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BACHELOR THESIS

Oligopoly Theory: Mobile Phone Providers in the Czech Republic

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Declaration of Authorship

The author hereby declares that she compiled this thesis independently, using only the listed resources and literature.

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Abstract

This paper studies an Oligopoly theory, which is applied on a mobile phone market in the Czech Republic in order to measure and analyze the market performance throughout the years (1995-2008). We present several approaches of measures of market performance. The chosen econometric model then gives the results. A central question we ask is whether and how much the behaviour of operators changed with an entry of new provider. We get rather expected results. Moreover, we include a critical evaluation of our model and analysis.

JEL Classification	D43, L13, L96
Keywords	oligopoly, telecommunications, measures of market performance

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Abstrakt

Tato bakalářská práce se zabývá Teorií oligopolů, která je aplikovaná na trh mobilních operátorů v ČR. Práce se snaží analyzovat trh v letech (1995-2008) a zjistit, které oligopolní chování bylo v průběhu let pro tento trh typické. Práce představuje několik přístupů a metod k měření oligopolního chování. Zvolený ekonometrický model přináší výsledky tržní analýzy a zodpovídá na hlavní otázku a to, zda a jak se chování operátorů změnilo s příchodem nového operátora. Závěr obsahuje kritické zhodnocení zvoleného modelu a analýzy.

Klasifikace JEL	D43, L13, L96
Klíčová slova	oligopoly, telekomunikace, měření tržn ího chování

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Acronyms

CR	Concentration Ratio
CTU	Czech Telecommunication Office
CSU	Czech Statistical Office
GSM	Global Systems for Mobiles
HHI	Herfindahl Hirschman index
NEIO	New Empirical Industrial Organization
MLE	Maximum Likelihood Estimator
MNP	Mobile number portability
SCP	Structure-conduct-performance
UOHS	Office for the protection of competition

Chapter 1

Introduction

Mobile phone industry is the largest growth area in the telecommunication industry and according to (Valleti 2003), the number of mobile phone subscribers has already exceeded the number of fixed lines. Moreover, telecommunication markets have recently faced expansion of new mobile operators who have increased the competition within the market. The rapid growth throughout the 1990s changed the mobile services from a niche market to the integral component of most national telecommunication markets.
The telecommunication markets mostly present the oligopolistic structure of a market, where there are only few competitors. The same implications and trends can be seen in the Czech Republic and the mobile phone industry dates back to 1990, when first provider entered the market.

The purpose of this thesis is to analyze oligopolistic structure and to econometrically estimate the degree of oligopoly competition on the mobile phone market in the Czech Republic. The mobile phone industry has been chosen from several reasons. Firstly the industry has been developing and has achieved a massive size in several EU countries, so its economic power, its implications for national infrastructures and its regulated nature, are significant. Moreover, mobile phone market is mostly characterized by oligopoly market.

This thesis is aiming to examine the Czech market throughout the years 1995-2008, because in this period new entrants came to the market and the market experienced changes from monopolistic, to duopolistic to finally current oligopolistic situation with more than two firms. The examined periods are divided into two. The first covers the duopoly time 1995-1999 and the sec-

ond 2000-2008 an oligopoly time. A central question we ask is if it is possible to estimate the market power using several methods and if so, how much the results correspond with a real world.

There are several approaches to testing oligopoly power. Recently, there has been an increase in methods, but mostly used empirical application is based on the ,,new empirical industrial organization" (NEIO) approach. We will modify this approach on the mobile phone industry and will estimate the coefficients using industry level data. The thesis is organized as follows.

In order to analyze the mobile phone industry, first section presents the telecommunications, main features of telecommunication market in general and shows the demand for phone services. After this, we introduce particularly the market in the Czech Republic, its key players Telefónica O2, T-mobile and Vodafone, regulators and its existence. Next section explains theoretical bases of oligopoly and shows its extended models. Third section presents several methods and approaches of measures of market performance and concentrates on a model of the mobile phone industry and its empirical implementation. Last section assesses the employed model, discusses the results and critically analyzes its limitations and finally concludes.

Chapter 2

Market structure

Telecommunication industry has been rapidly increasing with the technological changes and innovations for last few years. To one of the most growing areas belong the mobile phone industry. According to the 14th Report on the Implementation of the Telecommunications Regulatory Package (2008) the total turnover of mobile sector reached 3.0 billion EUR and the total value of tangible investments reached 565 million EUR in the Czech Republic as of 31 December 2007. The dramatic growth is due to several factors, such as technological, regulatory and competitive.

Market structure in telecommunications is defined by several basic elements. The classifications in every literature are different. We will divide them into *Seller concentration*, *Cost structure*, *Barriers to entry* and *Network Externalities*.

2.1 Seller concentration

Seller concentration refers to the market structure, to the degree of concentration, which mostly ranges from monopoly to oligopoly in a telecommunication industry. The degree of concentration is measured either by concentration ratios (CR) or by so called Herfindahl Hirschmann Index (HHI). The concentration ratio is calculated as a share of total output produced by largest firms to a total output of an industry. The ratio for monopoly is 100% and for oligopoly ranges from 20% to 100%, but there is a no strict line. *The Herfindahl Hirschmann Index* will be presented later, in section 4.1.1.

2.2 Cost structure

High fixed costs are typical for telecommunications as the industry is very demanding in terms of innovations and technologies. Considering a cost structure, mobile telephone market is characterized by relatively low marginal costs, does not matter in terms of costs how many subscribers use the network. Moreover, costs are often sunk as the initial investments are specific and very expensive. Presence of high sunk costs results in high exit barriers.
Furthermore, cost structure is a key factor in price setting. As stated already, there are high fixed costs and relatively low marginal costs, so a company in order to survive needs to set prices higher than marginal costs are. It is needless to mention the switching costs which occurs when consumer decides to switch from one network to another one. These costs especially create barriers to entry, and will be discussed below.

2.3 Barriers to Entry

Barriers to entry is how much is an entry for new company controlled or even blocked and how much the competition is restricted. These barriers can be natural, artificial (such as government interventions) or so called strategic entry barriers. As Buigues and Rey (2004) state, the presence of entry barriers in mobile networks is very significant due to the scarcity of spectrum and licensing of the regulatory agencies. Presence of switching costs is another factor that possibly increases the barriers.
Frequency spectrum is controlled by government and operated through legislations. To enter the market the spectrum must be available on the market, so number of licenses issued is very limited and it makes entry more difficult.
Existence of switching costs allows consumers to switch from one operator to another one, but it is costly. Chen (2010) supposes that switching costs affect consumers' product choice as well as firms' prices. If switching costs are high, the consumer buys products that he or she already has consumed. Similarly, in the indirect channel high switching costs affect firms' prices which then have an impact on consumers. Mobile number portability (MNP) can reduce the switching costs, but on the other hand, enhances the competition for customers between already existing providers.
Overall, the telecommunication market belongs to the industries with high bar-

riers to entry as well as with high exit barriers. So it is natural that the mobile phone industry market structure is mostly oligopolistic.

2.4 Network Externalities

The main difference according to Cave, Majumdar and Vogelsang (2002) that distinguishes telecommunication demand from other demands is that it is not consumed in isolation, but within a network, where must be a certain access. This causes the interdependencies, which are referred to as *network externalities*. Two effects can be seen in telecommunication networks.
In the first, which is the direct one, the value of a brand increases with increasing number of users using the same brand. Mobile phones would be useless if there were only few consumers. So the more people join the system-the network, the better and the higher utility and value.
The indirect effect is caused by a size of a network which leads to the lower prices and higher availability of complementary products. In our case-the mobile phone industry, there can be applied a basic network- externality model, firstly presented by (Rohlfs 1974).

2.4.1 Demand for Phone Services

As already stated, the value of a phone service increases with the number of subscribers. Let consider x being a group of continuum of potential phone users, $0 \leq x \leq 1$ and n be the total number of consumers who has already subscribed to the phone system and $0 \leq n \leq 1$, p the price of subscribing. Let's define the utility of a consumer as:

$$U^x = \begin{cases} n(1-x)-p \\ 0 \end{cases}$$

$n(1-x)-p$ if subscribes to the phone system
0 if does not subscribe

It is obvious that the utility increases with the increasing number of consumers n. Indifferent consumer $\hat{x}$ is a person who is at a given price p indifferent to the alternatives of subscribing, so:

$$0 = n(1-\hat{x}) - p$$

and the number of consumers is given by $n = \hat{x}$, so the demand is:

$$p = \hat{x}(1 - \hat{x})$$

This quadratic function has two intersections $\hat{x}_0^L$ and $\hat{x}_0^H$, that can be interpreted as that for a given level of price p_0 there can be two levels of demand-low and high one. However, only the $\hat{x}_0^H$ is considered to be stable demand equilibrium, the $\hat{x}_0^L$ is the critical mass, as any increase in the number of consumers shifts the demand to the point $\hat{x}_0^H$.

2.4.2 Model of Three Brands

In this section, we will present the extended model of the previous one. The extension considers number of firms on the market. We applied the model by (Shy 1996) and extended it for three firms.
At the beginning, we assume a market, where there are three brands of a product or a service. Moreover, we assume heterogeneous consumers, that means each customer prefers one brand over two other ones. Therefore, there are brands A, brand B and brand C.
Let a (similarly b, c) be amount of consumers who prefer brand a over two others b, c, (similarly b prefer over a, c and c prefer over a, b) and $(0 < a < 1)$, $(0 < b < 1)$,$(0 < c < 1)$.
The utility of a consumer increases with the increasing number of consumers buying the same brand. If consumer buys the less preferred brand, the utility falls by $\delta > 0$. Let us define $x_i = x_B + x_C$, $x_j = x_A + x_C$ and $x_k = x_A + x_B$ and be $x_A + x_B + x_C = 1$.
The utility functions are given as:

$$U^A = \begin{cases} x_A \\ x_i - \delta \end{cases}, \; U^B = \begin{cases} x_B \\ x_j - \delta \end{cases}, \; U^C = \begin{cases} x_C \\ x_k - \delta \end{cases}$$

x_A buys brand A (similarly x_B and x_C), $x_i - \delta$ buys either brand B or C (similarly $x_j - \delta$ A or C and $x_k - \delta$ A or B)

Possibilities

1. If $x_A = 1$ and $x_i = 0$, it is said that the product is standardized on A, (similarly for $x_B = 1$ and $x_j = 0$, $x_C = 1$ and $x_k = 0$)

2. If $x_A > 0$ and $x_i > 0$, it is said that the product is produced with

incompatible standards, (similarly for $x_B > 0$ and $x_j > 0$, $x_C > 0$ and $x_k > 0$)

3. An allocation between all brands x_A, x_B, x_C is an equilibrium, as no one would benefit from switching to the competing brand and all other customers do not switch from their preffered brand

Finally, we will discuss the equilibrium that can exist:

1. If $\delta < 1$, then three equilibrium exist, one in which A is the standard ($x_A = 1$), one in which B is the standard ($x_B = 1$) and lastly, one in which C is the standard ($x_C = 1$)

2. If $\delta > 1$, no single-standard equilibrium exist

At the end, we will describe under what conditions the industry will produce three brands.That means when $x_A = a$, $x_B = b$ and $x_C = c$ is an equilibrium. In this case, consumer A will not switch to B if holds $a > i - \delta$ and because $b = 1 - a - c$, we came to the $a > \frac{1-\delta}{2}$, similarly $b > \frac{1-\delta}{2}$ and $c > \frac{1-\delta}{2}$. If these three equations hold, then $x_A = a$, $x_B = b$ and $x_C = c$ is an equilibrium.

2.4.3 Switching Costs

Another important feature of network industries is a presence of, as already mentioned, *switching costs*. In this subsection, we will discuss the effects of switching costs on the consumers' utility and go into switching costs more in a depth.

The higher the switching costs are the more difficult and expensive is to switch between suppliers to reach an equilibrium. An increase or high level of switching cost forces consumer to stay loyal with his or her already consumed product, but this does not have to be the one that he or she prefers, so the utility in this case falls by $\delta > 0$ as depicted in 2.4.2.

Chen (2010) presented two opposite incentives of firms due to switching costs *harvesting incentive* and *investment incentive*.

In a first case firm charges high switching costs to ,,harvest" the locked-in customers for higher current profits, whereas on the other hand, the second incentive is to charge low prices in order to ,,invest" in an installed base and increase future profits.

The switching costs have an impact through either direct or either indirect

channel. Direct channel has direct effect on consumers. An increase in switching costs makes exit barriers higher for locked-in consumers and solidifies existing networks. Consumers in an installed base have harder to switch to competitor. Again, Chen (2010) refers this to so called *network solidification effect* of switching costs.

The process in indirect effect goes firstly through firms' prices and therefore these prices affect consumers. In indirect channel there can be found two effects, *Fat Cat Effect* and *Top Dog Effect*. In short, current or future costs distinguish them. An increase in current costs solidifies current networks and advantage the larger firms, which are very likely to higher their prices as its customers have difficulties to exit. This is called the Fat Cat Effect. Whereas an increase in a future switching costs makes a larger firm to price more aggressively than the smaller firms to build on its advantage. This company is so called the Top Dog.

Not only that switching costs affect utility and prices, but the market dominance as well. If switching costs are low, an increase can cause the change of market structure from being dominated by one firm to fragmentation. Similarly with the high switching costs and its increase.

This section introduced the telecommunications and mobile phone industry in general and next section focuses on an industry particular in the Czech Republic.

2.5 The Mobile Telecommunication Market in the Czech Republic

The history of mobile telecommunication market in the Czech Republic has started in 1990, when Eurotel entered the market. Afterward Radiomobil followed the Eurotel, offering the services under the name Peagas and last provider was Oskar. All of these companies later faced the acquisitions by multinational telecommunication giants, respectively Telefónica O2, T-mobile and Vodafone. There exist one provider more, called Ufon which entered the market in 2007, but because its shares have been still negligible and it targets different customers, we will consider in our study only the three key providers as named above.

During the last few years the number of mobile phone users has been steadily increasing and the mobile phone has been used by 8 out of 10 people. Furthermore, the number of active sim cards exceeded the number of active users and according to the Czech Statistical Office (ČSÚ) (2008) the ratio is 130:100. Moreover, with 88% of mobile phone users, the Czech Republic belongs to one of the countries with the largest mobile phone penetrations in the world. The number of active sim cards overcame the number of fixed lines already in 2000.

Figure 2.1: Active sim cards

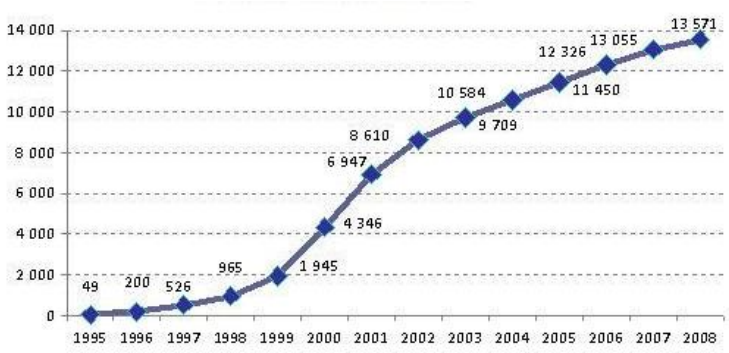

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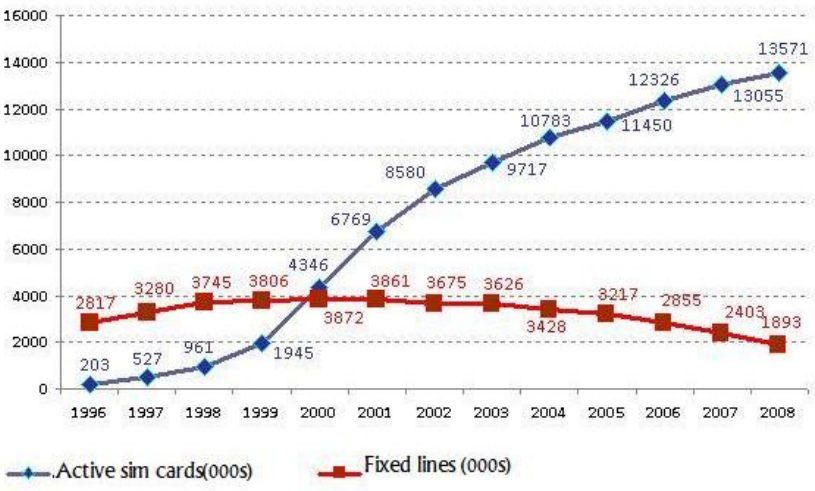
Figure 2.2: Active sim cards vs. fixed lines

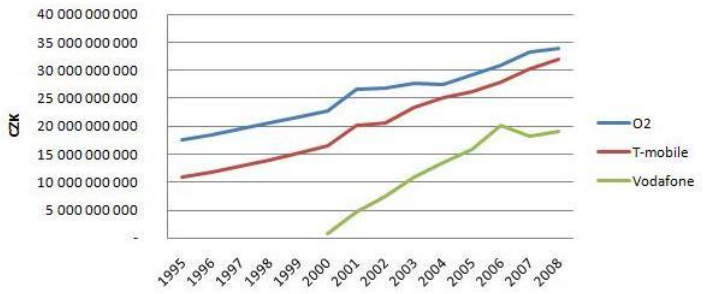


in 000s, source, operators,(ČTÚ)

In the mobile telecommunications, there are two different technologies, analogue and digital one. The first generation of analogue systems used frequency spectrum around 450MHz and later, the second generation spectrum around 900MHz. A real improvement came with a digital technology and according to Gruber and Verboven (1998) the most widely used digital system was the European standard GSM 900 (Global Systems for Mobiles), later it was introduced second generation GSM 1800. The Czech telecommunication market has experienced all these technologies and still follows the technological improvements.

The market is highly competitive and the shares of the three key players retain relatively stable. On the other hand, the market does not experience its heydays anymore and the market tends to be almost saturated. The market is growing in a decreasing tendency. This means that the market is already limited for new mobile phone provider's enter, so users only transfer from one provider to another one.

Figure 2.3: Profits



2.6 The Regulators

Mobile telecommunications belong to regulated industries. As Gruber and Verboven (1998) state that, entry is strictly regulated because of a scarcity of the spectrum. There is a need of a licensing government policy which considers technological standards to be adopted, the number of licenses to be granted and the procedure by which licenses are granted. Moreover, the regulations are needed as the initial investments are very large and the risk they take as well. Describing the Czech mobile phone industry is needless to mention *The Czech Telecommunication Office* (ČTÚ), which exercises state administration of electronic communications and mobile phone market. Its authority, as specified in Act No. 127/2005 Coll., on Electronic Communications and on the Amendments to the Other Acts (Electronic Communications Act), is defined within the scope of the Office activities, ensures that electronic communications and related international activities within number of governmental and non-governmental agencies and organizations are being performed. It has existed since 1993.

The most important is the regulation of the maximum price for calling from one network to another one. The same policy was implemented for the roaming services as well. Another directive is a % implementation of profit shares for the rendition of services to the mobile phone providers, as specified in section 49 §5, in 2007. As published by (ČTÚ) in its last report (2007), the shares for the Telefónica Czech Republic, a.s., T-mobile Czech Republic, a.s. and Vodafone Czech Republic, a.s. were respectively 46,29%, 26,28% and 15,1%.

As it has been already stated above, the market is highly competitive, so another institution *Office for the protection of competition* (ÚOHS) is in a such oligopolistic environment crucial. "It is the central authority of state administration responsible for creating conditions that favor and protect competition, supervision over public procurement and consultation and monitoring in relation to the provision of state aid."(ÚOHS, 2009).

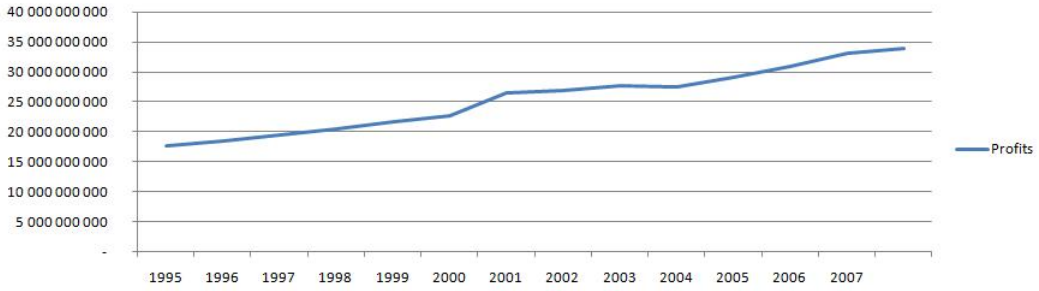
2.7 Czech operators

Three main mobile phone providers operate on the market. Next section shortly presents each of them, their establishment, acquisition, services and their profits in time. As it can be seen later, the profits have increasing tendency in years for almost all of the companies. This proves the general worldwide trend in telecommunications.

2.7.1 Telefónica O2

Eurotel Praha, spol. s.r.o.(later re-branded Telefónica O2) has been the first and the largest mobile phone provider in the Czech Republic. It entered the market offering analog NMT 450 system. Later, Eurotel received concession for new frequencies GSM 900 and in 2000 GSM 1800. In 2006 Eurotel Praha and Český Telecom merged to one company called Telefónica O2. Nowadays, Telefónica O2 Czech Republic is a major integrated operator in the Czech Republic, operating more than seven million lines, both fixed and mobile, which makes it one of the world's leading providers of fully converged services. The company offers the most comprehensive portfolio of voice and data services.
As stated already above, the international acquisition was made in 2006 by Telefónica O2 Europe. Telefónica O2 Europe is a business division of Telefónica O2 S.A. which belongs to one of the world leaders integrated operator in the telecommunication sector with presence in Europe,Africa and Latin America. In Europe, it operates markets in Great Britain, Ireland, Germany, the Czech and Slovak Republic, Spain and Isle of Man. In all, the international company has more than 49 million customers.

Figure 2.4: O2 Profits



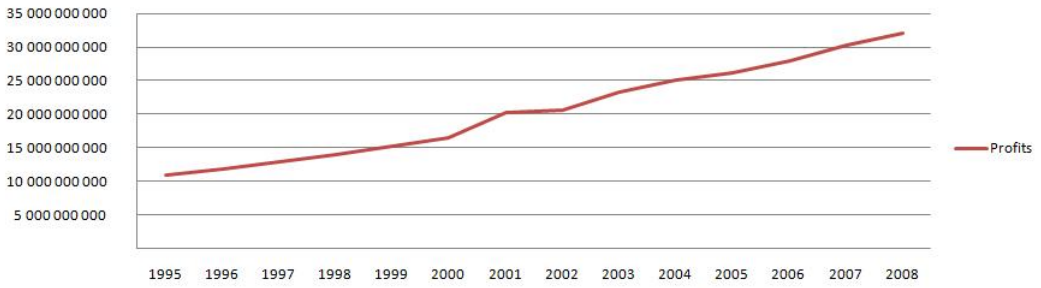
2.7.2 T-mobile

The monopoly era of Eurotel Praha on the mobile phone market ended in 1996, when new mobile phone operator RadioMobil a.s. entered the market. During its first year began offering mobile telecommunication services via the GSM network under the name Peagas. Company' s name was changed in 2002 to T-mobile Czech Republic a.s. According to the to the T-mobile, T-mobile portfolio includes a wide range of services for homes and professional solutions for the business segment and public sector. Not only voice services and SMS, but they offer to customers non-voice services such as data transmission via GPRS, WiFi, EDGE and UMTS as well.
T-mobile is fully owned by Deutsche Telekom AG and again this group is one of the world's leading telecommunications and information technology service companies. It serves over 200 million customers in more than 50 countries, Great Britain, Germany, Netherlands, Poland, Hungary, Austria and the Czech and Slovak Republic in Europe.

2.7.3 Vodafone

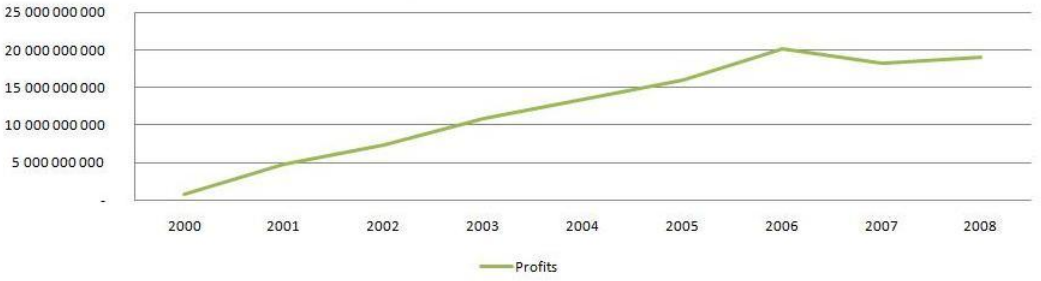
Český Mobil is the third and the youngest player who entered the Czech market in 2000. It provided the services under the name Oskar and from the beginning became one of the fastest developing mobile phone providers in Europe. In 2005 Oskar became a member of Vodafone group and from 2006 the Oskar changed to Vodafone Czech Republic a.s. Since all three groups are large competitors,

Figure 2.5: T-mobile Profits



once more it is the world's leading mobile telecommunications company and it has significant presence in Europe, the Middle East, Africa, Asia Pacific and the United States with more than 330 million customers.

Figure 2.6: Vodafone Profits



2.7.4 Historical Cases

History can tell us about the present and future, so we decided to include past cases on the Czech mobile phone oligopolistic market. Furthermore, it is very likely that if firms colluded in the past, they might behave the same way in the future as well.

In 2004 we can find a case of restricted competition. The (ÚOHS) found out

prohibited agreements among providers. The inter-connected agreements, first between Český Mobil (now Vodafone) and T-mobile in 2000 and later between Český Mobil and Eurotel in 2001, were related to the indirect determination of business conditions. This led to the distortion on the market as the agreements obliged the signatories to interconnect their networks exclusively by a direct form. These prohibited agreements affected the prices for end consumers and not only them, but the interconnections and relationships to other operators and institutions on the telecommunication market. The total amount of sanctions levied was 44 million CZK, 22 million CZK to Eurotel, 12million CZK to T-mobile and 10 million CZK to Český Mobil.

Another case dates back to 2000 and 2001. The Eurotel and Radiomobil (T-mobile) were accused of abuse of their dominant positions on the market between each other on the price per minute to the third network Český Mobil as they charged higher price than between each other.

It is interesting, what results will bring our analysis and if our analysis will verify the historical cases. Before the analysis and measuring the market performance, there is a section that presents the theory of oligopoly, a typical market form in a mobile phone industry.

Chapter 3

Oligopoly

Oligopoly is a situation where small number of competitors, so called *oligopolists*, dominate on the market and act independently but on the other hand, they are aware of their existence and have a negligible effect on a price. As Varian (2003) states, there are several models and several different ways for firms to behave in an oligopolistic environment.
The first way distinguishes the oligopoly whether the firms meet once or play *repeated game*. Another approach stems from the variables the firms are interested in, they are *price* and *quantity*. The last, but not least way depends on the firms' products, whether they compete in *homogenous* or *diversified* ones. It is important to consider another possible situation, it is a form of an interaction when firms do not compete against each other but collude.
Considering all above, there are following models *Cournot model*, *Stackelberg model*, *Bertrand model* and *Model of Price Leadership*.
For simplicity, these models are normally restricted only to the case of two firms, but because we analyze three-company market, we extend these models. Not all of the models will be demonstrated as we will focus our study only on models with quantity as a strategic variable. The explanation of this simplification is in 4.2.
Therefore, next section provides theoretical foundation of oligopoly models for three firms Cournot model and Stackelberg model and last part shows the collusive behaviour.

Moreover, other fundamental assumptions are made in our extended models:

- homogenous product
- inverse demand function $P(Q) = a - bQ$, where $a > 0$ and $b > 0$

- total output produced $Q = \sum_{i=1}^{N} q_i$
- number of firms N, N=3
- one period
- identical marginal costs

3.1 Cournot Model

Cournot model is a model, in which each firm must predict other firm's output choice and when all oligopolists forecast the output in one time. It is so called simultaneous quantity setting. The chosen output maximizes oligopolist's output.
The profit maximization problem for i-th firm, where i=1,2,3, is:

$$\max p(q_1 + q_2 + q_3)q_i - c(q_i)$$

Profit i-th firm:

$$\pi_i = p(q_1 + q_2 + q_3)q_i - c(q_i), i = 1, 2, 3$$

First order condition for i-th form:

$$\frac{\partial \pi_i}{\partial q_i} = p(q_1 + q_2 + q_3) + \frac{\partial p}{\partial q_i} q_i - MC(q_i) = 0$$

Alternatively, according to Varian (2003), under the assumption that there are 3 firms and the total output $Q = q_1 + q_2 + q_3$, then the marginal revenue equals marginal cost condition for i-th firm:

$$p(Q) + \frac{\partial p}{\partial Q} q_i = MC(yi), i = 1, 2, 3$$

The equation can be re-written as follows:

$$p(Q)[1 + \frac{\partial p}{\partial Q} \frac{Q}{p(Q)} \frac{q_i}{Q}] = MC(q_i)$$

Using the elasticity of the aggregate demand curve and i's firm share of total

market output $s_i = \frac{y_i}{Q}$, the equation reduces to:

$$p(Q)[1 - \frac{s_i}{|\epsilon(Q)|}] = MC(q_i)$$

Similarly, if we assume the linear demand function $Q = \alpha - \beta p$,
so $p = \frac{\alpha}{\beta} - \frac{1}{\beta}Q$ and be $\frac{\alpha}{\beta} = a$ and $\frac{1}{\beta} = b$, then the first order condition for i-th firm is:

$$\frac{\partial \pi_i}{\partial q_i} = a - c - 2bq_i - \sum_{i \neq j} bq_j = 0$$

Having this, it is possible to derive the Reaction function for firms, respectively 1 to 3:

$$R_1(q_2, q_3) = \frac{a-c}{2b} - \frac{(q_2 + q_3)}{2}$$

$$R_2(q_1, q_3) = \frac{a-c}{2b} - \frac{(q_1 + q_3)}{2}$$

$$R_3(q_1, q_2) = \frac{a-c}{2b} - \frac{(q_1 + q_2)}{2}$$

The output for firm 1 is derived:

$$q_1 = \frac{a-c}{2b} - \frac{q_2}{2} - \frac{q_3}{2}$$

and because we assume that $q_1 = q_2 = q_3$ the equilibrium output for Cournot oligopoly is:

$$q_i^C = \frac{a-c}{4b}, i = 1, 2, 3$$

The total output of an industry is :

$$Q^C = \frac{3}{4}\frac{a-c}{b}$$

and the price in Cournot model is:

$$p_i^C = \frac{a+3c}{4}$$

3.2 Stackelberg Model

Stackelberg model is a situation on the market, where there is a dominant firm. It is called a *leader* and it chooses its output first before other firms do. The rest of the firms takes the quantity as a fixed parameter. Firms sequentially set their prices. For simplicity, all above already mentioned assumptions are

applied. Moreover, each firm's objective is to maximize its profit. The author uses the derivation for three firms made by Pal nad Sarkar (2001).
Let firm 1 produces first and firm j produces after firm $j-1$ ($j = 2, 3$). During the quantity decision firm j already knows the quantities chosen by firms 1 to $j-1$ and takes them as a parameter. Also, firm k incorporates how its choice of quantity will influence the quantities chosen by firms $k+1$ to$N = 3$ ($k = 1, 2$). After firm 3 completes its quantity choice, the market price is determined by the inverse demand function. As (Pal and Sarkar (2001)) presented, following two conditions must hold:

$$c_1 \gg c_2 \gg c_3 \tag{3.1}$$

$$\frac{a}{2^3} + \sum_{i=1}^{3} \frac{c_i}{2^i} > c_1 \tag{3.2}$$

When conditions (3.1) and (3.2) hold, the individual firms' output is:

$$q_i = \frac{1}{b}(p^S - c_i)2^{3-i}, i = 1, 2, 3$$

The total output of an industry is :

$$Q^S = \frac{1}{b}\sum_{i=1}^{3} \frac{(a - c_i)}{2^i}$$

and the price in Stackelberg model is:

$$p^S = \frac{a}{2^3} + \sum_{i=1}^{3} \frac{c_i}{2^i}$$

3.3 Collusive Behaviour

Collusion occurs when firms do not operate independently, but they cooperate. The collusion may stem from unstable markets or risk avoidance. Practically, firms make an agreement on the output, price or employ other restrictive trade practices (such as price fixing etc.). Collusive behaviour can lead to the situation similar to "a single monopolist behaviour" on the market. The formal agreement is called a cartel and the practices of cartels are under legal restrictions and are being identified and broken up by institutions executing competitive policy, such as already mentioned *Office for the protection of competition* in the Czech Republic.

However, as we already know, the profit of i-th firm:

$$\pi_i = p(q_1 + q_2 + q_3)q_i - c(q_i), i = 1, 2, 3$$

and because firms cooperate, they maximize their profits together:

$$\sum_{i=1}^{3} \pi_i = p(Q) \sum_{i=1}^{3} q_i - \sum_{i=1}^{3} c(q_i)$$

so the first order condition is:

$$\frac{\partial \sum_{i=1}^{3} \pi_i}{\partial q_i} = 0$$

This was a theoretical part about oligopoly and it presented different types of oligopoly. Another theoretical part follows before the actual measuring and testing the market and this part is about the methods of measures of market performance.

Chapter 4

Measures of Market Performance

Most modern studies focus mainly on measuring the performance on the markets- the market power. On the contrary, in the past, researchers had different approach and mostly studied the relationship between performance and structure. This approach was so called *Structure-conduct-performance (SCP)* and the one from recent years is called the *New empirical industrial organization(NEIO).* Through the years, when the oligopolies were tested, according to the (Carlton and Perloff 2000) most of the researchers came to the conclusion that only three models: the competitive equilibrium, the Cournot model and the monopoly; can be predicted by the tests.

4.1 Structure Conduct Performance

The Structure Conduct Performance (SCP) approach dates back to the first half of 20st century and it was a revolutionary change. According to the (Carlton and Perloff 2000, p. 238), in its paradigm:
,, an industry's performance depends on the conduct of sellers and buyers, which depends on the structure of the market..., which depends on basic conditions such as technology and demand for a product."
However, there are no exact connections described. Furthermore, there are several criticism. One of them is that this approach is more descriptive than analytic. Although, this approach concentrates mostly on the market structure rather than on the market performance, still there can be find some attempts to measure the market power. As stated above, this approach is not flawless,

so we will present only some of these methods, but not in depth and we will concentrate more on a second, newer approach in the section 4.2
There are two ways of measuring that express how close an industry's performance is to the competitive benchmark. First is using the *rate of return* and the second one is the *price-cost margin*.
Rate of return measures how much is earned. The method is based on the comparison of a real rate of return and normal rate of return, so the competitive price is then derived.
This calculation has several problems, such as there are different interpretations of economic and accounting definitions. Moreover, some of the cost items, such as depreciation, used in these calculations are not measured properly or other problems with rate of return stem from inflation, taxes or risk.
Price-cost margin is a second tool how to measure the performance. It is also called the *Lerner index (LI)* and it shows the difference between price p and marginal cost MC as a fraction of a price $\frac{(p-MC)}{p}$. For a profit-maximizing form it equals the negative of the reciprocal of the elasticity of demand η

$$\frac{p - MC}{p} = -\frac{1}{\eta}$$

Due to the lack of availability of marginal costs, marginal costs are often replaced by the price-average variable costs.

4.1.1 Herfindahl Hirschman Index

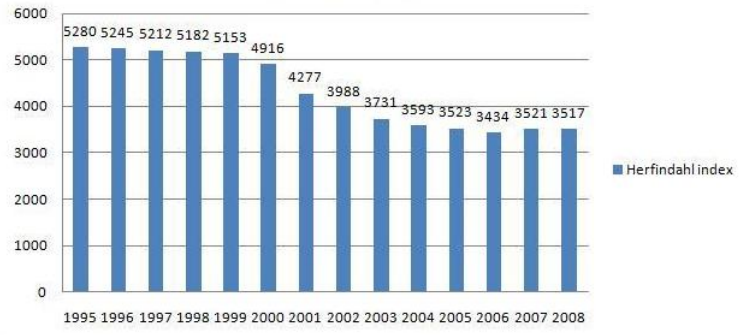
One useful measurement of market structure introduced in the SCP approach is a *Herfindahl Hirschman Index (HHI)*. Even though, our study concentrates mostly on the market performance, this index represents a very helpful tool and it gives us a valuable notion about the market. HHI is an effective tool to measure the size of a firm in relation to the industry and how market is concentrated. The formula is:

$$H = \sum_{i=1}^{N} S_i^2 \times 10000$$

where S_i is a market share of i-th firm, i=1,2,3
The index can range up to 10 000, which implies the monopoly on the market, values 1000-1800 indicates moderate concentration, above 1800 indicates

high concentration. Using collected data (see sec. 4.3.2), the Herfindahl index throughout the years has been on average 4327. This means high concentration, which is a typical feature for mobile phone industry markets. As it can be seen, the index proves the declining tendency with the increasing number of competitors on the market. Only a very slight increase can be seen in last two years, which is caused by a small redistribution of customers among Telefónica O2 and T-mobile.

Figure 4.1: Herfindahl Hirschman index



4.2 New Empirical Industrial Organization

New empirical industrial organization (NEIO) (Iwata 1974, Bresnahan 1981, Appelbaum 1982) is considered to be a useful tool in measuring the degree of market imperfection. The primary contribution is an empirical estimation of market power of imperfect contribution. Bresnahan (1989) explains a typical NEIO model that it is a foremost econometric model of how companies set price and quantity to infer the underlying conduct of the industry. (Suzuki and Kaiser 2006, p. 4) describe the NEIO approach:
,,The primary contribution of the NEIO framework is generalizing and extending conventional perfect-competition (monopoly) models to intermediate imperfect-competition models that can be empirically estimated."
This approach works directly with estimations of a degree of market power. This market power is expressed by so called *conjectural variations* or *conduct parameters* θ , which reflect rival's responses to changes in the company's price or quantity supply. There is a few interpretations of conjectural variation (Hyde and Perloff 2004). The original one is, as stated already above, the firm's conjecture about its rival's reaction to a change in its supply. The second interpretation is that conjectural variation stands as a measure of the degree of market power and how prices differ from marginal costs.

NEIO framework has been used by many researchers and applied in different industries, tobacco industry (Bhuyan and Lopez 1997), milk industry (Mello and Brandao 1999), sugar industry (Genesove and Mullin 1998), seed maize industry (Nzuma 2006), cable television industry (Rubinovitz 1993) or in the mobile telephone industry (Parker and Roller 1997).
NEIO approaches are divided by Suzuki and Kaiser (2006) into two categories: (1) a homogenous oligopoly with quantity as a strategic variable, known as a generalized Cournot model and (2) a product-differentiated oligopoly model with price as a strategic variable, known as a generalized Bertrand model. One of the assumption already made was a homogenous product, so we will proceed under the same assumption and will consider, apply and work only within the framework of a first category, with quantity as a strategic variable.

4.2.1 Basic Theory and Different Approaches

Let firm i, $i=1,2,3$ be in an industry where all firms offer a homogenous product and use quantity as a strategic variable. Firm i maximizes its profit in

the standard way as it has been already presented. There have been presented several methods of estimating the conduct parameter. We will consider following two different approaches: (1) Calibration and (2) Direct estimation as a Regression Parameters.

1. *Calibration* is a method, where we identify parameter values as ,,theoretically required residuals" by assuming that the necessary equilibrium conditions hold in the system."(Kaiser and Suzuki,2006).

A central equation from which we obtain the θ is following:

$$p(1 - \theta_i E) = MC_i \tag{4.1}$$

where p is the market price, θ_i is firm's conjectural elasticity and E is the inverse of the demand elasticity $(1/\eta)$.

Since we assume that the firms have same cost functions, so do marginal costs, the equation can be rewritten as follows:

$$p(1 - \theta E) = MC$$

and the θ can be expressed:

$$\theta = \eta \frac{P - MC}{P}$$

This expression is often called the *Elasticity-adjusted Lerner index*, which proves as an indicator of market power and stands as a substitute to the direct estimation method and should ascertain the findings. Under the assumption, that the equation (4.1) holds and with complete price and cost information and a specific form for demand, we can simply calculate the price-cost margin and multiply it by appropriate estimated elasticity of demand to derive a measure of θ.

2. *Direct estimation as a Regression Parameters* is a method, literally as stated in the name, where cost and demand functions are simultaneously estimated by using a system estimation method. The values are obtained for example from regression parameters. We will use this method as a major since we have data to estimate marginal costs and Calibration method will be used as a confirmatory. This method will be presented and moreover applied on the mobile phone industry in the next section.

4.3 Model of the Mobile Phone Industry

The best method for our analysis was realized to be the one that was presented by Parker and Roller (1997). Not only that is applied on the mobile phone industry, but moreover because it is applicable to industry-level data. So following a structural oligopoly model (see Bresnahan 1989) with the modification made in a paper by Parker and Roller (1997), and our modification that considers the Czech environment, the degree of competition will be estimated by θ. θ, the market power, will be obtained as a regression parameter.

To analyze properly the conduct, it is necessary to specify demand and cost conditions. Both are simultaneously estimated by a system estimation method. We assume that there is a demand function:

$$p_t = f(q_{1t} + q_{2t} + q_{3t}, Z_t), t = 1, ...T; \tag{4.2}$$

where t is the time period and q_{it} is the quantity produced and sold by firm i at price p and Z_t is a vector of market-specific exogenous factors (such as population etc.) Total costs are defined as follows:

$$TC_{it} = FC_{it} + VC_{it}(q_{it}, \omega_t)$$

where FC represents firm's fixed costs and VC firm's variable costs depending on output and (ω), which is a vector of market-specific factor prices (such as wages, energy prices, capital costs etc.) The first order condition is then:

$$\lambda \frac{\partial p_t(\cdot)}{\partial q_{it}} q_{it} + p_t(\cdot) - MC_{it}(\cdot) = 0 \tag{4.3}$$

where $MC_{it}(\cdot)$ is a marginal cost function, the λ measures the degree of competition. If $\lambda = 0$ the industry is perfectly competitive as price equals marginal cost. $\lambda = 1$ set the Nash behavior-the Cournot competition, $\lambda > 1$ implies the collusive price setting. And if $\lambda = N$, where N is the number of symmetric firms on the market, it implies the monopoly pricing. The unit of the observation is a market in time, so the first order condition for market by summing over firms is:

$$\lambda \frac{\partial p_t(\cdot)}{\partial Q_t} Q_t + N \cdot p_t(\cdot) - \sum_{i=1}^{N} MC_t(\cdot) = 0 \tag{4.4}$$

As we made the assumption that firm's marginal cost functions are symmetric, then $q_{1t} = q_{2t} = q_{3t}$, the expression can be re-written:

$$\theta \frac{\partial p_t(\cdot)}{\partial Q_t} Q_t + p_t(\cdot) - MC_t(\frac{Q_t}{N}, \omega_t) = 0 \tag{4.5}$$

It is obvious that $\theta = \lambda/N$ and because we assume $N_1 = 2$ in a period 1 and $N_2 = 3$ in a period 2, then the parameter $\theta = 0$ is consistent with perfect competition, $\theta_1 = 1/2$ and $\theta_2 = 1/3$ is consistent with Nash behaviour, $\theta_1 > 1/2$ and $\theta_2 > 1/3$, implies collusive behaviour and last monopoly pricing is when $\theta = 1$. Furthermore, Parker and Roller (1997) allowed the θ to depend on variety of market characteristics, so:

$$\theta_t = f(\mu_t) \tag{4.6}$$

where μ_t is a vector of market characteristics, such as multi market contact or cross ownership. Because our study analyses the Czech market, these specifications are not for our use that relevant.
This modeling approach had been used and tested in a case of a monopoly period, when the conduct was clearly known, and the results correctly predicted the monopoly period. So we will not test the model again on the period of monopoly and we will assume the previous findings by Parker and Roller(1997).

4.3.1 Empirical Implementation and Empirical Model

To examine the conduct, we need to estimate equations (4.2) and (4.5). Moreover, to identify the parameters, the demand must be specified as semilogarithmic and marginal cost as linear, which implies that costs are quadratic. Therefore, the equation (4.2) becomes:

$$p_t = \alpha_0 + \alpha_1 log(Q_t) + \alpha_2 log(POP_t) + \alpha_3 log(CON_t) + \alpha_4 (GDP_t) + \epsilon_t, \tag{4.7}$$

where Q is an output, POP is the market population, CON is an index of expenses for final consumption and GDP is a gross national product.
Using (4.7), we can re-write (4.5) as:

$$p_t - MC_t + \theta_t \cdot \alpha_1 + \nu_t = 0, \tag{4.8}$$

where ν is an identically and independently distributed stochastic disturbance.
For marginal costs, we have included the costs that were accessed from financial

reports included the most significant ones :

$$MC_t = \beta_0 + \beta_1 Q_{jt} + \beta_2 WAGE_t + \beta_3 MARK_t + \beta_4 RENT_t + \beta_5 OPER_t, \quad (4.9)$$

so marginal cost is a function of labor prices (WAGE), marketing expenses(MARK), rents and other rent related costs (RENT) and other operation costs (OPER). $t = 1, 2$ implies the examined period, (1) 1995-1999 is a duopolistic era, O2 and T-mobile. (2) 2000-2008 is a triopolistic era, O2 ,T-mobile and Vodafone.

4.3.2 Data

The frequency of data, the choice of instruments and functional form are the issues that arise in estimating the demand and cost function.
Annual data used were obtained from the Annual Financial Reports provided by all mobile phone operators. According to the Code of Accounting 563/1991 specified in section 3 §21 , there is an obligation of publishing the financial reports for firms registered in Register of Companies. Unfortunately, these financial reports had not been in a digital form till last years, so some of the data were missing. Due to the lack of sufficient information, we were forced to approximate the missing data. Moreover, the lack of information was caused also because not all operators report detailed list of their financial and cost concerns.
Telefónica O2 reports detailed list of costs and other data needed, while Vodafone and T-mobile report only the minimum information required. So it led us to approximate, forecast and predict some of the data. The approximation was made considering the company's stage, the duration of its existence and its size. Representative firm was Telefónica 02.
We are aware of the fact that these forecasted data may modify the results, but because several assumptions have already been made and we still work under these assumptions, we suppose, the modification of our results will not be significant and we will still estimate the conduct of a market satisfyingly.

Data were split into two periods, first-duopolistic period (1995-1999) and second-triopolistic period (2000-2008).

The second issue involves the choice of instruments. Data required for our estimation cover following areas:

- *service prices and output*
  The price used in this study is a monthly bill of an average customer.

These prices were calculated from total profits of mobile services and from total number of customers.
The output data used here are the total profits from mobile services.

- *input factor prices*
  Input factor prices were carefully selected from the financial reports. Due to the lack of detailed information published, we chose the inputs which were available and which are the most costing for company. These are wages (WAGE), marketing (MARK), rents (RENT) and other operation costs (OPER), which include depreciation and amortization and other costs related to the mobile services.

- *demand variables*
  Considering the demand variables, we decided on the following: population (POP), expenses for final consumption of households (CON) and gross domestic product (GDP). All of these macro-economical data were obtained from the Czech Statistical Office. Population is a traditional demographic indicator counted on a yearly basis as per 31 st December. Gross domestic product expresses the country's overall economic outcome and it is a sum of market value of all final goods and services produced in the Czech Republic in one year. Expenses for final consumption represent expenses paid by households, firms from disposable income to satisfy their needs. We assume that all these variables positively affect the demand market. Since we do not include market characteristics market structure variables are not needed.

Although the data included were carefully considered and selected, we admit that other variables might have been included in the demand and cost specifications as well. But it would have been necessary to have detailed list of costs, which we unfortunately lacked. Following table 4.1 shows mean, minimum and maximum values for our variables.

Table 4.1: Mobile Phone Industry Data

Variable	Mean	Minimum	Maximum
P	8232.43	6304.52	12584.00
Q	53830.18599	28461.51121	84989.848
POP	10.28518200	10.20326900	10.46754200
CONS	3.32	-0.80	8.40
GDP	2490.47857	1466.50000	3689.00000
WAGE	3531.80	1095.15	6497.10
MARK	2888.80	1788.74	3644.21
RENT	921.81	382.06	1668.85
OPER	18341.13	9187.937647	31093.00

Notes: Q-in millions, POP-in millions, GDP-in billions, WAGE-in millions, MARK-in millions, RENT-in millions, OPER-in millions

Source: Authors' calculations

Chapter 5

Results and Interpretations

The following section finally presents outcomes from our analysis. In this section we used econometric techniques for estimating the unknown parameters in a linear regression model. First of all we estimated the parameters of our demand p_t (4.7). For this estimation we used a basic method called Ordinary Least Squares (OLS) and we got fitted p and estimates of α.
Second step in our procedure was the second equation (4.8). This was realized as a more difficult one due to the lack of data. We had to made an assumption of stable θ in our two periods 1 and 2 as we did not have a sufficient amount of data and number of observations. We would not have been able to come to any result otherwise. In this equation we use the estimates from the first regression model and we simply estimate θ using the Maximum likelihood estimation (MLE) method.
All of the estimated parameters of a baseline model are shown in tables. Coefficients are split to demand and marginal cost parts and to period one and two. Because the demand function is specified as semilogarithmic the coefficients are interpreted as elasticities. Tables 5.1 and 5.2 include the estimated coefficients of our functions and estimated θ .

In a period 1 (1995-1999) there must have been done further modifications in a model. Due to the small number of observed years, we had to exclude some regressors from our model. 5 observed years are not much and for econometric model with 5 parameters in demand function and 6 parameters in cost function. The chosen regressors were selected to be the most significant ones. In a demand function (4.7), we excluded the variable consumption (CONS) and in equation (4.9) we excluded marketing costs (MARK), rent costs (RENT) and

operation costs (OPER). The obtained results as we expected are not significant, which is due to the lack of data and due to the small number of observed years, so the degrees of freedom are very small. However, the estimated coefficients prove similar trends as in a period 2.
Moreover, the estimated θ is 0.93, which is close to the monopoly-cartel behaviour (θ=1). We suppose that in this period firms played very similar strategies controlling each other. There might have occurred a tacit collusion.

Table 5.1: Baseline Model of Mobile Phone Industry in the Czech Republic

Period 1			
	Parameter	t-statistic	p-value
Demand			
Intercept	592.29	0.097	0.464
Q	-44.191	-0.1196	0.456
POP	-2108.7	-0.086	0.468
GDP	-58.405	-0.085	0.229
Marginal cost			
Intercept	-0.00029	-1.36628E-05	0.499
Q	-0.19665	-1.1807	0.161
WAGE	2.4447	1.1016	0.192
θ	0.935		

Source: Authors' calculations

In a period 2 (2000-2008), most of the variables influencing a demand side did not proved to be significant. These variables are definitely affected by small number of observations. Furthermore, some coefficients reached the expected values, some for example population (POP) did not. We would expect rather smaller coefficient in absolute value or a positive sign- the bigger the population, the higher the demand.
On the marginal cost side there can be find that marginal costs are slightly decreasing in output. This could mean either constant or either increasing returns to scale. This sign is seen in most of the costs as well as the marginal cost is decreasing in the wage costs, marketing and rent costs. The explanation is simple. The increasing number of mobile phone services provided does not necessary lead to the significant increase in wages, marketing costs and rents. As it has been already stated, the telecommunication sector is characterized

by high fixed costs and by relatively low marginal costs.
The estimated conduct parameter for this period is 0.13, which implies that the market in a period 2 falls between perfect competition ($\theta = 0$) and Nash-Cournot noncooperative behaviour ($\theta = 1/3$). The market is definitely highly competitive and according to our results the entry of the third operator changed the market structure significantly. We suppose that the lower conduct parameter and the higher competitiveness is affected by increasing pressure in the industry and by increasing number of phone-call related services, such as calling via internet.
Furthermore, we have not verify any historical case from sec.2.7.4, but this we suppose it is caused by the simplification of stable θ over the period.

Table 5.2: Baseline Model of Mobile Phone Industry in the Czech Republic

Period 2			
	Parameter	t-statistic	p-value
Demand			
Intercept	113.22	1.508	0.175
Q	-76.041	-2.321	0.053
POP	-417.55	-1.187	0.273
CONS	3.224	1.0767	0.3172
GDP	93.763	1.7986	0.115
Marginal cost			
Intercept	-0.00028	0000134	0.999897
Q	-0.0246	-0.5285	0.6135
WAGE	-0.375	-0.671	0.523
MARK	-0.514	-1.383	0.209
RENT	-1.0063	-0.556	0.595
OPER	0.115	0.94	0.3786
θ	0.131		

Source: Authors' calculations

5.1 Critical Evaluation and Limitations of a Model

At the end, we evaluate our model from several aspects. In some studies, theory is not applicable on a real world situation and even if some values are obtained, the interpretations do not correspond with a market. The results that we obtained from a model are affected already from the beginning. We worked under several assumptions and simplifications to fit our case to the theoretical models.

First was the oligopoly market with homogenous product. In a real world, no homogenous product exist on a market. The existence of switching costs makes the product heterogenous. So better application would be a differentiated, heterogenous product. Moreover, in NEIO methods of estimating market power that we used, the analysis only work with one type of strategic variable, either quantity or price. As we assumed a homogenous product, price as a strategic variable was missing in our testing and because of this we excluded some of the Oligopoly types, such as *Bertrand model* or *Models of price leadership*. Again, in a real world, competitors behave and react not only to one variable, but to both – price and quantity variables.

Another simplification we worked with was one period. Normally competitors meet on the market on a regular basis for some time and especially oligopolists who have such a significant size and economic power. These oligopolists then play several games among each other using different strategies to win over other competitors.

Several researchers admit disadvantages in methods for estimating the conjectural variations. One of these limitations is a restricted number of types of market structures that can be observed from the model. As stated above, only perfect competition, monopoly, Cournot model and cartel can be recognized. So although, we considered quantity as the only strategic variable, the Stackelberg model was not included as well.

Last issue we were concerned with were data. Nowadays, relevant data are not easily accessible. Some of the data can be acquired from financial reports, but not all periods and whole details are open to public. Moreover, there is no single public or commercial institution in the Czech Republic to collect detailed data. If there exist any kind of legislation regulating disclosure of information, analyzing the market performance would be much easier.

On the other hand, this empirical model if proper data employed can stand as an interesting indicator of a market. However, as seen in our results, the estimated parameter for market power just shows between which categories the market falls and behave. So even despite the fact we are properly equipped with data, the estimated θ tells us nothing more but the low and high barriers.

Chapter 6

Conclusion

In this paper we examined an oligopolistic structure of mobile phone industry in the Czech Republic and we tried to measure the market performance. The central question was whether the behaviour of mobile phone providers had changed with an entry of new mobile phone operator and moreover, whether the existing models of measure the market performance result in misinterpretations.
In order to achieve this, we surveyed literature about telecommunications and we presented main features of telecommunication market structure. We examined the cost structure and barriers to entry.
Moreover, as the mobile phone market represents a network externality with an existence of switching costs, we surveyed the demand for phone services and the impact of switching costs. Having mapped the main characteristics of mobile phone providers, we turned to an analysis.

There has been an increasing number of studies in past 15 years investigating the competitive structures and market power. These studies were applied on several industries from food industries to telecommunications.
In this paper we have reviewed literature dealing with various models of measuring a market power. Several methods of estimations are used. These methods are divided into two approaches, SCP and NEIO.
Our study concerns and analyzes mobile phone industry market in the Czech Republic and we use the more modern approach. We apply an econometric model, which was build upon a study by Parker and Roller (1997). This model was used because of its application on telephone industry and its previous verification on a monopoly period. The analysis was split into two periods, the

duopolistic one (1995-1999) and the triopolistic one (2000-2008).
There have been made several assumptions and simplifications in order to yield a conduct parameter. The assumptions considered one period, homogenous product and the simplification was quantity as the only strategic variable. Another issue we dealt with in our study were data and due to the lack of some data we had to approximate some of them. However, the results have expected signs.

Our results support to a presence of nearly monopoly-cartel behaviour in a period 1 between Eurotel (now Telefónica O2) and Peagas (now T-mobile), which had changed with an entry of a new provider Oskar (now Vodafone) to the highly competitive environment in a period 2. We are aware of shortcomings and limitations of our model due to the certain factors, thus at the end, we discuss them.

We conclude, that the econometric model we used to measure the market performance proved to be a useful tool and the results of our analysis did not lead to the misinterpretations. However, it has opened a wide space for further research of other models of measure the market performance in order to reduce the limitations and shortcomings of the model.

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