Principles of Economics
Lecture Notes
(Fall 2019)

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CONTENTS

[1] Dayanıklı mallar.
[2] TR: Planlı Eskitme.

INTRODUCTION

So far we have studies the basic tools of microeconomics: supply and demand, and the market equilibrium that puts pressure on the price level in various ways. We have learned and worked with fundamental notions of economics such as the elasticities and cross-elasticities of demand. We then studied the standard model of consumer behavior, which relied on utility maximization, and give us descriptions of consumption choices in terms of marginal properties that describe the relations among goods in existence. Along with the following chapter, these topics also constitute an introduction to the current modeling paradigms in economics.

Turning to production, we have studied the basic properties of cost functions and their role in economic thinking and modeling. The neoclassical model of production, we have argued, is not very appropriate in describing current production systems, except perhaps at the level of large aggregates, where the notion of input substitution has proper meaning. If there is to be a firm-level production function, it should have fixed coefficients (Leontieff production function).

In this second half of the class, we study **theories of production and competition** in markets. This includes the study of **perfect competition**, **monopoly**, and **oligopoly**. Studying oligopolies requires modeling "strategic" interaction, which gives us a chance to make an introduction to **Game Theory**.

We then turn to economic analysis at the aggregate (**Macroeconomics**), which is most appropriate to study economic activity and economic policy at the national level. Some of these analysis apply to the global economy as well.

The following are our lecture notes for the topics for which you will be responsible in the final exam. There are a number of sections that are named *optional*. You are not responsible for these topics in the final exam.

Chapter 1 FIRMS AND MARKETS

The firm is the most basic economic organization, and is currently the prevailing form of the organization of production. Most of our current production, as well as most of R&D activity takes place within private firms. While existing firms have quite a bit of diversity in their organizational forms and objectives, they share a great deal of similarity as well. A great number of firms operate internationally, and have varying degrees of internalization in their production, distribution, and management. Some firms are so large that their objectives find political significance and relevance through their impacts on governments. This has spawned a large literature about the firm in critical theory.

A literature in economics deals with the question of why firms exist and the factors that determine the firm-market boundary. From a theoretical point of view, a description of why some transactions take place within firms, and some others take place in markets (the question of the "boundary" of the firm) may be of interest. I do not deal with these issues here. The interested student can find these discussions in Tirole (2001), p 16-34[1].

Market Structures

We observe a great variety of market forms as well. Some industries are characterized by neck-and-neck price competition, to such an extent that producers have little power over the selling price of their products. Such markets are named as **perfectly competitive** markets. In others, certain firms have significant market power over their consumers, and can basically decide their price level without any hindrance or constraint. A firm's **market power** is defined as the extent of its ability to influence the price of its output. Monopolies have complete market power, and perfectly competitive firms have none. In between these two extremes, we have a range of "oligopolistic" market forms. Most actual industries are oligopolies. Monopolistic competition refers to markets with a large number of producers who can (credibly) ignore the effect of their actions on the market as a whole in the short-run.

The following table gives a summary of market structures. Also see Table 9.1 from Samuelson and Nordhaus which is reproduced below as well.

Market Structures:	
Perfect competition	
Monopoly	
Oligopoly	
Differentiated Oligopoly:	Horizontal differentiation
	Vertical differentiation
	Monopolistic competition

[1] Tirole, Jean, 1999, The Theory of Industrial Organization. MIT Press, Cambridge.

Types of Market Structures

Structure	Number of producers and degree of product differentiation	Part of economy where prevalent	Firm's degree of control over price	Methods of marketing
Perfect competition	Many producers; identical products	Financial markets and agricultural products	None	Market exchange or auction
Imperfect competition				
Monopolistic competition	Many producers; many real or perceived differences in product	Retail trade (pizzas, beer, . . .), personal computers	Some	Advertising and quality rivalry; administered prices
Oligopoly	Few producers; little or no difference in product	Steel, chemicals, . . .		
	Few producers; products are differentiated	Cars, word-processing software, . . .		
Monopoly	Single producer; product without close substitutes	Franchise monopolies (electricity, water); Microsoft Windows; patented drugs	Considerable	Advertising

TABLE 9-1. Alternative Market Structures

Most industries are imperfectly competitive. Here are the major features of different market structures.

In oligopolies, competition takes place mostly in

(i)	Prices	(Bertrand analysis)
(ii)	Quantities	(Cournot-Nash analysis)
(iii)	Qualities	(Vertical differentiation)

but can also take place (iv) at a scientific or technical frontier (innovation). We study (i) and (ii) in this class, and only make short descriptions or remarks in passing on (iii) and (iv).

In many industries, all firms produce identical (homogenous) goods. **Product differentiation** exists in most industries, in that firms produce and sell goods that are different, but close enough to be considered as part of the same market. **Horizontal differentiation** is differentiation in the sense that the goods produced are different, but one of them is not necessarily "better" than the other. BMW and Mercedes-Benz are horizontally-differentiated producers. You will find horizontal differentiation in your purchase of many goods, such as most packaged food items. **Vertical differentiation** is differentiation in the sense that one of the goods is objectively better than another, such as having higher quality.

The Firm

A firm is an organization that undertakes the production of a good (or goods), or provides a service (or services), in order to obtain profits. In doing so, it faces many neccesities and constraints. Production may be taking place on one or more of these constraints, which are likely to change only in the long-run. In order words, the description of the economic environment in terms of the following will be necessary in order to understand its behavior (its output and price decisions, as well as decisions of which items to produce and which not).

(1) Input costs, fixed (cost of capacity adjustment) and variable (short-term expenditure)
(2) Investment capital and opportunity
(3) Organizational capability
(4) Knowledge and innovation
(5) Competitors

Note that these also describe important rigidities that may change slowly, hence amenable to long-run analysis.

(1) is the subject of classical and modern economic analysis. (2) is the subject of both modern and Marxian economic schools of thought, but more significantly (and more successfully) of the latter. (3) is mostly the focus of business research, and is only taken as a minor topic in economics. (4) cannot be sufficiently covered by any one discipline, hence is a very interdisciplinary field of analysis and research. This includes contributions from economics, business research, and also from scientists and engineers themselves. (5) is the focus of Industrial Organization in economics.

Also recall the Analysis of Costs we have learned before the midterm. The use of appropriate cost structures is important in the analysis of firm-level production and competition.

We also distinguish between the **short-run** and the **long-run**. Short-run is understood as a time period in which only variable inputs can change. Long-run is a time period during which we can consider all inputs (including fixed costs) as variables. Hence, nothing is fixed in the long-run. Many of the rigidities above refer to things that can only be considered as variables in the long-run. These variables (capital/capacity, organizational capabilities, technical and scientific knowledge, reputation and brand recognition, ...etc) should be considered as fixed and given in short-run analysis.

Chapter 2 PERFECT COMPETITION

Perfect competition refers to a market structure in which there are too many producers producing an identical good, so that intense price competition drives market price down to the marginal cost of production. Firms have no market power, hence cannot affect the price of their product. They have to take the market price as given. There is **free-entry**, which means that it is very cheap and relatively effortless to enter this market as a new producer (yani, there are **no entry barriers**).

The most important thing you should know about a perfectly competitive market is that **Price** = **Marginal Cost**.

$$\mathrm{P} = \mathrm{MC}$$

The following can be derived from the description of perfect competition:

1. Short-run demand curve for a firm is perfectly elastic (horizontal). This is because the firm is "stuck" with a single price (if they increase their price, all consumers are lost).

2. The short-run supply curve is the marginal cost curve. This is a consequence of marginal-cost pricing.

   Short-Run Supply $\equiv$ MC Curve

3. In the long-run, supply curve is horizontal at minimum average total cost (**min ATC**). Hence, price equals average total cost in the long run, and no long-run profits can be made. Firms can make some short-run profits. In the long-run, the possibility of any non-zero profit attracts the entry of new firms to the market, which drives profits back to zero[1].

The following figure describes these observations and some more:

Profits are denoted with the symbol Π. Note the **zero-profit point** ($P = P_Z$) and the **shutdown point** ($P = P_{SD}$) on the graph. If price is between these two, the firm can survive in the short-run for some time, since it can pay its average variable cost. If price is below the shutdown point ($P < P_{SD}$), the firm cannot survive in the short-run, and will shut down.

Perfect competition describes a small fraction of real-life markets. Therefore, it is not generalizable to all industries. However, it may be a close description of industries that are based on well-established (and easily replicable) technologies, and industries in which product differentiation is not possible or very difficult. Examples include markets for various food products, agricultural products, printing houses, transportation, and many others).

[1] In economics, **zero-profits** refers to a situation in which the firm covers all its variable and fixed costs (pays for all its inputs, pays the wages of all its workers, salaries of management) but no surplus above these costs can be earned.

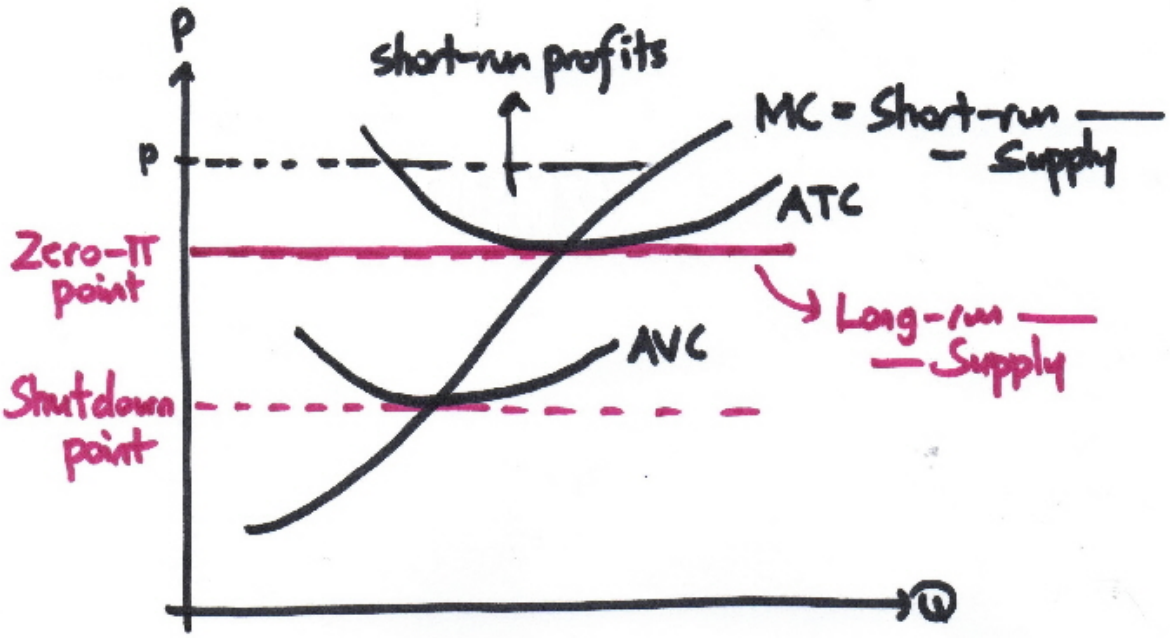


Figure 1 Perfect Competition

The model of perfect competition is important in that it is a benchmark for welfare analysis. Perfect competition is "efficient," yani, it maximizes total well-being in industry, which we defined as the sum of Consumer Surplus and Producer Surplus before.

Perfectly competitive markets attain highest $W = CS + PS$

Chapter 3 MONOPOLY

Monopoly refers to the presence of a single producer in a given market. Monopolies are common. More common are "dominant firms" that have near-monopoly power, but are not the single producer in their industries.

Suppose a monopoly faces inverse demand curve $P(Q)$ and has constant marginal cost MC. Hence, total cost of producing output Q is $TC = MC \times Q$ where MC is the constant marginal cost[1]. Then, total revenue is given by $TR = P(Q) \times Q$ and profits of the monopoly can be written as

$$\Pi = TR - TC$$

A monopoly maximizes profits. We write down the first-order condition for profit maximization, which gives

$$\begin{aligned} 0 &= \frac{\partial \Pi}{\partial Q} \\ &= \frac{\partial TR}{\partial Q} - \frac{\partial TC}{\partial Q} \\ &= MR - MC \end{aligned}$$

where MR is **marginal revenue**, the first partial derivative of total revenue. MR is the revenue obtained from an additional unit of production. The Figure below shows typical demand and MR curves, as well as the constant MC. The monopolist produces the quantity at which $MR = MC$, shown on the graph as Q^M. Look at the demand curve to see that the price at which this quantity can be sold is P^M, which we call the **monopoly price**. The monopolist makes profits

$$\Pi^M = (P^M - MC) \times Q^M$$

which is the area of the rectangle shown on the figure below.

Example (Linear Demand) Let the inverse demand curve be given by the linear demand curve $P = \alpha - \beta Q$, and the total cost of production by $C(Q) = cQ$. where α, β and c are constant numbers. Solve for Q^M,P^M and Π^M.

Solution Marginal revenue is the first derivative of $TR = PQ = (\alpha - \beta Q) Q$, hence $MR = \alpha - 2\beta Q$. Marginal cost is $MC = c$. Equating MR to MC, hence solving for quantity in $\alpha - 2\beta Q = c$, we get the solution

$$Q^M = \frac{\alpha - c}{2\beta}$$

[1] Recall that increasing MC means there is *decreasing returns to scale*, and decreasing MC means that there is *increasing returns to scale*. I use constant marginal cost (constant returns to scale) because it is scale-neutral. Analysis with increasing or decreasing MC are similar, but are not covered in these notes (or in class).

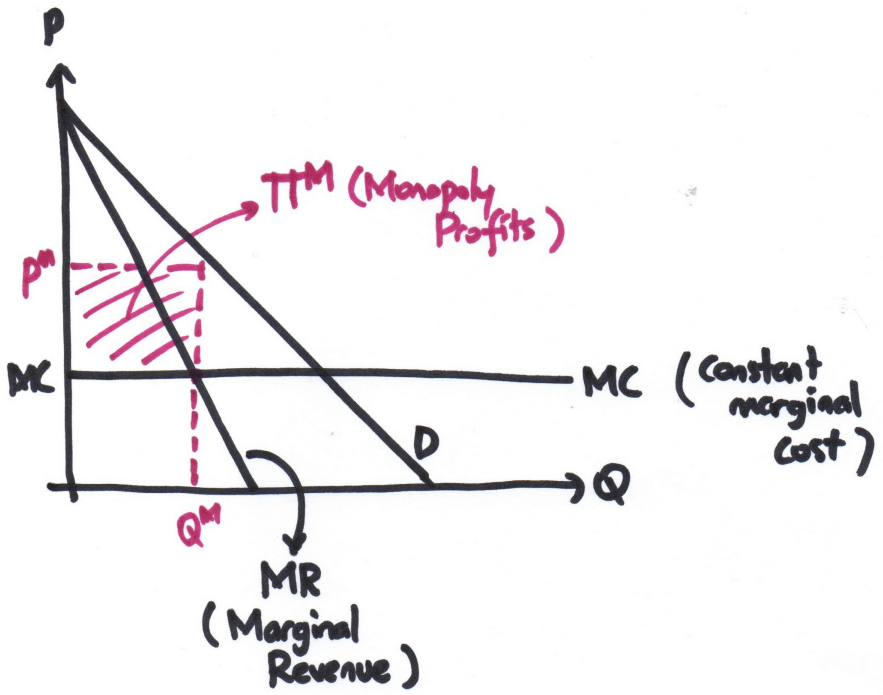


Figure 1 Monopoly Quantity, Price and Profits

Using the demand curve,

$$\begin{aligned} P^M &= \alpha - \beta Q^M \\ &= \alpha - \beta\left(\frac{\alpha - c}{2\beta}\right) \\ &= \frac{\alpha + c}{2} \end{aligned}$$

Finally,

$$\begin{aligned} \Pi^M &= \left(\alpha - \beta Q^M - c\right) Q^M \\ &= \frac{(\alpha - c)^2}{4\beta} \end{aligned}$$

Solution 2 Alternatively, we can write the profit function as $\Pi = TR - TC = PQ - cQ = (P - c)\,Q$. Using the demand curve for P, we can write this as

$$\Pi = (\alpha - c - \beta Q)\,Q$$

The first order condition for profit maximization gives

$$\begin{aligned} 0 &= \frac{\partial \Pi}{\partial Q} \\ &= -\beta Q + (\alpha - \beta Q - c) \\ &= \alpha - c - 2\beta Q \end{aligned}$$

which gives the solution

$$Q^M = \frac{\alpha - c}{2\beta}$$

Check that the second order condition for maximization is satisfied as well. The rest follows as in the first solution[2].

Suppose for a moment that production in this market is not undertaken by a monopoly, but by a perfectly competitive industry. The perfectly competitive outcome is given by the equilibrium that equates Demand to Supply, where the supply curve is the MC curve. Compared to this competitive output, the monopolist undertakes a production level that is too small, and charges a price that is too high. The resulting loss of welfare is called a **Deadweight Loss**. These are benefits that could be enjoyed by some in the economy, but are just lost due to the inefficiency of monopoly. See the figure below.

Finally, let us note the following.

1. A monopolistic market does not have a supply curve. The production decision of the monopolist cannot be separated from the demand curve, hence no independent supply curve exists.

2. The monopolist's decision of quantity can be considered as its long-run choice of production capacity as well. We then expect production capacity of monopolies to grow with market size.

3. A **patent** is a legal document that gives the right to the monopolistic production of a good for a limited time, but as long as the patent is renewed every year (currently for a maximum of 20 years in Turkey, Europe, Japan and the U.S.). Hence, the patent system shares the inefficiency of monopolies to some extent. This is considered to be a necessary cost in order to motivate innovation.

4. While the expectation of future profits are necessary for innovation, monopolies are known to resist innovation, and are not likely to be very innovative. This is because innovation essentially replaces their current profits. We do

[2]Note that the assumption of linear demand is restrictive. Despite this, it allows us to interpret the relationship of prices and quantities to market size (parameter α) and elasticity of demand (which is inversely related to β). A more general model shows that the monopoly price can be desribed by the equation

$$\frac{P^M - c}{P^M} = \frac{1}{\varepsilon_d}$$

where ε_d is the elasticity of demand. Hence, the part of the price that is above cost (the price-cost margin) is inversely related to demand elasticity. The left hand side of the equation is a direct measure of market power and is known as the Lerner Index (this will come up later, when we study oligopolies).

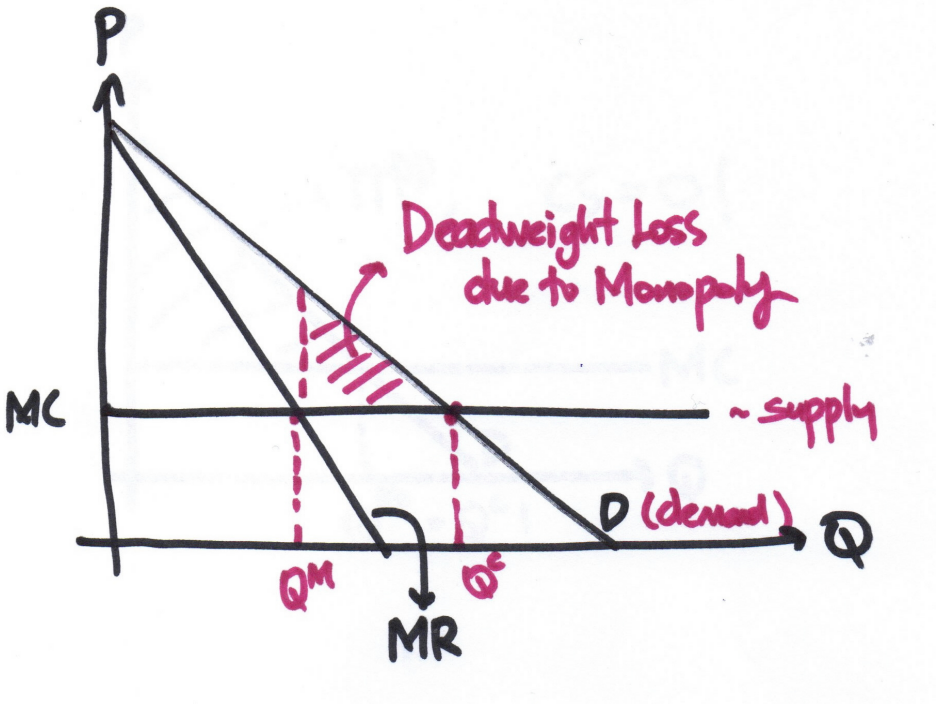


Figure 2 Comparison of monopoly output with the competitive output, and the Deadweight Loss due to monopoly.

not expect much innovation in perfectly competitive settings (there is no motive to innovate when rewards are little, either), and not much innovation in monopolistic markets, either.

Strategies by Monopolists (or firms with market power in general) to gain and exploit market power

1. **Predatory pricing** is pricing below cost ($P < AVC$) in order to push competitors our of the market. This is illegal in U.S., E.U., and Turkish law, but it is difficult to detect.

2. **Tying** is the act of selling two products only as tied together (tying of Internet Explorer to Microsoft Windows). A monopolist may try this in order to leverage market power in a market (Microsoft has dominant position in the market for operating systems) into one where it has a weak competitive position (Internet explorer has lower market shares than its competitors).

3. **Price discrimination** (see below).

4. **Planned obsolescence** (see below).

Price Discrimination

Price discrimination (TR: fiyat ayrımcılığı) refers to charging different prices to different consumers for the same good. It can be practiced by monopolies but also

firms with varying degrees of market power. Price discrimination takes three basic forms:

1. **First-degree price discrimination**. The monopolist can charge each consumer her maximum willingness to pay. A high-paying consumer (who is positioned high on the demand curve) is charged her maximum willingness to pay, and a consumer with a lower willingness to pay is charged that small amount, as long as she can be charged a price above marginal cost. This is not possible to perform in reality, but there are mechanisms that can approximate it with some success. In this case, the monopolist produces Q^{PD} which equals the competitive quantity. Hence, a first-degree price discriminating monopolist produces the efficient level of output. But, it realizes the entire market welfare as profits (shown as Π^{PD} on the graph). See that consumer surplus (CS) is zero.

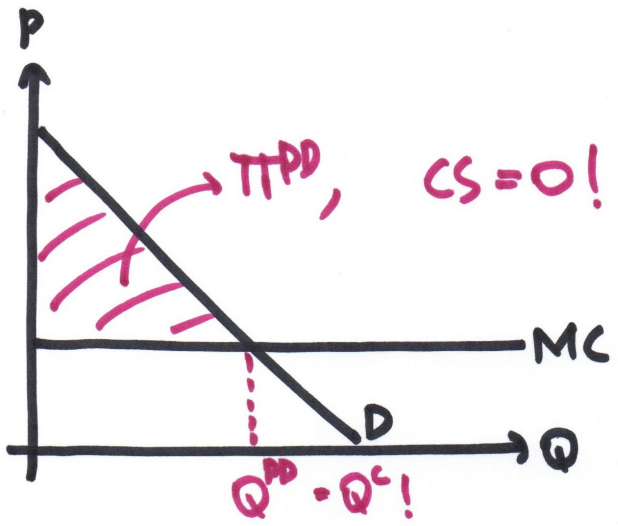


Figure 3 First-degree price discriminating monopolist

2. **Second-degree price discrimination.** The monopolist tries to approximate the first-degree solution (selling everyone their willingness to pay) by offering **price-quality pairs**, or "menus". A price-quality pair is meant to be sold to a particular segment of the market. A high quality product (sold at a higher price point) is meant for high-paying consumers, and lower quality products for lower-paying consumers, ...etc. By offering such menus the monopolist can extract a larger fraction of consumer surplus as profit. There can be an arbitrary number of such "options." In reality, we observe a small number of such choices being offered. For instance, airlines offer three "classes" of travel; economy, business, and first-class.

Suppose that there are two such pairs, a High-quality (q_H) and a low quality (q_L) .

Quality	Price
q_H	p_H
q_L	p_L

An interesting and important dynamic is that reducing q_L allows the monopolist to increase p_H, which increases total profits of the firm. The quality of the low-quality good can be further (and inefficiently) reduced in order to be able to charge a higher price for the high-quality good. An interesting example of this occurred early on in the history of train transportation, where the tops of economy-class parts were removed, so that first-class tickets could be charged a higher rate. Deliberate quality reductions in the production of some goods and services may reflect such pricing tactics.

$$q_L \ (\downarrow) \Rightarrow p_H \ (\uparrow)$$

3. **Third-degree price discrimination**. Consumers can be identified according to an observable characteristic, such as being a student or not. The two observable groups can be considered as different market segments and can be charged different prices. Prices in each group will be inversely related to the group's own price elasticity of demand.

Durable-Goods[3] Monopoly and Planned Obsolescence[4]

The previous analysis of monopoly is very general and applies to all studies of monopoly. Given the specific situation, the MR and MC curves will take different forms. An interesting case is the monopoly (or dominant) producer of a durable good. These are items that are usually consumed one unit per consumer, such as cell phones, personal computers, dishwashers, refrigirators, cars ...etc. A durable-goods monopolist is an interesting case in that:

1. It has to compete with its future selves. Selling one unit today means that there may be fewer demand tomorrow, if the market is not constantly growing.

2. It usually competes with a secondary (used) market.

As a result, a durable-goods monopolist, if it is able to do so, can greatly increase its future profits by Planned Obsolescence: **purposefully producing a good that has an inefficiently short durability (hence a shorter lifetime of use).** Note that such practices are highly wasteful and inefficient from a social welfare standpoint, even though it may increase the profits of a firm with significant market power over consumers.

Example 1 *Did you ever wonder why most of the textbooks you study have new editions appearing very frequently? Our class textbook (Samuelson and Nordhaus) made 19 editions, while Young and Freedman's University Physics and Brown et al's Chemistry are both on their 14th. Are all of these successive editions really different enough to justify a new edition? Part of the reason for so many editions is that this is a way the publisher can kill off the secondary market regularly, opening room for the sales of new books. Hence, publishers practice a form of planned obsolescence when they introduce new editions with few updates.*

Companies practicing planned obsolescence may claim that this is necessary due to the competitive pressures described above (competing with its future self, as well as with a secondary market). However, casual observation and simple economic reasoning suggests that this is not necessary. While Apple clearly undertakes planned obsolescence for many of its products (most notably chargers and other peripheral equipment), there are companies who produce similar goods at much lower production scales, hence at a higher cost point than Apple (remember economies of scale: a larger production scale means unit cost is lower), but who produce highly durable and modular products that are simple to be repaired if an component malfunctions. The British company "Fairphone" has been in existence for some time (they do not ship to Turkey, I believe), among others, and there are other products currently in development[5]. Their existence and success shows that planned obsolescence is not a requirement of the cost structure of production for such devices.

[3] Dayanıklı mallar.

[4] TR: Planlı Eskitme.

[5] See http://www.modularphonesforum.com/

Chapter 4 GAME THEORY

The subject matter of game theory is strategic interaction. This includes competitive environments, but "strategic" does not necessarily mean the presence of competition or adversity among agents. We understand strategic interaction as a situation in which the payoffs of agents depend on the decisions and actions of others in an explicit way.

A game consists of the following elements.

		Notation
Set of Players	:	$i = 1, ..., N$
Set of Actions (Strategies) for each player	:	$A^i \equiv \{a^i, b^i, c^i ...\}$
A payoff function for each player	:	$U_i : A \rightarrow \mathbb{R}$

where $A = A^1 \times A^2 \times \cdots \times A^N$, the Cartesian product of all N action sets.

Games can be classified as **Static** (one-time) and **Sequential** (played over time) games. The information structure classifies games as perfect information games and imperfect information games.

The assumption of **rationality** states that all players make decisions to maximize their own payoffs. The assumption of **rationality** has spawned a big discussion on whether or not humans are rational decision makers. I note that the question of human rationality cannot be answered from the perspective of a single discipline, but calls for contributions from many sciences and philosophies. Also, using optimization as a tool (like we did for utility maximization) does not require us to be fully rational, but just calculative and thoughtful when necessary.

A player can play a **pure strategy** (just one action from the set A^i), or a **mixed strategy** (a probability distribution over possible strategies). Accordingly, we can study a **pure strategy equilibria** or **mixed strategy equilibria** of games. In a mixed strategy equilibrium, a player's strategy is something like: play strategy a with probability P_a, play strategy b with probability P_b, and so on. In this class we will focus on pure strategies. We only give an optional mixed strategy example.

Important solution (equilibrium) concepts are

1. **Dominant strategy equilibrium**

2. **Nash equilibrium**

Nash and Dominant Strategy Equilibria

Prisoner's dilemma

Two criminals are caught for a crime they have committed together (they are guilty). Police puts them in different questioning rooms. Each have two choices, he can talk to the police about the crime (**C**onfess) or remain silent (Do **N**ot Confess), which we summarize as the list $\{C, N\}$. Payoffs are $(-1) \times$ (years in prison) , and

are given by the following game matrix. Players can be named 1 and 2, each has strategy $\{C, N\}$, and payoffs are given in the game matrix below.

		Player 2	
		C	**N**
Player 1	**C**	$(\mathbf{-5}, \mathbf{-5})$	$(\mathbf{0}, \mathbf{-6})$
	N	$(\mathbf{-6}, \mathbf{0})$	$(\mathbf{-1}, \mathbf{-1})$

Here, each possible outcome is represented in a single box, and payoffs are given in a way such that the first entry gives payoff to player 1, and the second the payoff to Player 2. For instance, the outcome (C,N) gives 0 (zero years in prison) to Player 1 and -6 (six years in prison) to Player 2.

Finding the equilibria of the game

- Let us look at the game from Player 1's perspective.
  - If player 2 plays C, it is best for Player 1 to play C. [Mark the corresponding payoff on the matrix].
  - If player 2 plays N, it is best for Player 1 to play C. [Mark the corresponding payoff on the matrix].
  - Therefore, C is the better strategy, and will be chosen by Player 1 regardless of Player 2's choice. [You have marked both payoffs for the first row].
  - Such a strategy is called a **dominant strategy**.
- We should also do the same from Player 2's perspective. Since the game is symmetric, we can immediately say that C is a dominant strategy for Player 2 as well.
- Then, we call (C, C) the **dominant strategy equilibrium** of the game.

We can find the dominant strategy equilibrium of a game by the sequential elimination of dominated strategies: Above, N is a **dominated strategy** for both players (it will never be played as long as strategy C is available). Eliminating N for both players leaves the dominant strategy (C, C).

Not all games have dominant strategy equilibria.

Nash Equilibrium

Let us define the notion of **Best Response**. You can also define this as a function, but this is not necessary. Above, Player 1's best response to Player 2's "C" is "C" itself, hence we say that C is a best response to C. We can also write $B_1(C) = C$, where B_1 indicates Player 1's best response function. We will define a set of strategies a **Nash Equilibrium** if players are best-responding to each other while playing their strategies. Above, Player 1 best-responds to C by playing C, and

player 2 best-responds to C by playing C. (C, C) is a point at which players best-respond to each other. Hence, it is a Nash Equilibrium of the game as well.

This should be sufficient for us. Formally (and a bit unnecessarily), we can write this as

Definition 2 (Nash Equilibrium) *The strategy pair* (A_1^*, A_2^*) *is a Nash Equilibrium of the game if*

$$A_1^* \in B_1\left(A_2^*\right), \qquad \textit{and} \qquad A_2^* \in B_2\left(A_1^*\right)$$

where B_1 *and* B_2 *are best-response correspondences of Players 1 and 2. If best-responses are unique,* B_1 *and* B_2 *are functions, and you can change the "*$\in$*" above with "*$=$*":* $A_1^* = B_1\left(A_2^*\right)$, *and* $A_2^* = B_2\left(A_1^*\right)$.

This may help understand the concept a bit better. You will not see such notation and mathematical detail in the final exam.

A game need not have a Nash Equilibrium in pure strategies, but any game is guarenteed to have at least one Nash equilibrium in mixed strategies. A game can have multiple Nash equilibria, which reduces the predictive power of the concept somewhat in such settings.

Imagine that we begin from random strategies by each player, and successively ask each player to change their choice if they want to. That is, we ask player 1 is she wants to revise her action, and update her choice accordingly. Then we ask player 2 if she wants to change his original strategy. Then ask 1 the same again, and continue until neither player wants to make a change. This process of successive choices and best-responses to each other will converge the play to a Nash equilibrium outcome. **Hence, we can also define a Nash equilibrium as a strategy profile in which no player wants to deviate.**

Also note that:

1. The Prisoner's dilemma is important in its result that individually rational behavior may lead to very poor aggregate outcomes. Rational individual action may give outcomes that appear to be irrational from the perspective of the whole. Note that the outcome of the play (N, N) **Pareto dominates** the outcome of the play (C, C), but players are stuck with this inferior outcome.

2. Pre-play communication does not help the players in Prisoner's dilemma. This is known in game theory as **cheap-talk**. To be able to coordinate on the clearly better outcome (N, N) one needs a commitment device, which may or may not be available.

3. This game form comes up in many natural problems, such as:

   (a) **Arms races** (silahlanma yarışı) between nations. You can consider the amount of expenditure on "guns" to be the strategies of players. $A^{1,2} \equiv \{\mathbf{H}igh, \mathbf{L}ow\}$.

(b) **Advertising games.** Similar payoffs come up if we formulate the amounts of advertising by two firms. Again, $A^{1,2} \equiv \{\mathbf{H}igh, \mathbf{L}ow\}$.

[**Optional**] The original paper by Nash (1950) is shared with you on cms. This is a one-page paper that is very condensed, and it is a great reading if you enjoy mathematics for itself. What we have called a "Best Response" in class, Nash (1950) calls "countering." The definition of Nash Equilibrium is simply stated by "a self-countering n-tuple (strategy set) is an equilibrium of the game," followed by general proofs of existence. Prof. Tony Padilla claims this to be the "short-paper" that has made the most impact per word, in the video shared with you on cms[1].

[1]Video URL (Skip to 6:20 if you only want to watch the part about Nash (1950)): https://www.youtube.com/watch?v=QvvkJT8myeI

Examples

Solve for Nash Equilibria and Dominant Strategy Equilibria

A 2 × 3 game

		Player2		
		Left	**Middle**	**Right**
Player1	**Up**	$(\mathbf{1}, \mathbf{0})$	$(\mathbf{1}, \mathbf{2})$	$(\mathbf{0}, \mathbf{1})$
	Down	$(\mathbf{0}, \mathbf{3})$	$(\mathbf{0}, \mathbf{1})$	$(\mathbf{2}, \mathbf{0})$

Confirm that **(Up, Middle)** is the only Nash Equilibrium of the game. There is no dominant strategy equilibria.

Battle of the sexes

A couple must decide how to spend the night. One of them prefers going to a concert, and the other prefers going to a football game. They both prefer spending the evening together rather than alone.

		Player 2	
		Concert	**Football Game**
Player 1	**Concert**	$(\mathbf{2}, \mathbf{1})$	$(\mathbf{0}, \mathbf{0})$
	Football Game	$(\mathbf{0}, \mathbf{0})$	$(\mathbf{1}, \mathbf{2})$

Confirm the two Nash Equilibria of the game.

The Stag-Hunt game

Two hunters are working together to hunt a stag (this is a kind of deer/geyik). They can continue working together (Stag option). One of them have the option to leave the collective hunt to hunt a rabbit. The rabbit is enough for one person, but the stag is good for two families as a whole

		Hunter 2	
		Stag	**Rabbit**
Hunter 1	**Stag**	$(\mathbf{2}, \mathbf{2})$	$(\mathbf{0}, \mathbf{1})$
	Rabbit	$(\mathbf{1}, \mathbf{0})$	$(\mathbf{1}, \mathbf{1})$

Here Stag represents the collaborative choice, while Rabbit is the selfish act. Confirm that the two Nash Equilibria of the game are **(Stag, Stag)** and **(Rabbit, Rabbit)**.

Investment game

		Firm 2	
		I	**N**
Firm 1	**I (Investment)**	$(\mathbf{100}, \mathbf{100})$	$(\mathbf{-40}, \mathbf{80})$
	N (No Investment)	$(\mathbf{80}, \mathbf{-40})$	$(\mathbf{10}, \mathbf{10})$

A simplified pricing game

		Firm 2	
		L	**H**
Firm 1	**L (Low price)**	$(1,1)$	$(4,0)$
	H (High price)	$(0,4)$	$(2,2)$

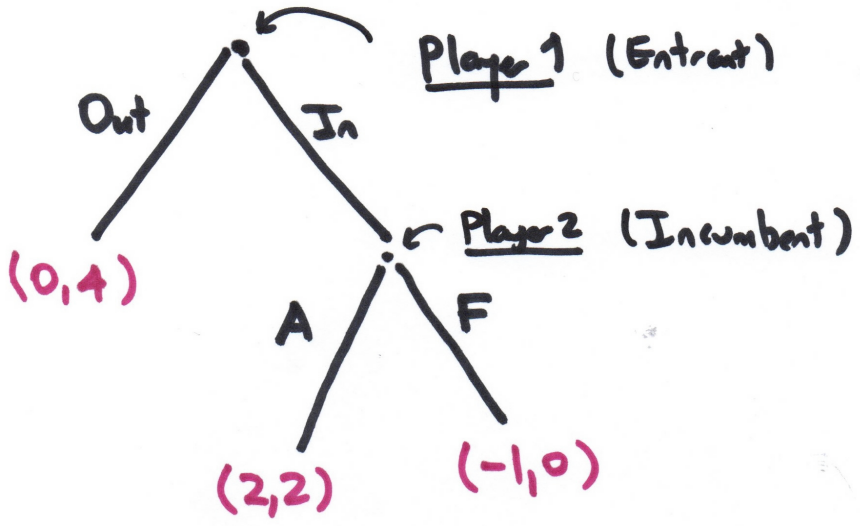
Some other games

		Player 2	
		Left	**Right**
Player 1	**Up**	$(1,3)$	$(4,1)$
	Down	$(0,2)$	$(3,4)$

		Player 2	
		Left	**Right**
Player 1	**Up**	$(-1,1)$	$(3,0)$
	Down	$(4,2)$	$(0,-1)$

A sequential (extensive form) game of entry

The following figure is an example of a sequential game. Player 1 is a company that needs to decide whether it should enter this market (**entrant**), and player 2 is the already existing monopoly in the industry (**incumbent**). The entrant moves first, and has choices $\{\mathbf{Out}, \mathbf{In}\}$. Observing the choice of Player 1, 2 decides to fight the entrant or accommodate, yani, the choices of the incumbent are $\{\mathbf{A}, \mathbf{F}\}$.



A sequential (extensive form) game of entry

We solve sequential games using **Backward Induction:** Starting from the last period, note that **A** is preferred by Firm 2 (Incumbent) if Firm 1 has entered. Then, the first-period choice of Firm 1 (Entrant) is "**In**". Confirm that "**A**" is a best-response to "**In**" and "**In**" is a best-response to "**A**". Therefore (In, A) is a Nash Equilibrium of the game.

We have also considered an extended version of this game in which Player 2 (the Incumbent) has the option to make a costly investment (such as capacity extension) at a previous stage. This way, the Incumbent may commit to playing F in case entry occurs, which deters entry. See your class notes.

(Optional) Repeated Games

Discussed in class.

EQUILIBRIUM POINTS IN N-PERSON GAMES

By John F. Nash, Jr.*

Princeton University

Communicated by S. Lefschetz, November 16, 1949

One may define a concept of an n-person game in which each player has a finite set of pure strategies and in which a definite set of payments to the n players corresponds to each n-tuple of pure strategies, one strategy being taken for each player. For mixed strategies, which are probability distributions over the pure strategies, the pay-off functions are the expectations of the players, thus becoming polylinear forms in the probabilities with which the various players play their various pure strategies.

Any n-tuple of strategies, one for each player, may be regarded as a point in the product space obtained by multiplying the n strategy spaces of the players. One such n-tuple counters another if the strategy of each player in the countering n-tuple yields the highest obtainable expectation for its player against the $n - 1$ strategies of the other players in the countered n-tuple. A self-countering n-tuple is called an equilibrium point.

The correspondence of each n-tuple with its set of countering n-tuples gives a one-to-many mapping of the product space into itself. From the definition of countering we see that the set of countering points of a point is convex. By using the continuity of the pay-off functions we see that the graph of the mapping is closed. The closedness is equivalent to saying: if $P_1, P_2, \ldots$ and $Q_1, Q_2, \ldots, Q_n, \ldots$ are sequences of points in the product space where $Q_n \to Q$, $P_n \to P$ and Q_n counters P_n then Q counters P.

Since the graph is closed and since the image of each point under the mapping is convex, we infer from Kakutani's theorem[1] that the mapping has a fixed point (i.e., point contained in its image). Hence there is an equilibrium point.

In the two-person zero-sum case the "main theorem"[2] and the existence of an equilibrium point are equivalent. In this case any two equilibrium points lead to the same expectations for the players, but this need not occur in general.

* The author is indebted to Dr. David Gale for suggesting the use of Kakutani's theorem to simplify the proof and to the A. E. C. for financial support.

[1] Kakutani, S., *Duke Math. J.*, 8, 457–459 (1941).

[2] Von Neumann, J., and Morgenstern, O., *The Theory of Games and Economic Behaviour*, Chap. 3, Princeton University Press, Princeton, 1947.

Figure 1 Nash (1950) "Equilibrium Points in N-Person Games" PNAS 36(1), p48-49.

Chapter 5 OLIGOPOLIES

An oligopoly describes a market with few competitors. Such firms interact with each other strategically in their decisions of prices, quantities, qualities, durability choices, ... and other parameters of interest. Most real-world industries are oligopolies of some sort. We see continuous entry (by entrepreneurs and by existing firms) and exit (bankruptcy, liquidation) in many such markets. Many oligopolistic markets are dominated by few large, established players We have discussed many examples in class.

Measures of Market Power and Concentration

Recall that a firm's (or industry's) market power is defined as its ability to affect the market price of its product. A measure of market power is the **Lerner Index (LI)**. Measures of industry-wide concentration include the N-Firm (most commonly 4-Firm) **Concentration Ratios** and the **Herfindahl-Hirschmann Index (HHI)**.

Measures of Market Power	**Definition**
Lerner Index (**LI**)	$\text{LI} = \dfrac{P-c}{P}$, where P is market price and c is marginal or average cost. LI is the "mark-up" on cost $(P-c)$ divided by P.
4-Firm Concentration Ratio **(CR4)**	Total market share of the largest 4 firms in the industry
Herfindahl-Hirschmann Index **(HHI)**	$\text{HHI} = \sum_{i=1}^{N} s_i^2$ where s_i is the market share of firm $i = 1, 2, ...N$ HHI is the sum of the squares of market shares in the industry.

Note that HHI takes its highest value (HHI = 1) in case of a monopoly, and takes its lowest value in case the N firms in the market have equal market shares, which gives $\text{HHI} = \sum_{i=1}^{N} \left(\frac{1}{N}\right)^2 = 1/N$. Hence, HHI takes values in the interval $\left[\frac{1}{N}, 1\right]$, and its minimum value approaches zero as the market becomes more and more competitive (as $N \to \infty$).

- **ADD:** Assessing the degree of competition in a given market/industry: The above metrics. Often, we may not have measurements and we have to rely on other observations. (1) Number of firms. (2) market segmentation (or head-to-head competition?) (3) opportunities for differentiation]

Below we study the basic models of competition in oligopolies.

Price Competition (Bertrand Model)

[Bertrand Model is not included in the final exam)] There are two firms, called 1 and 2. Demand curve is given by $Q(P)$, and the constant marginal cost of production is the same for both firms and equals $MC_1 = MC_2 = c$. The two firms sell identical products and choose price simultaneously. Consumers incur no search cost, hence all buy from the lower price firm. Demand for Firm 1 can be written as

$$Q_1(P_1, P_2) = \begin{cases} Q(P_1) & \text{if} \quad P_1 < P_2 \\ \frac{1}{2}Q(P_1) & \text{if} \quad P_1 - P_2 \\ 0 & \text{if} \quad P_1 > P_2 \end{cases}$$

For any price for Firm 2 that is larger than c, Firm 1 can obtain higher profits by undercutting it a little, i.e., announcing a price that is a bit smaller than P_2. Firm 2 would do the same, cutting the price a bit more. This goes on until

$$P_1^* = P_2^* = c$$

which is the only Nash Equilibrium of the game. Both firms charge a price that is equal to the marginal cost of production.

The only Nash Equilibrium is $(P_1^*, P_2^*) = (c, c)$.

Some comments:

- Recall that $P = MC$ is also the price level in a perfectly competitive industry. The Bertrand game shows the consequences direct price competition for homogenous goods. It may be realistic for certain market settings, but such conditions are not very common. It is a "threat point" in strategic market interaction, and one that producers thrive to avoid. Such harsh price competition is usually avoided through
  - Investing in production capacity (Cournot game of the next section).
  - Product differentiation, horizontal or vertical.
- An interesting reversal of this environment gives us Auction (açık-artırma) mechanisms, in which potential buyers bid to raise the price in order to obtain a unique good.

Quantity Competition (Cournot Duopoly)

There are 2 firms, named Firm 1 and Firm 2. Each firm chooses its production level, or quantity, independent of the other. We call their choices Q_1 and Q_2. Demand curve is given by $P = D(Q)$ for total output $Q = Q_1 + Q_2$. We can also write the demand curve as $P = D(Q_1 + Q_2)$. Firms have constant marginal cost equal to c, hence total cost is $C(Q) = cQ$.

This is a situation in which the two firms bring quantities Q_1 and Q_2 to the market, and the demand curve decides the resulting market price. Again, quantity choices Q_1 and Q_2 can be considered choices of capacity investment [üretim kapasitesi belirleme].

Let the demand curve be given by the linear function

$$P = \alpha - \beta Q = \alpha - \beta(Q_1 + Q_2)$$

which is the same demand curve we studied for Monopoly. We will solve for the Nash Equilibrium in quantity choices.

Write Firm 1's profits as

$$\begin{aligned} \Pi_1 &= PQ_1 - cQ_1 \\ &= [\alpha - \beta(Q_1 + Q_2)]Q_1 - cQ_1 \end{aligned}$$

Firm 1 chooses the Q_1 level that maximizes Π_1, taking Firm 2's choice as given.

This will give us Firm 1's Best-Response function. The first-order condition is

$$\begin{aligned} 0 &= \frac{\partial \Pi_1}{\partial Q_1} \\ &= -\beta Q_1 + \alpha - \beta(Q_1 + Q_2) - c \\ &= \alpha - c - 2\beta Q_1 - bQ_2 \end{aligned}$$

Solving for Q_1, we get Firm 1's best-response to Firm 2's output

$$Q_1 = \frac{\alpha - c}{2\beta} - \frac{Q_2}{2} \equiv B_1(Q_2)$$

We do the same for Firm 2 (choose Q_2 to maximize Π_2), which gives

$$Q_2 = \frac{\alpha - c}{2\beta} - \frac{Q_1}{2} \equiv B_2(Q_1)$$

Solving these two together (meaning we are finding the quantities for which the firms best-respond to each other) solves for the unique Nash Equilibrium in quantities. Let's call these the Cournot-Nash quantities

$$Q_1^{CN} = Q_2^{CN} = \frac{a - c}{3b}$$

hence total output in this duopoly is

$$\begin{aligned} Q^{CN} &= Q_1^{CN} + Q_2^{CN} \\ &= \frac{2}{3}\frac{a-c}{b} \end{aligned}$$

Using the demand curve, the price level is

$$P^{CN} = \frac{a+2c}{3}$$

which is smaller than the monopoly price (P^M) we found for the same demand curve. Also see that $Q^{CN} > Q^M$. A duopoly produces more than a monopoly, and charges a smaller price for its product. This is the two-firm solution. It can be checked (you don't have to) that output increases and price falls as the number of competitors increase.

As an (optional) exercise you can calculate equilibrium profits and the Lerner Index by substituting $P = (a+c)/3$ or $Q = 2(a-c)/(3b)$ in the relevant formulas.

Product Differentiation

Here I will give a very brief summary of basic differentiation modes.

[**You should know the definition and meaning of each type of differentiation, but you are not responsible from the models described below.**]

Horizontal differentiation

This is differentiation in the sense that the goods produced are different, but one of them is not necessarily "better" than the other. BMW and Mercedes-Benz are horizontally-differentiated producers. You will find horizontal differentiation in your purchase of many goods, such as most packaged food items.

To get the basic idea, imagine that all consumers live on a "linear city" of length 1, say the interval between 0 and 1. Two companies must choose their "locations" on this linear city. The distance between them is interpreted as the *distance between products*, yani, the closer they are located on the interval, the more similar their products are. Consumers have a per-unit cost of travel, say t. See the figure below. The optimum location choices of the companies are the two extreme locations on this linear city. If they are closer, they need to compete for more consumers, which keeps the price level lower. As a result, they differentiate as much as they can.

To think about this a bit more, imagine that you are resting on your favorite beach (which is represented by the $[0,1]$ interval above). Two ice cream sellers enter the beach from the two opposite ends of the beach. Where should each of them locate on the beach? If they are located in the middle, they will have to directly compete for any consumer who walks to their common location. If they are further away towards the ends, each will have increased market power over consumers nearby, since walking to the other seller is costly. As a results, prices and profits will be higher. Note that even if we imagine the two sellers as selling identical

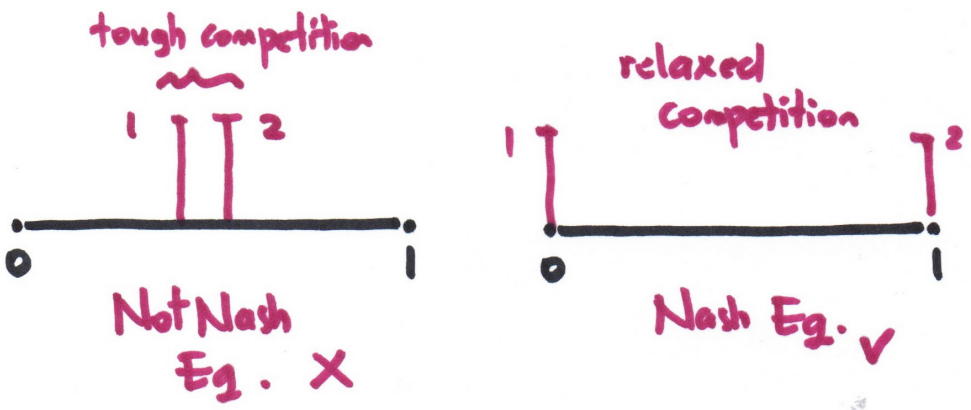


Figure 1 The "linear city" model of differentiation: Firms prefer to be far apart to one another rather than close, since being close to eachother increases competition.

types of ice cream, we can think of them as different goods because of the necessity to walk, which is costly. A seller in my own location describes my favorite version of the good. As the seller moves further away from me, he represents versions of the good I like less and less.

Vertical differentiation

This is differentiation in the sense that one of the goods is objectively better than another, such as having higher quality.

Suppose two firms make product quality choices, q_1 and q_2, and consumers enjoy higher quality goods. We do not solve such a setting but note its basic dynamics: In the Nash Equilibrium one producer produces a good with the highest possible quality level (say $q^{\max}$) and the other the minimum possible quality level ($q^{\min}$). They do not prefer their quality levels to be similar, because this would increase competition between them. This is because they would have to compete for the same consumers rather than "taking" their part of the demand curve: one of them takes higher-paying consumers (the top portions of the demand curve) by selling the high-quality good at a higher price, and the other takes the lower-paying consumers by selling a lower-quality good at a lower price. Note the similarity of this to the case of the *2nd-degree price discriminating monopolist* above. This time the demand curve is divided into segments by two competing firms instead of one that produces all quality levels.

In both cases of differentiation, horizontal or vertical, producing goods that are similar increases the competitive pressure on price (if goods are more similar, competition is stronger), so that firms try to differentiate their products in ways that are available to them. Horizontal differentiation usually appears as a choice of design or marketing, and vertical differentiation as a choice of product quality. Differentiation may not be possible or easy in many industries, such as transportation (goods or human transportation), markets for various food and agricultural products, printing houses, and many others). Industries for which differentiation is little can be considered to be more competitive.

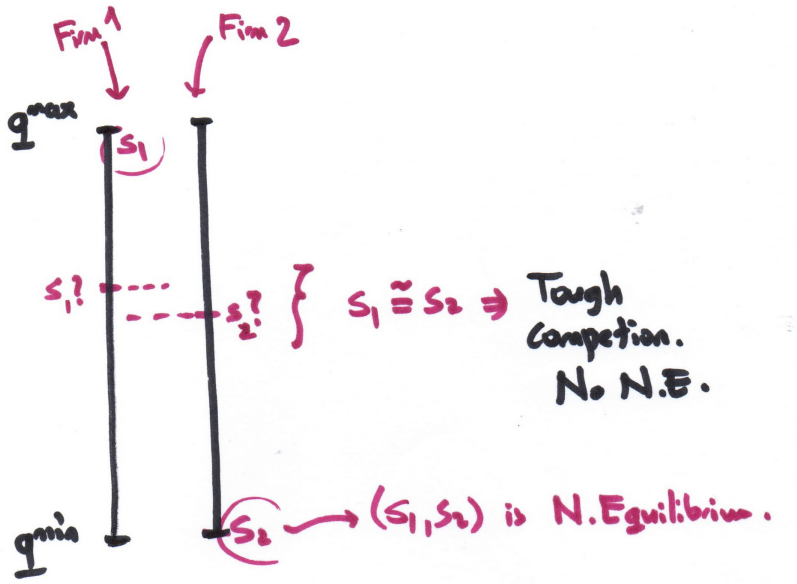


Figure 2 Vertical (quality) differentiation by two firms gives another instance of maximum differentiation: One produces highest, the other the lowest possible quality level.

An interesting result out of the vertical differentiation model is the presence of Natural Oligopolies: If we increase the number of firms in the quality-choice setting, we see that there are situations in which the market can only take a limited (often very few) number of firms in equilibrium. As the number of firms in the market increases (the vertical line between quality levels $q^{\min}$ and $q^{\max}$ in the figure becomes more and more populated), higher-quality firms have to be close to each other, and will have to compete more heavily. This reduces their prices. With the price of the high-quality good low enough, no low-quality firm can exist after a quality threshold.

Chapter 6 MACROECONOMICS

Here we begin looking at fundamental issues regarding the aggregate economy at large and make an introduction the field of Macroeconomics. The concepts and ideas presented here are most appropriate for thinking about economic issues at the national level, but some are useful for thinking about the aggregate world economy as well.

We begin by a review of the most fundamental concepts in Macroeconomics and some measurement issues related to them.

Measuring the aggregate economy

GDP and GNP

The most common and important macroeconomic variable is the **Gross Domestic Product (GDP)** (Turkish: Gayri Safi Yurt İçi Hasıla).

GDP is the market value of all final goods and services produced *within the borders of a country* during a given year. It is meant to capture the total size of an economy, in terms of the total value added of production in the economy during a given year.

An alternative to this is Gross National Product (GNP) (Turkish: Gayri Safi Milli Hasıla). GNP is the **market value of all final goods and services produced *by the citizens of a country* during a given year.**

Both variables (and many more macroeconomic variables of interest) are calculated (in fact, estimated) by national statistical agencies, such as the **Turkish Statistical Institute** (Turkstat) in Turkey[1]. In national accounts, GDP in a given year can be calculated in three equivalent methods. GDP can be calculated as

1. Total spending: Sum of spending by households, firms, governments, and residents of other economies.
2. Total income: Sum of all incomes received, including wages, profits, taxes,...
3. Total production: Total value added of all industry classifications.

GDP is a geographical definition, but it needs to take into account the openness of an economy, by keeping track of its imports and exports.

So, we can say that GDP is

1. the value added of domestic production. Or,
2. the expenditure on domestic production. Or,
3. the income due to domestic production.

[1] http://www.turkstat.gov.tr

Let us look at the terms in the definition of GDP a bit closer to better understand what exactly this variable measures:

- The term **"gross"** indicates that GDP is a sum that contains all existing products and services: shoes, houses, cars, haircuts, chocolate, shirts, rent, financial consulting, cat food,... and so on.

- It is the **"market value"** of all such production, hence existing market prices are used to indicate the value of goods and services. This means that GDP is sensitive to inflation, and may need to be adjusted for it if we would like to make comparisons over time or calculate meaningful growth rates.

- It sums up the value of all **"final goods and services,"** meaning **intermediate goods are not counted**. These are goods that will be used further as inputs in the production of some other good. If we explicitly count such goods, we would make a double-counting, or multiple-counting error: The aluminum used in the production of a car is already valued in the price of the car itself. By including the value of the car in GDP, we already count the value of its aluminum content once. If we include the aluminum explicitly in GDP, which is mined by another industry, we would be counting it twice. Another way to avoid double-counting is to add the **value-added** for each industry classification. Value-added (TR: katma-değer) refers to market value of output minus the cost of inputs, yani, the net value created by the industry.

On the expenditure side, we have the following important identity:

$$\text{GDP} = \text{C} + \text{I} + \text{G} + \text{NX}$$

where

- C is the **Consumption** of goods and services by households,

- I stands for **Investment**, the spending on all productive items, tools and equipment,

- G is **Government Spending**, which covers any and all spending by the government, including the wages of government personnel, purchases by governmental institutions, expenses on infrastructure, expenditures of the police force and of the military, ...etc.

- NX is **Net Exports**, which can be written as the value of Exports minus the value of Imports, or

  $$\text{NX} = \text{X} - \text{M}$$

  in short. NX is also called a country's **trade balance**. Exports are the value of goods and services produced domestically and sold abroad. Imports denote the value of goods and services produced abroad and sold domestically.

GDP is a measure of the overall size of an economy. **GDP per-capita = GDP/Population** (TR: kişi başı gayri safi yurt içi hasıla) is a measure of the average income level in a country. It is often used for comparing average living standard across countries. While both GDP and GDP per-capita are essential variables, they have some important deficiencies as well. For instance, GDP does not account for the depletion of the natural environment or natural resources.

GDP per-capita is more useful when used along with measures that take into account other measures of the **quality of life** in a country, such as excess to education, health and environmental quality. The **OECD Better Life Index**[2] and the **Human Development Index**[3] try to achieve this particular goal.

Inflation, price indexes, Nominal and Real GDP

Inflation refers to a rise in the general price level. Statistical agencies follow the following methodology to calculate the inflation rate. Using household surveys, we first determine a **fixed basket of goods** that represents the annual consumption of an *average* household living in Turkey. This includes all goods and services that this average household purchased during a given year, including many loafs of bread, kilos of tea, socks, phones, apples,...etc. The percentage change in the total price of this basket is the official inflation rate. The inflation basket needs to remain relatively stable over time, and changes must be applied to previous year's basket as well. It needs to be adjusted for the increase in the quality of available goods (how this is done is outside the scope of this class).

Let the total price of this basket at year t be P_t. Then the **consumer inflation rate** at year t is

$$100 \times \frac{P_t - P_{t-1}}{P_{t-1}}$$

If we normalize the price of this basket (P_t) to be 100 at a given year (which we call the **base year**), we obtain the **Consumer Price Index (CPI) (TR: Tüketici Fiyar Endeksi, veya TÜFE)**. So, the consumer inflation is computed as the percentage change in CPI from one year to the next.

The contents of this basket has to be changed in time to incorporate the introduction of new goods and changes in the quality of goods and services.

Other price indexes include the **Producer Price Index (PPI)** (**TR: Üretici Fiyat Endeksi, veya ÜFE**) which tracks the prices of a basket of "production inputs" used by the average Turkish company in a given year. Its percentage change from one year to the next is the **producer inflation rate**.

The **GDP Deflator** is a price index that takes into account the prices of all components of GDP. Recall that GDP is computed using current prices for the market value of final, goods and services. This is called **Nominal GDP**. **Real GDP** is a better measure of the total value-added of production in an economy, and is simply:

$$\text{Real GDP}_t = \frac{\text{Nominal GDP}_t}{\text{GDP Deflator}_t}$$

[2] http://www.oecdbetterlifeindex.org

[3] http://hdr.undp.org/en/content/human-development-index-hdi

if the GDP Deflator is normalized to have a value 1 (rather than 100) at the base year. Real GDP can be directly interpreted as the total value-added of production at the base-year price level.

Economic growth is primarily measured and stated as the percentage growth rate in Real GDP_t. If you need to work with such numbers using statistical or computational tools, note that it is usually better to compute this using logarithmic growth*

$$\text{LGR}_t = \ln\left(\frac{\text{Real GDP}_t}{\text{Real GDP}_{t-1}}\right)$$

instead of the one some of you may find more intuitive or more obvious,

$$\text{GR}_t = \frac{\text{Real GDP}_t - \text{Real GDP}_{t-1}}{\text{Real GDP}_{t-1}}$$

which is also used by statistical institutes. Computing LGR_t is akin to the assumption that growth occurs continuously, but we are looking at it at yearly windows.

Measurement of unemployment

Another important statistic produced by Turkstat is the **Unemployment Rate**. Unemployment rate is defined as the fraction of the unemployed within the labor force, or

$$\text{Unemployment Rate} = 100 \times \frac{\text{Number of } \textbf{unemployed} \text{ adults}}{\text{Number of adults in the } \textbf{labor force}}$$

Unemployed are those who are not currently working, but are actively looking for a job. The **labor force** consists of the employed and the unemployed. A person who is not employed but is not looking for a job is outside the labor force.

The definition of unemployment excludes **discouraged workers**, who are adults that looked for employment in the past, but have given up, thinking there is no demand in the labor market for their skills.

Business cycles and long waves

Economic activity is cyclical. Plotting the growth rate of various countries over time, we see periods in which GDP shrinks (becomes smaller). We call such periods **recessions**. When GDP is growing, we are in a period of expansion. These periods of ups and down occur around an increasing trend. Unemployment falls during expansions and rises during recessions (**Okun's Law)**.

FIGURE 8.1

A business cycle
The solid curve graphs the behavior of aggregate economic activity over a typical business cycle. The dashed line shows the economy's normal growth path. During a contraction aggregate economic activity falls until it reaches a trough, *T*. The trough is followed by an expansion during which economic activity increases until it reaches a peak, *P*. A complete cycle is measured from peak to peak or trough to trough.

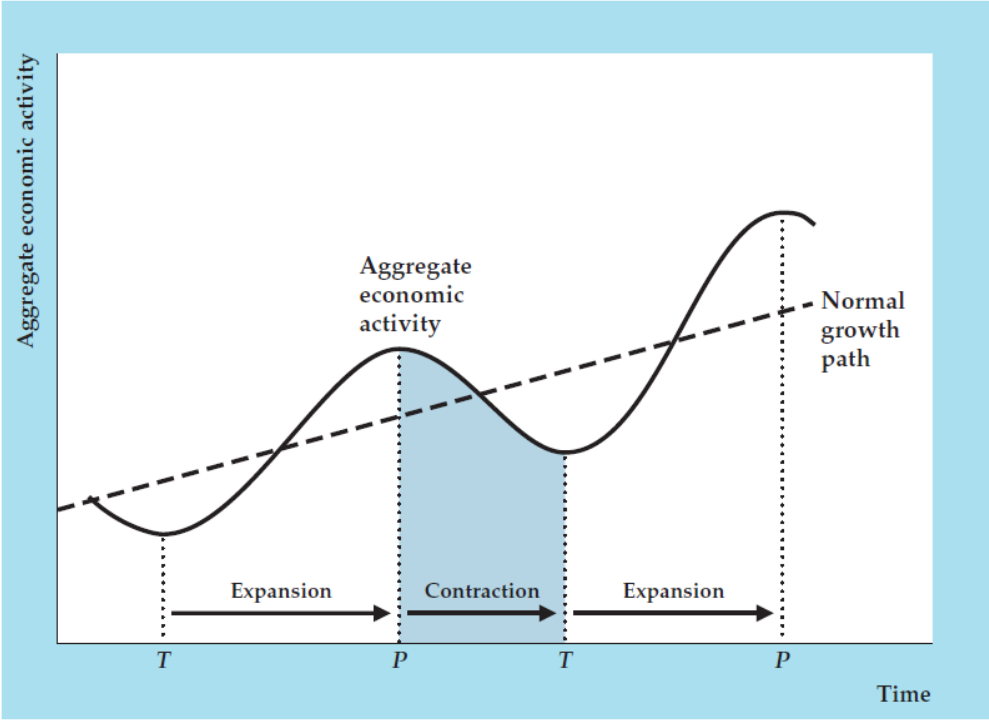


Figure 8.1 from "Macroeconomics (8th Edition)" by Abel, Bernanke and Croushore.

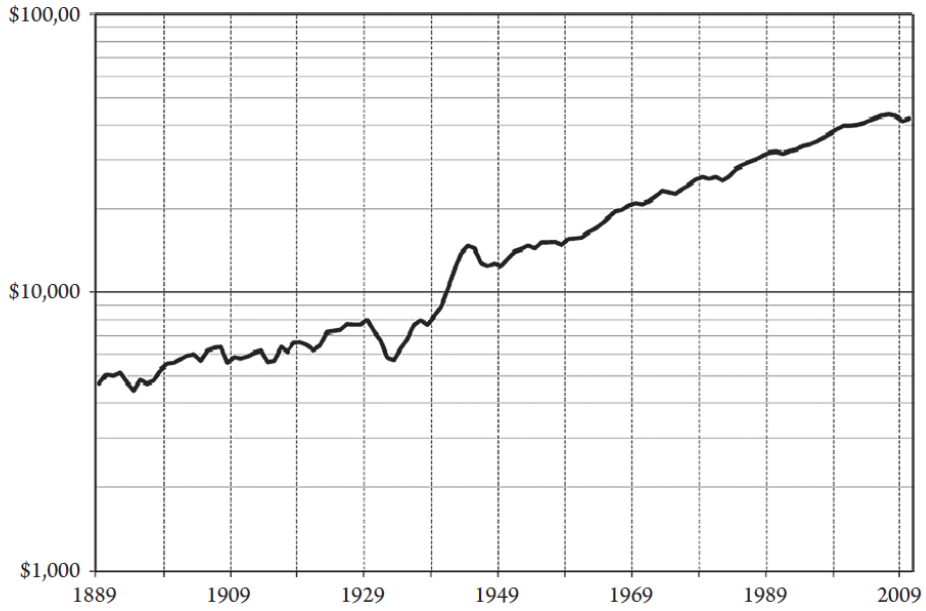


Figure 2.3 US Real GDP per Capita, 1889–2010

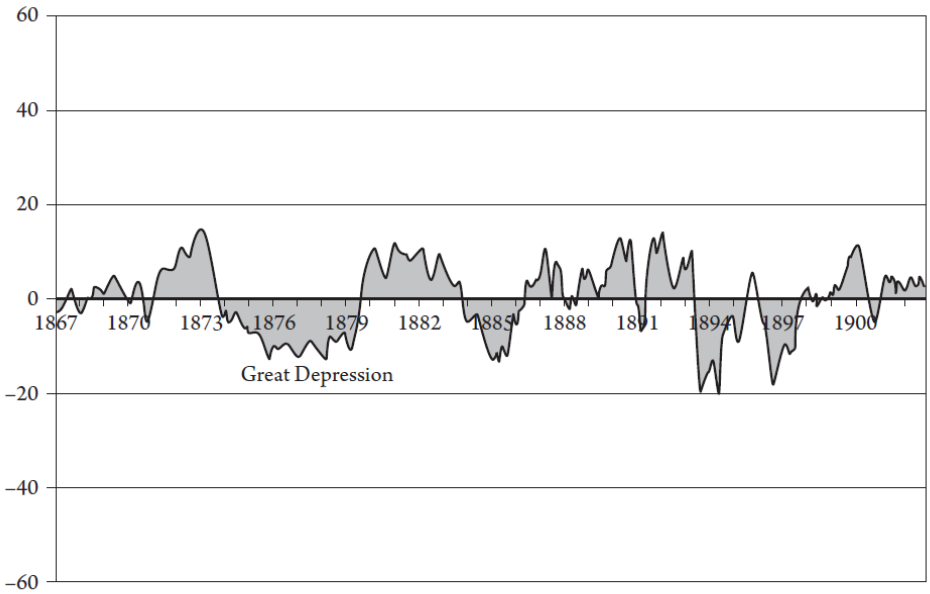


Figure 2.4B Business Cycles, 1867–1902

Figure: US GDP per capita (up) and its growth (down) since 1800s (reproduced from Sheikh 2016).

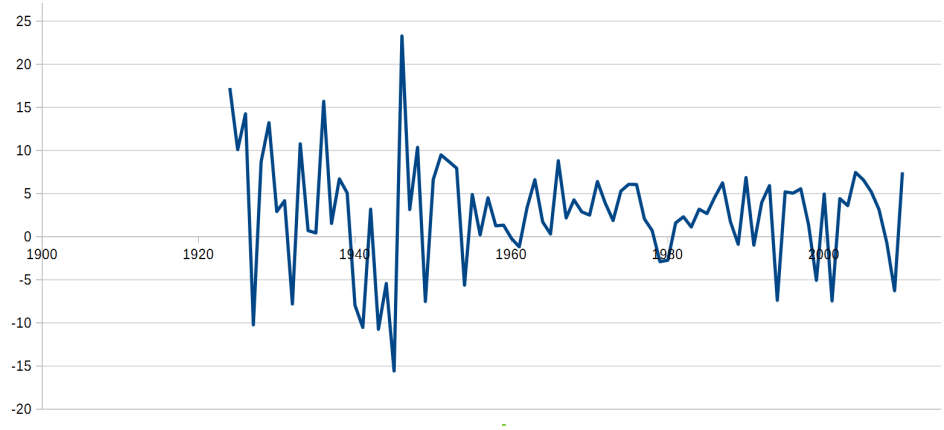


Figure. Turkish rate of growth pf GDP per capita since 1923

In general, we can detect at least two short-term, and one long-term cycles in economic activity. The first two have periods of roughly 3-5 years, and one that has a period of around 15-20 years. These are the cycles that are most commonly known as **business cycles**.

An important reason for the existence of business cycle fluctuations is that the shocks that hit a given economy propagate through **multiplier effects**; the initial effect is compounded with feedback effects that reinforce and multiply the effect of the initial shock.

During the business cycles, agricultural output is more volatile than other sectors. Variation in the growth rate of agricultural output is three times that of the growth rate in industrial putput, and 10 times that of the services sector.

Consumption smoothing refers to the general household behaviour to "smooth" its consumption pattern over time. Households do this by borrowing during times of low income and saving during high-income periods. Investment is more volatile due to the profit-regarding nature of investments.

A demand-led recession can be caused by an initial shock to **Aggregate Demand** (the total demand for all goods and services in the economy), in the following way

$$\text{Shock:} \quad (\text{AD}\downarrow) \Rightarrow \left\{ \begin{array}{l} (\text{Income}\downarrow) \\ (\text{Production}\downarrow) \end{array} \right\} \Rightarrow \left\{ \begin{array}{l} (\text{Consumption}\downarrow) \\ (\text{AD}\downarrow) \end{array} \right\} \Rightarrow \left\{ \begin{array}{l} (\text{AD}\downarrow) \\ (\text{Income}\downarrow) \\ (\text{Production}\downarrow) \end{array} \right\} \ldots$$

and so on. An investment-led recession can look like

$$\text{Shock:} \quad (\text{Investment}\downarrow) \Rightarrow (\text{Income}\downarrow) \Rightarrow \left\{ \begin{array}{l} (\text{Consumption}\downarrow) \\ (\text{AD}\downarrow) \end{array} \right\} \Rightarrow \ldots$$

Leading Indicators

The prediction of the growth rate in GDP is important in order to plan for the future. Forecasting GDP growth is not straightforward. There are indicator variables and indices that are very helpful in forecasting the movement of GDP (expansion or recession) and its growth rate. Most common of these are,

- The Purchasing Manager's Index (PMI). TR: Tedarik Yöneticileri Anketi. This is measured by the İstanbul Chamber of Commerce (İstanbul Sanayi Odası) in Turkey. An index value above 50 signals expansion, and a value below 50 an upcoming recession.
- Durable Goods Report (DGR).
- Consumer Confidence Index (TR: Tüketici Güven Endeksi).
- Credit volume: Credit use is among the most useful predictors of economic activity.

We have studied recent movements in some of these indices in class.

Kondratieff cycles, or long-waves

There are also cycles that have periods of 30 to 50 years, which are called **long-waves**, or **Kondratieff cycles**.

Productivity

Labor productivity can be defined as the **output (=GDP) produced per hour worked**. Gains in productivity usually result from

(i) efficiency gains due to technology and innovation,

(ii) better use of existing capital,

(iii) changes in the composition of employed workers. Because of this latter, productivity may increase during recessions, since those who become unemployed are more likely to be of lower productivity.

Labor works with capital in order to produce, hence a measure of productivity that takes into account the use of labor and capital together will be more useful. This is known as **Total Factor Productivity (TFP)** or sometimes Multi-factor Productivity.

In order to compute TFP, we need a production function, which gives output (GDP) produced when different quantities of labor and capital are employed. Hence, it is a function such as

$$Y = A \cdot F(K, L) \tag{6.1}$$

where Y is output (GDP), K stands for capital inputs, L stands for labor hours worked, and A is a parameter interpreted as productivity (TFP). A famous function in empirical work is **Cobb-Douglas production function**,

$$Y = AK^{\alpha}L^{\beta} \tag{6.2}$$

where α and β are paremeters to be estimated from actual data on Y, K, and L. After taking the natural logarithm of both sides,

$$\ln Y = \ln A + \alpha \ln K + \beta \ln L \tag{6.3}$$

and total factor productivity is measured by

$$\ln A = \ln Y - \alpha \ln K - \beta \ln L$$

Equation (6.3) can also be used to decompose the growth rate of GDP into its components in terms of the sources of growth: productivity growth, capital growth, and labor growth. We write (6.3) by adding time-dependence (subscript t)

$$\ln Y_t = \ln A_t + \alpha \ln K_t + \beta \ln L_t$$

and take the time-derivative of both sides. This gives

$$\frac{Y_t'}{Y_t} = \frac{A_t'}{A_t} + \alpha \frac{K_t'}{K_t} + \beta \frac{L_t'}{L_t} \tag{6.4}$$

where Y_t' denotes the time derivative of Y_t (and similarly for other variables).

If we have estimates of α and β, equation (6.4) decomposes this into the growth rates of inputs and productivity.

We have discussed the time series of TFP in Turkey and the U.S. over time, as well as the decomposition of U.S. growth into its components.

Macroeconomic policy

[We haven't covered the rest of the notes, so you are not responsible for them in the final exam. You should read them nevertheless.]

Inflation and unemployment: the Phillips Curve

The term **full employment** refers to a situation in which *all adults who are authorized and are willing to work can obtain employment in a reasonable amount of time.* In full employment, unemployment rate is not zero, because there are two sources of unemployment that prevents that.

In any given time, there is some

1. Frictional unemployment, and
2. Structural unemployment.

Frictional unemployment results from the usual process of job-to-job transfer. On any given day, there are individuals who will find employment (or will start their own business) but this hasn't happened yet. Such individuals are making job applications, going to interviews, or simply preparing to move for a job in a different city, and are unemployed at the current time. **Structural unemployment**, on the other hand, refers to the mismatch between skills that people have, and skills that are required by the labor market.

The Phillips Curve exhibits to **the negative relationship between unemployment and inflation.** This is a short-run relation, and happens due to the effect of changes in aggregate demand on the overall price level. If unemployment goes down, total income goes up and so does **aggregate demand**. When aggregate demand increases, so will the prive level, hence higher inflation. Obviously, this is not the only reason inflation exists.

Inflation redistributes wealth from those who have nominal debt, to those who have nominal assets (if you owe someone, you will gain; if others owe you, you will lose). A small amount (max 5%) inflation is considered acceptable (and often desirable) since it alleviates the state's debt payments.

Fiscal and monetary policy

The government's adjustment of the amount, timing and content of its expenditures (G) is called Fiscal Policy.

The multiplier effects discussed above work the other way as well. The basic Keynesian idea is that government expenditures (G) should be counter-cyclical. If the government reduces its expenditures during recessions, this would reinforce the recession, further increasing unemployment. However, the government is in a unique situation to shoulder the recession and make sure it does not go as deep as it would otherwise can, by adjusting its spending. According to Keynes, G must be high during recessions, and it is OK if the government runs a deficit in order to keep its expenditures high. During expansion, G must fall and the government can pay off its deficit.

Fiscal Policy can have significant effects on output, especially during recessions. A study by Auerbach and Gorodnichenko (2012) shows that a \$1 increase in G leads to an increase in output that is worth \$1.50 to \$2.00 *during a recession.* The same \$1 increase in G leads to an increase output that is worth \$0.50 *during an expansion.* Similar estimates are found in many economies. Hence, counter-cyclical fiscal policy can be really effective.

Monetary policy is governed by central banks (**Turkish Central Bank** in Turkey). Tools of monetary policy include

1. Changing the total money supply directly: This is undertaken by central banks by so-called **open market operations.** The latter refers the buying and selling of bonds in order to adjust the amount of money in circulation. Central banks increases the money supply during times of the year when consumption is high, such as towards new year's, or religious holidays such as Kurban and Ramazan bayramı. After the public's desire for consumption is reduced, Turkish Cental Bank reduces the money supply.

2. Changing the policy interest rate, i : This is the interest rate at which banks can borrow from the central bank. The interest rate for consumers and investors is determined by market conditions and competition in the banking industry. As the interest rate goes up, cost of investment increases, and demand for local assets (such as its currency) increases.

3. Adjusting the **reserve requirement** for private banks: The reserve requirement is the minimum percentage of deposits that a bank is required (by law) to keep physically in its vaults. The rest of deposits can be lended out as credits. To see the effect of the reserve requirement, imagine that a newly printed 100TL bill is deposited in Bank A, and the reserve requirement is 0.10, or 10%. Bank A keeps 10TL in its vaults and lends out the remaining 90TL. This is spent, and deposited to say, Bank B. Bank B will keep 9TL and lend the remaining 81TL,.. and so on. At each step, 10% of the money is reserved by the bank and 90% is lended out. It is easy to show that this process creates a total circulation of 100TL/0.1 = 1000TL of money. In general,

$$\text{Money Supply} = \frac{M}{r}$$

where M is the total amount of denominations (total sum of existing paper money and coins), and r is the reserve requirement in decimals. Notice that reducing the reserve requirement will indirectly (but very effectively) increase the money supply.

Interest rates

The interest rate is the time value of money. One can simply think of the interest rate as the price, or (more accurately) the rent value of money. The interest rate balances the investors' desire to lend and the desire to borrow for investment and consumption. As the interest rate goes up,

The interest rate as advertised in the **Nominal Interest Rate**, which has to take into account inflation. Since inflation is the rate by which a currency loses value, it is not desirable to lend money if the nominal interest rate is below inflation (this would mean that the investment effectively *loses* money). The important (real) part of the interest rate is the part of the nominal rate above inflation. This relationship is knows as **Fisher's Equation:**

$$\text{Real Interest Rate} = \text{Nominal Interest Rate} - \text{Inflation} \tag{6.5}$$

The following diagram summarizes the effect of a fall in the (real) policy interest rate (i) on other important variables. You can reverse the arrows in order to write down the effect of an increase in the interest rate.

$$\text{Policy } i \downarrow \Rightarrow \left\{ \begin{array}{c} \text{Market } i \downarrow \\ \text{Asset Prices} \uparrow \\ \text{Expectations} \uparrow \\ \text{Exchange rate} \downarrow \\ \text{(depreciation)} \end{array} \right\} \Rightarrow \left\{ \begin{array}{c} \text{Domestic} \\ \text{AD} \end{array} \uparrow \quad \begin{array}{c} \\ \\ \text{Net} \\ \text{Exports} \end{array} \uparrow \right\} \Rightarrow \left\{ \begin{array}{c} \text{AD} \uparrow \\ \\ \text{Import} \\ \text{Prices} \end{array} \uparrow \right\} \Rightarrow \text{Inflation} \uparrow$$

If the policy interest rate falls, the the market interest rate will fall, as it is cheaper for banks to borrow money. This increases the demand for assets (non-monetary holdings such as houses, machines, ...etc) and asset prices will go up. Expectations about the future are adjusted to be more optimistic. The exchange rate falls (the local currency depreciates, i.e., loses value agains foreign currencies). As a result, domestic and foreign demand for the country's goods increase. Since the local currency has lost value, import prices will be higher. This will increase the price level, causing higher inflation than otherwise.

This can be confusing since central banks adjust the nominal interest rate to the current level of inflation, so that the real interest rate is at reasonable levels. As a result, nominal interest rate is highly (and positively) correlated with the rate of inflation.

End