willingness of sellers to adjust their productive decisions after a price change. Here is the list of the main factors:

1. *Availability of raw materials:* The larger the availability

of raw materials, the more elastic supply tends to be. On the other hand, if additional raw materials are not available, a firm might be unable to produce more.

2. *Factors mobility:* The more mobile the factors of production, the higher the elasticity. If a firm can easily divert its factors of production from one good to another, then it can rapidly increase production of those goods which happen to be in demand.

3. *Inventories / Excess capacity:* The larger the amount of inventories and excess capacity, the higher the elasticity. If a firm has a large number of goods in storage (inventories), then it can quickly increase the amount supplied in the market. Excess capacity is a situation where there is relative abundance of fixed factors of production compared to variable ones. A firm that has excess capacity can respond more quickly to an increase in demand. This can be achieved by increasing the number of variable factors of production (provided that these variable factors are readily available).

4. *Time horizon:* The longer the time horizon, the higher the elasticity tends to be. If the time horizon is long enough, producers can search for alternative inputs and revise their production plans more conveniently.

REVISION QUESTIONS

Question 1.

A profit maximising firm, operating in a perfectly competitive market, will make a negative profit and continue to produce in the short-run, but not in the long-run, if and only if the following conditions are satisfied:

a) The price is lower than the minimum average total cost AND higher than the minimum average variable cost.

b) The price is lower than the minimum average variable cost AND higher than the minimum average fixed cost.

c) The price is lower than the minimum average variable cost AND higher than the minimum marginal cost.

d) The price is lower than the minimum marginal cost AND higher than the minimum average total cost.

Question 2.

The short-run supply curve for a profit maximising firm operating in a perfectly competitive market is the:

a) the portion of the firm's average variable cost curve that lies above the marginal cost curve.

b) the portion of the firm's marginal cost curve that lies above the average variable cost curve.

c) the portion of the firm's marginal cost curve that lies above the average total cost curve.

d) the firm's marginal cost curve.

Question 3.

When a firm produces a quantity such that the average variable cost is minimized,

a) the marginal cost equals the average variable cost.

b) the marginal cost is decreasing.

c) the average variable cost is less than the marginal cost.

d) the average total cost is less than the average variable cost.

Question 4.

There are two interpretations of the supply curve, the vertical and horizontal interpretation. Explain each interpretation with the assistance of a diagram.

Question 5.

Consider the following statement,

"firms will always produce where the price equals the marginal cost."

a) Is this statement true or false?

b) Assume that a firm wants to maximise profits, using a diagram (with marginal costs, average total costs and average variable costs), explain the decisions a firm will make to maximise profits. Remember to consider the long-run and short-run in your answer.

c) Critical Thinking: what areas in the diagram could be used to represent the profits/loss that the company makes when profits are maximized?

Question 6.

At the local ice-cream shop ice creams sell for $5 each. Consider the following information:

Workers/day	Ice creams/day	Fixed Costs ($/day)	Variable Costs
0	0	500	0
1	25	500	10
2	75	500	20
3	150	500	30
4	200	500	40
5	205	500	50

Calculate the point at which the marginal costs begin to increase (i.e., the increasing marginal cost sets in at the employment of the $?^{th}$ worker per day).

Question 7.

The figures in the table below indicate the costs to a fast food enterprise producing gourmet Pizza. Note that is the firm operates in a perfectly competitive industry. Use the information to answer the following questions.

Variable Input (Work)	Output (Qty)	Fixed Costs	Variable Costs	Marginal Cost
0	0	100	0	
1	10	100	200	
2	25	100	400	
3	45	100	600	
4	60	100	800	
5	70	100	1000	
6	75	100	1200	
7	76	100	1400	

a) Complete the Marginal Cost column.

b) With the addition of what unit of labour do the marginal costs begin to increase?

c) Assuming all gourmet pizzas sell for $20 and the firm wants to maximise profits, calculate number of employees the firm should employ and the profit the firm will earn.

Question 8.

a) Assuming that labour is a variable factor of production and capital is a fixed factor of production, what can help explain the fact that

- we often observe increasing marginal costs, and
- the average total cost curve initially decreases and then increases.

b) In a perfectly competitive market, explain why in the short-run, in most cases, the supply curve is represented by the marginal cost curve above the AVC. In your answer you should also explain the case where the supply curve is not represented by the marginal cost curve.

3
Demand in a Perfectly Competitive Market

In the previous chapter we showed how to derive the supply curve, both for a single individual and for a firm. Here we look at the same market from the perspective of the consumers.

3.1 Demand Curve for an Individual

Consider an individual consumer (Isa) who has a $4 daily budget. For simplicity, let's say that she has only two options: the soda brand produced by the entrepreneur described in the previous chapter (sold at $2 per unit) and a bunch of other goods (sold at $1 per unit). As usual, the decision making is done at the margin by asking the following question: Should Isa buy the first can of soda?

In order to answer this question we need to keep in mind a couple of things. First, observe that the opportunity cost of the first can of soda is 2 units of the other goods available. This is simply due to the fact that the can of soda costs $2. With that amount of money Isa could have bought 2 units of the other goods — remember that the price of the other goods is $1. Second, in order to help Isa make a decision, we need to gauge the satisfaction that she would derive from consumption. In economics we use the concept of *utility*. For the purpose of this course just keep in mind that *utility* is a way of expressing the satisfaction that Isa derives from consumption, measured in *utils* per unit of time. It is important to specify the unit of time because people's preferences vary enor-

Utility: Utility denotes the satisfaction that an individual derives from consuming a given good or taking a certain action. It is measured in *utils* per unit of time.

mously depending on the time window. For example, drinking 10 litres of water in one day might not be very pleasant, but drinking the same amount over the course of a week might bring a much higher level of satisfaction. Hence, utility is a meaningful concept only if we specify the time frame over which it is measured.

One interesting feature of utility is that it tends to decrease at the margin. Think of the first glass of water after a day spent running across the desert in summer (this is just a hypothetical example, don't attempt it!). It will give you a huge amount of satisfaction. The second one might also be great, but eventually the more you drink the less appealing the next glass of water will be. We presume that the utility of the 100^{th} glass of water might even be negative (again, don't try this experiment at home!). This is referred to as *decreasing marginal utility*.

Decreasing Marginal Utility: Decreasing Marginal Utility implies that the utility from consuming an extra unit of a given good decreases with the number of units that have been previously consumed.

Here we will assume that Isa's utility from the consumption of soda features this type of decreasing marginal utility. Table 3.1 presents Isa's marginal and total utility as a function of the number of cans of soda she consumes. For example, over the course of a day, Isa derives 2 *utils* from the first can of soda but only 4/3 *utils* from the second one. In economic language, these utility levels represent the *marginal benefit* for the first and second can of soda respectively.

Soda			Other Goods		
Units	**Total Utility**	**Marginal Utility**	**Units**	**Total Utility**	**Marginal Utility**
0	0	0	0	0	0
1	2	2	1	1	1
2	10/3	4/3	2	2	1
3	13/3	1	3	3	1
4	77/15	4/5	4	4	1
5	174/30	4/6	5	5	1
6	...	...	...	...	...

Table 3.1: Isa's satisfaction.

Table 3.1 also shows Isa's marginal and total utility for all the other goods. This category contains a number of

different goods — think of it as a basket of goods containing all sort of products and services that Isa can choose from, going from apple juice to songs on iTunes. Because there is a huge variety of them, we assume that the marginal utility is not decreasing. If Isa is getting bored of consuming a certain good, she can switch to another! To keep things simple we are going to assume that the marginal utility *for all other goods* is constant. More precisely we are going to assume that Isa derives 1 *util* from each unit of the other goods she consumes.

LET'S GO BACK TO our original question: should Isa buy the first can of soda? By consuming the first can of soda Isa obtains 2 *utils*. Keep in mind that the price for a can of soda is $2, so to get the first one Isa has to forgo 2 units of the other goods (priced at $1 each), which would have brought her 1 *utils* each for a total of 2 *utils*. We assume that, when indifferent, Isa chooses the soda can. Hence Isa should buy the first can of soda. The rest of Isa's budget should be allocated using this protocol.

A fast inspection of Table 3.1 reveals that Isa should not consume the second can of soda.[1] If she were to do so she would obtain 4/3 *utils* from the extra can of soda, but she would have to forgo 2 units of the other goods for a total of 2 *utils*. Hence, Isa maximizes her utility when she consumes 1 can of soda and the remaining portion of her budget is used to buy 2 units of the other goods. In economics we say that the daily *quantity demanded* of soda and other goods is respectively 1 and 2 — when the price of soda is $2, the price of the other goods is $1 and the budget is $4.

How would the quantity demanded change if there was a change in prices? For example, suppose the price of a can of soda increases to $4. With this new price, by consuming the first can of soda Isa obtains 2 *utils* and has to forgo 4 units of the other goods, which would have brought her 1 *utils* each for a total of 4 *utils*. Hence, Isa should not buy the first can of soda. The quantity de-

[1] If you want to peek into the math under the hood, keep in mind that the utility function we used is $U(soda, others) = 4 \times \ln(1 + soda) + others$ and the budget constraint is $p_{soda} \times soda + p_{others} \times others = budget$. Substituting *others* from the budget constraint into the utility function and maximizing the latter with respect to *soda* yields the quantity demanded of soda we found in this section. The only difference being that in this footnote we used a *continuous* model instead of a *discrete* one.

Quantity Demanded: Quantity Demanded represents the quantity of a given good or service that maximizes the utility experienced by the individual consuming it.

manded is now 0 sodas and 4 other goods.

Why did the quantity demanded of soda decrease? One immediate reason is that the other goods became cheaper (relative to the price of soda) than before and so Isa decided to consume more of it. Given the fixed budget something needed to give and in this case the quantity of soda consumed decreased. In economics we call this *substitution effect*. The other more subtle channel is that an increase in the price soda makes Isa poorer in terms of her purchasing power. To see this, note that Isa could no longer afford the original consumption bundle after the price increase. Having less purchasing power entails again that something has to give, and in our case the consumption of soda did. In economic language, this is called *income effect*.

Substitution Effect: The Substitution Effect captures the change in the quantity demanded of a given good following a change in its relative price.

Income Effect: The Income Effect captures the changes in the quantity demanded of a given good following the reduction in the consumer's purchasing power.

Unlike the *substitution effect* — which always reduces (respectively increases) the quantity consumed of a good following an increase (respectively decrease) in its price — the *income effect* can go either way. For a *normal good* a decrease (and respectively an increase) in income reduces (and respectively increases) the quantity consumed. However, in the case of an *inferior good* the opposite applies: a decrease (and respectively an increase) in income increases (and respectively decreases) the quantity consumed.[2]

[2] An example of a normal good is expensive wine — as someone becomes richer, she tends to consume more of it. A classic example of an inferior good is fast food — as someone becomes richer, she tends to consume less of it.

Even when the good is inferior, the substitution effect is almost always stronger than the income effect and so an increase in the price of a good tends to reduce the quantity demanded of that good. Hence, in general, price and quantity tend to move in opposite directions: when the price increases the quantity demanded decreases. On the other hand, when the price decreases the quantity demanded increases.

This is also known as the *Law of Demand*, which simply states that demand curves tend to be downward sloping.[3]

Law of Demand: Demand curves have the tendency of being downward sloping.

[3] **Giffen Goods:** The exception to the Law of Demand is a Giffen Good for which an increase in price increases the quantity demanded. But these goods are extremely rare, in fact, almost mythical!

A VERY IMPORTANT CONCEPT in economics is that of

the *demand curve*. The demand curve represents the relationship between the price of a given good or service and the quantity demanded of that good and service. Keeping this in mind, let's derive the demand curve for soda in our example. To do so, suppose the price of soda decreases to $1 and find the optimal quantity. (Little hint: the quantity demanded of soda will increase to 3.) Now plot the price as a function of the quantities consumed we have derived so far. Connect these points and you will obtain the demand curve - see Figure 3.1. A quick look at Figure 3.1 reveals that the demand curve is indeed downward sloping.

Demand Curve: Demand Curve represents the relationship between the price of a good or service and the quantity demanded of that good or service.

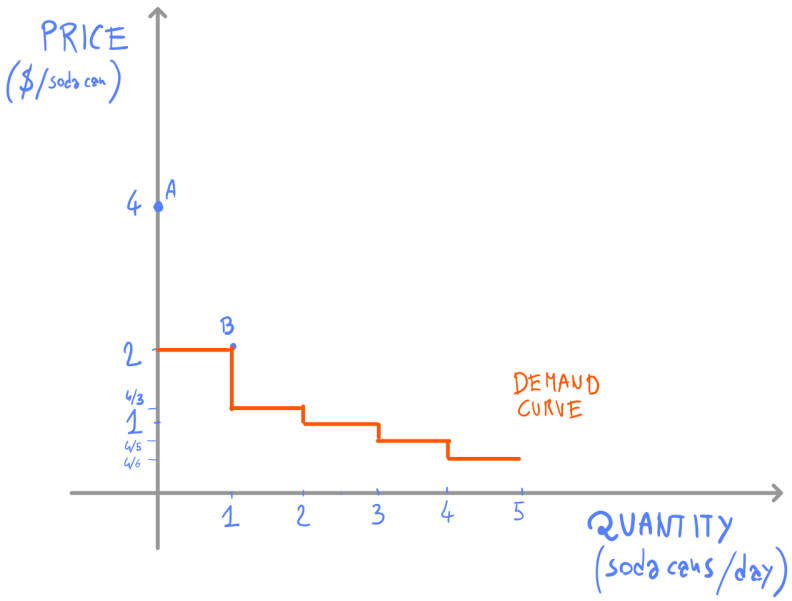


Figure 3.1: A representation of the demand curve.

The demand curve can be interpreted in two different ways, *horizontally* and *vertically*. The horizontal interpretation is easy: start from a certain price and then use the demand curve to derive how many units of the goods will be consumed at that price. The vertical interpretation is more tricky: start for a given quantity, say 2 cans of soda. Then find the associated price on the demand curve. The price you found can be interpreted as the maximum amount of money the consumer is willing to pay for the 2nd can of soda. In economics we call this *maxi-*

Horizontal Interpretation (of the Demand Curve): Start from a certain price and find the associated quantity on the demand curve. The quantity you found indicates how many units the consumer is willing to buy at that price.

Vertical Interpretation (of the Demand Curve): Start from a certain quantity (say 2 units) and find the associated price on the demand curve. The price you found indicates the maximum amount of money the consumer is willing to pay for the *marginal* unit (in our example the marginal unit would be the 2nd unit).

mum amount of money the *reservation price* or *willingness to pay* for the 2nd can of soda.

Consumer Reservation Price (or Willingness to Pay): Consumer Reservation Price (or Willingness to Pay) denotes the maximum amount of money an individual is willing to pay for a certain good or service.

3.2 *From a Discrete to a Continuous Model*

In the previous section we considered a model where the consumer could only buy goods in whole numbers. This implied that there was a limited set of soda cans that could be acquired and consumed.

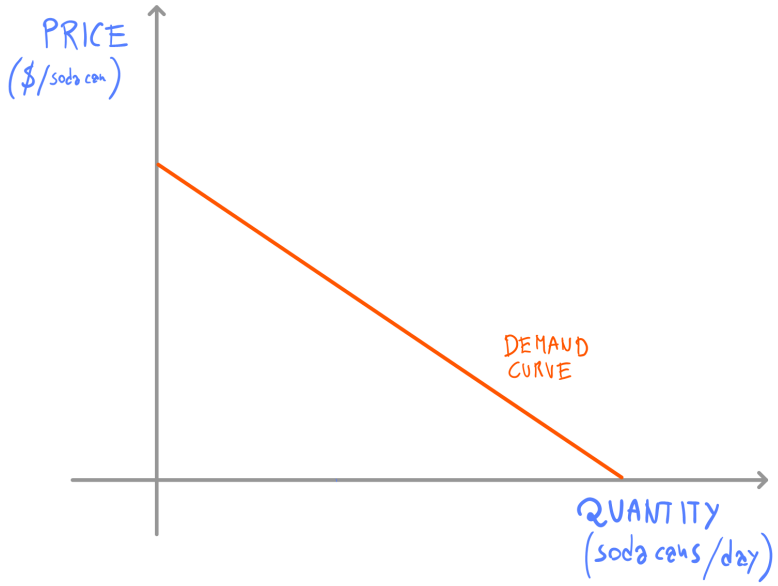


Figure 3.2: A representation of the demand curve in a continuous model.

What would happen if the demand were much more flexible, and say the consumer could select the exact amount of soda cans she wants — for example 0.5? The resulting graph would be smooth as in Figure 3.2.

There might be reasons other than the price of soda that might affect Isa's decision of how many cans of soda she consumes.

Keep the price of soda constant and suppose the entrepreneur launches a particularly effective marketing campaign. This might increase the marginal utility that Isa experiences from soda consumption. Even though the price has not changed, the number of soda cans consumed by Isa might increase. This generates a *shift* of the

demand curve to the right.

Another factor that might affect Isa's decision is the price of other goods. In our example, we looked at two goods that are substitutes — at any given point in time Isa consumes soda or other goods and does not find particularly attractive to consume them both *at the same time*. More rigorously, we say that two goods are *substitutes* when an increase in the price of one causes an increase in the quantity demanded of the other. In our example an increase in the price of other goods would *shift* the demand curve of soda to the right.

Substitutes: Two goods are Substitutes when an increase in the price of one causes an increase in the quantity demanded of the other.

We assumed that Isa does not enjoy mixing soda and other goods. However, she might like eating chips while she drinks her soda. In this case, chips and soda are *complements*. More rigorously, we say that two goods are complements when a decrease in the price of one causes an increase in the quantity demanded of the other. In our example, a decrease in the price of chips would *shift* the demand curve of soda to the right.

Complements: Two goods are Complements when a decrease in the price of one causes an increase in the quantity demanded of the other.

Here is the list of the factors that can generate a shift *to the right* of the demand curve of a given good. (A shift to the left is generated if these factors move in the opposite direction.)

1. *Successful marketing campaign*
2. *Decrease in the price of complements*
3. *An increase in the price of substitutes*
4. *An increase in income for a normal good*
5. *A decrease in income for an inferior good*
6. *A positive shift in consumers' preferences towards a certain good*
7. *Expectations of an increase in future prices that push the buyers to try to purchase the goods early*
8. *Population growth*

3.3 *Price Elasticity of Demand*

It is useful to have a measure of the "responsiveness" of the quantity demanded of a given good to changes in its price. This measure is used by governments and firms to have a better understanding of the markets they are interacting with. Of course, there are many ways of measuring this responsiveness. Economists often use the notion of *price elasticity of demand*.

Price Elasticity of Demand: The Price Elasticity of Demand captures the percentage change in quantity demanded resulting from a very small percentage change in price.

Take two points, A and B, on a demand curve that is a straight line. Denote by P_A the price at point A and by P_B the price at point B. Also, denote by Q_A the quantity demanded at point A and by Q_B the quantity demanded at point B. Finally, let ΔQ and ΔP capture the change in quantity ($\Delta Q = Q_B - Q_A$) and the change in price ($\Delta P = P_B - P_A$), respectively. Here is the formula for elasticity *at point A*:

$$Elasticity_A = \frac{\frac{\Delta Q}{Q_A}}{\frac{\Delta P}{P_A}} \tag{3.1}$$

where the percentage change in price ($\frac{\Delta P}{P_A}$) is suitably small (say, for example, $\frac{\Delta P}{P_A} = 1\%$).

Suppose that the per-unit price of apple pie changes from \$10 ($P_A = \$10$) to \$10.1 ($P_B = \$10.1$). Then the percentage change in price ($\frac{\Delta P}{P_A}$) is exactly 1% ($\frac{\$0.1}{\$10} = 0.01 = 1\%$). Also assume that, following this 1% change in price, the quantity demanded decreases from $1,000$ to 900 apple pies per day. Then the percentage change in quantity ($\frac{\Delta Q}{Q_A}$) is -10% ($\frac{-100 pies/day}{1{,}000 pies/day} = -0.1 = -10\%$). Remember the price elasticity of demand is equal to the percentage change in quantity divided by the percentage change in price. In this case, the elasticity is equal to -10!

NOTE THAT THE PRICE elasticity of demand is almost always negative. This is due to the fact that price and quantity tend to move in opposite directions: when the price increases the quantity demanded decreases. On the other hand, when the price decreases the quantity

demanded increases. This is what we characterized above as the *law of demand* (remember?) — demand curves tend to be downward sloping. If a demand curve is indeed downward sloping, then its elasticity must be negative.

For simplicity, hereafter we will ignore the negative sign and we will just consider the absolute value of the price elasticity. In the context of our previous example, we will say that the price elasticity is 10 (instead of -10).

Moreover, we will say that the demand is:

(i) *elastic* if price elasticity of demand is greater than 1,

(ii) *unit elastic* if price elasticity of demand is equal to 1,

(iii) *inelastic* if price elasticity of demand is less than 1.

Elastic Demand: Demand is elastic if the price elasticity of demand is greater than 1.

Unit Elastic Demand: Demand is unit elastic if the price elasticity of demand is equal to 1.

Inelastic Demand: Demand is inelastic if the price elasticity of demand is less than 1.

A simple way to compute the price elasticity of demand is by using a graph. Look at Figure 3.3 and take point A as the initial combination of price and quantity, which are denoted by P_A and Q_A respectively. The formula for elasticity at point A can be rewritten as follows:

$$Elasticity_A = \frac{P_A}{Q_A} \times \frac{1}{slope} \tag{3.2}$$

where the term *slope* indicates the gradient of the demand curve.[4] Given that the demand curve represented in Figure 3.3 is a straight line, the slope will be the same in every point on the curve. However, the elasticity will not be the same. Take for example point B in Figure 3.3. The elasticity at that point is $3/7$, which is different from the elasticity at point A (which is 1). In fact, the elasticity will decrease along the demand curve moving from left to right, as the price decrease and the quantity increases. In the mid-point for the demand curve (point A in Figure 3.3), the elasticity is exactly equal to one.

[4] It is easy to see that 3.2 is just a rearranged version of equation 3.1. To see this, note that $slope = \frac{\Delta P}{\Delta Q}$ (rise/run, remember?).

3.4 *Determinants of Price Elasticity of Demand*

What are the factors that make demand more or less elastic? In order to answer this question, we need to understand what affects the willingness of an individual to ad-

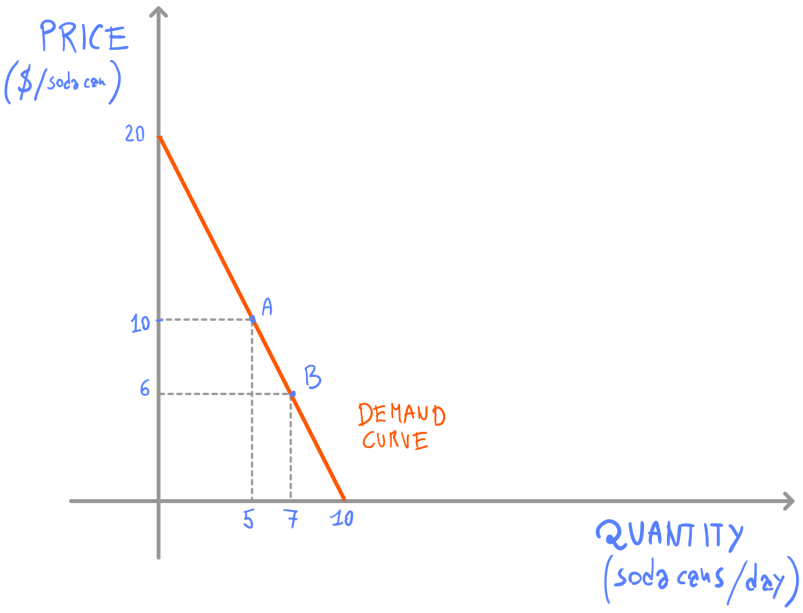


Figure 3.3: A simple way of computing elasticity using a graph.

just his consumption decisions after a price change. Here is the list of the main factors:

1. *Availability of substitutes*: The larger the number of substitutes, the more elastic demand tends to be. If there are many close substitutes for a certain good (or service), consumers are likely to respond strongly to an increase in its price — because they can easily switch to similar products.

2. *Definition of a good:* The broader the definition of a good (or service), the lower the elasticity. If you take *salt* as the whole category, then this category has almost no substitutes and so, elasticity is likely to be low. However, if you consider a certain *brand* of salt, then the elasticity for that particular brand is likely to be high as there are many alternative brands of salt that are very close substitutes.

3. *Income share:* The larger the share of income required to purchase a good (or service), the higher the elasticity. Think of an 80% increase in the price of a $0.2 pen. You would probably hardly notice it, and it might not affect your decision to buy that pen at all. How about

a 80% increase in the price of that expensive $6,000 vacation you wanted to take? Well, that might affect your decision quite drastically!

4. *Time horizon:* The longer the time horizon, the higher the elasticity tends to be. If the time horizon is long enough, buyers can search for alternative substitutes and revise their consumption plans more easily.

REVISION QUESTIONS

Question 1.

When the price of an inferior good rises, ceteris paribus, which of the following statements is true?

a) The income and substitution effects both act to increase the quantity demanded.

b) The income and substitution effects both act to decrease the quantity demanded.

c) The income effect acts to decrease the quantity demanded, while the substitution effect acts to increase the quantity demanded.

d) The income effect acts to increase the quantity demanded, while the substitution effect acts to decrease the quantity demanded.

Question 2.

The publisher of a magazine gives his staff the following information:

Current price	$2.00 per copy
Current sales	150,000 copies per month
Current revenue	$300,000 per month
Current costs	$450,000 per month

He then tells the staff, "Our costs are currently $150,000 more than our revenues each month. I suggest we solve this problem by raising the price of the magazine to $3.00 per copy. This will result in our revenue being exactly equal to our cost." Which of the following statements is correct?

a) The publisher's analysis is correct only if the demand curve is elastic.

b) The publisher's analysis is correct only if the demand curve is unit-elastic.

c) The publisher's analysis is correct only if the demand curve is vertical.

d) The publisher's analysis is correct only if the demand curve horizontal.

Question 3.

What is the concept of utility in economics?

a) Something useful.

b) The state of being useful, profitable, or beneficial.

c) Infrastructure such as gas, electricity and water.

d) It is a way of expressing the satisfaction that an agent derives from consuming a good, typically measured in utils per unit of time.

Question 4.

a) Explain the implications of a shift of a demand curve. Also, what does this suggest about the factors that have caused the shift?

b) Consider a movement along a demand curve. Economically, what does this suggest?

c) Explain two factors that might shift the demand curve and one factor that may cause a movement along the demand curve.

d) What is the definition of a substitute? And what is the definition of a complement good?

e) Suppose that the price of printer cartridges increases. How will this affect the demand curve for the good it complements, i.e. printers?

Question 5.

a) What does decreasing marginal utility mean?

b) Assume that you derive utility from the consumption of two goods, CDs and hamburgers. The utility you receive from each good at various levels of consumption is shown below. Complete the following table for hamburgers and CDs:

Hamburgers			CDs		
Units	Total utility	Marginal utility	Units	Total utility	Marginal utility
0	0		0	0	
1	25		1	48	
2	48		2	59	
3	68		3	63	
4	84		4	66	
5	98		5	68	
6	108		6	69	
7	116		7	70	
8	122		8	70	
9	122		9	70	
10	120		10	70	

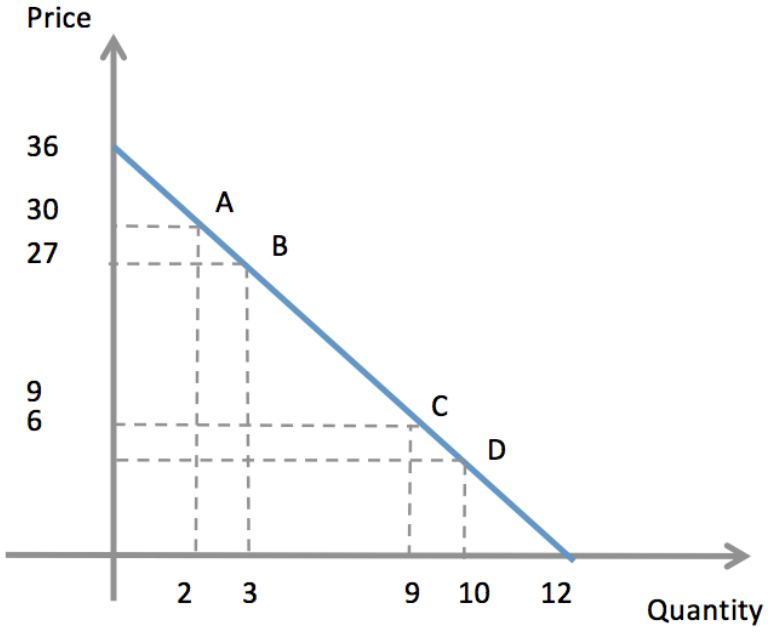
c) Using the data in b), assume that:

- you have $40 to spend, and the price of CDs is $10, while the price of hamburgers is $5.
- in expanding the consumption of CDs, whenever the marginal benefit is equal to the marginal cost, the buyer will decide to purchase the CD.

Using these assumptions, calculate the optimal amount of CDs and hamburgers that maximizes utility. (Note: CDs and hamburgers can only be purchased in integer amounts).

d) What does the information in the table tell you about the 9th and 10th hamburger?

Question 6.



What is the absolute value of price elasticity of demand at point B?

Question 7.

The absolute value of price elasticity of demand for a product is 4. Assume that the price for this product decreases by 15%. If sales before the price change were 200 units, what will sales be after the price change, ceteris paribus?

Question 8.

Consider a linear demand curve.

a) Define elasticity and explain what it captures.

b) Explain why the elasticity of demand is declining, as you move from left to right along the demand curve. (Use the math formula for elasticity to explain your answer.)

4
Demand and Supply: An Equilibrium Analysis

It is now time to put the analysis of demand and supply together and discuss how these two forces affect the price in a market. To this purpose, we need to move from individual demand and supply curves to the aggregate ones, which include a potentially large number of buyers and sellers.

4.1 Demand and Supply Aggregation

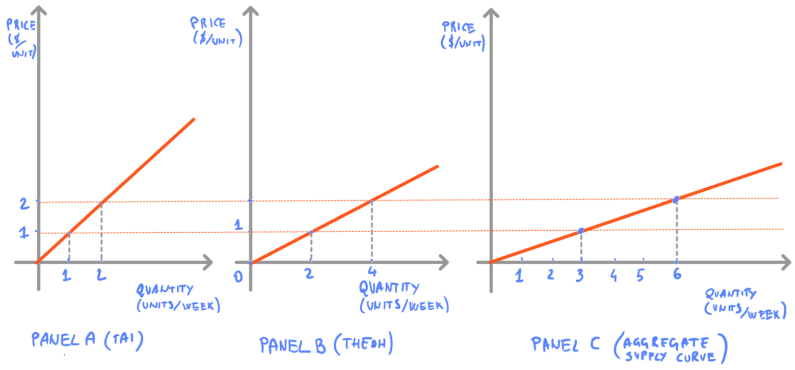


Figure 4.1: Building the aggregate supply curve.

Consider the apple juice market, where Theoh is the producer and Isa is the consumer. Suppose now there is another producer of apple juice (say, Tai). The product offered by Tai is identical to the one produced by Theoh even though the production technology might be different. For this reason Tai's supply curve is different. See panel A in Figure 4.1. In order to find the supply curve for the whole market we need to sum up the two sup-

ply curves *horizontally*. To do so, take a price, check how much Theoh and Tai are willing to produce at that price and then sum up these quantities. Repeat the operation for a number of different prices and you will obtain the aggregate supply curve. See panel C in Figure 4.1.

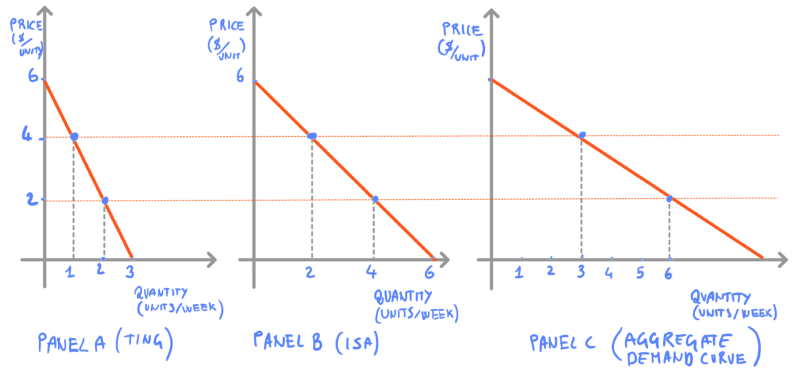


Figure 4.2: Building the aggregate demand curve.

Similarly, Isa might not be the only consumer. Meet Ting. She is looking into buying some apple juice and her demand function is presented in panel A in Figure 4.2. In order to obtain the aggregate demand for the whole market you just need to sum the demand curves *horizontally*, as we did before for the supply side of the market. See panel C in Figure 4.2.

Oftentimes, markets are composed by a large number of consumers and producers. Our example with two consumers and two producers is just that, an example. However, the process to obtain the aggregate demand and supply for a market with many individuals is the same as the one described above: the *aggregate* demand and supply is the *horizontal* sum of the individual demand and supply curves.

4.2 *Market Equilibrium*

We are finally ready to show how much gets traded in the market and at what price, that is the market equilibrium.

Figure 4.3 depicts the aggregate demand and supply in the market for apple juice where there are many buyers

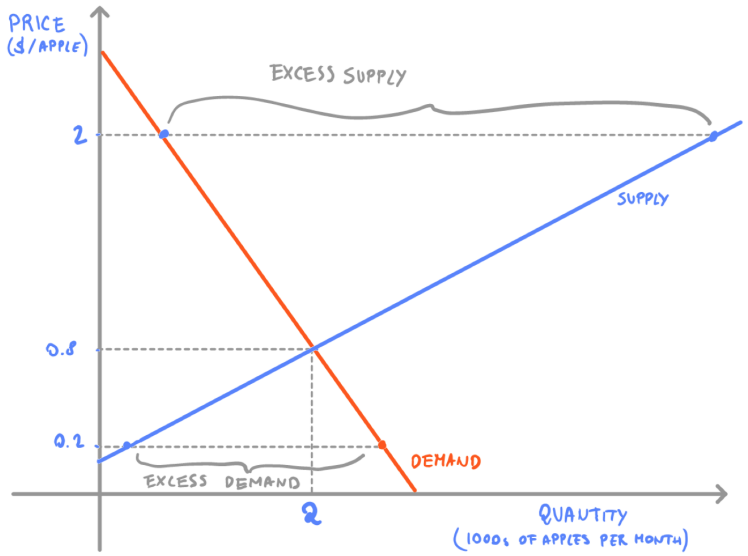


Figure 4.3: The market for apple juice.

and sellers. Note that $0.80 is the only price at which the quantity demanded equals the quantity supplied. Any other price would either create an *excess demand* or an *excess supply*.

Excess Demand: Excess Demand depicts a situation where the quantity demanded is larger than the quantity supplied.

Excess Supply: Excess Supply depicts a situation where the quantity supplied is larger than the quantity demanded.

A price that generates either excess demand or excess supply in the market is unlikely to be an equilibrium because either the buyers or the sellers have an incentive to change their behaviors. In the case of an excess supply, it is easy to see that sellers who are left without a buyer will find it desirable to lower the price in order to attract one (buyer). In the case of an excess demand, the buyers who are unable to secure the good will be willing to pay a higher price in order to get some. This adjustment process will continue until this excess demand or supply is eliminated. We denote by *equilibrium price and equilibrium quantity* the price and quantity such that the quantity supplied equals the quantity demanded. At the equilibrium price and quantity no one has an incentive to change the prevailing behavior.

Equilibrium Price and Quantity: The Equilibrium Price (Quantity) represents the price (quantity) such that the quantity supplied equals the quantity demanded.

One aspect of this equilibrium analysis might be surprising. We have defined a *perfectly competitive market* as a market where both buyers and sellers are price takers. But our discussion pointed out that both of them *can* ac-

tually change the price. However, they are unwilling to do so if the price is at the equilibrium level. To be precise then, our definition should read as follows: "in order for a market to be perfectly competitive, buyers and sellers need to be (equilibrium) price *accepters*".

An example of how this mechanism could operate might be useful at this point. Let's consider a market with 6 buyers and 6 sellers. Each buyer wants to buy at most one unit of the (indivisible) good, while the sellers are willing to sell at most one unit each. The buyers differ in terms of their *reservation price*, where the reservation price is simply the highest price they are willing to pay for a given good. If the price at which the good is sold is above the buyer's reservation price, the buyer will not buy it. Similarly, the sellers also have different *reservation prices*, which are defined as the lowest price they are willing to accept. If the price at which the good is sold is below the seller's reservation price, the seller will not supply it. Of course the reservation prices indicate just the opportunity costs associated with acquiring (for the buyers) and producing (for the sellers) the good, measured in dollars. Some different buyers and sellers are depicted in Figure 4.4. The y-axis reports the price and the x-axis shows the quantity. Figure 4.4 also depicts the reservation prices in descending order for the buyers and ascending order for the sellers.

Reservation Price (Buyer): The Reservation Price of a Buyer is the highest price a buyer is willing to pay for a given good.

Reservation Price (Seller): The Reservation Price of a Seller is the lowest price a seller is willing to accept for a given good.

Here we make a simplifying assumption: the buyers who value the good more will be the first to buy it. This is called the *rationing rule*. The allocation mechanism can then be construed as a sequential game. The buyer with the highest reservation price moves first and decides which seller to approach, where the price requested by each seller is *common knowledge*. Once the seller is approached, the buyer pays the price and the seller produces the good and transfers it to the buyer. The buyer with second highest evaluation then moves and decides which seller to approach among the remaining ones, and so on and so forth.

Rationing Rule: The Rationing Rule states that buyers who value the good more will be the first to buy it.

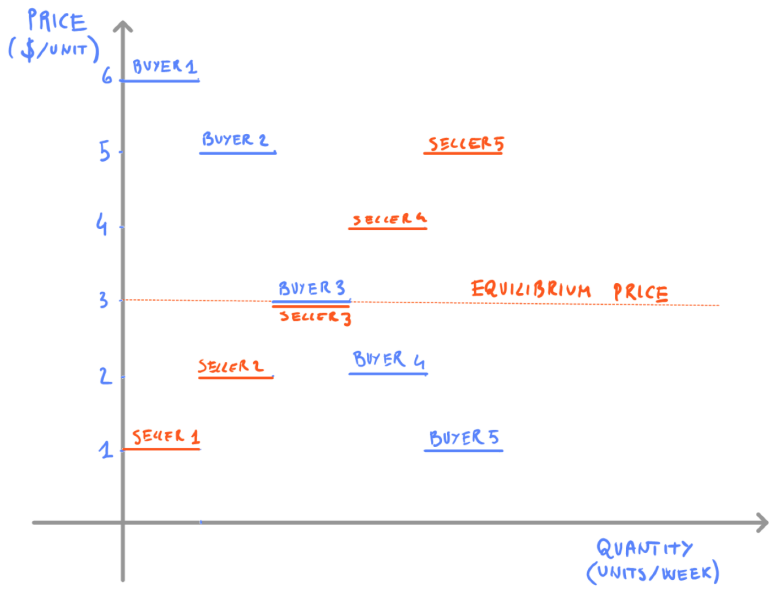


Figure 4.4: The reservation prices of buyers (in descending order) and sellers (in ascending order).

What we want to show is that in equilibrium (a) every seller sells at the same price, and (b) the price is such that the quantity demanded is equal to the quantity supplied. Suppose that the price is $5. Buyer 1 buys the good from Seller 1. Note that the amount she had to pay is less than what she was willing to pay (her reservation price); the difference between the two is called *consumer surplus*. The consumer surplus for Buyer 1 is given by her reservation price ($6) minus the price that is actually payed ($5). In a formula,

Consumer Surplus: Consumer Surplus represents the difference between what a consumer is willing to pay for a good or service (her reservation price) and what she actually pays for that good or service.

$$\text{Consumer Surplus (Buyer 1)} = \$6 - \$5 = \$1. \qquad (4.1)$$

Given that Buyer 1's consumer surplus is a positive number, the cost-benefit principle suggests that Buyer 1 should indeed acquire the good. Something similar applies to our Seller 1, the price she received is higher than what she was willing to accept (her reservation price). The *producer surplus* for Seller 1 is given by the price she actually receives ($5) minus her reservation

Producer Surplus: Producer Surplus represents the difference between the price a seller receives for a good or service and what he was willing to receive for that good or service (her reservation price).

price ($1):

$$\text{Producer Surplus (Seller 1)} = \$5 - \$1 = \$4. \qquad (4.2)$$

It is easy to check that the same applies to the pair Seller 2 / Buyer 2. However, Buyer 3 is unwilling to acquire the good because her surplus is negative ($3 - $5 < 0), and so do all the remaining buyers.

Does any participant to this market have an incentive to modify his or her behavior? As it turns out, the answer is yes! Seller 3 has an incentive to lower the price to $4 dollars.

Let's analyze the impact of this deviation on the buyers' behavior, and keep the behavior of all the other sellers constant. Remember that Buyer 1 moves first, so she will buy from Seller 3 who is now selling the good at the lowest price ($4 compared to everyone else selling at $5). Seller 3 makes a positive surplus ($4-$3=$1) and so, this was indeed a positive deviation for him. Buyer 2 continues to buy from Seller 2, and Buyers 3-4-5 continue to refrain from buying.

Given this new outcome, does any participant to this market have an incentive to modify his or her behavior? Clearly, Seller 1 lost his client to Seller 3 and so he suffered a reduction in his surplus. A natural response would be for Seller 1 to lower the price to $4 dollars, essentially undercutting Seller 2. A fast inspection reveals that this process will continue until the point where all the sellers offer $3. It is also easy to check that whenever the market price reaches $3 nobody has an incentive to change the behavior.

Similarly if the market price starts from a value below $3 some buyer will find it optimal to announce that she is willing to pay a higher price. The result would again be convergence back to the outcome where all sellers are offering the good at the same price $3.

We can then conclude that the market described above satisfies the first condition required from this market to be referred to as *perfectly competitive*. Buyers and sellers

are price-takers in the sense that if they were to try to change the price away from the equilibrium level they would be unable to sell or buy anything. Thus, they take the equilibrium price as given.

4.3 *Consumer and Producer Surplus*

There is a simple way to gauge the total consumer and producer surplus by looking at the demand and supply graph. Just note that the area comprised between the reservation price and the market price for each consumer and producer represents their economic surplus. See Figure 4.5.

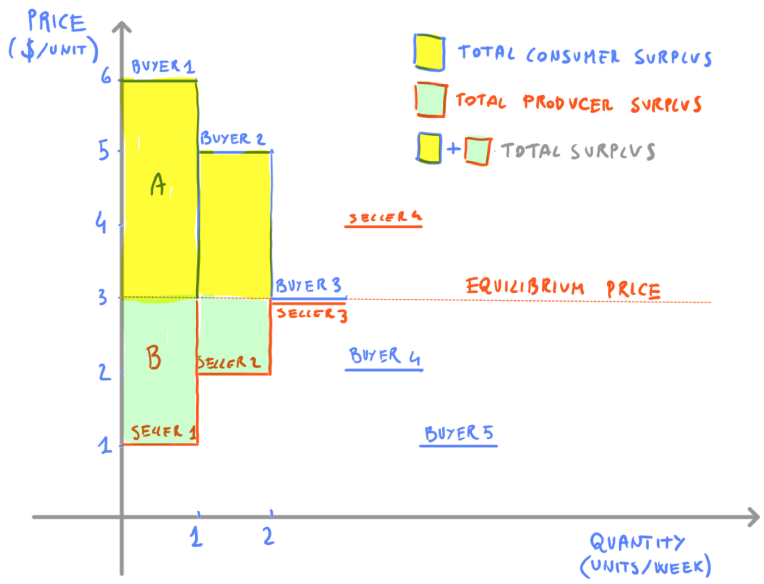


Figure 4.5: Consumer and Producer surplus.

We call the sum of the economic surplus of all consumers *total consumer surplus*, whereas the sum of the economic surplus of all producers is referred to as *total producer surplus*. Finally, the sum of the total consumer surplus and total producer surplus is refered to as *total surplus*.

Total Consumer Surplus: Total Consumer Surplus represents the sum of the economic surplus of all consumers.

Total Producer Surplus: Total Producer Surplus represents the sum of the economic surplus of all producers.

Total Surplus: Total Surplus is the sum of the total consumer surplus and the total producer surplus.

Interestingly, in this perfectly competitive market, the total surplus is maximized exactly at the equilibrium price. Check this by calculating the total surplus for any

alternative price. You will find that the equilibrium price is the only one that maximizes the total surplus.

So far we have considered a market with a limited number of buyers and sellers, all of whom are able to sell or buy at most one unit of the good. If one would increase the number of buyers and sellers, the demand and supply graph would look more akin to Figure 4.6.

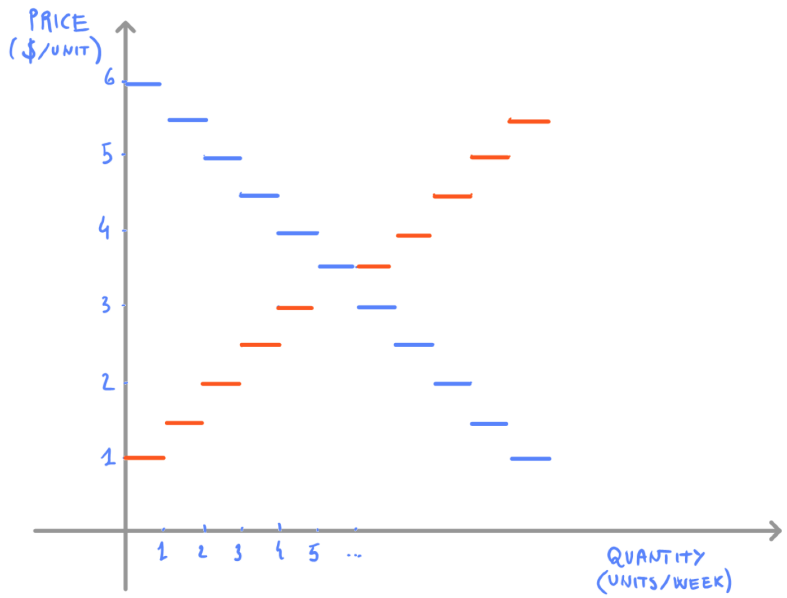


Figure 4.6: Consumer and Producer surplus in a larger market.

An even larger market, with a huge number of buyers and sellers, all capable of selling and buying multiple units, would look like the one depicted in Figure 4.7. For simplicity, hereafter we will consider large markets where the demand and supply curve can be represented by smooth straight lines such as the ones depicted in Figure 4.7.

In this case, the total consumer surplus is equal to the area below the demand curve and above the market equilibrium price; the total producer surplus is equal to the area above the supply curve and below the market equilibrium price. As before, the sum of these two areas is maximized when the perfectly competitive market reaches its equilibrium price and quantity. If you are skeptical, just try as many different prices as you want.

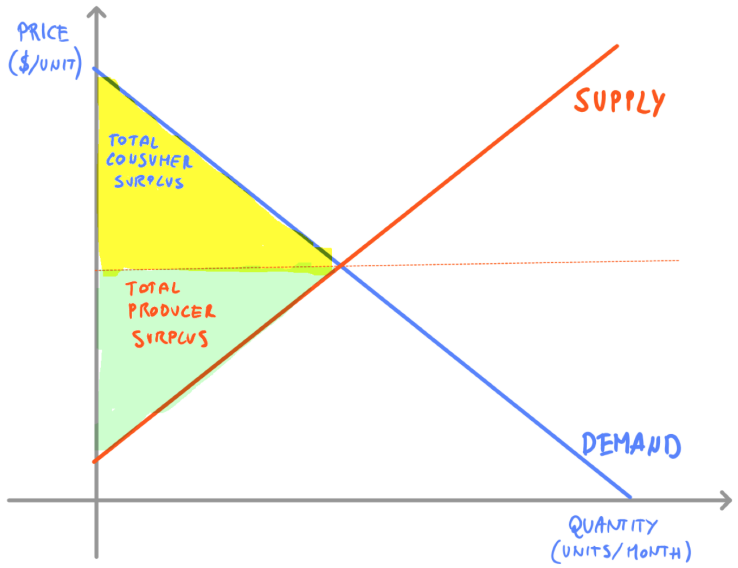


Figure 4.7: An even larger market!

You will notice that the corresponding total surplus at any other price is going to be lower than the one achievable at the market equilibrium price.

4.4 *This Toy is Yours to Play With*

In economics we would call the demand-supply model we just built a *toy model*. It is simple and yet powerful, and if you play with it you can learn something interesting. This is the quintessence of a toy model: it is not a perfect representation of reality, but it is an interesting tool to *discuss* about it, provided that you are willing to use it wisely and are ready to recognize its limitations. For example, suppose your dad reads in the newspaper that there has been an increase in the number of people with an interest in sailing boats in the Sydney bay, an activity that he also loves doing. He must be asking himself: "Am I going to end up paying more for my little sailing hobby?" This is a question that you should be able to answer. Recall that an increase in the number of consumers will shift the demand curve to the right. How does this affect the equilibrium price? Our model suggests that

the price will increase. The best way of seeing this is to actually draw the demand and supply and their corresponding movements. See for example Figure 4.8.

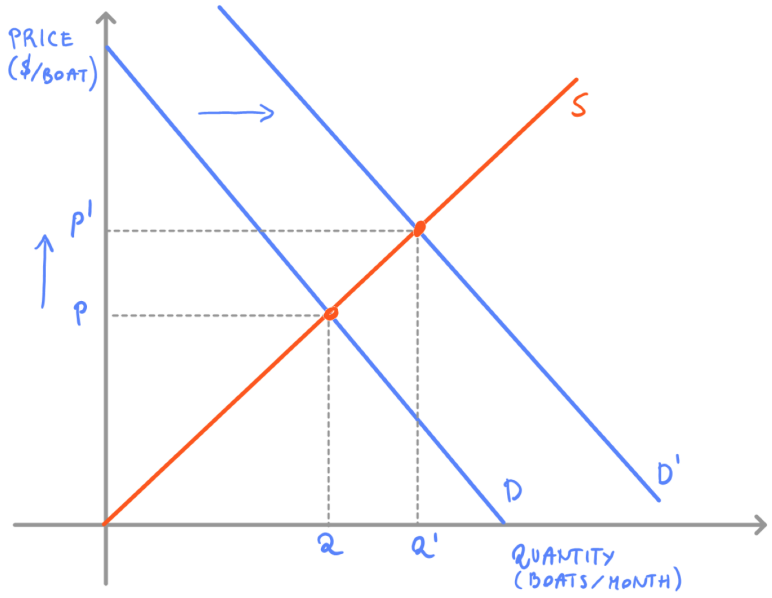


Figure 4.8: The effect of an increase in the number of consumers on the equilibrium price.

What if instead the number of suppliers renting out their boats were to increase instead? Well, our model offers a simple prediction. The supply curve shifts to the right and the equilibrium price decreases. See Figure 4.9.

Sometimes the answer is not that straightforward. Suppose that following a successful advertising campaign people are suddenly more keen on sailing (demand shifts to the right). Suppose also that the cost of producing new boats decreases due to an excess in the supply of a certain type of wood. Hence, old boats that are no longer usable are replaced at a faster rate than before (supply shifts to the right). What is the effect on the equilibrium price? Well, given the information we have, we cannot provide a definite answer. See Figure 4.10 for an example where the equilibrium price might increase or decrease as a result of a simultaneous change in both demand and supply.

Clearly, there are a number of different scenarios and combinations of demand and supply shifts that might occur in the real world. The demand-supply model gives

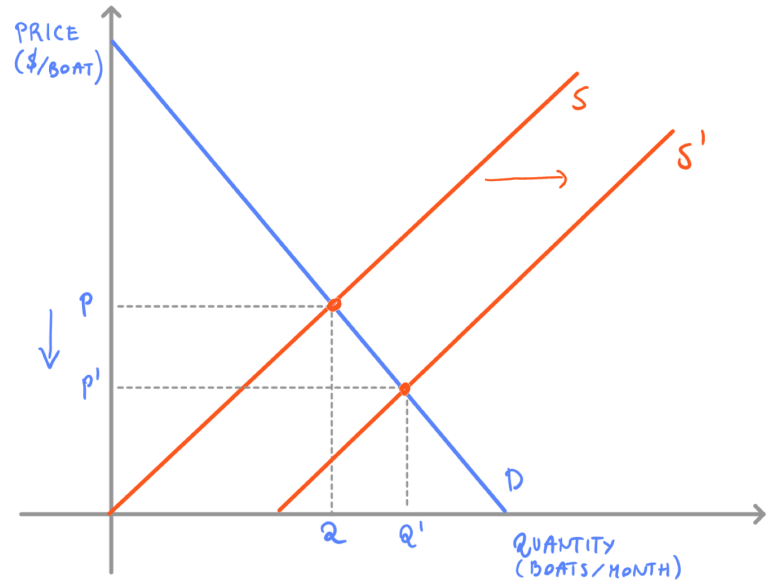


Figure 4.9: The effect of an increase in the number of producers on the equilibrium price.

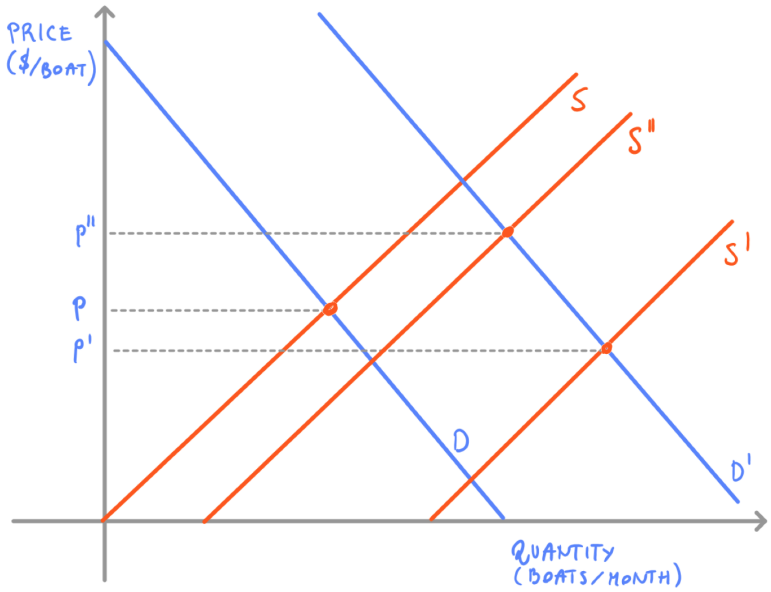


Figure 4.10: A situation where the equilibrium price might increase or decrease as a result of a change in the market demand and supply.

you a simple tool to make quick predictions. Your predictions are based on reasonable assumptions regarding consumers' preferences (decreasing marginal utility), suppliers' cost structures (increasing marginal cost) and market condition (no single consumer or supplier can affect the market price). The model you use is simple (you can explain its basic features in less than a minute), but those who are not familiar with it would not be able to come up with it off the top of their head. And we can guarantee you this: having a model in mind behind any economic conversation you have is going to make you look incredibly smart! This toy model really is for you to play with!

4.5 *Competitive Markets Are Great! Pareto Efficiency (Short Run)*

One of the reasons why economists love competition is that a perfectly competitive market equilibrium is *Pareto efficient*. Pareto efficiency is a situation in which it is impossible to make any individual better off without making at least one other individual worse off.[1] In other words, a situation is Pareto efficient if there is no transaction that be can be arranged that would make someone better off without harming someone else. This kind of transaction is called a *Pareto improving transaction*. The perfectly-competitive market equilibrium is Pareto efficient because any attempt to move the price from its equilibrium level results in a reduction of the total surplus, hence someone must be left worse off.

Pareto Efficiency: Pareto Efficiency is an outcome situation in which it is impossible to make any individual better off without making at least one other individual worse off.

[1] Vilfredo Pareto (1984-1923) was an Italian economist who studied economic efficiency and income distribution.

Pareto Improving Transaction: A Pareto Improving Transaction is a transaction where all parties involved are better off.

If you pause one moment to think about it, you will find that this result is very striking. Markets are capable of coordinating production in a way that eliminates any excess supply or excess demand. And they do so autonomously, even when they involve countless buyers and sellers, and without the need for any centralized control, dictator or head of state. And this is not all. Markets achieve this in a way that is Pareto efficient, which means that the total societal surplus is maximized — there is no

alternative outcome that could make society as a whole better off. Isn't this amazing!

We know, we know... Economists can get overly excited about markets and we are no exception. If you are also getting excited, we must recommend caution and critical thinking.

The notion that the market equilibrium is Pareto efficient is certainly a good thing. But we need to keep in mind that an efficient outcome does not need to be a *desirable one*. One problem with the concept of Pareto efficiency is that it is completely agnostic when it comes to equity, for example. It also makes no statement about the overall well-being of a society. Imagine a situation where a rich person owns hundreds of wild horses, yachts, remote Fijian islands and private jets. Suppose also this rich man suffers from a complete lack of altruism: he cares only about himself. Now take a poor individual hardly able to provide for himself. Imagine a situation where we take $10 from the rich guy and we transfer them to the poor guy. Would this transaction be Pareto Improving? Well, many of us would agree it is, but strictly speaking, from a Pareto point of view, it is easy to see that it is not. The poor man is better off, but the rich man is made worse off — however marginally. This transaction, then, cannot be Pareto improving.

This example should highlight that Pareto efficiency is a valuable objective, but it cannot be the final goal. A society should facilitate markets in their quest of maximizing social surplus and achieving Pareto efficiency. But once this objective is achieved (the social pie is maximized), society should consider how to redistribute the surplus in order to realize other goals, such as equality of resources and opportunities.

4.6 *Competitive Markets Are Great! The Invisible Hand (Long Run)*

The Invisible Hand Principle: The Invisible Hand Principle states that individuals' independent efforts to maximize their gains (profits for the sellers and utility for the buyers) will generally be beneficial for society and result in the socially optimal allocation of resources.

As if the previous section was not praising them enough, here we present yet another reason why markets are desirable - the *invisible hand principle*. We show they have the additional feature of *pushing* firms to produce at the lowest possible total cost. This is likely to happen in the *long run*, a period of time where (1) existing firms can adjust all their factors of production and perhaps exit, and (2) new firms can enter the market.

The mechanism is incredibly simple. If firms in a market are making positive profits, there is an incentive for new ones to enter the market. An increase in the number of firms shifts the supply curve to the right, which in turn reduces the equilibrium price. See Figure 4.11.

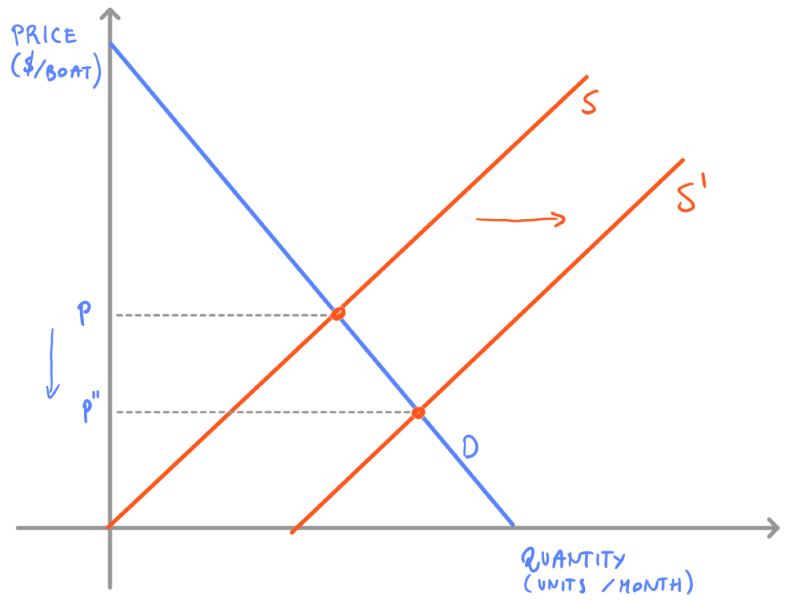


Figure 4.11: Reduction in the equilibrium price due to entry.

Remember that firms in a perfectly competitive market are price takers and so, they just take the new equilibrium price as given. Figure 4.12 shows the reduction in profit due to the change in the equilibrium price.

Let's consider here a simple example, where all firms have the same productive technology. Therefore, their

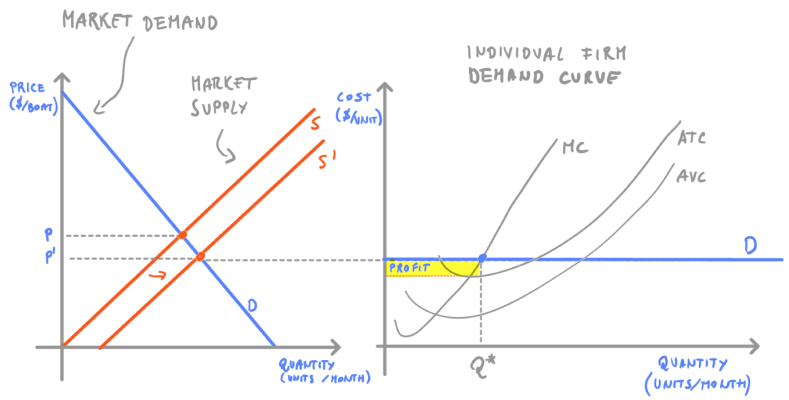


Figure 4.12: Reduction in profit due to entry.

cost curves are also identical. In this case, entry will continue until the point where all the firms in the market are making exactly zero profit. Note that at this long run equilibrium price each firm produces a quantity such that the average total cost (ATC) is minimized. The long run equilibrium price is then just equal to the minimum ATC. See Figure 4.13.

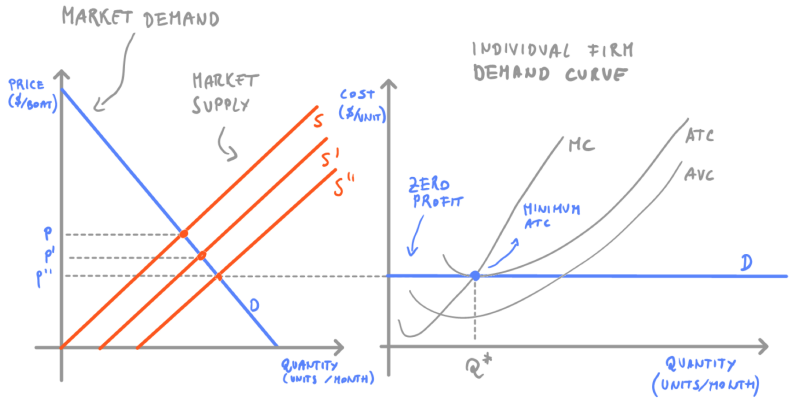


Figure 4.13: Entry continues until the point where profits are equal to zero and the market price equals the minimum average total cost.

Note that a similar process would occur whenever firms make negative profits. In that case, some of the firms would exit the market. The supply curve shifts to the left and the equilibrium price increases, effectively reducing the loss incurred by the surviving firms. This exit process, followed by an increase in price, continues until the firms remaining in the market make zero profit.

4.6.1 *The Long Run Supply Curve*

What does the long run supply curve look like in this type of market? Remember we assumed there was a large number of firms all producing the same good and using the same technology. Hence, in the long run consumers can buy as many units as they want at a price equal to the minimum *ATC*. Hence the long run supply curve for the whole market is going to be a horizontal line, with vertical intercept equal to the minimum average total cost. Figure 4.14 depicts the long run equilibrium in the market.

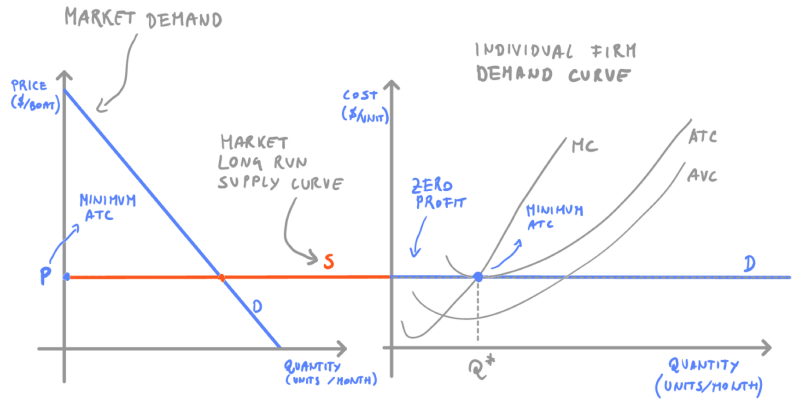


Figure 4.14: Long run market equilibrium. Supply curve is a horizontal line.

Think back of the example where your father read the newspaper and discovered that there was an increase in demand for renting sailing boats. In the short run we predicted that the market would adjust to this change by increasing the equilibrium price. After all, the increase in demand puts pressure on existing suppliers to rent out sailing boats for more hours each day. Because of increasing marginal costs, the suppliers find it more and more costly to rent out for the extra hours and this in turn pushes the price up. In the end, the quantity of boats rented out (per day) will increase and so will the new equilibrium price.

In the long run, on the other hand, an increase in demand would have no effect on the market. See Figure 4.15.

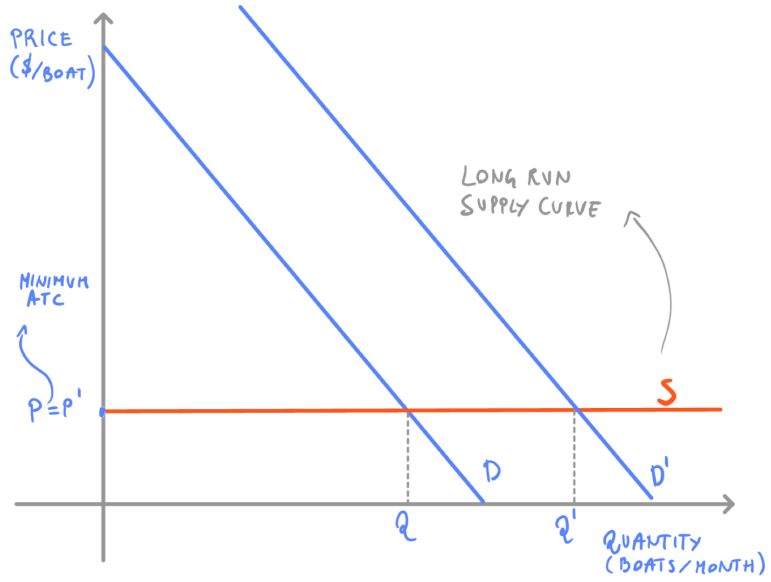


Figure 4.15: In the long run demand shifts have no effect on the equilibrium price.

This is due to the fact that new suppliers enter the market, effectively nullifying the pressure on existing suppliers. Entry continues and the price remains stable at the level of the minimum *ATC*. What changes, and dramatically at that, is the quantity rented out, which increases more than it would have in the short run.

This example offers us an interesting occasion to reflect on the differences between short and long run. In the short run an increase in the quantity demanded raises the price and the quantity, whereas in the long run the price is more likely to be stable and all the adjustment occurs via the quantity offered in the market.

Using the concept of elasticity, we can present this point with alternative wording by saying that our theory suggests that the supply is *more elastic* in the long run.

4.7 The Long Run Supply Curve in a More General Model

In the previous section we showed that the long run supply curve is horizontal. This result holds only if all firms have the same identical productive technology. A model with heterogeneous firms would be more complicated to present and may result in long run market supply curves

that are upward- or even downward-sloping. However, the basic intuition behind the role of the *invisible hand* on the long run market equilibrium would still hold, and so would our general conclusions.

Appendix — Computing the Analytical Solution to the Equilibrium Problem

Assume a perfectly competitive market, in which the demand curve is given by

$$Q_D = 200 - 5P.$$

The supply curve, on the other hand, is given by

$$Q_S = 5P.$$

What is the equilibrium price and quantity in this market?
In equilibrium, Quantity Demanded = Quantity Supplied,

$$Q_D = Q_S.$$

In our case, this condition leads to

$$200 - 5P = 5P \rightarrow P^* = \$20.$$

We can now substitute P^* in either the demand or the supply equation to find Q^*. For instance,

$$Q^* = 5P^* \rightarrow Q^* = 100.$$

Hence, the equilibrium is given by $(Q^*, P^*) = (100, \$20)$.

REVISION QUESTIONS

Question 1.

Assume that a perfectly competitive market has reached its equilibrium. Which of the following statements describes efficiency in that market?

a) Consumers are maximising benefits while producers are maximising revenues.

b) The price of the good is equal to the lowest point on the short-run average variable cost curve.

c) The price of the good is equal to the wages of the workers used to produce it.

d) The total economic surplus is maximised.

Question 2.

When both the supply and the demand curve shift to the right,

a) the equilibrium price remains unchanged.

b) the equilibrium price always rises.

c) the equilibrium price might rise or fall or remain unchanged.

d) the equilibrium price always falls.

Question 3.

Assuming perfectly competitive markets, the supply and demand curves measure the

a) total benefit divided by the level of the activity.

b) the cost of producing the product

c) marginal cost of producing the product and the reservation price (willingness to pay) for consuming the product.

d) the total benefit resulting from an extra unit of the activity.

Question 4.

What does the equilibrium point denote?

a) The point where there is neither excess supply nor excess demand.

b) The point where consumer surplus is always maximised.

c) The point where produce surplus is always maximised.

d) None of the above.

Question 5.

Assuming that the market is perfectly competitive, which of the following is not true of an equilibrium price?

a) It is always a fair and equitable price.

b) It measures the value of the last unit sold to consumers.

c) It measures the marginal cost to produce the last unit of the good.

d) It is an 'efficient' price (i.e., it maximises economic surplus).

Question 6.

Consider a perfectly competitive market. In the long run the equilibrium price equals

a) the maximum Average Variable Cost.

b) the minimum Average Total Cost.

c) the minimum Marginal Cost.

d) the Fixed Cost.

Question 7.

Consider a perfectly competitive market where all producers use the same production technology. In the long run the supply curve is

a) perfectly Inelastic (i.e., an vertical line).

b) perfectly Elastic (i.e., a horizontal line).

c) upward sloping.

d) none of the above.

Question 8.

The Invisible Hand Principle states that individuals' independent efforts to maximize their gains will generally be beneficial for society and result in the socially optimal allocation of resources

a) in any type of market.

b) particularly in the short run.

c) if the market is perfectly competitive.

d) if firms are free to enter but not to exit the market.

Question 9.

Explain the concepts of Producer and Consumer Surplus.

Question 10.

Consider a perfectly competitive market. What is the impact on equilibrium price and quantity of an increase in the marginal cost of production for all firms? Explain the process of adjustment to equilibrium in your answer.

Question 11.

Use a supply and demand model to explain how buyers and sellers behave when the price of a good is below the equilibrium level.

Question 12.

Suppose that the market is currently in equilibrium. Suddenly, there is an increase in wages. Using a supply-demand diagram explain how the new equilibrium price and quantity differ from the original one.

Question 13.

Consider a perfectly competitive market. Explain why economists think that the competitive equilibrium is a great outcome for society. Your answer should include a discussion of the following concepts:

- Pareto efficiency and economic surplus;
- Short run and long run.

Question 14.

Consider a perfectly competitive market. Suppose that the supply curve is perfectly elastic (i.e., the supply curve is an horizontal line) at a price of $10. Demand is given by the equation P = 100 - Q.

Use this information to answer the following questions:

a) Calculate the consumer and producer surplus at the competitive equilibrium.

b) Suppose that there is an increase in demand where at every price there is 10 extra units demanded. Write down the demand curve and re-calculate consumer and producer surplus.

c) Provide an intuition for the results.

Question 15.

Assume the demand curve for a product is approximated by the equation $D = 30 - 5P$, and supply is given by $S = P$, where both D and S are measured in millions of units. Suppose the price for this product falls from $4 to $3.

a) Calculate the estimated gain in the total consumer surplus. In your calculation assume that consumers can buy as many units of the good they want at the indicated prices.

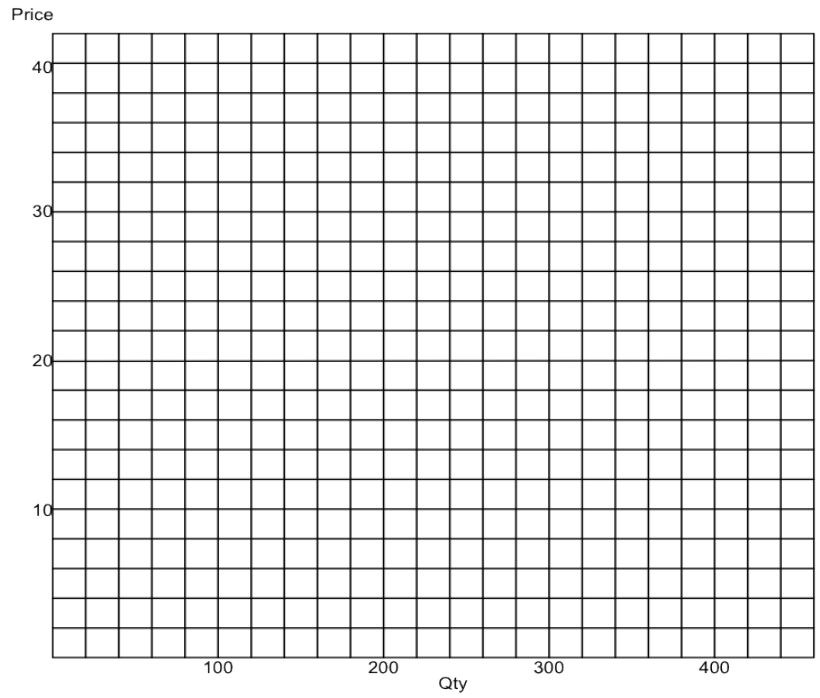
b) Calculate the loss in total producer surplus. In your calculation assume that producers can sell as many units of the good they want at the indicated prices.

c) Calculate the net gain/loss in total surplus. Is this total surplus going to be realised in the market?

Question 16.

Suppose that the demand curve is $D = 200 - 5P$, while the supply curve is given by $S = 5P$. Using this information:

a) Graph the supply and demand curve below:



b) What is the equilibrium price and quantity in this market?

c) Calculate the total consumer surplus.

d) Calculate the total producer surplus.

e) Calculate the total surplus.

Question 17.

The demand for a product is given by the equation $D = 120 - 8P$, while the supply is given by $S = 6P - 20$ (P is measured in \$).

a) Calculate the absolute value of the price elasticity of supply at the market equilibrium price and the total producer surplus at this price.

b) Calculate the absolute value of the price elasticity of demand at the market equilibrium price and the total consumer surplus at this price.

c) Calculate total surplus at the market equilibrium price.

Question 18.

Consider a perfectly competitive market. If the demand curve for a commodity is given by $D = 150 - 3P$, and the supply curve is given by $S = 5P - 10$, calculate the absolute value of the price elasticity of demand at the competitive equilibrium.

Question 19.

Assume that demand and supply curves for a particular chemical product are given by the following equations:

Demand: $D = 150 - 15P$,

Supply: $S = 5P - 30$, with price measured in \$ per ton and quantity measured in tons.

Calculate the equilibrium quantity and price for this market.

5
Government Intervention: The Cost of Interfering with Market Forces

In what follows, we are going to analyze the effect of a number of government interventions that have the potential to influence the workings of a market. In the previous chapters, we showed that a perfectly competitive market converges towards an equilibrium where the total surplus is maximized. Therefore, any government intervention that prevents a market from reaching its equilibrium price must have a negative effect on total surplus. This suggests that the government should avoid any intervention. In this chapter we take this question seriously by examining several types of government interventions and discussing their implications in terms of Pareto efficiency.

5.1 Price Ceiling

As we previously discussed, markets are not necessarily able to guarantee an equal distribution of income and opportunities across different groups within a given population. In certain situations, for example, the government might conclude that the price consumers are paying is *unfairly* high, especially for low-income households.

One policy instrument that governments use to control market prices is the so-called *price ceiling*. A price ceiling policy specifies a maximum allowable price in a given market. If the market equilibrium price is $100, and the price ceiling is set to $80, the market will not be able to

Price Ceiling: The Price Ceiling represents a maximum allowable price imposed by the government.

reach its natural equilibrium, but instead it will be forced to stop at $80. Of course, a price ceiling of $110 (or any other price ceiling above $100) would have no impact whatsoever.

But is there any situation where a society as whole might be better off by imposing a price ceiling in a perfectly competitive market? We now have all the tools to answer this question. Figure 5.1 presents the two scenarios, before and after an $80 price ceiling is imposed.

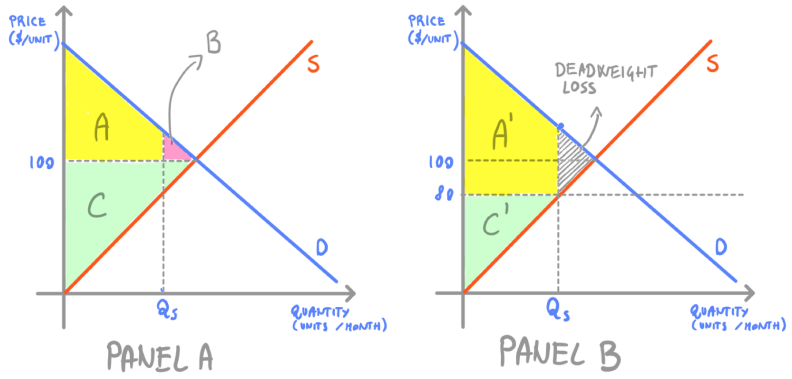


Figure 5.1: Panel A: Market equilibrium in the absence of a price ceiling. Panel B: Market equilibrium after the introduction of the price ceiling.

There are a few things that are immediately noticeable. First, the introduction of the price ceiling forces the price down, effectively creating excess demand. Second, the lucky buyers with the highest willingness to pay can acquire the good at a lower price,[1] and so their surplus (area A') increases compared with the surplus they get in the absence of the price ceiling (area A). However, a certain group of consumers that previously could acquire the good will be left unserved after the price ceiling is introduced. This is simply the result of the reduction in price that occurs after the introduction of the price ceiling, which in turn reduces the quantity that producers are willing to supply. Hence, certain consumers will now be left unserved. The amount of surplus lost can be gauged graphically in Figure 5.1 (area B). Producers are also definitely worse off as their initial surplus (area C) is larger than the final one (area C').

[1] Remember that this is due to our *rationing* assumption: Those who value the good most are among the first to acquire it. This might occur in a variety of different ways. Take for example the annual launch of the new iPhone. Consumers with high willingness to pay are more likely to show up on day one and stand in line for several hours to acquire a new phone before the Apple store runs out of stock. Consumers with lower willing to pay are instead more likely to wait a couple of months until the supply is stable. Those with the lowest willingness to pay might even wait until a new model is released to acquire the old one at discount.

If one were to compare the total surplus before ($A + B + C$) and after the introduction of the price ceiling ($A' + C'$), the general intuition becomes clear: The introduction of any price ceiling is doomed to decrease the total surplus in the economy. The amount by which total surplus decreases as a result of a price ceiling being imposed is called *deadweight loss*. The deadweight loss is essentially the loss in economic surplus due to the fact that the market is prevented from reaching the equilibrium price and quantity where marginal benefit equals marginal cost. So, if the government wanted to help the low-income households, a direct lump sum transfer would have been more efficient. Tinkering with the market reduces instead the total surplus.

Deadweight Loss: The Deadweight Loss is the loss in economic surplus due to the market being prevented from reaching the equilibrium price and quantity where marginal benefit equals marginal cost.

Interestingly, the winners from this policy would be the consumers with high willingness to pay. Empirical research (and common sense) reveals that these consumers are likely to be richer on average. Therefore, this policy, which is usually advertised by government as making prices more affordable for the poor, is likely to achieve the opposite result: it can result in a transfer of surplus from the poor to the rich![2]

[2] If you ask Marco, one of the authors of this textbook, he will tell you that the rationing assumption is not always realistic or substantive — sometimes people with a low willingness to pay end up acquiring the goods before those that have high willingness to pay. He will also tell you that, in this case, our model would still make the same predictions but this last argument — the poor are the ones suffering the most from a price ceiling — would not apply. Point well taken!

5.2 *Price Floor*

There are situations where the government might consider that prices are too *low*, and that producers should be protected by preventing them from reaching their equilibrium levels. A *price floor* is a minimum allowable price, and it can be used to reach this objective. For example, price floors were common in Europe as a form of protection for the agriculture sector.

Price Floor: The Price Floor represents a minimum allowable price imposed by the government.

A price floor is essentially the opposite of a price ceiling. If the price floor is set below the market price, it will have no effect whatsoever — the market will naturally tend to push the price above the price floor until it reaches the equilibrium level where demand equals supply. Instead, if a government imposes a price floor above

the equilibrium price the market will be forced to settle at the price level dictated by the price floor.

Price floors generate an excess supply. The producers who manage to sell the good benefit from the higher price imposed by the government. The producers who are unable to sell their products experience a sharp decline in surplus. Consumers are all worse off. Compare the total surplus before ($A + B + C$) and after the introduction of the price floor ($A' + C'$) in Figure 5.2. The general intuition applies here as well: The introduction of any price floor unambiguously decreases the total surplus in the economy. And the amount by which total surplus drops after the government imposes a price floor represents the deadweight loss in the economy.

In order to understand just how inefficient this policy is, consider the following point. Those who *lose* are (i) the producers and consumers who are no longer able to buy and sell the good after the price floor is implemented and (ii) the consumers who are able to buy the good but have to pay a higher price ($120 instead of $100). They experience a loss in surplus and they would be willing to pay the *winners* (the producers that continue to sell and now at a higher price, $120) in exchange for the elimination of the policy. This transaction can be designed in such a way that everyone is better off. This would be a Pareto Improving Transaction!

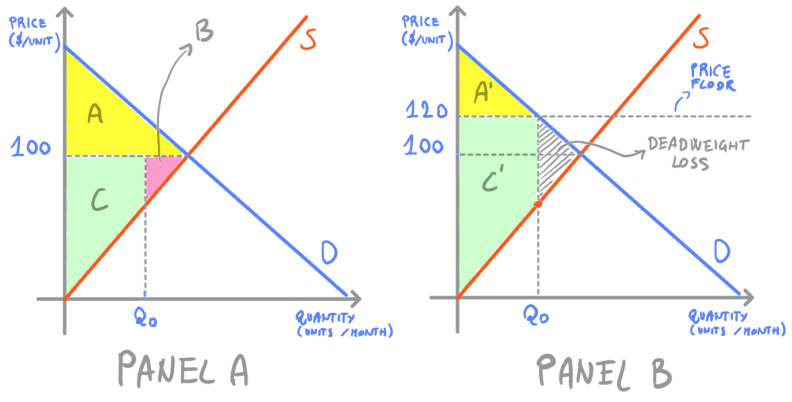


Figure 5.2: Panel A: Market equilibrium in the absence of a price floor. Panel B: Market equilibrium after the introduction of the price floor.

5.3 *Taxation*

Governments often set taxes to improve the distribution of income and opportunities across different population groups. Unlike the price ceiling and the price floor, a tax generates *tax revenues* that can be used to redistribute wealth within a society.

In this section we analyze the impact of such a tax. For simplicity, we assume that the tax is levied on producers. (The same results would apply if we were to assume that the tax is levied on consumers instead.) It will be clear soon that it is not important who ultimately pays the tax to the government. What is important in determining who bears the cost of taxation is the relative responsiveness of demand and supply to changes in price (due to the tax).

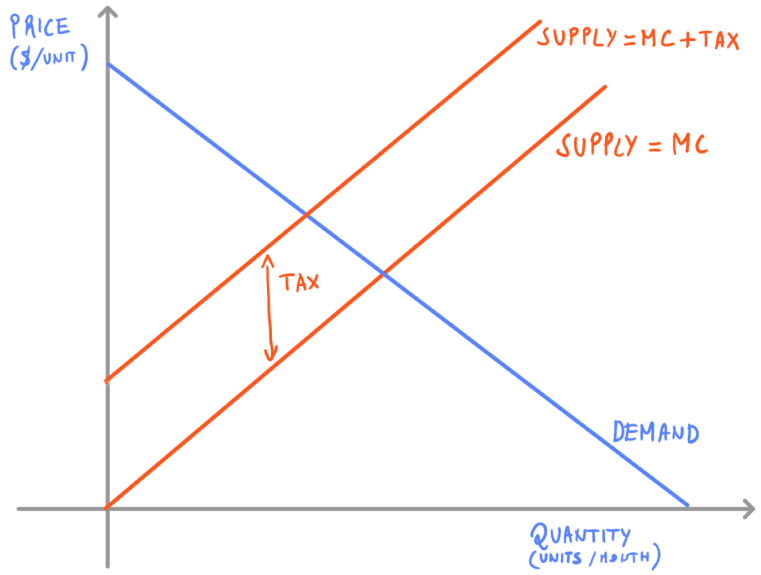


Figure 5.3: Shift of the supply curve following the introduction of a $1 tax.

Consider a per-unit tax imposed on each of the goods sold in the market. From the perspective of a supplier, the effect of this tax is similar to an increase in the production cost for each unit by exactly the amount of the tax. In other words, the marginal cost increases by exactly the tax amount. Recall that the supply curve for a single

firm is given by its marginal cost curve.[3] Hence, the introduction of a tax induces a shift of the supply curve to the left, where the vertical distance between the original curve and the shifted one is constant and equal to the tax amount. See Figure 5.3.

In order to appreciate the effect of a tax on the equilibrium price and quantity, let's compare the two scenarios, with and without the tax. Figure 5.4 depicts the market equilibrium before (Panel A) and after (Panel B) the tax is introduced.

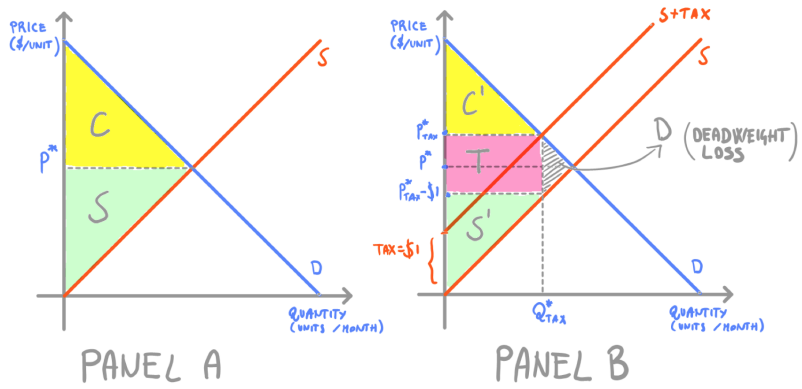


Figure 5.4: The market equilibrium before (Panel A) and after (Panel B) the introduction of a $1 tax.

In this example, it is easy to see that the equilibrium price must increase following a shift to the left of the supply curve.[4] And so, the equilibrium quantity will decrease after the introduction of the tax.

The situation is not looking great: the effect of the tax is to increase the price and decrease the quantity exchanged in the market. It is easy to see that this translates into a reduction of surplus for the consumers. To verify this, just compare the consumers' surplus before (area C) and after (area C') the tax. This reduction is due to the increase in price.

But how much of the tax burden is imposed on consumers? In order to find the answer we need to compare the initial equilibrium price P^* and the equilibrium price after the tax P^*_{tax}. It is easy to note that the difference between these two numbers is $0.5, which is smaller than the $1 per-unit tax. Hence, the consumers bear only a

[3] To be more precise the supply curve is given by the portion of the marginal cost curve above the minimum average variable cost (short run) or the minimum average total cost (long run), depending on the time frame considered.

[4] Note that the equilibrium price would be unchanged only when the supply curve is vertical (perfectly inelastic) and/or the demand curve is horizontal (perfectly elastic).

fraction of the tax burden because they suffer an increase in price that is smaller than the full tax amount.[5]

[5] The only case in which the consumers bear the entire tax burden is when the market demand is perfectly inelastic and/or supply is perfectly elastic.

The remaining part of the tax burden must be borne by the producers. This could be counter intuitive: how can the producers be worse off if the market price goes up? Don't be tricked into thinking that the increase in price benefits the producers! Remember that the producers have to pay \$1 to the government for each unit of the good they sell. Hence, their marginal revenue (the revenue for each unit of the good sold) is given by the price at which the good is sold, P^*_{tax}, minus the per-unit tax, \$1. Comparing the initial marginal revenue, P^*, with the new marginal revenue, $P^*_{tax} - \$1$, we can observe that there is an overall reduction in the marginal revenue equal to \$0.50. This is the share of the tax burden that is borne by the producers. To see the loss in producer surplus just compare the two areas — S (surplus without the tax) and S' (surplus with the tax).

So far, it certainly looks like both buyers and sellers are worse off after imposing the tax. However, in our analysis we cannot forget the government. The government is definitely making some tax revenues out of it! In order to compute the exact amount of tax revenues you need to multiply the tax by the number of units sold in the market (\$1 per good on Q^*_{tax} goods). The tax revenues are represented by area T in Figure 5.4. The government can use the tax revenues to the benefit of the buyers and sellers. For example, the government could reduce the taxes imposed on other markets. In this case, even though buyers and sellers experience a loss of surplus caused by imposing the tax, they also enjoy a reduction in the other taxes they pay. However, even after other taxes are taken into account, it is easy to see that there is still a loss in total surplus due to the tax. To see this, compare area $C + S$ (initial total surplus) and area $C' + S' + T$ (final total surplus). Clearly the first is bigger than the former by the area denoted by D (in Figure 5.4) – the deadweight loss from taxation.

The deadweight loss from taxation arises because, after imposing a tax, the market reaches an equilibrium price and quantity where the marginal benefit equals the marginal cost *plus the tax*.

In order to understand how inefficient taxation can be, consider the following point. The consumers and the producers (the *losers* who were harmed by the tax) lost more than the tax revenues accrued to the government (the *winner*). Hence, the losers would prefer to pay the winner the exact amount it gained from the intervention in exchange for the cancellation of the tax. This would be a Pareto Improving Transaction!

THE CONCLUSION OF OUR analysis is that taxation creates a loss in economic surplus. Does this mean that the government should not tax any market at all? Clearly, there is a cost-benefit analysis that needs to be taken into consideration here. After all, the government offers a number of important services such as lighthouses, national security, flood control systems and street lighting. If these vital services come at the cost of a small *deadweight loss* then society might well be better off with a tax system in place rather than without one. We will discuss these issues in detail in Chapter 10.

If tax revenues are necessary for a society to thrive, then the question should be: "What is the most efficient way of collecting tax revenues?" As it turns out, the answer to this question depends on how responsive demand and supply are with respect to price changes. The more elastic supply and demand are at the initial equilibrium price, the bigger the deadweight loss. The reason for this is simple: if supply and demand are highly elastic, even a small tax will determine a large reduction in the quantity demanded and supplied. The larger the departure from the original equilibrium quantity, the larger the deadweight loss will end up being. Also, the larger the reduction in the quantity exchanged, the larger the reduction in tax revenues. Figure 5.5 depicts two markets

characterized by different elasticities at the initial equilibrium price. Clearly, the more *responsive* market (Panel A) suffers from a higher deadweight loss and lower tax revenues with respect to the less responsive one (Panel B).

If the government needs to impose a $1 tax on the economy, the most effective way of doing it is to apply it to the market in Panel B (that is less responsive and will generate lower deadweight loss).

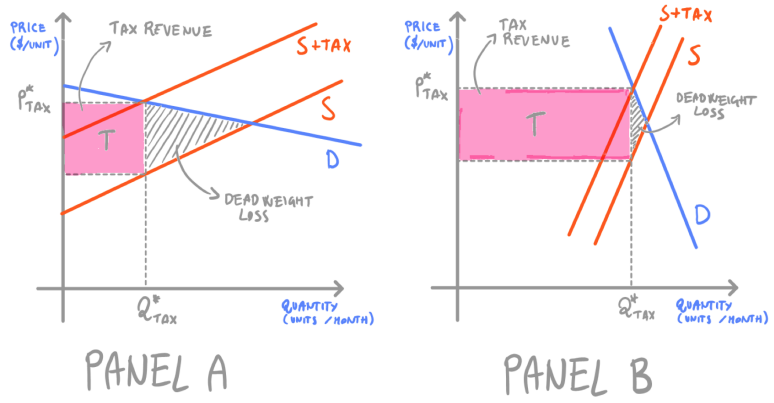


Figure 5.5: The impact of a $1 tax on markets with different elasticities of demand and supply (at the initial equilibrium price).

5.4 *Subsidy*

A subsidy is essentially the opposite of a tax. Assume, as before, that a per-unit $1 subsidy is applied to the sellers. Essentially, the government *pays* the sellers $1 for each unit sold in the market. Then the marginal cost effectively *decreases* by $1. The supply curve shifts to the right, and the market experiences a reduction in price and an increase in the quantity exchanged. Figure 5.6 depicts the market equilibrium before (Panel A) and after (Panel B) the subsidy is applied.

Unlike a tax, a subsidy is a cost for the government (not a revenue). The total cost of the subsidy is $1 per good on $Q^*_{subsidy}$ goods, which is represented by area S in Figure 5.6.

To appreciate the change in surplus, compare areas $C + P$ (initial total surplus) and areas $C' + P' - S$ (final

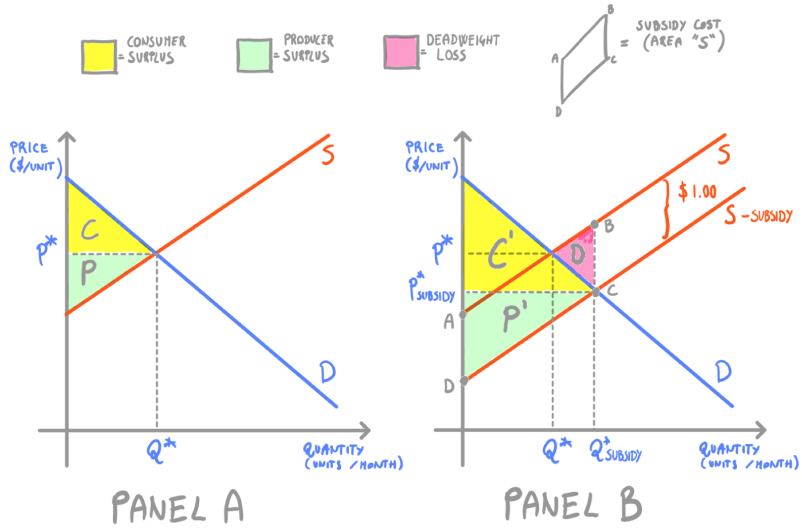


Figure 5.6: Panel A: Market equilibrium before the introduction of a $1 subsidy. Panel B: Market equilibrium after the introduction of a $1 subsidy.

total surplus). Clearly the first is bigger than the former by the area *D* in Figure 5.6. As in the case of taxation, the subsidy creates a *deadweight loss*.

Sometimes governments claim that subsidies are used to make certain goods more affordable for certain groups of poor consumers. Our analysis suggests that this policy brings about a considerable deadweight loss and therefore is not necessarily optimal. A less distortive intervention would be a lump-sum transfer from the rich to the poor. In fact, even the rich would prefer this kind of solution as long as the transfer is smaller than the deadweight loss they would suffer under the subsidy.

REVISION QUESTIONS

Question 1.

If a per-unit tax is imposed on producers in a perfectly competitive market, the only curves that will shift upwards are

a) the average variable cost and marginal cost curve.

b) the average fixed cost and average total cost curve.

c) the average fixed cost and average variable cost curve.

d) the average variable cost, average total cost and marginal cost curve.

Question 2.

Holding all else constant, in a perfectly competitive market, the imposition of a legally enforced price floor above the market equilibrium price will

a) create more excess supply the lower the price elasticity of supply.

b) create more excess supply the greater the price elasticity of supply.

c) create more excess demand the lower the price elasticity of demand.

d) create more excess demand the higher the price elasticity of supply.

Question 3.

Holding all else constant, the deadweight loss created by a per unit tax imposed on the producers of a good will

a) increase as the demand for the good becomes less price elastic.

b) have no effect on total surplus.

c) decrease as the supply becomes more price elastic.

d) increase as the supply becomes more price elastic.

Question 4.

a) Draw a Supply and Demand model, carefully labelling your diagram, and show how the imposition of a per-unit sales tax will affect the equilibrium price and quantity.

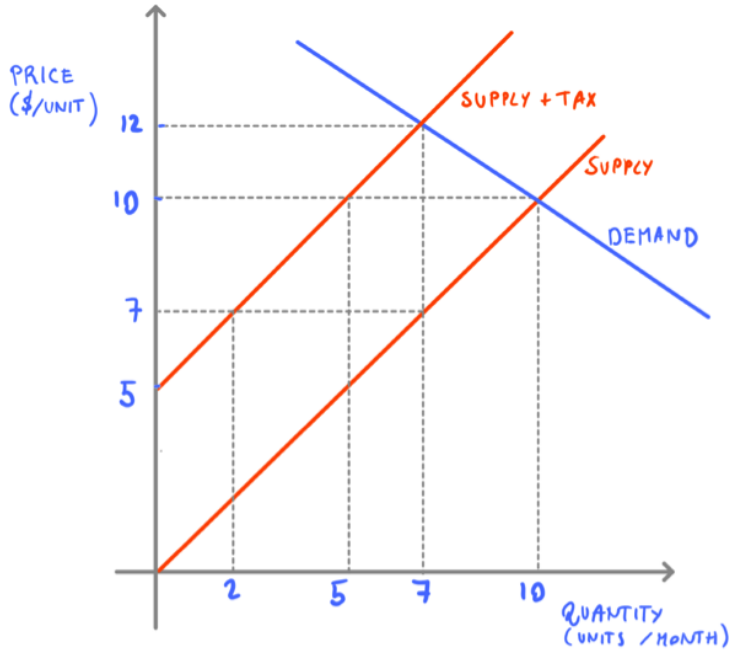
b) Show on your diagram how the incidence of the tax is shared between producers and consumers.

c) Using a similar diagram, now draw a steeper demand curve through the same market equilibrium point and highlight the deadweight loss to consumers and producers. Proportionally, who bears a greater tax burden?

d) Present an economic intuition to explain the results, i.e. why does the burden of the tax change?

Question 5.

Consider the situation depicted in the graph below



a) Calculate the producer surplus after the imposition of a per-unit sales tax and the loss in producer surplus.

b) Following the imposition of the sales tax, what is the government revenue?

c) Following the imposition of the sales tax, what is the loss in consumer surplus?

d) Following the imposition of the sales tax, what is the loss in total surplus?

Question 6.

Consider the following equations describing the supply and demand curves, respectively:

Supply: $P = 4 + S$,

Demand: $P = 10 - D$.

a) Find the equilibrium price and quantity of this market. Then work out the consumer surplus, producer surplus and total economic surplus at the market equilibrium.

b) Suppose that the government has decided to provide a subsidy of \$2 per unit to suppliers. Write down the new supply curve for the suppliers. Then, work out the new equilibrium quantity.

c) Given the new quantity produced and sold, calculate consumer surplus, producer surplus and the cost of the subsidy. Then work out total economic surplus.

d) Calculate the deadweight loss of the subsidy.

Question 7.

Consider a market whose supply and demand curves are given by

Supply: $P = 4S$,

Demand: $P = 12 - 2D$.

a) How will the equilibrium price and quantity in this market be affected if a \$6 per-unit tax is imposed on sellers? What is the actual per unit revenue received by the sellers (this is the actual price received by the sellers, tax excluded)?

b) Given the new quantity produced and sold, calculate consumer surplus, producer surplus and the tax revenue. Then work out the total economic surplus.

c) Calculate the deadweight loss of the tax.

6
International Trade

At the start of the book we left you standing in the dark, feeling intimidated by a toothbrush. Fortunately for you, there are other people in the world who are rather good at making dental products. In fact, six countries account for 50% of the world's dental product exports so let's thank Germany, the UK, Mexico, Ireland, the USA and Poland for their contributions to global oral hygiene! While we're at it we should give a round of applause to China for illuminating us with its whopping 55% of world exports of light fixtures.

Hmm, so if Australia is not the dental factory of the world, how can we pay for these wondrous goods? Well, you probably know that Australia is quite rich in minerals, so much so that it's the number one exporter of iron ore (43%!) and accounts for 33% of coal briquette exports (Indonesia provides a further 18% of coal). Wow!

Now, what if our Prime Minister decided that as well as iron ore, Australia really should make more of its own toothbrushes? Is this a good idea or not? In this chapter we'll complement our earlier comparative advantage analysis with a supply and demand model of international trade and then use it to say: no, dear Prime Minister, for the sake of our oral health, please don't put a tariff on toothbrushes!

In Chapter 1 we saw that a country can achieve more consumption if it opens up to international trade. This came from extending our concept of comparative advan-

tage from individuals (Alberto and Leo) to a country as a whole: a country can gain from trade by moving towards specialising in goods they have comparative advantage in making and then exporting these goods.

What we will do now is to expand the analysis of international trade by using our (now familiar) demand and supply framework. First, we'll think about how much a country will import or export, and then we'll think about what happens if governments intervene by implementing trade policies. What will matter in determining who trades what is the price they can sell at on the world market (the *world price*, P_w) compared to what they can get selling locally (the *domestic price*, P_d). Similar to our assumption that under perfect competition firms are price-takers, we'll assume that our country is a *small open economy*. When small open economies engage in free trade they take the world price as given, that is, they are price-takers on the world market. This is because no seller will accept less than the world price as he can always sell overseas at that price; and no buyer will pay more than the world price because she can always buy from overseas at that price. For most goods and services, the small open economy assumption suits Australia (and Italy, Romania and New Zealand amongst many others) pretty well but we will note that market power can occur for some goods and therefore the model would need to be adapted ... that's what International Trade courses are for!

World Price: World Price represents the equilibrium price on the international market.
Domestic Price: Domestic Price represents the equilibrium price that would occur in a country if no international trade is allowed.
Small Open Economy: A Small Open Economy is an economy that participates in international markets for goods and services, but its production or consumption is small enough compared to the rest of the world that its supply or demand does not affect the world price.

6.1 Exporting Country

Let's imagine the price of a rabbit domestically is $10, but the world price is $15. Figure 6.1 shows this. Is our little economy going to export the rabbits we've worked so hard to collect or not?

Without trade, domestic supply must equal domestic demand and the equilibrium will be $P_d^* = \$10$ and $Q^* = 500$. With free trade, $P_w = \$15$, so domestic suppliers are now willing to sell 900 rabbits, but domestic con-

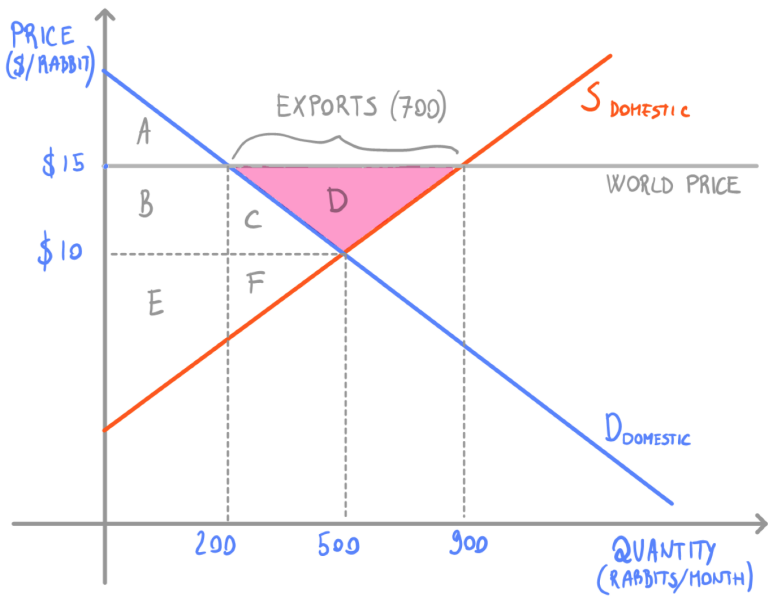


Figure 6.1: International trade: The case of exporting.

sumers only want to buy 200. What happens to the rest? 700 rabbits are now exported — who knew that solving Australia's rabbit problem could be so easy?!

More generally, we can say that if $P_d < P_w$ our country has comparative advantage in producing that good and will become an *exporter* upon opening up to international trade.

But why do economists generally want countries to open up to trade? We can use our notions of consumer and producer surplus from Section 4.3 to help answer this.

If we start with a *closed economy* (no trade), the equilibrium price is $10 and quantity is 500. Consumer surplus is the area above price P_d and below the demand curve (in Figure 6.1 this is $A + B + C$). Producer surplus is the area above the supply curve and below the price P_d ($E + F$). Adding these together we get a total surplus in the closed economy of $A + B + C + E + F$.

Closed Economy: A Closed Economy is an economy that does not engage in international trade. Also known as autarky.

If we let our superior domestic rabbit producers sell internationally, however, the price becomes P_w. This will be bad for our domestic rabbit consumers because the price goes up to $P_w = \$15$ and the quantity purchased falls to

200, so consumer surplus is now only area A. Our domestic producers are the winners though: they sell more (now 900 rabbits) at a higher world price, so producer surplus is now $B + C + D + E + F$. The total surplus in our *open economy* (with trade) is $A + B + C + D + E + F$, which is bigger than without trade by area D, and that's why economists like trade!

Open Economy: An Open Economy is an economy that engages in international trade.

Where did these *gains from trade* come from? From international consumers who have a relatively high demand for our rabbits. Unfortunately, trade so far isn't looking good for our domestic consumers (of rabbits at least). Let's look now at a market where the world market price is less than the domestic price.

Gains from Trade: The Gains from Trade capture the extra total surplus available in an open economy situation compared to a closed economy.

6.2 *Importing Country*

Suppose the price of bananas is \$3 per kg without trade, but is only \$2 per kg on the international market. Figure 6.2 shows this.

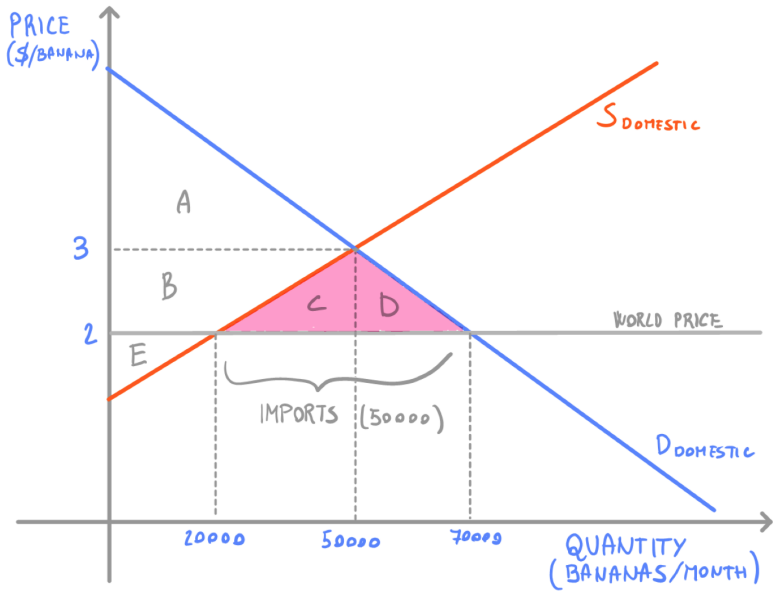


Figure 6.2: International trade: The case of importing.

Without trade, domestic supply equals domestic demand and the equilibrium is $P_d^* = \$3$, $Q^* = 50,000$. Consumer surplus is area A, producer surplus is $B + E$ and

total surplus is $A + B + E$. After opening up to trade, the world price (holding banana quality constant) is lower, so domestic consumers will want to purchase 70,000 kg of bananas. At $P_w = \$2$ domestic producers are only willing to sell 20,000 kg of bananas, so our little country will need to import 50,000 kg of bananas. Consumer surplus is now area $A + B + C + D$, producer surplus is only E, but total surplus is $A + B + C + D + E$. Hence, the gains from trade in bananas are represented by the areas $C + D$ and come from the larger surplus attained by our domestic consumers who buy more and at a lower price.

6.3 Winners and Losers from International Trade

These examples of rabbits and bananas have shown us that whether a country imports or exports, the total surplus is higher with trade than without, but ... domestic consumers lose surplus when their country starts to export the good in question and domestic producers lose surplus when their country starts to import. If the consumers, in the first case, or the producers, in the second, are big and powerful enough, they may be able to organize themselves to lobby the government to *restrict free trade*. Because the gains from trade are often thinly spread over many consumers but the losses are felt strongly by a small group of producers, in practice the lobbying is done by domestic producers wanting to restrict imports. This is what we see, in part, from Australian banana farmers and car manufacturers.

There are other benefits from engaging in trade that we do not see in a simple model. These include:

- Consumers have access to a wider variety of goods (Italian soft drinks, Indian movies),
- Producers may be able to take advantage of economies of scale by selling to a larger market (bauxite, copper),
- Domestic monopolies or oligopolies might face international competition, reducing their market power (book-

stores),

- The flow of ideas and technology is faster and easier, and

most importantly, you get us, your brilliant, insightful and enthusiastic economics lecturers!

6.4 *Trade Restrictions*

What if the anti-trade lobbyists win and the government decides to restrict trade? There are two main forms of trade restrictions: *tariffs* and *quotas*.

A tariff is just a special name for a tax on imported goods. It's different from a sales tax because it is only applied to the goods produced abroad, not to the domestically produced ones. Figure 6.3 shows the effect of a tariff of $10 per imported book.

Import Tariff: An Import Tariff represents a tax on imported goods or services.
Import Quota: An Import Quota represents a quantity limit on the amount of goods or services permitted to be imported.

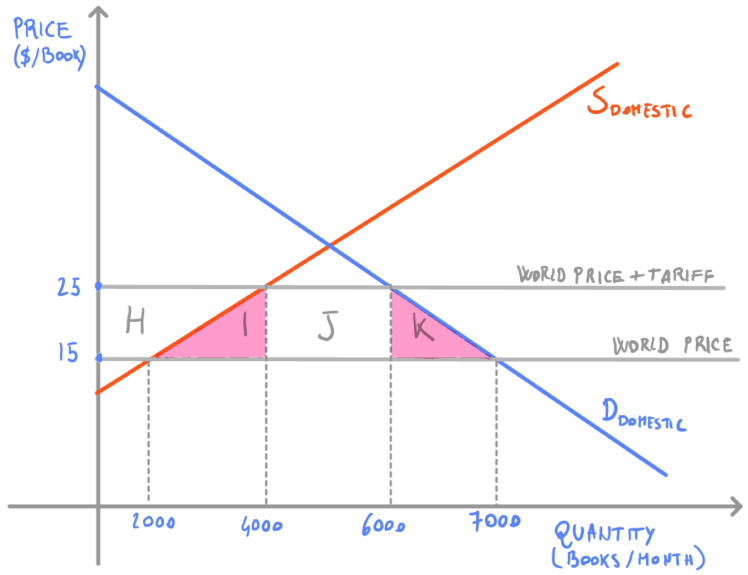


Figure 6.3: International trade: The case for tariffs.

With free trade, the world price is $15, domestic consumers purchase 7,000 books per month, domestic producers supply 2,000 books and Australia imports 5,000 books. Adding the $10 tariff per imported book means the price of *all* books will now be $25.

Why all books? Imported books cost $15 plus the $10 tariff ($P_w + t = \$25$), so that means the domestic publishers can also charge $25 and still have customers. Domestic consumers now only want 6,000 books, domestic producers are willing to sell 4,000 and imports fall to 2,000 books. Okay, domestic consumers lose (and the nation's literacy standards fall!) but domestic producers gain. So is a tariff good or bad?

Let's look at what happens to surplus again. Domestic consumers will lose $H + I + J + K$ because they buy less and at a higher price. Domestic producers gain H because they sell more at a higher price. The government gains from getting the tariff revenue of area J, paid only on the imported books (remember a tariff is a *tax* on imports) . Overall, consumers lose more than what the producers and government gain - this is the deadweight loss of the tariff represented by area $I + K$ (lost area I comes from buying from the relatively expensive domestic producers; area K is lost because total consumption falls). We can see that the tariff is good for our domestic book publishers, but extremely bad for our book consumers.

An alternative (anti-)trade policy is an import quota, which directly changes the quantity of imports. Figure 6.4 shows the same book market but, instead of the tariff, the government explicitly limits the number of imported books to 2,000 per month (yes, this number is purposely chosen to mimic the tariff policy!).

To find the equilibrium with the quota, we take the supply from our domestic producers and add (horizontally) the 2,000 imported books (the allowed supply from overseas) to get our total supply. The price will be $25 and consumers will buy 6,000 books in total (2,000 imported and 4,000 produced in Australia). The effect on consumer surplus of this quota is the same as the $10 tariff: it falls by $H + I + J + K$. The surplus of our domestic producers rises by H again.

The difference, compared to the tariff, is what happens

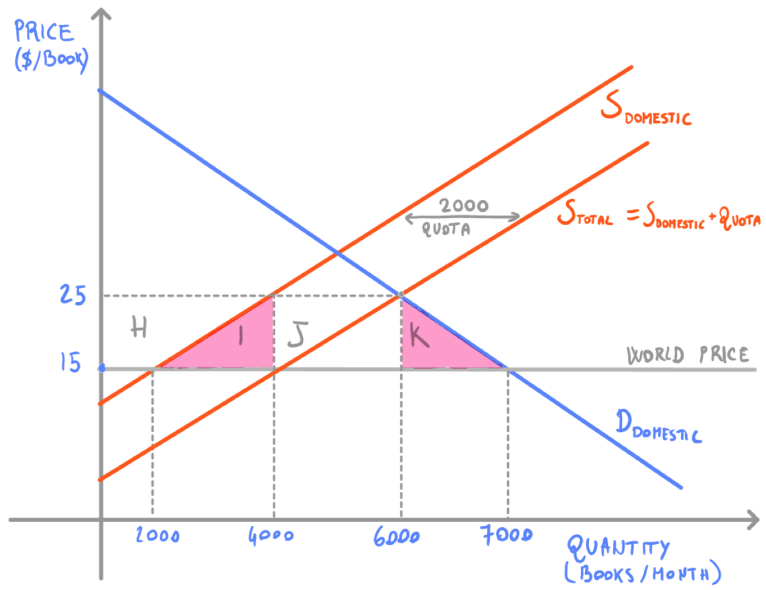


Figure 6.4: International trade: The case for quotas.

to area J. This is the 'bonus' that anyone lucky enough to be a book importing agent will receive: they pay only $P_w = \$15$ to the international publishers, but they can charge \$25 to the consumers.

If the government charges a fee to book importing agents, then the government revenue could be the same as the tariff revenue (transactions costs and bribery aside). If not, being a book importing agent is a pretty fabulous job!

IN TERMS OF TOTAL SURPLUS, a quota and a tariff can both lead to the same prices and quantities and generate a deadweight loss of area $I + K$ (if they are set to mimic each other). What's different is the behind-the-scenes action: is it simply the tariff revenue that the government gets or are there secret dealings on who gets to be an import agent (the Prime Minister's cousin for example!)? This transparency is, in part, why the World Trade Organisation has asked its member countries to convert their trade restrictions to tariffs. It is also much simpler to negotiate multiple-country deals to reduce trade restrictions if they are all measured in percentage tariffs - rather than

numbers of rabbits and kilograms of bananas.

REVISION QUESTIONS

Question 1.

Assuming that a home country imposes a tariff on an imported product and the world price plus tariff is below the no-trade price (i.e., the closed economy price), which of the following statements is true for the home country?

a) The imposition of the tariff will benefit the home producers.

b) The imposition of the tariff will benefit the home consumers.

c) Overall, the home economy will gain.

d) There is no effect.

Question 2.

Assuming that a home country imposes a binding quota on an imported product, which of the following statements is true for the home country?

a) There is no reduction in consumer surplus.

b) There is no increase in producer surplus.

c) The overall effect is similar to that of a tariff, except there are no government revenues associated with the quota.

d) There is no effect.

Question 3.

Which of the following best describes a tariff?

a) A tax on imports.

b) A cap on imports.

c) A tax on domestic production.

d) All of the above.

Question 4.

What is a quota? Who are the winners and who are the losers when a quota is imposed? Use a graph to support your answer.

Question 5.

The weekly demand for wool in Australia is given by $P = 800 - D$, while the weekly supply of wool is given by $P = S$, where P is price, D is quantity demanded and S is quantity supplied. The world price of wool is set to $300 per bale. Suppose that the country is not open to trade. What is the net gain/loss in total economic surplus compared to the free trade case?

Question 6.

Consider a setting described in Question 5 above. Now suppose that there is a tariff of $50 per bale imposed by the Australian government on the import of wool. Use this information to answer the following questions:

a) What is the gain in producer surplus in Australia?

b) What is the loss in consumer surplus in Australia?

c) What is the amount of tariff revenue accrued to the government?

d) What is the overall loss in economic surplus following the introduction of the tariff?

Part III

Imperfectly Competitive Markets

Part II has been a celebration of the perfectly competitive market: Such a market allocates resources efficiently and effectively (Adam Smith's Invisible Hand) in a way that maximizes social surplus (Pareto optimality) with virtually no need for government intervention. That's a pretty impressive list of achievements!

Even though economists love their markets, they are also quick to admit that markets in real life are seldom *perfectly competitive*. There are many obstacles and frictions that prevent this from happening.

Motivated by this observation, in Part III we are going to look at *imperfectly competitive markets*. These markets are very similar to the ones we considered in Part II, except that at least one of the following characteristics fails to be satisfied:

1. *Consumers and suppliers are price takers*
2. *Homogenoues goods*
3. *No externality*
4. *Goods are excludable and rival*
5. *Full information*
6. *Free entry and exit*

7
Market Power: Monopoly

Characteristics number 1, 2 and 6 of a perfectly competitive market state that consumers and suppliers are price takers, goods are homogenous and there is free entry/exit. In the next two chapters we challenge all these assumptions.

Previously we have considered *price-taking* firms. These firms can sell as much as they want at the current market price. However, if they increase the price, they lose all their sales. Visually, this means that the demand curve for the individual firm is horizontal (perfectly elastic).[1] Panel A in Figure 7.1 depicts the demand curve for an individual price-taking firm.

[1] Note that the demand curve for the individual firm is horizontal, but the demand curve for the *entire* market need not be.

In this chapter we look at firms that have some *market power*. Firms with market power are said to be *price-makers (or price-setters)* in that they have the ability to set their own prices. This means that when the price-setting firm increases the price, it does not lose all its customers (just some of them). This is the basic difference between a price-taking and a price-setting firm. Visually, this entails that the demand curve for a price-setter is downward sloping. Panel B in Figure 7.1 depicts the demand curve for an individual price-setting firm.

Market Power: A firm has Market Power if it has the ability to set its own price.

A market composed by firms that are price-setters is said to be an *imperfectly competitive market*. There are three main forms of imperfectly competitive markets:

Imperfectly Competitive Market: An Imperfectly Competitive Market is a market where that at least one of the characteristics of a perfectly competitive market fails to be satisfied.

1. *Monopoly*: There is only one firm in the market. Hence, the firm's individual demand curve coincides with the

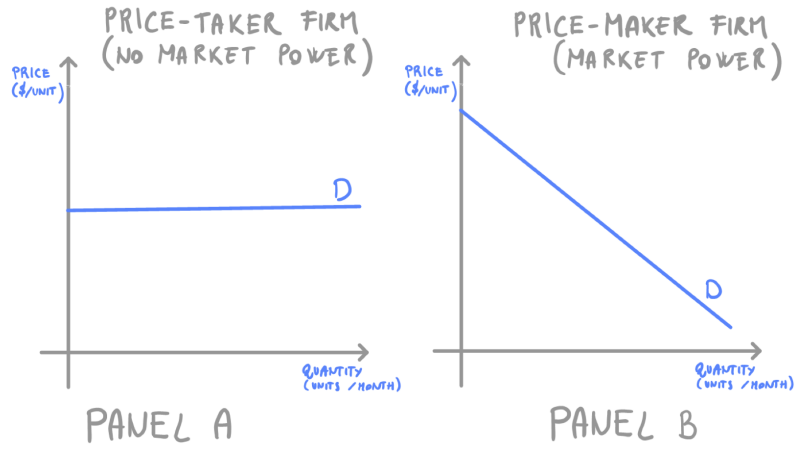


Figure 7.1: Panel A: Demand curve for an individual price-taker firm. Panel B: Demand curve for a firm with market power.

market demand curve. One of the most famous example of monopoly is Microsoft and its most notorious operating system Windows, which is essentially the only operating system in the whole market for personal computers.[2] Other examples of monopolies are DeBeers (a cartel of companies that dominate the diamond industry), local natural gas companies, and Australia Post.

2. *Monopolistic Competition*: There is a large number of firms, each producing a slightly differentiated product. One example is the restaurant industry. An Italian restaurant offers a similar product compared to a Japanese restaurant (i.e., food), but they don't offer exactly the same type of food. This provides a measure of market power, where the Italian restaurant can increase the price without losing all its sales because Italian and Japanese food are not perfect substitutes. Another example is the competitive structure in which petrol stations operate. At first glance, it appears that every petrol station sells the same product — petrol. However, each one has a different location and some of them offer special services like car-wash facilities and bars. This differentiates the service they offer. If the petrol station located in the vicinity of your home increases its price, you might continue to go there be-

[2] Microsoft has been involved in several anti-trust suits and it was fined €493 million in 2004 by the European Commission and US$1.35 billion in 2008 for noncompliance with the 2004 anti-trust rules.

cause driving to the next one might not be worth the effort.

3. *Oligopolistic Competition*: There is a small number of firms that sell goods that are close substitutes. In Australia, there are several examples of this form of market structure. The media outlet industry (dominated by News Corporation, Time Warner and Fairfax Media), the grocery retailing (dominated by Coles Group and Woolworths) and the banking sector (dominated by ANZ, Westpac, NAB, and Commonwealth Bank). In the United States, the movie industry is dominated by six major studios who receive almost the entirety of American film revenues.

7.1 Determinants of Market Power

The Invisible Hand Principle suggests a simple mechanism that eliminates market power: whenever firms make profits, some new firms will be willing to enter the market and commence production of the same good. This entry process will continue until the firms in the market make zero profit and are essentially left with no market power.

At the heart of this process lies the ability of firms to freely enter and exit the market. As soon as this ability is hindered, market power is likely to arise. Economists refer to these impediments to entry as *barriers to entry*. Here is a list of the major barriers to entry:

1. *Control Over Scarce Resources*: If a firm has exclusive control over some key inputs of production, it might be impossible for other firms to enter the market and compete against it. Example: OPEC's [3] market power comes from the control over a scarce resource, oil.
2. *Government-Created Barriers to Entry*: Governments are sometimes responsible for creating barriers to entry. They do so by issuing patents, offering copyright protection and granting licenses. For example, if a pharmaceutical company holds a patent for a particular drug

[3] OPEC is an international organization whose goal is to collude in influencing world oil prices.

then no other company is allowed to produce the same drug. Whichever company holds the patent becomes a monopolist in the market for that particular type of drug for the term of the patent — which is roughly 20 years in Australia.

3. *Increasing Returns to Scale*: We say that there are *increasing returns to scale (or economies of scale)* when the average total cost of producing a certain good decreases with the amount of the good produced. When a firm experiences economies of scale it also becomes more profitable with size. In this case, a single firm producing a large quantity of the good can do so more efficiently than a large number of firms each producing small quantities. For this reason, industries featuring increasing returns to scale tend to be dominated by a small number of large firms. A monopoly that is established as a result of increasing returns to scale is called a *natural monopoly*. Public utilities — such as water supply, electricity and gas — are good examples of natural monopolies because they require costly infrastructure to operate and therefore feature increasing returns to scale.

Increasing Returns to Scale: We say that there are Increasing Returns to Scale (Economies of Scale) when the average total cost of producing a certain good decreases with the amount of the good produced.

Natural Monopoly: A Natural Monopoly denotes a monopoly that occurs because of increasing returns to scale.

4. *Network Economies*: Similar to economies of scale are the so-called *network economies*. Network economies emerge when the customers' satisfaction with a given product increases with the number of users. (For example, take Facebook — it would not be quite as fun if you were the only user, right?) Network economies are similar to economies of scale because in both cases a company's market position gets stronger and stronger as it expands production. Other examples include power companies, cable television companies and wireless communication companies.

Network Economies: Network Economies emerge when the customers' satisfaction with a given product increases with the number of users.

7.2 Monopoly

The simplest example of an imperfectly competitive firm is a *monopolist*. By definition, *monopoly* is a market struc-

Monopoly: Monopoly is a market structure where there is only one firm operating in the market.

ture where there is only one firm operating in the market.

Table 7.1 shows the costs of production for a given monopolistic firm. A quick inspection reveals that this table is very similar to Table 2.2. (This is great, nothing new here for you to learn!)

Workers per day	Units per day	Fixed Cost ($/day)	Variable Cost ($/day)	Total Cost ($/day)	Average Cost		Marginal Cost ($/unit of output)
					Variable ($/unit of output)	Total ($/unit of output)	
W	Q	FC	$VC = \$10 \times W$	$TC = VC + FC$	$AVC = \frac{VC}{Q}$	$ATC = \frac{TC}{Q}$	$MC = \frac{\Delta TC}{\Delta Q}$
0	0	100	0	100	–	–	–
1	200	100	10	110	0.05	0.55	0.05
2	400	100	20	120	0.05	0.3	0.05
3	600	100	30	130	0.05	0.22	0.05
4	800	100	40	140	0.05	0.17	0.05
5	1000	100	50	150	0.05	0.15	0.05

Table 7.1: Production costs for a monopolistic firm.

Our discussion regarding costs and production decisions of a perfectly competitive firm applies also to a monopolist.[4] However, there is one big difference: a perfectly competitive firm faces a horizontal demand curve — it can sell any number of units at the market price. This entails that the *marginal revenue* (the extra revenue from selling one additional unit of the good) is constant and equal to the market price. On the other hand, the demand curve for a monopolist is the same as the demand curve for the entire market and this demand curve is unlikely to be horizontal. The fact that the monopolist faces a downward sloping demand curve changes things considerably. The most important aspect of it is that the monopolist needs to *reduce* the price in order to increase the quantity sold.[5]

Let us assume that the demand curve for the monopolist is as depicted in Figure 7.2. It is easy to see that the monopolist can sell 200 units if the price for each soda can is $0.85. However, if the monopolist wants to increase

[4] Note that in Table 7.1 the daily wage is $10 and the production schedule is such that the marginal cost is constant.

[5] Alternatively, one can see this point from a different perspective: The monopolist needs to reduce the quantity in order to increase the price at which the good is sold.

production and sell 400 units instead, the price needs to be reduced to \$0.65. We can compute the marginal revenue of increasing production from 200 to 400 in the following way:

$$MR = \frac{\Delta R}{\Delta Q} \tag{7.1}$$

where the ΔR represents the change in revenues when the firm goes from selling 200 to selling 400 units ($400 \times \$0.65 - 200 \times \$0.85 = \$90$), and ΔQ is the change in the quantity sold (400 units -200 units $=$ 200 units). Hence,$MR = \frac{\$90}{200 units} = \$0.45$ per unit of output.

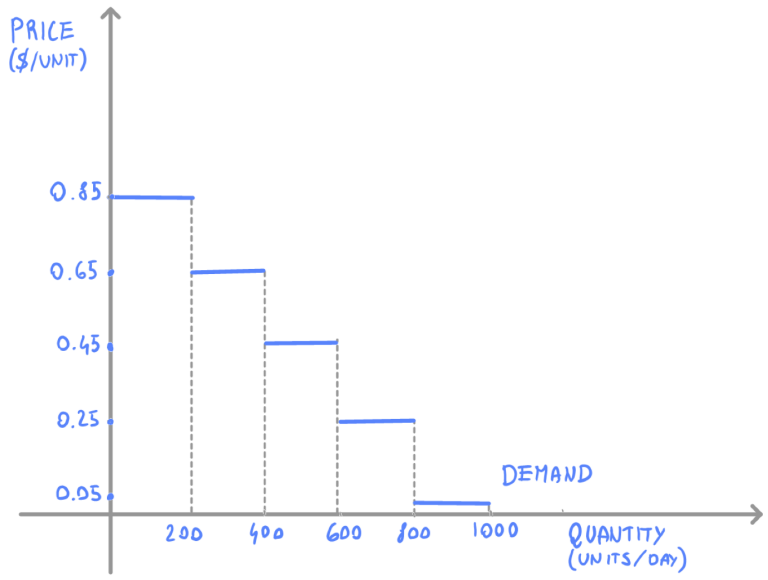


Figure 7.2: Demand curve for a monopoly.

We can now derive the marginal revenue for *any additional employee* and add this information to our table. Column 3 in Table 7.2 presents the price at which the monopolist can sell different number of units (you can check that these prices are derived from Figure 7.2). The marginal revenue is presented in column 6.

Having constructed Table 7.2, we are now ready to determine the number of units that maximizes the monopolist's profit. The rule we use is the usual one: expand production until the marginal revenue equals the marginal

1 **Workers per day**	2 **Units per day**	3 **Market Price (or Marginal Benefit) ($/ unit of output)**	4 **Revenues ($)**	5 **Marginal Cost ($/ unit of output)**	6 **Marginal Revenue ($/ unit of output)**
W	Q	P	$R = P \times Q$	$MC = \frac{\Delta TC}{\Delta Q}$	$MR = \frac{\Delta R}{\Delta Q}$
0	0	–	0	–	–
1	200	0.85	170	0.05	0.85
2	400	0.65	260	0.05	0.45
3	600	0.45	270	0.05	0.05
4	800	0.25	200	0.05	−0.35
5	1000	0.05	50	0.05	−0.75

Table 7.2: Revenues and costs for a monopolistic firm.

cost. In this case, the monopolist maximizes its profit by hiring 3 employees and selling 600 units per day at $0.45 each.

7.3 Monopoly and the Invisible Hand

Consider this decision of the monopolist that maximizes its profit (600 units sold at $0.45 each) more closely. Is this the socially optimal quantity that maximizes social surplus? The answer is clearly, no. Remember that the demand curve represents the *marginal benefit* or *reservation price* for different amounts of the good that are consumed. It reflects the increase in surplus by consuming an extra unit of the good. For this reason, column 3 in Table 7.2 represents both the price the consumers are willing to pay for different amounts of the good and *also* the marginal benefit.

Keeping this in mind, is the monopolist's production decision optimal for society? To answer this question, we need to check what would happen if the monopolist were to expand production by hiring an extra worker. The quantity produced would then be 800. The marginal benefit for consumers (as reported in column 3) would be equal to $0.25 (the extra benefit for society from each extra unit consumed) and the marginal cost would be

equal to $0.05 (the extra cost of the firm for each extra unit produced). Clearly the marginal benefit is greater than the marginal cost, and so hiring the 4th worker and increasing production from 600 to 800 units would increase the total surplus. However, what's great for society is not necessarily great for the monopolist. The consumers clearly stand to gain from having more goods in the market. But what about the monopolist? The monopolist would be worse off. To see this compare the profit when the monopolist hires 3 workers and when it hires 4 of them. The profit with 3 workers is higher. (This should not come as a surprise given that we have already shown in the previous section that hiring 3 workers maximizes the monopolist's profit).

Why is there a conflict between what the monopolist wants and what consumers desire? Well, the reason is simple. In order to sell the extra units of the good and attract new consumers, the monopolist needs to reduce the price. This reduction in price affects every unit that is sold by the monopolist because the monopolist needs to charge all consumers the same price. Hence, there is an implicit cost in increasing the quantity sold, and this leads to an equilibrium production level that is lower than the socially optimal one.

What is the socially optimal level of production? In order to find this level we need to expand production until the marginal benefit is equal to the marginal cost. It is easy to see that this occurs when the monopolist hires 5 workers — the quantity produced is 1000 and the price is 0.05. Figure 7.3 portrays the *socially optimal* quantity (Panel A), the *monopoly equilibrium* quantity and the deadweight loss for society (Panel B) due to the fact that the monopolist does not select the socially optimal quantity. See the associated video for the derivation of the graph.

It is easy to see that the *invisible hand principle* does not apply in the case. The principle says that individuals' independent efforts to maximize their gains (profits for the sellers and utility for the buyers) will generally be

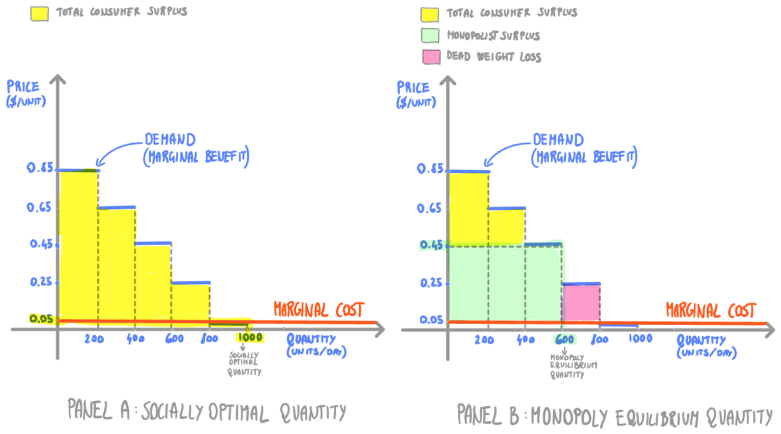


Figure 7.3: Monopoly and sub-optimal equilibrium production.

beneficial for society and result in the socially optimal allocation of resources. In the case of a monopoly this principle fails: when the monopolist maximizes its profit the result is not socially optimal.

7.4 *Government Regulation*

A simple way of solving these inefficiencies is to stimulate competition by encouraging new firms to enter the market. Governments around the world achieve this by establishing *competition laws*, which are intended to foster market competition by regulating anti-competitive conduct by firms. The final objective of this type of legislation is to ensure that consumers are charged the lowest possible prices.

Competition Law: Competition Law denotes laws intended to foster market competition by regulating the anti-competitive conduct of firms.

However, in the case of a natural monopoly where there are increasing returns to scale, this government intervention might create its own inefficiencies because a single firm producing a large quantity of the good can do so more efficiently than a large number of firms each producing small quantities. In order to increase the total surplus in the presence of a natural monopoly, governments often regulate the price at the which the monopolist is allowed to sell its products. One such policy is the so called *average cost pricing*. By using this policy, the government

Average Cost Pricing: The Average Cost Pricing denotes a policy through which the government forces the monopolist to set the price and quantity at the intersection of the *ATC* curve and the demand curve.

sets the price and quantity at the intersection of the average total cost (*ATC*) curve and the demand curve. This eliminates any positive profit accrued to the monopolist.

This looks like a simple way to eliminate all the inefficiencies due to the presence of a monopolist, while retaining all the advantages coming from the increasing returns to scale. However, average cost pricing is hard to implement because

- government does not know the *ATC*, it can only estimate them,
- once this policy is in place, firms have no incentive to invest in new technology to lower their production costs — they make zero profit either way,
- when the government uses average cost pricing, the firm's output is *allocatively inefficient*. This is due to the fact that the price usually exceeds the marginal cost. Recall that a perfectly competitive market is allocatively efficient precisely because in equilibrium the price equals the marginal cost. In order to solve this problem, the government could set a *price ceiling* equal to the marginal cost — effectively forcing the monopolist to sell its product at the marginal cost. But this approach is also problematic because it might force the monopolist to make negative profits. Not unlike average cost pricing, setting the correct price ceiling is also difficult because the government can only estimate what the marginal cost of production is.

Allocatively Inefficient: A firm's output is said to be Allocatively Inefficient if the price asked for the goods produced exceeds their marginal cost.

7.5 First Degree Price Discrimination

One of the reasons why the monopolist does not produce enough — produce less than what would be socially optimal — is that it needs to set the same price for all consumers. What if the monopolist could set a different price for different consumers?

To begin with, assume that the monopolist knows the maximum price (or *reservation price*) that every consumer

is willing to pay and can charge each consumer exactly his reservation price. This is called *first degree price discrimination*. Let's go back to our previous example and see how the monopolist's optimal decision changes when first degree price discrimination is allowed. For simplicity, assume that the first 200 units are sold in the Italian market where all consumers have the same marginal benefit (or reservation price) of \$0.85 per unit of output. The second batch of 200 units is sold in the French market where all consumers have marginal benefit (or reservation price) of \$0.65 per unit of output. The third batch of 200 units is to be sold in the US market where all consumers have marginal benefit (or reservation price) of \$0.45 per unit of output. The fourth batch of 200 units is intended for the Canadian market where all consumers have marginal benefit (or reservation price) of \$0.25 per unit of output. The fifth batch of 200 units is for the Brazilian market where all consumers have marginal benefit (or reservation price) of \$0.05 per unit of output.

First Degree Price Discrimination: First Degree Price Discrimination describes a situation in which the monopolist knows the reservation price of each consumer and is able to charge each consumer his marginal benefit (or reservation price).

This information is reported in Table 7.3. Comparing Table 7.3 with Table 7.2, note first that we are now explicitly indicating in Column 3 what countries are associated with the different marginal benefits.

Given that the monopolist can now charge each market a different price (equal to the marginal benefit of the consumers in that country), column 4 is also amended to account for this. For example, when the monopolist hires the first worker and produces 200 units, it sells them at \$0.85 per unit, and makes \$170 in revenues. When the second worker is hired, the monopolist continues to sell the first 200 units at \$0.85 in the Italian market, but now it also sells 200 units in the French market at \$0.65 per unit. We just need to sum the revenue in the Italian market (\$170) with the revenue in the French market ($200 \times \$0.65 = \$130$) to find the total revenue (\$300). Using this method, please verify that the remaining values in column 4 are indeed correct.

We can then use columns 2 and 4 to derive column 6

(marginal revenue) as we did in the previously. A quick inspection reveals that the marginal revenue is now equal to the marginal benefit. This is due to the fact that selling more units in a new country does not require the monopolist to reduce the price on all the units sold in the other countries.

1 **Workers per day** W	2 **Units per day** $Q(W)$	3 **Market Price (or Marginal Benefit) ($)/unit of output** $P(W)$	4 **Revenues ($)** $R = \sum_{n=1}^{W}(P(n)\times$ $\times[Q(n) - Q(n-1)])$	5 **Marginal Cost ($/ unit of output)** $MC = \frac{\Delta TC}{\Delta Q}$	6 **Marginal Revenue ($/ unit of output)** $MR = \frac{\Delta R}{\Delta Q}$
0	0	–	0	–	–
1	200	0.85 (Italian Market)	170	0.05	0.85
2	400	0.65 (French Market)	300	0.05	0.65
3	600	0.45 (US Market)	390	0.05	0.45
4	800	0.25 (Canadian Market)	440	0.05	0.25
5	1000	0.05 (Brazilian Market)	450	0.05	0.05

Table 7.3: Production costs for a monopolistic firm that can engage in first degree price discrimination.

The Cost Benefit Principle suggests that the monopolist should expand production until the marginal revenue is equal to the marginal cost. This occurs when the monopolist hires 5 workers and sell 1000 units — essentially covering all the available countries.

It is striking to note that this is the quantity that would be sold in a perfectly competitive market (see Figure 7.3)! Hence, a monopolist that can engage in first degree price discrimination is actually selling the socially optimal quantity — or, in other words, the quantity that maximizes social surplus. However, albeit social surplus is maximized, the *distribution of surplus* within the society is very uneven: the monopolist charges the consumers exactly their marginal benefit (or reservation price) and so leaves them with zero surplus! The monopolist is the one who accrued all the surplus available in the market.

7.6 Other Forms of Price Discrimination

There are situations where a monopolist cannot engage in first degree price discrimination. This might be due to existing laws that prevents the monopolist to do so, or it could be due to the monopolist's inability to learn each consumer's reservation price or to prevent consumers with low reservation price from buying the good at low price (from the monopolist) and reselling it at a higher price to consumers with high reservation price.

When first degree price discrimination fails, there are other forms of price discrimination that include:

1. *Second degree price discrimination:* the monopolist charges different prices depending on the quantity demanded by each consumer. If a consumer buys a large quantity of the good, the unit price charged is lower compared to the unit price for a consumer that demands a smaller quantity. This essentially works as a *bulk discount*. By offering "discounts" the monopolist manages to distinguish between consumers with high and low reservation price, without having to know that information in advance. Airlines' habit to offer different seat classes (first class, business class, economy class) is also a form of second degree price discrimination based on *quality*. It allows the airlines to discriminate between consumers with high and low reservation price and to charge different prices to different groups — with the final objective of capturing more consumer surplus. If you have ever felt uncomfortable in your economy seat, know that your miserable condition was no accident. Making economy seats uncomfortable is a way to push richer consumers to buy a business or first class ticket instead!

2. *Third degree price discrimination*: the monopolist charges different prices depending on observable consumers' attributes such as location. Look at Table 7.3 and now assume that the monopolist cannot charge each consumer a price equal to her marginal benefit — in other

words first degree price discrimination cannot be used. However, if third degree price discrimination is possible, the monopolist could still charge consumers from different continents (in this case Europe, North America and South America) a different price. What would be the profit-maximizing quantity produced by the monopolist in this case? And what would be the profit-maximizing prices for the different continents? From the monopolist's perspective, there are now three different markets. Tables 7.4 - 7.6 present the relevant variables for each market.

(Please verify that the monopolist would continue to serve all countries as in the previous case.)

The monopolist maximizes its profit when it serves all consumers and charges European consumers $0.65, North American consumers $0.25 and South American consumers $0.05. In this example, moving from first degree price discrimination to third degree price discrimination does not affect the number of consumers that are served. But how would the distribution of surplus change? The answer is simple. The monopolist makes less profit (verify this!) and the Italians and the Americans are better off because they pay a lower price (they pay $0.65 and $0.25 instead of $0.85 and $0.45 respectively). The French, the Canadians and the Brazilians pay the same price as before. Overall, there is a shift of surplus from the monopolist to the consumers.

REVISION QUESTIONS

Question 1.

What is the Average Cost Pricing policy?

a) A policy intended to ensure that the market price remains high enough.

b) A policy through which the government forces a firm

1 **Workers per day**	2 **Units per day**	3 **Market Price (or Marginal Benefit) ($)/unit of output**	4 **Revenues ($)**	5 **Marginal Cost ($/ unit of output)**	6 **Marginal Revenue ($/ unit of output)**
W	Q	P	$R = P \times Q$	$MC = \frac{\Delta TC}{\Delta Q}$	$MR = \frac{\Delta R}{\Delta Q}$
0	0	–	0	–	–
1	200	0.85 (Italians)	170	0.05	0.85
2	400	0.65 (French)	260	0.05	0.45

Table 7.4: Third degree price discrimination: The European market.

1 **Workers per day**	2 **Units per day**	3 **Market Price (or Marginal Benefit) ($)/unit of output**	4 **Revenues ($)**	5 **Marginal Cost ($/ unit of output)**	6 **Marginal Revenue ($/ unit of output)**
W	Q	P	$R = P \times Q$	$MC = \frac{\Delta TC}{\Delta Q}$	$MR = \frac{\Delta R}{\Delta Q}$
0	0	–	0	–	–
1	200	0.45 (Americans)	90	0.05	0.45
2	400	0.25 (Canadians)	100	0.05	0.05

Table 7.5: Third degree price discrimination: The North American market.

1 **Workers per day**	2 **Units per day**	3 **Market Price (or Marginal Benefit) ($)/unit of output**	4 **Revenues ($)**	5 **Marginal Cost ($/ unit of output)**	6 **Marginal Revenue ($/ unit of output)**
W	Q	P	$R = P \times Q$	$MC = \frac{\Delta TC}{\Delta Q}$	$MR = \frac{\Delta R}{\Delta Q}$
0	0	–	0	–	–
1	200	0.05 (Brazilians)	10	0.05	0.05

Table 7.6: Third degree price discrimination. The South American market.

to charge $0 for each unit of the good sold in the market.

c) A policy where through which the government forces a firm to select a price and a quantity such that the marginal revenue equals the marginal cost.

d) A policy through which the government forces the monopolist to set the price and quantity at the intersection of the Average Total Cost curve and the demand curve.

Question 2.

A cinema charges a lower admission price for non-working patrons over the age of 60 (seniors) than for other adults seeking entry to see a movie. This is an example of

a) no price discrimination

b) first degree price discrimination

c) second degree price discrimination

d) third degree price discrimination

Question 3.

Which of the following statements about a monopolist is true?

a) If the monopolist engages in first degree price discrimination, it will set a price and quantity such that the total surplus is maximised.

b) The monopolist will always choose a price and quantity such that the total surplus is maximised.

c) A monopolist will always produce an output level such that the Average Total Cost is minimised.

d) A monopolist will always make a positive economic profit, both in the short and the long run.

Question 4.

What is the purpose of the competition law?

a) To influence firms' productive decisions in markets that are perfectly competitive.

b) To induce firms to set a price and a quantity such that the Average Total Cost is minimised.

c) To foster market competition by regulating the anti-competitive conduct of firms.

(a) To maximise the producer's surplus.

Question 5.

List the characteristics of a perfectly competitive market and explain how they differ from those of a monopoly.

Question 6.

Suppose the government seeks to regulate the behaviour of the monopolist using Average Cost Pricing. Define what is meant by this policy and highlight some difficulties with implementing this pricing policy.

Question 7.

The following table gives the demand schedule for a monopolist:

Price ($)	Quantity demanded	Total revenue ($)	Marginal revenue ($)
10	0		
8	1		
6	2		
4	3		
2	4		
0	5		

a) Complete the table above.

b) Assuming that the marginal cost of production is constant and equal to $4, what is the profit maximizing level of output in the short run (i.e., you can ignore the fixed cost)?

Question 8.

Consider a monopolist facing a demand curve given by $P = 20 - Q$, where P is price and Q is quantity. Assume that the monopolist's marginal cost is constant and equal to $10 per unit and there are no other costs. If the monopolist engages in first degree price discrimination, what is the deadweight loss? Explain your answer.

Question 9.

Consider a monopolist that cannot engage in any kind of price discrimination. Why does the monopolist produce a smaller quantity at a higher price compared to the equilibrium price and quantity that would prevail in a perfectly competitive market?
(In answering this question consider a market with a certain Supply curve —which captures the Marginal Cost curve for the identical firms operating in the market— and a certain Demand Curve —which represents the Marginal Benefit curve for the consumers— then consider two situations, one in which there is only one firm operating in the market (i.e., the monopoly case) and one in which there are many identical firms and all of them are price takers.)

8
Market Power: Oligopoly

Recall that in a perfectly competitive market, firms are price-takers and so, there is no real strategic interactions among them in equilibrium. In a monopoly, there is only one firm dominating the entire market, so there is no scope for strategic interactions among firms either.

On the other hand, oligopoly is a market structure that features a small number of firms. In Australia, there are several examples of this form of market structure: The media outlet industry (dominated by News Corporation, Time Warner and Fairfax Media), the grocery retailing (dominated by Coles Group and Woolworths) and the banking sector (dominated by ANZ, Westpac, NAB, and Commonwealth Bank).

In these types of markets, the actions of one firm have a direct impact on the other firms, and vice versa. For this reason, we say that there are strategic interactions among firms: in making its own decision, a firm tries to anticipate what the other firms are about to do.

In order to study these kind of strategic interactions, economists use *game theory*. Here, we are going to present game theory in a very informal way. More specifically, we are going to present three examples of strategic interactions that are likely to occur in the context of oligopolistic markets and we are going to analyze their implications in terms of social surplus.

All the games presented here are *simultaneous games* in the sense that the players move simultaneously or, alternatively, they are unaware of the other players' actions

Simultaneous Game: A Simultaneous Game is a game in which the players move simultaneously or, alternatively, they are unaware of the other players' actions.

— which is to say that firms are qualitatively the same in terms of the information available to them when they make their moves.

8.1 A Simple Entry Game

Consider the social network industry. This industry is a good example of oligopoly because there are only a few dominant networks (Facebook being the most prominent one) that face limited competition, owing to high barriers to entry. There are both economies of scale and network economies at play in this industry. Developing the infrastructure and a large user base is a very costly operation, and it might require years before the heavy losses associated with these fixed costs are finally mitigated by advertising income — the primary source of income in the industry.

In this context, consider the following example of an entry game. (This is a simple example, but it is helpful to flesh out a few important concepts.) Imagine a company, AceBook, which is considering entering the social network market. For simplicity, we assume that AceBook has only two strategies available: "entry" or "no entry". Facebook also has two strategies "exit" or "stay". AceBook and Facebook make their decisions simultaneously. In other words, this is a simultaneous move game.

If Facebook chooses "exit" and AceBook chooses "entry", Facebook exits the market and makes zero profit, whereas AceBook serves all the consumers. However, AceBook is not well equipped to deal with the huge infrastructure costs and ends up running a loss equal to 10 billion dollars.

If Facebook chooses "stay" and AceBook chooses "no entry", AceBook stays out of the market and makes zero profit, whereas Facebook serves all the consumers and obtains a profit equal to 10 billion dollars.

If Facebook chooses "exit" and AceBook chooses "no entry", both AceBook and Facebook stay out of the mar-

ket and make zero profit.

Finally, if Facebook chooses "stay" and AceBook chooses "entry", they compete in the market. Owing to Facebook's preexisting user base, Facebook dominates the market and makes a 8 billion dollars profit, whereas AceBook, burdened by the high fixed costs, makes a 20 billion dollar loss. The payoffs (in billions) are presented in Table 8.1.

		AceBook	
		Entry	*No Entry*
FaceBook	Stay	8, *−20*	10, *0*
	Exit	0, *−10*	0, *0*

Table 8.1: Table of payoffs of FaceBook and AceBook (in billion dollars). AceBook's payoffs and strategies are depicted in *italics*.

This game is a real no-brainer. Consider the decision that Facebook faces. Clearly, Facebook has a *dominant strategy*: by choosing "Stay", Facebook achieves the highest level of profit irrespective of what AceBook does. Hence, we would expect Facebook to select that strategy. AceBook also has a dominant strategy. "No entry" is always preferred, no matter what Facebook does. We would then expect AceBook to play "No entry".

Dominant Strategy: A Dominant Strategy represents a strategy that is preferred by a player irrespective of the strategy selected by the other player.

This type of game is somewhat trivial because strategic interactions play no role. The optimal decision for both firms does not depend on the behavior of the competitor.

Consider now a slightly more complex game. Google is considering entering the social network market by launching Google Plus. For simplicity, we assume that Google has only two strategies available: "entry" or "no entry". Facebook chooses one of two strategies "exit" or "stay". Facebook and Google make their decisions simultaneously.

If Facebook chooses "exit" and Google chooses "entry", Facebook exits the market and makes zero profit, whereas Google serves all the consumers and obtains a profit equal to 10 billion dollars.

If Facebook chooses "stay" and Google chooses "no entry", Google stays out of the market and makes zero profit in the social network industry, whereas Facebook

serves all the consumers and obtains a profit equal to 10 billion dollars.

If Facebook chooses "exit" and Google chooses "no entry", both Google and Facebook stay out of the market and make zero profit.

Finally, if Facebook chooses "stay" and Google chooses "entry", they compete in the market. Owing to its pre-existing user base, Facebook dominates the market and makes a 8 billion dollars profit, whereas Google, burdened by the high fixed costs, makes a 2 billion dollars loss. The payoffs (in billions) are presented in Table 8.2.

		Google	
		Entry	*No Entry*
Facebook	Stay	8, -2	10, *0*
	Exit	0, *10*	0, *0*

Table 8.2: Table of payoffs of Facebook and Google (in billion dollars). Google's payoffs and choices are depicted in *italics*.

We constructed this example in such a way that Google has no dominant strategy (verify this on your own!). Hence, we cannot use the solution we discussed in the previous example. This is clearly a more complex scenario. However, even in this case, there is a simple and reasonable way to establish what equilibrium is likely to emerge from the game.

To see this, consider the decision that Facebook faces. Clearly, Facebook has a dominant strategy — "Stay" is the strategy that brings Facebook the highest level of profit irrespective of what Google does. Hence, you would expect Facebook to select that strategy. Anticipating that Facebook will choose "Stay", Google is now facing a smaller game, which corresponds to the following Table:

		Google	
		Entry	*No Entry*
Facebook	Stay	8, -2	10, *0*

Table 8.3: Table of payoffs of Facebook and Google (in billion dollars). Google's payoffs and choices are depicted in *italics*. The table was created by keeping only Facebook's dominant strategy ("stay") from the game presented in Table 8.2.

In the reduced version of the original game presented in Table 8.3, Google actually has a dominant strategy: "no entry" is clearly the optimal option for Google. Hence, the expected outcome of the game is for Facebook to select "stay" and for Google to play "no entry" and stay

out of the market. This solution concept is called *iterated elimination of dominated strategies*.

Iterated Elimination of Dominated Strategies: The Iterated Elimination of Dominated Strategies is solution concept that involves iteratively removing strategies that are not dominant.

Albeit quite reasonable, this solution concept requires the important assumption of rationality. It is vital that Google believes that Facebook is *acting rationally* — meaning that Facebook acts with the objective of maximizing its profit. This is a delicate assumption that makes this solution concept more fragile.

OUR SIMPLE EXAMPLE might explain why Facebook remained the only major social network portal for many years. Google's decision to finally enter the social network industry could be rationalized as an attempt to support other parts of its business — maintaining a high profile presence is vital for Google's search engine — or it could be motivated by the projected long run profit that has the potential to cover the short run losses.

8.2 Prisoner's Dilemma Game

The prisoner's dilemma game is a type of game where firms (or individuals) might decide not to cooperate even though doing so would be beneficial to both of them. The classic example in economics is a situation where firms decide whether to increase spending on advertising or not. For simplicity, we assume that the only two *strategies* available are "advertising" or "no advertising". To make things even simpler, we assume there are only two firms in the market, say ANZ and NAB. As before, this is a simultaneous game.

If both ANZ and NAB select "no advertising", they each earn a profit equal to 100 million dollars.

If both ANZ and NAB select "advertising", the respective consumer bases remain the same: The advertising efforts nullify each other, essentially leaving the market condition unchanged and preventing the two firms from stealing each other's consumers. However, advertising costs 30 million dollars. Hence, when both ANZ and

NAB engage in advertising they each earn a profit equal to 70 million dollars.

Finally, if one firm selects "advertising" but the other does not, the former manages to steal 50 million dollars worth of consumers from the other firm. Hence, the firm which selects "advertising" obtains a profit equal to $(100 + 50 - 30 =)120$ million dollars and the other firm earns a profit equal to 50 million dollars. The payoffs (in millions) are presented in Table 8.4.

		ANZ	
		Advertising	*No Advertising*
NAB	Advertising	70, *70*	120, *50*
	No Advertising	50, *120*	100, *100*

Table 8.4: Table of payoffs of ANZ and NAB (in million dollars). ANZ's payoffs and strategies are depicted in *italics*.

A quick look at the table reveals that *collectively* it would be optimal for both ANZ and NAB to choose "no advertising" — by doing so they would earn 100 million dollars each, for a total of 200 million dollars, which is the maximum profit they can hope to achieve *collectively* in this game.

However, it might be difficult for ANZ and NAB to cooperate and agree to play "no advertising". The reason is simple and it has to do with the temptation of violating the agreement and playing "advertising" when the other party plays "no advertising". Take for example the situation where both ANZ and NAB play "no advertising". Given that NAB is playing "no advertising", ANZ has an incentive to violate the agreement and play "advertising" instead — by doing so ANZ makes 120 million dollars instead of 100. It is easy to see that NAB has the same kind of temptation.

To see this point from a different perspective, note that ANZ and NAB have the same *dominant strategy*: "advertising". Hence, we would expect both of them to select that strategy.

IT CAN BE QUITE SURPRISING to realize that the expected outcome is not a very good outcome for either ANZ or NAB — they only get 70 million dollars worth of profit.

By acting according to their self interests, ANZ and NAB obtain a profit that is lower than the one they could have achieved if they had cooperated.

Furthermore, if we assume that advertising has no social value in itself, there is something even more surprising coming out of this example: the outcome of the game does not satisfy Pareto Optimality because advertising is a wasteful activity — the producer surplus would have been larger if ANZ and NAB had decided not to advertise, and the consumer surplus would have been unchanged.

This observation flies in the face of Adam Smith's Invisible Hand Principle (remember that this principle states that individuals' independent efforts to maximize their gains will generally be beneficial for society and result in the socially optimal allocation of resources). By introducing the possibility of strategic interactions among firms we have just discovered something quite reasonable and important: The individual quest for profit might not translate into the socially optimal allocation of resources.

In the next section we will analyze a situation where the possibility of strategic interactions among firms can be helpful to consumers and can be instrumental in reducing the likelihood of collusion among firms.

8.3 Cartel Game

Oligopolistic markets are characterized by a small number of firms. This makes collusion more likely and it might result in a number of private and secret agreements among these firms. In economics, we refer to these agreements as *cartels*. A cartel is aimed at increasing the profit of the cartel members by reducing competition in the market. A cartel agreement achieves this objective by controlling prices or by preventing new competitors from entering the market.

Cartels: Cartels represent private agreements aimed at increasing the profit of the cartel members by reducing competition in the market.

Private cartels such as these are illegal nearly everywhere in the world and are prohibited under *competition*

law — a law that is intended to foster market competition by regulating anti-competitive conduct by firms. The final objective of this type of legislation is to ensure that consumers are charged the lowest possible prices.[1]

[1] The anti-competition regulator in Australia is the Australian Competition and Consumer Commission (ACCC).

Given that cartels are illegal, cartel members cannot write enforceable contracts to keep the other members in line. The situation they face is akin to the prisoner's dilemma we discussed in the previous section.

To see this point, consider the following example: a cartel is established to keep the market price above a certain level. To this purpose, the members of the cartel are instructed to avoid price cuts. For the sake of simplicity, suppose that there are only two firms in the market (respectively firm A and firm B) and that there are only two strategies: "price cut" and "no price cut". The game is simultaneous.

In this game, choosing "no price cut" would be the cooperative behavior prescribed by the cartel. Choosing "price cut" would be the non-cooperative behavior and would violate the agreement. By choosing "price cut" a firm steals customers (and profits) from the other cartel member. If the cartel members choose this strategy they mutually defect, and the consumers are charged a lower price. The payoffs (in millions) are presented in Table 8.5.

		Firm B	
		Price Cut	*No Price Cut*
Firm A	Price Cut	150, *150*	300, *100*
	No Price Cut	100, *300*	200, *200*

Table 8.5: Table of payoffs of firm A and B (in million dollars). Firm B's payoffs and choices are depicted in *italics*.

A quick look at the table reveals that there is only one likely outcome in this game: Both firms choose to "price cut". To see this point, note that these are indeed the dominant strategies.

Interestingly, the strategy recommended by the cartel ("no price cut") is not likely to be an outcome of the game: Both firms would increase their profits by changing their strategy and engaging in a price cut, if the other cartel member selects "no price cut".

By making cartels illegal, anti-trust authorities make it hard for firms to collude and ultimately promote a market equilibrium that benefits the consumers and increases social surplus by closing up the price gap between perfectly competitive markets and oligopolistic ones.

8.4 Coordination Game: The Battle of the Sexes

To conclude our brief selection of games, we are now turning to the so called *coordination games*. These games are characterized by multiple possible outcomes. They capture those situations where the players benefit from coordinating their decisions.

Coordination Game: Coordination Games are a type of games that capture those situations where the players benefit from coordinating their decisions.

A common example is the *battle of the sexes*, a game in which the players differ with respect to which activity they would prefer to engage in, but they still prefer engaging in the same activity over going alone. For the sake of simplicity, suppose there are only two activities, namely going to the "Stadium" or going to the "Theatre". Players A and B must select the activity they want to perform without the ability to communicate with each other (i.e., this is a simultaneous move game). Player A's and B's payoffs (expressed in utils) are presented in Table 8.6.

		Player B	
		Theatre	*Stadium*
Player A	Theatre	20, *10*	0, *0*
	Stadium	0, *0*	2, *15*

Table 8.6: Table of payoffs of A and B (in utils). B's payoffs and strategies are depicted in *italics*.

If A and B decide to engage in different activities they get zero utils — they just don't enjoy any activity if they are are not together! If A and B engage in the same activity they obtain a positive amount of utils, but A gets more utils from going to the theatre (20 instead of 2) while B gets more from going to the stadium (15 instead of 10).

It is important to notice that we constructed this example in such a way that there are no dominant strategies — for example, A prefers to go to theatre if B goes too but this is no longer the case if B decides to go to the stadium instead. Hence, we cannot use the solution we discussed

in the previous sections. We need a new solution concept!

Notice that it is unlikely that the *strategy profile* (Theatre, *Stadium*) will be the outcome of this game because A would have an incentive to change her strategy from "Theatre" to "Stadium" and obtain 2 utils instead of 0. Similarly, the strategy profile (Stadium, *Theatre*) is also unlikely to be the outcome of the game for the specular reason — B would have an incentive to deviate.

Strategy Profile: A Strategy Profile denotes a set of strategies, one for each player. In our example there are four strategy profiles: (Theatre, *Stadium*); (Stadium, *Theatre*); (Stadium, *Stadium*); (Theatre, *Theatre*). The payoffs corresponding to each strategy profile are presented in Table 8.6.

This leaves us with two strategy profiles that are reasonable candidates as equilibria of the game: (Stadium, *Stadium*) and (Theatre, *Theatre*). Under this strategy profile neither A nor B can benefit by changing strategy while the other keeps its strategy unchanged. Or, in other words, neither A nor B can benefit from *unilaterally* changing their strategies. To see this point, take the strategy profile (Stadium, *Stadium*). Now ask A the following question: Would you prefer to change your strategy given that B is choosing "Stadium"? And then ask B the same question: Would you prefer to change your strategy given that A is choosing "Stadium"? If the answer to both questions is *no*, then there is no player that benefits from changing its strategy *unilaterally*.

In economics we say that the strategy profiles (Stadium, *Stadium*) and (Theatre, *Theatre*) constitute the *Nash equilibria* of the game.

Nash Equilibrium: A strategy profile is a Nash Equilibrium if no player can benefit from *unilaterally* changing her strategy.

IT CAN BE QUITE surprising to realize that the concept of Nash Equilibrium leaves us with no clue regarding which equilibrium is going to be eventually chosen. Which one is more likely to be occur? How would real people solve coordination problems without the ability to communicate with each other? Economists have proposed that some Nash equilibria are focal for one reason or another. In our example (Theatre, *Theatre*) is more fair in terms of the distribution of utils and it gives *collectively* more of them. Hence, one might argue that this Nash equilibrium is more likely to occur. Empirical work is useful in these cases to inform the theoretical analysis.

REVISION QUESTIONS

Question 1.

Which of the following is true for a cartel?

a) It is likely to increase competition and decrease profits for its cartel members.

b) It is always legal in Australia.

c) It is likely to reduce competition and increase profits for its cartel members.

d) It always increases consumer surplus.

Question 2.

When a player has a dominant strategy, it means that

a) this strategy is preferred by the player irrespective of the strategy selected by the other player.

b) both players make different choices.

c) both players make the same choice.

d) the payoff to a strategy depends on the choice made by the other player.

Question 3.

Which of the following statements is true for the firms operating in an imperfectly competitive market in which these firms have some market power?

a) To maximise profit the price they charge is equal to their minimum average total cost.

b) To maximise profit the price they charge is equal to their marginal cost.

c) To maximise profits each firm needs to consider the actions of the other firms.

d) To maximise profit the price they charge is as high as it can be.

Question 4.

Define the following terms:

- Strategy profile, and
- Nash equilibrium.

Question 5.

Explain why firms in an oligopolistic market have an incentive to form a cartel, but also the incentive to cheat on any collusive agreement.

Question 6.

Explain why Game Theory is not applicable neither to a perfectly competitive market nor to a monopoly.

Question 7.

Assume two rival car rental companies (Ace Rentals and Bob's Rentals) are considering whether to discount their rates as a method of increasing market share. The following pay-off matrix gives the expected monthly profits (in $'000) of each company (Ace, Bob's) under alternative strategies. The payoffs and strategies for Bob's are in *italics*:

		Bob's	
		Discount	*Do not discount*
Ace	Discount	12, *10*	24, *6*
	Do not discount	8, *20*	16, *14*

Find the Nash equilibrium of this game. Explain your answer.

Question 8.

Below are the pay-off matrixes for two games. Assume you are player Row, and your opponent is player Col. S1 is strategy 1 and S2 is strategy 2. The payoffs and strategies for player Col are in *italics*:

		Col	
		S1	*S2*
Row	S1	4, *4*	1, *5*
	S2	5, *1*	2, *2*

Table 8.7: Game 1.

		Col	
		S1	*S2*
Row	S1	2, *3*	0, *2*
	S2	3, *1*	1, *0*

Table 8.8: Game 2.

a) What is a simultaneous move game?

b) Explain the meaning of the terms "Coordination Game" and "Prisoner's Dilemma"?

c) Find the Nash equilibrium for each game.

d) Suppose you are Row. If you could choose which of the two games you wanted to play, which would you choose? Why?

e) Would Col agree with your choice? Why?

Question 9.

The publishers of two daily city newspapers, BUGLE and CLARION, compete vigorously for sales. Each publishing company is considering whether to cut the price of its newspaper. Assume that the strategy choices for each company can be modelled as a choice between two alternative strategies: Cut Price or Maintain Price. The following payoff matrix gives the expected monthly profits (in $'000) for each newspaper (BUGLE, CLARION) under alternative strategies (payoffs and strategies for Clarion in *italics*):

		Clarion	
		Maintain price	*Cut price*
Bugle	Maintain price	66, *72*	36, *90*
	Cut price	96, *30*	54, *42*

What is

a) the dominant strategy for Bugle and Clarion? Explain.

b) the Nash equilibrium of this game? Explain.

9
Externalities

The 3rd characteristic of a perfectly competitive market states that there are no externalities. In this chapter we challenge this assumption.

9.1 Positive Consumption Externality

In order to give a real-world example, we will refer to you, the perfume-wearer student attending our classes. We know that you derive a certain marginal benefit from wearing perfume. In fact, your demand curve for perfume captures the marginal benefit (or reservation price) you obtain from different amounts of perfume. Figure 9.1 depicts your private demand curve — your marginal benefit for each unit of perfume — in Panel A.

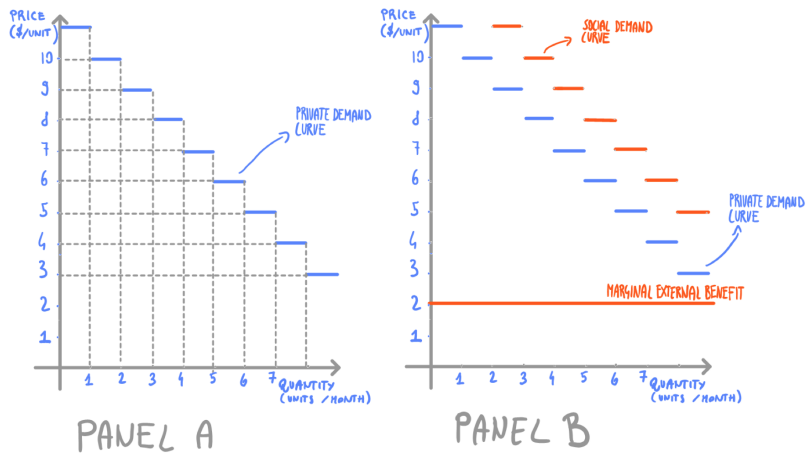


Figure 9.1: Panel A: Private demand curve for perfume. Panel B: External benefit and social demand curve are introduced.

When you decide how much perfume to wear every day, you are probably doing (more or less consciously) a cost benefit analysis: expand the amount of perfume you wear until the point where your marginal benefit is equal to the marginal cost (in this case the market price of perfume).

And there lies the problem! You are considering *your* marginal benefit from wearing perfume and, by doing so, you underestimate (or even ignore) the external effects on others. The student sitting next to you might love your perfume. He or she cannot get enough of it. Are you considering his or her preference when you decide how much perfume you wear? The answer is: probably not. This is an example of a *positive consumption externality*. For simplicity, assume that the person next to you experiences a marginal benefit equal to $2 for each unit of perfume you wear. This marginal external benefit is represented by the horizontal line in Figure 9.1 (Panel B). In order to find the *social demand curve* we just need to add up the private marginal benefit and the marginal external benefit for each unit of perfume. The resulting curve is parallel to the private demand curve, where the vertical distance between the two is equal to the marginal external benefit. The social demand curve is depicted in Figure 9.1 (Panel B).

Positive Consumption Externality: A Positive Consumption Externality represents a benefit accrued to someone who is not involved in the consumption of a given good.

SUPPOSE THAT THE PRICE of perfume is $8 per unit. Your private demand curve suggests that you should buy 4 units per month. This definitely satisfies the cost benefit principle — 4 units is the quantity for which your marginal benefit ($8) is equal to the marginal cost (the market price, $8).

However, does this choice maximize social surplus? It is easy to see that the answer is no. The social marginal benefit when you consume 4 units is given by your personal marginal benefit ($8) plus the marginal external benefit ($2), for a total of $10.

What if you were to consume one more unit of per-

fume? The social marginal benefit would be equal to $9 whereas the marginal cost remains $8. This implies that society as a whole would experience a $1 surplus on the 5^{th} unit of perfume. Finally, if you were to consume one extra unit (the 6^{th} unit) you would reach the point where the social marginal benefit ($8) would be equal to the marginal cost ($8). The cost benefit principle then suggests that consuming 6 units of perfume maximizes the social surplus.

By making consumption decisions without accounting for their external benefit, you are not maximizing social surplus. The deadweight loss due to the presence of positive consumption externalities is depicted in Figure 9.2.

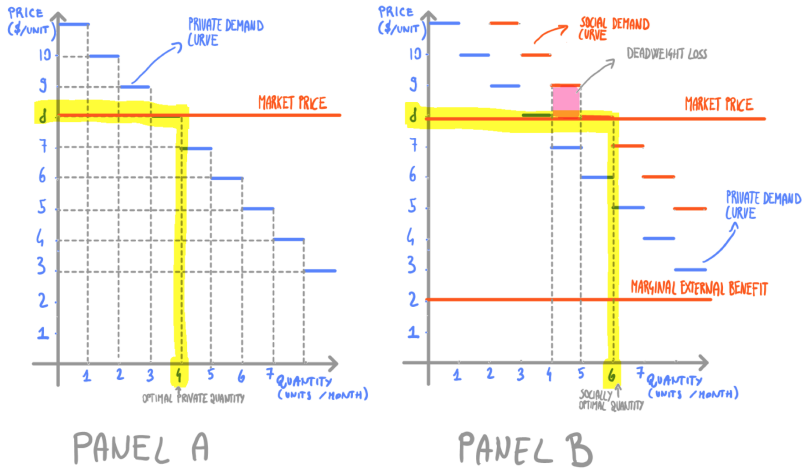


Figure 9.2: Deadweight loss due to a positive consumption externality.

This result once again highlights the limitations of the Invisible Hand Principle. In this example, you are doing what's best for you when you consume 4 units. However, the action that maximizes your own satisfaction does not translate in the optimal amount of consumption for society as a whole.

How could we solve this problem? Luckily for us, this one has a pretty simple solution. In a situation like the one we described, it is easy to see that the under-consumption problem can be solved by *private negotiation*. If the student sitting next to you really loves your per-

fume, he or she might let you know that. Then a simple negotiation begins: you can offer to consume two extra units of perfume (6 units instead of 4) in exchange for $2 per extra unit. He or she would accept because the price you are asking is exactly equal to the external benefit associated with consuming two more units of perfume. You are also better off with this deal in place. The private marginal benefit of the 5^{th} unit ($7) plus the subsidy ($2) is greater than the marginal cost ($8). And the private marginal benefit of the 6^{th} unit ($6) plus the subsidy ($2) is exactly equal to the marginal cost ($8).

The idea that in certain cases the inefficiency arising from externalities can be solved without government intervention is encapsulated in *Coase Theorem*:

> "**If trade in an externality is possible and there are no transaction costs, bargaining will lead to an efficient outcome regardless of the initial allocation of property rights.**"

Coase Theorem: "If trade in an externality is possible and there are no transaction costs, bargaining will lead to an efficient outcome regardless of the initial allocation of property rights."

In our example, Coase's conditions are satisfied — dealing with the student next to you does not involve any cost (*no transaction costs*) and you are allowed to *trade in the externality* by requesting a subsidy for each extra unit of perfume you consume above your preferred amount.

THERE ARE NUMEROUS OTHER EXAMPLES of positive consumption externalities. Here is a list that includes some of them:

1. *Fitness activities*: by remaining in good health, an individual reduces the health care costs incurred by society.

2. *Vaccinations*: by receiving a vaccination, an individual reduces the likelihood that others get infected.

3. *Bike to work*: by biking to work, an individual reduces traffic congestion and pollution.

4. *Education*: by acquiring an education, an individual has a positive impact on society overall in the form of increased productivity.

5. *Social networking*: by participating in social networks, an individual has the potential to enrich the experience for the other members of the network.

6. *Fire protection services*: by acquiring fire protection services, an individual reduces the likelihood that a fire originated in his or her place may spread to other homes.

9.2 *Negative Production Externality*

In this section we are going to need a new example. For this one, we are looking at you, entrepreneurial student who sells hot-dogs outside our lecture theatre!

It is a fact of life that you incur a certain marginal cost from selling hot-dogs. In fact, your supply curve captures the marginal cost (or reservation price) you incur for different amounts of hot-dogs sold. Figure 9.3 depicts your private supply curve — your marginal cost for each hot-dog — in Panel A.

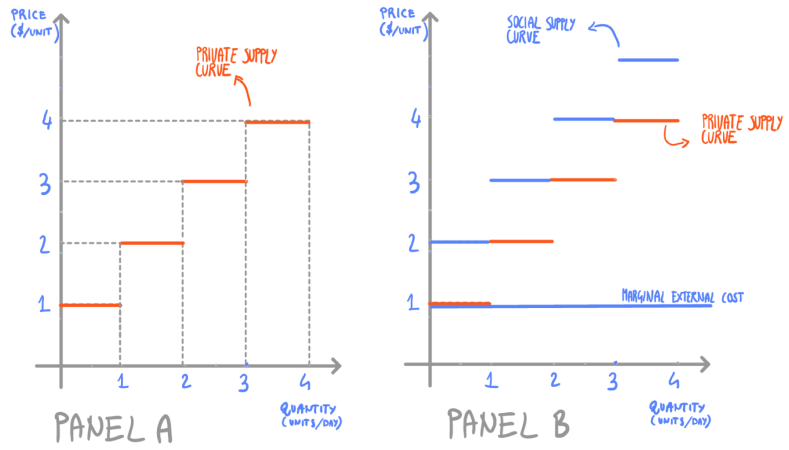


Figure 9.3: Panel A: Private supply curve for hot-dogs. Panel B: External cost and social supply curve are introduced.

When you decide how many hot-dogs to produce every day, you are probably doing a cost benefit analysis: expand the number of hot-dogs until the point where your marginal benefit (in this case the market price of hot-dogs) is equal to the marginal cost.

And there lies the problem. (Again!) You are considering *your* marginal cost and, by doing so, you ignore the external effects on others. The student sitting next to you outside the lecture theater dislikes the pollution (all the smoke and that hot-dog smell) you are creating as a by-product of your business. This is an example of a *negative production externality*. For simplicity, assume that the person next to you experiences a marginal external cost equal to $1 for each hot-dog you produce.

Negative Production Externality: A Negative Production Externality represents a cost incurred by someone who is not involved in the production of a given good.

This marginal external cost is represented by the horizontal line in Figure 9.3, Panel B. In order to find the *social supply curve* we just need to *add* the marginal external cost to the private marginal cost for each unit of hot-dog. The resulting curve is parallel to the private supply curve, where the vertical distance between the two is equal to the marginal external cost. The social supply curve is depicted in Figure 9.3 (Panel B).

ASSUME THAT THE PRICE of a hot-dog is $3. Your private supply curve suggests that you want to sell 3 units per day — when you produce 3 units your marginal benefit (the market price, $3) is equal to the marginal cost ($3).

As usual, in the presence of externalities, your private production decision does not maximize social surplus. To see this point, note that the social marginal cost when you produce 3 units is given by your personal marginal cost ($3) plus the marginal external cost ($1), for a total of $4. The social marginal cost ($4) is clearly greater than the marginal benefit (the market price, $3), hence society as a whole experience a negative surplus equal to $1.

What if you were to produce one less unit? The marginal benefit would remain $3 whereas the social marginal cost would decrease to $3 (private marginal cost, $2, plus external marginal cost, $1). This is the quantity that maximizes the social surplus because the social marginal cost equals the marginal benefit. (Try to check this independently by looking at Figure 9.3.)

This example reveals that, by making production de-

cisions without accounting for their external costs, you are not maximizing social surplus. The deadweight loss due to the presence of negative production externalities is depicted in Figure 9.4.

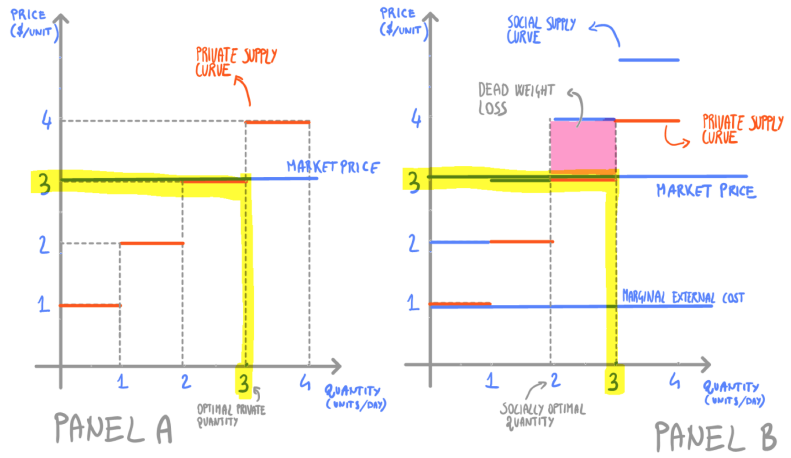


Figure 9.4: Deadweight loss due to a negative production externality.

As in our previous example, the over-production problem can be solved by private bargaining. You can offer to decrease production by one unit (2 units instead of 3) in exchange for $1. The student sitting next to you would accept because the price you are asking is exactly equal to the external cost he or she has to incur. On the other hand, you are strictly better off with this deal in place. The marginal benefit from the 3^{rd} unit ($3) minus the marginal cost ($3) would have provided you with a surplus equal to $0, which is lower than the transfer ($1) you receive from the student sitting next to you.

There are numerous other examples of negative production externalities. Here is a list including a few:

1. *Harmful production activities*: by adopting inadequate production technologies, firms impose a cost on society by increasing air, water, and noise pollution. The costs associated with *global warming* are considered as the biggest negative production externality ever created in human history.

2. *Excessive risk-taking*: by engaging in excessive risk-taking, banks can kickstart global financial crises that have the potential to affect thousands of people.

3. *Over-fishing*: by engaging in over-fishing, firms run the risk of depleting the stock of fish in the ocean.

9.3 *Externalities in Large Markets*

Let us now consider a market with many buyers and sellers, characterized by smooth *private* demand and *private* supply curves as the ones depicted in Figure 9.5.

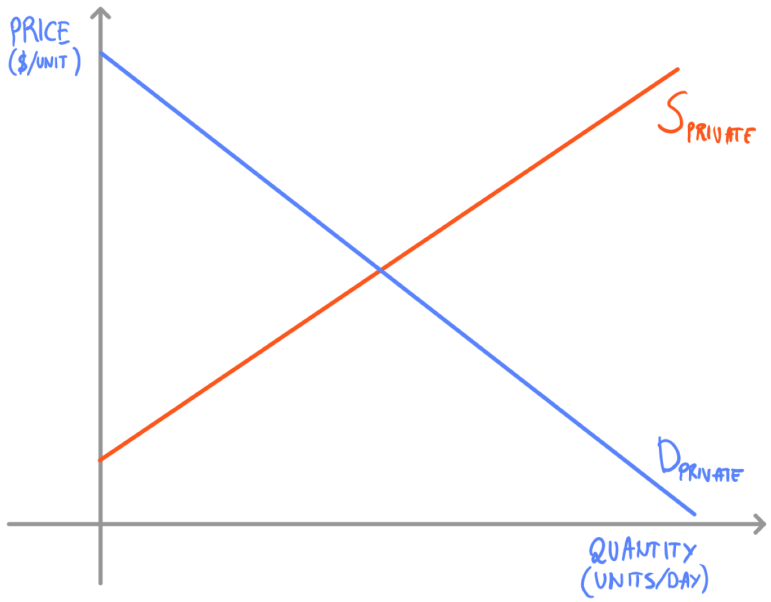


Figure 9.5: Supply and demand curve in a market with many buyers and sellers.

In the presence of externalities, we can construct social demand and supply curves exactly like we did in the previous sections of this chapter. In Figure 9.6, Panel A shows the social demand curve in a market with positive consumption externalities; Panel B shows the social supply curve in a market with negative production externalities.

In both Panels, point M represents the market equilibrium. However, it should be clear from our discussion in the previous sections that the socially optimal price and quantity is located where the social curves intersect. The

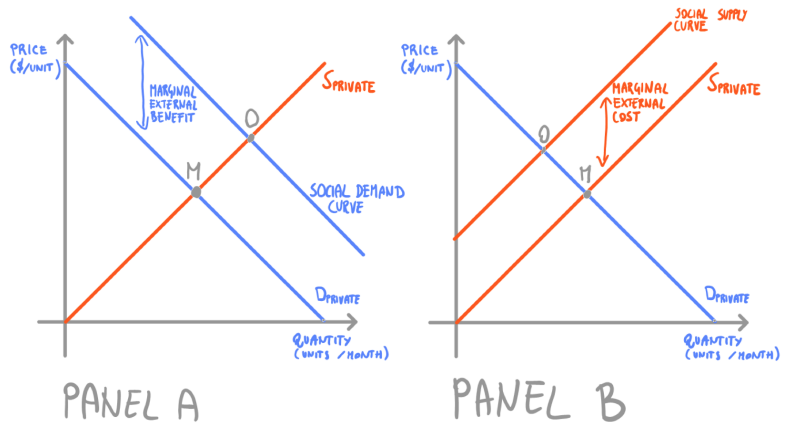


Figure 9.6: Panel A: Social demand curve in a market with positive consumption externalities. Panel B: Social supply curve in a market with negative production externalities.

corresponding points are denoted by O in Figure 9.6. As before we have indicated in Figure 9.6 the deadweight loss associated with the market operating at an equilibrium represented by Point M, instead of Point O.

What is fundamentally different in this market is that the Coase's conditions no longer apply. The sheer number of buyers and sellers creates high transaction costs as those involved in the market struggle to negotiate with all the relevant parties.

Government intervention is then necessary to fix what the market cannot handle on its own. A simple set of policies (taxes and subsidies) can achieve this objective.

We know that a subsidy can stimulate consumption by shifting the demand curve to the right. A subsidy equal to the marginal external benefit depicted in Figure 9.6 (Panel A) would shift the private demand curve to right to the point where the new private demand curve (which includes the subsidy) is identical to the social demand curve. By using a well-designed subsidy, the government can affect the market in a such a way that the socially optimal quantity is realized (Point O). See Panel A in Figure 9.7.

The market presented in Figure 9.6 (Panel B) can be fixed using a tax. Note that a tax equal to the marginal

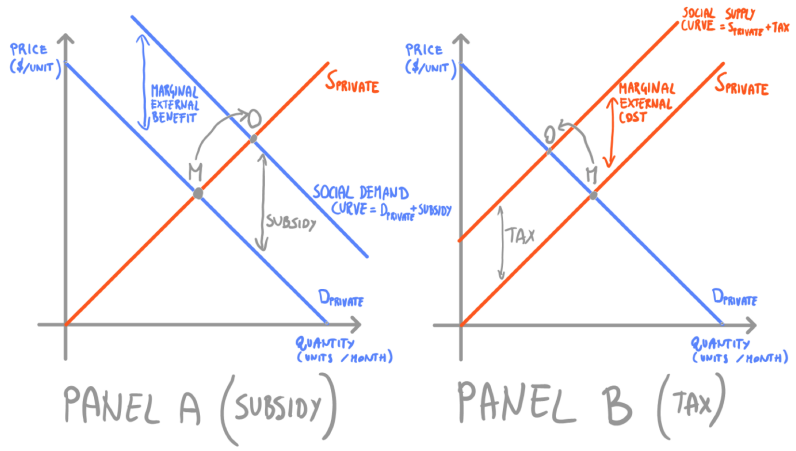


Figure 9.7: Panel A: Introducing a subsidy equal to the marginal external benefit. Panel B: Introducing a tax equal to the marginal external cost.

external cost would shift the private supply curve to left to the point where the new private supply curve (which includes the tax) intersects the private demand curve in Point O. See Panel B in Figure 9.7.

9.4 *Negative Consumption Externality*

It is easy to see how the initial perfume example can be turned around into an example of a negative externality.

To see this point, just assume that the student sitting next to you *hates* your perfume. This would be an example of a *negative consumption externality*. For simplicity, assume that the person next to you experiences a marginal cost equal to $2 for each unit of perfume you wear.

Negative Consumption Externality: A Negative Consumption Externality represents a cost incurred by someone who is not involved in the consumption of a given good.

The case of such a negative consumption externality is qualitatively similar to the case of a negative production externality. They are both associated with a social cost. In this perfume example, the social marginal cost equals $2. The solution concept is the same as the one presented above for the negative production externality.

THERE ARE NUMEROUS OTHER EXAMPLES of negative consumption externalities. Here is a list including a few of them:

1. *Smoking*: by smoking, an individual imposes a health

cost on the people surrounding him or her.

2. *Alcohol abuse*: by abusing of alcohol, an individual increases the health care costs incurred by society.

3. *Driving*: by driving, an individual increases traffic congestion and pollution.

9.5 Positive Production Externality

Let's go back to the example of the hot-dog stand. What if your hot-dog stand attracts people who then decide to visit the local bookshop? This would be an example of a *positive production externality*. For simplicity, assume that the local bookshop experiences a marginal benefit equal to $1 for each hot-dog you produce.

Positive Production Externality: A Positive Production Externality represents a benefit accrued to someone who is not involved in the production of a given good.

The case of such a positive production externality is qualitatively similar to the case of a positive consumption externality. They are both associated with a social benefit. In this example the social marginal benefit equals $1. The solution concept is the same as the one presented above for the positive consumption externality.

Here is a list including a few examples of positive production externalities:

1. *Beneficial production activities*: by performing certain productive activities, a firm can benefit other firms around it. A beekeeper fosters the pollination of surrounding crops by keeping bees. An operating airport benefit the shops situated around it (or inside it) by attracting customers.

2. *New production technologies*: by using new production technologies, a firm disseminates knowledge that can be useful to other firms in the market.

3. *On-the-job training*: by offering on-the-job training, a firm improves the employee's productivity. This has the potential to be useful to other firms as the worker moves to a new job.

REVISION QUESTIONS

Question 1.

Which of the following is a necessary condition for Coase Theorem to lead to an efficient outcome?

a) There are a large number of people involved.

b) No transaction costs.

c) Property Rights are not defined.

d) There are economies of scale present in the production process.

Question 2.

If production of a commodity generates a negative externality, which of the following is true?

a) Social supply curve is to the left and above the private supply curve.

b) Social supply curve is to the right and below the private supply curve.

c) The commodity will be overpriced and undersupplied in a competitive market.

d) The commodity will be overpriced and oversupplied in a competitive market.

Question 3.

Consider a situation where the production of a good leads to large positive externalities. Now consider the market equilibrium without any government intervention. From a social perspective,

a) too much of the good is produced.

b) too little of the good is produced.

c) the efficient amount is produced.

d) none of the above.

Question 4.

Which of the following activities is likely to result in a negative consumption externality?

a) Development of new production technologies

b) Driving

c) Excessive risk taking in the banking sector

d) Over fishing

Question 5.

Which of the following activities is likely to result in a positive production externality?

a) Smoking

b) On-the-job training

c) Alcohol abuse

d) Over fishing

Question 6.

What is an externality? Explain why the efficient (or optimal) output may be different from the free market output for a product when an externality exists.

Question 7.

It has been suggested by health officials that an increase in the tax on cigarettes would be an effective way to reduce cigarette smoking.

a) Explain why cigarette smoking may be considered to have a negative consumption externality.

b) Explain how the tax increase may result in a more socially efficient allocation of cigarettes.

Question 8.

Education is said to have positive externalities. Diagrammatically show how a government subsidy to tertiary education sector may move the number of students attending university towards the optimum level.

Question 9.

Suppose that Tim and Jim are roommates. Tim needs quiet to study to pass an exam, which he values at $500. Jim likes to listen to music after work to relax, which he values at $200. Because his music bothers no one else, Tim cannot legally force Jim to not play his music. Using Coase's Theorem, what should Tim pay Jim not to play the music for an efficient outcome?

Question 10.

Suppose that in the Sydney suburbs the demand for flowering plants is given by $P = 60 - D$, where D represents quantity demanded (in thousands) and P is the price of a plant.

The supply for flowering plants is given by $P = 0.2S$, where S represents quantity supplied (in thousands).

a) What will be the market price and the quantity supplied of flowering plants?

b) Suppose that there is an external marginal benefit equal to $6 for each extra flowering plant that is consumed. What is the socially optimal number of plants?

c) How does the socially optimal quantity from point (b) compare to the private optimal quantity (i.e., the quantity that would be realized in a market with no government intervention) from point (a)? Should the government impose a tax or give a subsidy to ensure that the socially optimal outcome is achieved? Explain your answer.

10
Public Goods

So far we have considered the production and consumption of private goods. In this chapter we will talk about public goods. Some of the most important goods (and services) in our society are public: education, health care, the judiciary system, national defence, infrastructure. We will see that markets are not well equipped for providing public goods and, as a result, they under-provide them or, at times, fail to provide them at all. In this sense, public goods are a classic example of market failure. Because of this, the provision of public goods is one of the most important justification for government intervention. But let's proceed in order.

10.1 Non-rivalry and Non-excludability

What is the difference between private and public goods? Private goods are *rivalrous* and *excludable*. What does it mean? A good is rivalrous if its consumption by an individual prevents someone else from consuming it. For instance, consider a chocolate bar: if you eat it, your friend can't eat it and vice versa. It is true that you can split it between the two of you, but then each one of you would benefit only from half a chocolate bar. This defines rivalry, what about excludability? A good is excludable if you can exclude someone else from consuming it. Consider, for example, the same chocolate bar. You can exclude your neighbour from eating it, right? If he tries to eat it ... you can call the police! Thus, a chocolate bar is a

private good.

Public goods, on the contrary, are goods that are neither rivalrous nor excludable. To be more precise, goods that are non-rivalrous and non-excludable are called *pure public goods*.

Pure Public Goods: Pure Public Goods represent goods that are *perfectly* non-rivalrous and non-excludable.

Can you think of goods with such characteristics? Think, for instance, of a lighthouse in the Sydney harbour. It is non-rivalrous, as a boat benefiting from its guiding light at night does not impede other boats from benefiting as well. Technically, *non-rivalry* is related to the marginal cost of production: unlike a private good, the marginal cost of providing the public good to an additional user is zero. The lighthouse is also *non-excludable*: no one can exclude a boat from benefiting from the lighthouse. Thus the lighthouse is an example of public good. Another example is national defence. The Australian Defence Force defends all of the people residing in Australia from an external attack: no one can be excluded (non-excludability) and the defence of an extra person does not diminish your own safety (non-rivalry).

Non-Rivalry: One individual's consumption of the good does not impede another individual from consuming it as well: the marginal cost of providing the public good to an additional individual is equal to zero.

Non-Excludability: No one can be excluded from consuming the good.

IT TURNS OUT THAT pure public goods are pretty rare, while there exist innumerable examples of *impure public goods*. What do we mean by impure public goods? These are goods that satisfy the two public good conditions to some extent, but not fully. There exist non-rivalrous goods that, however, are excludable. A typical example is pay-tv. You cannot watch Fox TV unless you pay a subscription, thus you can be excluded. However, it is clearly a non-rivalrous service: whether you are the only person watching a football game or a million other people are also watching it, your enjoyment is unchanged. Several public goods we use every day are excludable, although the marginal cost of servicing an extra user is zero. Think of a bus which is not completely full or an airplane that is not fully booked: the marginal cost of letting you get on is zero, but the bus company and the airline will not allow you to get on unless you pay the ticket.

Impure Public Goods: Impure Public Goods represent goods that are non-rivalrous and non-excludable only up to a point.

There also exist several examples of goods that are non-excludable, but rivalrous. Think of the following example. It's a hot Sunday morning and you decide to take your car and drive from Brisbane to the Sunshine Coast. It is a beautiful day, and thousands of other people had the same idea. Indeed, too many people had the same idea! Result? The motorway is congested and it takes you 4 hours (instead of 2 hours) to get there. A congested motorway is an example of impure public good. It is non-excludable, since there is no toll, but the extra users diminish your benefit, as it now takes you twice as long to get to the coast.

Typically, most public goods are pure only up to a point, that is when the number of users create congestion because of a capacity constraint and thus the good becomes rivalrous. Think, for instance, of this Microeconomics course. As long as there are available seats in the lecture theatre, the lecture is non-rivalrous: an extra student can come in and enjoy (hopefully!) the lecture on public goods without detracting from your own benefit. Now suppose that you get to your lecture and find out that all seats are already taken: clearly, now, the presence of other students diminishes the benefit that you get from the lecture. The same can be said for most public goods, such as: hospitals, schools or public transport; as long as they are not congested the marginal cost of servicing an additional customer is zero, but when they become congested the marginal cost starts to be positive.

10.2 *Aggregating Individual Demands: Marginal Social Benefit and Efficiency*

By now you should know very well how to construct the aggregate demand for a private good: by summing up horizontally the individual demands. Do you think that the same apply to a public good? The answer is no. In order to properly construct the aggregate demand for a public good we have to sum the individual demands

vertically. Let's see why.

Consider the case of two flatmates, Anna and Zoe, depicted in Figure 10.1.

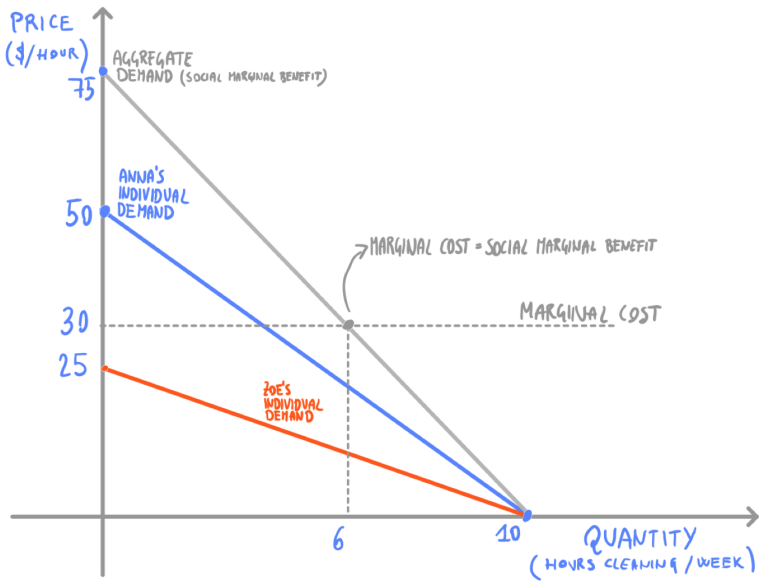


Figure 10.1: Aggregate demand for public goods.

Anna and Zoe would like to hire a cleaner to look after their apartment, but they have to decide on how many hours per week to contract him. Looking at Figure 10.1, we can see that neither of them wants to hire the cleaner for more than 10 hours per week. However, while Anna is willing to pay up to $50 per hour, Zoe is not willing to pay more than $25 per hour. Indeed, notice that Anna's willingness to pay for each extra hour is *always* above Zoe's.

Let's construct the two flatmates' aggregate demand for cleaning. If we proceeded as we learned to do with private goods, we would ask what quantity each individual demands at a given price: thus for every price we would sum the quantity demanded by each flatmate. For example, when the price is $10 per hour, we can see from Figure 10.1 that Anna demands 8 hours of cleaning per week and Zoe demands 6 hours. Thus, at a price of $10 per hour they would hire the cleaner for 14 hours per

week. But, wait a second....this makes no sense, since we started by saying that neither flatmate wants to hire the cleaner for more than 10 hours per week! So, what did we do wrong? We forgot to take into account the non-rivalrous nature of the public good. Unlike a private good, when one flatmate hires (and pays) the cleaner for one hour, the other flatmate *also* enjoys the benefit generated by one hour of cleaning. In order to properly aggregate individual demands for a public good we must ask a different question, that is: for a given quantity, how much is each individual willing to pay? By doing this, we would discover that, in aggregate, Anna and Zoe are willing to pay up to $75 per hour, but they don't want to hire the cleaner for more than 10 hours. This is equivalent to summing their individual demands vertically. We have found out the *marginal social benefit* for cleaning.

Marginal Social Benefit: The Marginal Social Benefit is the vertical sum of the individual marginal benefits.

What is the efficient number of hours Anna and Zoe should contract the cleaner for? As long as the marginal social benefit is greater than the marginal cost, Anna and Zoe should, collectively, hire the cleaner for an extra hour. Vice versa, if the marginal social benefit is less than the marginal cost, then the two flatmates should decrease the hours of cleaning per week.

To find out the efficient number of hours, we set the marginal social benefit equal to the marginal cost. Suppose that a cleaner's hourly wage is $30 per hour. Then, looking at Figure 10.1, we would discover that it is efficient for Anna and Zoe to hire the cleaner for 6 hours per week. Note that, by construction, the marginal social benefit is given by the sum of the individual marginal benefits. Hence, when setting the marginal social benefit equal to the marginal cost, what we are really doing is setting the *sum of the individual marginal benefits equal to the marginal cost.* This is called *Samuelson condition*[1] and is used to determine the efficient provision of a public good.

Samuelson Condition: The Samuelson Condition states that the efficient quantity of a public good is found by setting the sum of the individual marginal benefits equal to the marginal cost.

[1] Paul Samuelson (1915-2009) was an American economist whose research founded and established neo-Keynesian and neoclassical economics.

10.3 Market Provision and Free-riding

Throughout this course we have learned that markets are efficient mechanisms to produce and allocate private goods. Nevertheless, as we have seen, public goods differ substantially from private goods. Thus, it is only natural to ask the following question: do markets provide public goods efficiently? We will answer this fundamental question by considering again the case of Anna and Zoe. Going back to our example, this is equivalent to asking: left to their own devices, will Anna and Zoe hire the cleaner for the efficient number of hours? Let's look at it.

In a free market, Anna and Zoe will *individually* and *independently* decide how many hours to contract a cleaner for. Let's start by looking at Anna's decision.

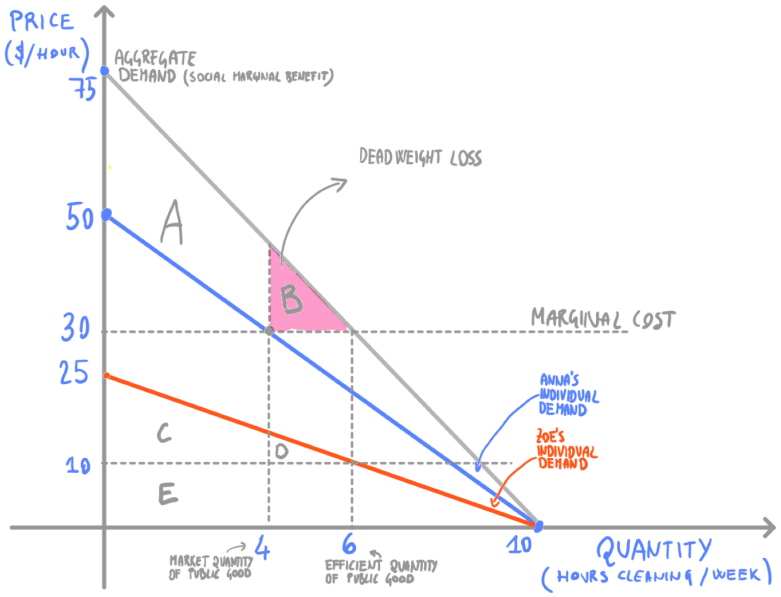


Figure 10.2: Free-riding.

From Figure 10.2, we can see that, setting her marginal benefit equal to the marginal cost, i.e., $30 per hour, it is individually optimal for her to hire the cleaner for 4 hours per week. On the other hand, Zoe's marginal benefit is always below the marginal cost, meaning that Zoe's optimal choice is not to hire the cleaner at all. Now, recall

that a public good is non-excludable. Hence, what will happen in a free market is that Anna will hire the cleaner for 4 hours and Zoe will reap the benefit for free! In other words, Zoe will *free-ride* on Anna's public good's provision. As a consequence, the good is *under-provided*, i.e., less than the efficient quantity is produced.

Free-Riding: Free-Riding denotes the action of enjoying a good without paying for it. The free-riding problem is caused by the non-exludable nature of public goods and it results in their under-provision.

Indeed, looking at Figure 10.2 we can see that the surplus generated by hiring the cleaner for 4 hours is captured by area A, i.e., the area below the social marginal benefit and above the marginal cost. This is less than the surplus generated by the efficient public good provision, i.e., 6 hours, captured by the sum of area A and B. Triangle B represents the deadweight loss associated with the market provision of a public good.

YOU ARE PROBABLY WONDERING: why shouldn't Anna and Zoe agree to hire the cleaner for 6 hours, i.e., the efficient number of hours, per week? Indeed, equipped with the Samuelson condition we derived above, there seems to be an obvious solution to our problem. Each flatmate could pay her own marginal benefit and, at the efficient level, the sum of their payments should be exactly equivalent to the marginal cost. So, Anna could pay her valuation, i.e., \$20, and Zoe could pay hers, i.e., \$10, thus covering the marginal cost, that is \$30 per hour. These are called *Lindahl prices*, after the Swedish economist[2] who first proposed to share the marginal cost of providing a public good according to the individual marginal benefits.

Lindahl Prices Structure: Lindahl Prices imply that each individual pays for the provision of a public good according to their marginal benefit.

[2] Erik Lindahl (1891-1960) was a Swedish economist who first proposed financing public goods in accordance with individual benefits. The public good quantity to be provided satisfied the marginal social benefit equals marginal cost condition.

Although this may, apparently, look like a sensible proposition, we are going to show why the two flatmates will not agree on it. Let's look again at Figure 10.2. We can see that Zoe's surplus from hiring the cleaner for 6 hours and paying \$10 per hour is captured by the sum of areas C and D. On the other hand, if Zoe free-rides on Anna's individual provision, she can enjoy 4 hours of cleaning per week for free. In this case, her surplus is equivalent to the sum of area C and E. Notice that area

D is equal to $5, while E is equal to $40. Thus, C+E is greater than C+D. Because of the non-excludable nature of the public good, Zoe prefers to free-ride on Anna's provision. As a result, the quantity of public good provided by the market is less than efficient. We have uncovered a typical market failure: the under-provision of public goods. While in this example private provision of the public good is inefficient but positive, it is possible that the market may fail to provide the public good at all.

10.4 Public Goods and Externalities

We are now ready to make an interesting discovery. By now, you might have realized that there is a close connection between public goods and externalities. Indeed, a public good is an *extreme case of positive externality*. Like with a positive externality, no one can be excluded from benefiting from the good. By extreme case, we mean that, unlike a standard externality, the benefit accrued to those who enjoy the public good does not depend on who is providing it; indeed, this is another way of defining non-rivalry. You can now fully appreciate why, when deriving the marginal social benefit we drew very similar graphs to the ones we worked out in the case of a positive externality. Similarly, you can see the similarity between positive externalities and public goods, in that both are under-provided by the market.

10.5 Market, Government, and Taxation

We have seen that markets are not well equipped to provide public goods. Because of non-rivalry, each individual can benefit from someone else's public good provision; and, because of non-excludability, she cannot be stopped from enjoying it. This is one of the most important reasons for government intervention, i.e., why governments interfere with free markets and impose taxation in order to provide public goods, such as national defence, edu-

cation and infrastructure. Indeed, unlike a free market, a government can impose taxation because it possesses coercive power. We could even go one step further and think that the origin of the state, from an evolutionary perspective, is precisely the necessity to provide essential goods and services which, otherwise, a society would not be capable of acquiring, and without which a society would capitulate or cease to exist.

We may be tempted to believe that the power to impose taxation is enough to easily reach the first best, that is to provide the efficient level of public good provision. In other words, going back to our example, we could think that a benevolent (i.e., wanting to do the efficient thing) third entity with coercive power, let's call it the government, could hire the cleaner for 6 hours and tax Anna and Zoe $20 and $10 per hour, respectively, that is their Lindahl prices. This could be possible if Anna's and Zoe's marginal benefits were common knowledge. However, in reality their willingness to pay is private information and is not known by others. Hence, if one had to ask Anna and Zoe how much they value one hour of cleaning, they would have an incentive to understate their true valuations, hoping to free-ride on the other's provision. For this reason, although government's taxation greatly helps closing the gap between market and efficient public good provision, it cannot realistically be perfect. As individual demands, in reality, remain unknown, taxation tends to follow two fairness principles. Firstly, governments tax according to people's ability to pay: richer people should provide more; this is, for instance, the reason for progressive taxation, i.e. the fact that income tax rate is higher the more one earns. Second, they tend to tax according to a pay-as-you-go principle, especially when *need* is a less important consideration; think, for instance, of tolls on bridges and tunnels, imposing a higher burden on those who use them more often.

REVISION QUESTIONS

Question 1.

Which of the following goods is "non-excludable"?

a) A local council swimming pool

b) A hotdog

c) A local bus service

d) A lighthouse

Question 2.

What are the characteristics of a *pure* public good?

a) Non-excludability only

b) Non-rivalry only

c) Non-rivalry and non-excludability

d) Rivalry and excludability

Question 3.

What are the characteristics of an *impure* public good?

a) A good that is non-excludable and non-rivalrous but only up to a point.

b) A public good that is provided by the private sector.

c) A public good that is provided by the government.

d) A good that is excludable and rivalrous.

Question 4.

The aggregate demand curve for a public good is constructed by

a) Summing each consumers' desired quantity of the good at various prices.

b) Surveying consumers on how much of the particular good they would desire at various prices.

c) Summing all consumers' marginal benefits at each quantity.

d) Finding the averages of the total individual consumers' demand curves.

Question 5.

What is the "Samuelson condition"? What is its significance?

Question 6.

What is the free riding problem? Does the free-riding problem result in overprovision or under provision relative to the social optimal? Explain.

Question 7.

Fred and Ted each have the following individual demand curve for urban parkland:
Fred: $P = 10 - Q$, and
Ted: $P = 1 - 0.1Q$

a) Assuming that parkland is a public good, find the aggregate demand curve for urban parkland.

b) Suppose that the marginal cost of maintaining the parkland is \$5 per unit of parkland. Calculate the quantity demanded individually by Fred and Ted.

c) What is the socially optimal quantity of the public good that maximizes total surplus? Compare this to the quantity that you obtained in point (b) above. What does this suggest about public goods? Explain.

Part IV

Useful Information

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