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Market Concentration and Product Differentiation

- A study of the GSM Network Solutions Suppliers' Market

Authors: Robert Borin
Karin Nilsson

Professor: Jonas Häckner

ABSTRACT

This paper will analyse and derive the reasons to and possible effects of changes of the concentration in the western European GSM Network Solutions Suppliers' market. First we present the specific properties of this market, present the economic models that we intend to use and apply them to derive the current market situation. After that we test what will happen if a change in concentration and differentiation occurs and discuss possible effects and outcomes both from an economic and a legal aspect in two scenarios. The results show that the Bertrand model applies to this market as the impact of the marginal production costs increase as the differentiation level decreases. We also see that both scenarios result in higher concentration, but can not say that the change in concentration will result in higher prices. The models used in this study are not exclusive for the GSM Network Solutions Suppliers' market, they are all general and applicable on most oligopoly markets acting without cartels.

CONTENTS

1 INTRODUCTION

Because all markets change over time and the changes have a great affect on all aspects of that market, we have chosen to study the effects on an oligopoly market. The paper will analyse how changes in concentration on the western European GSM Solutions Suppliers' market lead to changed sensibilities to product differentiation in respect to profit-maximizing quantities.

1.1 Method

In order to investigate the effects of changes of concentration and differentiation on the market we will use the Bertrand model. The model allows for price competition on differentiated markets and the level of differentiation is denoted by gamma (γ). The assessed value of γ together with the market shares make it possible for us to solve for the various marginal production costs. We will then use the numerical values of the marginal costs to derive the different profit maximizing quantities and see how the market changes as the concentration and differentiation alters. Market concentration is usually derived by either the Herfindal-Hirshman index or the four-firm concentration ratio. The Herfindal-Hirshman index is calculated as the sum of the squared market shares and thus includes inequalities that have a great impact on the features of the market of our choice. The four-firm ratio only takes the size of the four largest firms into consideration and is therefore not accurate for this paper. In the paper we will test the differentiation and concentration of the European GSM[1] Network Solutions Suppliers' market. We chose this market because it is clearly an oligopoly with, to some extent, a standardized product.

1.2 Outline of the paper

The paper consists of six major chapters. In chapter one we will introduce the reader to the paper and briefly present its contents. Chapter two presents the theory and the market characteristics that we will use to analyse market concentration. The third chapter will give the reader the necessary information about the models we will use to derive the current market situation. Chapter four will give a basic introduction to European competition/merger legislation. Two scenarios will be presented to the reader in chapter five, and in the last, sixth chapter we will discuss and put forward our conclusions.

[1] GSM = Global System for Mobile communication. Most widely adopted standard in the world, with over 578 million subscribers in 400 networks in 171 countries (www.ericsson.com).

2 PRESENTATION OF THE MARKET CHARACTERISTICS

This chapter will present the reader to the market of our choice and all of the different aspects of the market that have an impact on the analysis. It should be noted that the market is a business-to-business and not a business-to-consumer market.

2.1 A brief history

As the development of the GSM networks began to accelerate in the late eighties, the situation was not that different to the situation that we can see on the mobile networks market today as we are experiencing a switch of standards from 2G to 3G[2]. The rights to operate different frequencies were distributed and operators got licenses almost automatically in the areas that they were already working. England was one of the first countries to distribute licenses and as Ericsson was already working closely with the English operators they could relatively easily sign contracts for the expansions, something that helped them get a head start. Motorola was actually a leader at first but signed many contracts for test networks and when the time came to extend the capacity in Europe; Motorola was stuck with maintenance of the test networks. At this time the prices did not have a large influence on demand, price elasticity was low, and a large proportion of the market power was in the hands of the suppliers. The reason for this was that the operators were eager to get systems up and running and not get left behind as the technology developed (Högberg).

2.2 The Suppliers

The European GSM Solutions Suppliers' market of today consists mainly of the seven actors defined in *table 2.1* below. When looking at the different firms' market shares, it is clear to see that Ericsson is the largest actor with its 40 percent of the market.

Company	**Market share (%)**
Ericsson	40
Nokia	25
Siemens	12
Motorola	7
Alcatel	7
Nortel	6
Lucent	3

Table 2.1, The current market shares. (Gustafsson and Högberg)

[2] 2G is the current generation in mobile telephone communications known to most people as the GSM networks. 3G is a generic term covering a range of future wireless network technologies, including WCDMA, CDMA2000, UMTS and EDGE (www.ericsson.com).

Before going any further it is necessary to define how the market shares are defined. Most of the suppliers on the market talk about "services provided". This measures the maximum capacity (how many users the network can carry at one time) of a network. The market shares are then calculated as the percentage of the total network that a specific supplier has delivered. For example, if a country only has one service provider, which has a capacity of 100' simultaneous mobile phone users, and the hardware to cover 70' of these simultaneous users is delivered by one supplier, this supplier is said to have 70 percent of the market.

The "services provided" measure is more relevant on some markets than others. For instance on the European market, which today mainly consists of upgrades and maintenance of already existing networks, this measure is becoming more accurate to determine the real market share, than markets under development such as Africa and China. Since it is more likely for a customer to turn to the original supplier for service and upgrades than to a third party (Gustafsson).

Ericsson, Nokia and Siemens are the market leaders, having 77 percent of the market combined where Ericsson has as much as 40 percent of the western European market and has the GSM networks as their cash cow. A common factor for these companies is that they are all European companies with Europe originally as their main market. Lucent and Motorola, both minor actors, are American companies and have their main activities in other areas of the telecommunications market[3].

2.3 The Customers

Twelve years ago when the GSM network was introduced on the European market most countries still had strictly regulated telecommunication markets with only the publicly owned service provider as an active part. The last ten years of liberating restrictions on these markets have led to an increasing number of local actors. Today most countries in the West European region have between 3-5 suppliers of GSM services which gives us a total of 54-90 service suppliers but only in Sweden about 20 actors have received licenses (www.pts.se). The increasing amount of external actors, (like Campus Mobile and DJUCE) leasing capacity from the established ones, is constantly pushing the limits of capacity forward. This could be looked upon as if they are acting as indirect customers, making the number of actors in the market considerably larger. However, we have chosen not to define the customers as a

[3] The information has been found on the companies' respective homepages, see chapter 7.4 for details.

number of discrete actors, but as a group, acting according to the same behavioural pattern through the whole market.

When the customers are to buy new capacity, services or upgrades most often they have a fixed amount of money to spend determined by their company budget. This means that the network suppliers need to compete trough "giving as much for the money as possible" (Gustafsson).

The situation on the market has changed as the operators have experienced financial difficulties after the high costs resulting from the auctions of licenses for 3G. This has affected all active operators and we interpret it as a shift inwards of the demand curve rather than a change in slope. As a result the price elasticity at different points in the curve has not been affected and the market power remains the same[4].

2.4 The Product

We are only looking at the West European market. This market is not defined as "a market under construction" such as the African or Chinese markets. The mature status of this market gives us a quite radical change in the definition of the product. Since most countries already have the physical infrastructure, the West European market consists of upgrades in capacity and maintenance of already existing networks. Hence they are now competing through various levels of product support and included software features (Gustafsson).

2.4.1 The differentiation of the product

The standardization of GSM has substantially reduced the so-called compatibility-threshold, which can be explained as the problems a customer experiences when making the existing products work with the newly purchased "other brand"-ones. This has made it possible to put together a network that consists of parts from different suppliers (Gustafsson). It also means that any supplier can deliver software features and maintenance to a network regardless of which supplier originally delivered it. Knowledge of the specific needs of the operator, future demands of the market and of the networks will determine the components of the product. As a result, the employees of the suppliers determine how the suppliers choose to differentiate (Gustafsson). Since the suppliers offer products (mostly services and upgrades) that are not exactly the same and the operators' preferences for features of the product differ this market differeniation allows for variation of prices. It is however, important to note that, as has

[4] This due to the fact that all changes have been proportionate.

already been said, most operators have a specific sum of money to spend and the suppliers can then compete through delivering different things for the same amount of money. This means that the prices on the market lay close together, something which might seem to contradict the Bertrand model[5]. The fact that you get different things for the same amount of money can however be interpreted as different prices for the same products.

The market shares of this market is represented by "services provided", the amount of networks that one supplier has delivered on the market. During the delivery of a network, a project that takes several years, the supplier and the operator work very closely together and form working routines and norms that follow from close contact. If an operator decides to switch supplier for a new feature or the maintenance of the network, these working relations must be created again and the cost of doing so will be regarded as an extra cost of changing supplier. Another aspect that affects the differentiation of the market is differences in quality and on this market there is a perception that some suppliers deliver a product of higher quality than others. Differences in perceived quality can arise from a number of things such as marketing, large investments in R&D and the number of years that the supplier has been an actor on the market.

[5] Under Bertrand market structure companies maximize profit, using prices as strategic variables (Shy, [1996, p 139]).

3 PRESENTATION OF MODELS BEING USED

In this chapter we first look at which type of economy we are studying, is this a Bertrand or Cournot economy? Second, we look at the differentiation and the market shares from a more theoretical point of view. We put forward the basic assumptions needed to build a mathematical representation of the current situation, but also present two possible scenarios and the modifications required for each situation.

3.1 Bertrand vs. Cournot

We have chosen to use the Bertrand model in our study because we think it presents the most accurate picture on how prices and quantities are set in this market.

Under Cournot market structure the suppliers use quantities as their strategic variable and assume that the competing companies hold their quantities constant. Under Bertrand structure the firms on the market maximize their profit by choosing a price level, assuming all other firms hold their price level constant, and then sell the quantity demanded at this price (Shy [1996, p 109]).

Since the product is upgrades in capacity and maintenance of the networks price competition is more reasonable than quantity competition.

$$q_i = \alpha - (\beta p_i + \gamma p_j) \quad (3.1)$$

Bertrand market price with differentiated products.

$$\pi_i = p_i \left[\alpha - (\beta p_i + \gamma p_j) - c_i\right] \quad (3.2)$$

Bertrand profit with differentiated products.

Box 3.1, The Bertrand function (Shy [1996, p 139]).

The product we study is differentiated, the model has to show how the quantity demanded from firm *i* is affected by firm *i*'s own price (which we in our model assume is in direct relation to the production costs) and how much it is affected by the other prices on the market. The closer γ is to 1, the more firm *i* is affected by other firms' production. Alpha (α) represents different levels in quality and beta (β) represents how much the firm is affected by its own price. We have chosen to let α and β have a level of one for all companies, meaning that all products have the same qualities and then let other vertical differences become a matter of taste for the customer and therefore be included in γ. Quality is not better or worse but simply different.

3.1.1 Value of γ

It is γ that shows the level of differentiation on the market. A high γ means a low level of differentiation, γ = 1 means that the market has perfect competition and γ = 0 implies monopoly power. In the model the supplier's cost is a function of γ, and is what allows for different market shares and prices, in a Bertrand model with a homogeneous product (i.e. γ = 1) only the company with the lowest cost will produce (Shy [1996, p 110]).

It is impossible to know the exact level of γ but the information of the market can be used as clues. The spread of market shares makes it evident that the level of differentiation must be rather high. We also know that as the GSM networks were being built there was no standardization and different suppliers had different features, something that also shows for a low level of γ. The situation on the market has changed and is now becoming increasingly homogenous even though it is still rather differentiated. On the basis of this we assess γ to have been 0.2 and then increased to 0.4 today.

3.2 Creating a Mathematical model

To create a representative model of the market we use the definition of market share together with the seven different market shares defined in table 2.1. The purpose of this operation is to get a representative picture of how the seven companies interact with each other with respect to prices and product differentiation. The market share definition in chapter 2.2 implies that the market share of firm *i;* s_i equals each company's produced quantity divided by the sum of all the quantity produced on the market. This equation is put up for all seven companies, giving us a system with seven equations and seven unknowns.

$$s_i = \frac{q_i}{\sum_{i=1}^{n} q_i}, n = 7 \qquad (3.3)$$

$$s_1 = 0.4; s_2 = 0.25; s_3 = 0.12; s_4 = 0.07; s_5 = 0.07; s_6 = 0{,}06; s_7 = 0{,}03; \qquad (3.4)$$

Box. 3.2 The definition of market share and the seven given market shares.

To get a relation between the market shares and the differentiation in the market we use the utility function from which we derive the reaction function.

$$U(q, I) = \sum_{i=1}^{n} q_i a_i - \frac{1}{2}\left(\sum_{i=1}^{n} q_i^2 + 2\gamma \sum_{i=1}^{n} q_i a_i \right) + I, n = 7 \qquad (3.5)$$

Box. 3.3 The utility function for the aggregate demand side in a market with n price-setting firms.

In the market we look at seven different companies (n = 7). Summing the reaction functions over all firms we achieve the equilibrium quantities (q_k) for firm k (Häckner [2001]).

$$q_k^*(c,\gamma)=\frac{\left[(1-c_k)\left[\gamma^2\left(n^2-5n+5\right)+3\gamma(n-2)+2\right]-(\gamma(n-2)+1)\gamma\sum_{i\neq k}^{n}(1-c_i)\right]\left[\gamma(n-2)+1\right]}{(1-\gamma)\left[\gamma(n-3)+2\right]\left[\gamma(n-1)+1\right]\left[\gamma(2n-3)+2\right]}$$

Box 3.4 The equilibrium quantity as a function of γ and all the costs (3.6), (Häckner [2001]).

In *box 3.5* we use all the equilibrium quantities, which are functions of the cost (c_i) and the differentiation (γ) and solve for c_1 to c_7 as functions of γ.

In this paper we let the market shares represent the differences in marginal costs since marginal costs is what allows for differences in prices. Using the quantity equations we solve for numeric values for the marginal costs, normalizing the cost of the company with the largest market share to zero. While solving for the costs we assume that γ was 0.2 at the time[6] of the constructions of the market, the time that is the base of the market shares. We then assume that the marginal costs are fixed and let the market change. Since there is such great difference between market shares there will be a large difference in marginal costs. There is a possibility that the differences in marginal production costs exceed real differences in marginal costs but as there is no other party other than the companies themselves that have more information about the cost situation this is our only way to solve the equations.

Under the assumption that the firm with the largest market share is a zero marginal cost producer (c_1=0) and that firm four and five have equal marginal costs, we achieve:

$$s_k = f(c_i,\gamma)=\frac{q_k = f(c_i,\gamma)}{\sum_{i=1}^{n} q_i = \sum_{i=1}^{n} f(c_i,\gamma)}, n=7 \qquad (3.7)$$

$$c_1=0, c_2=\frac{3}{4}\phi, c_3=\frac{7}{5}\phi, c_4=c_5=\frac{33}{20}\phi, c_6=\frac{17}{10}\phi, c_7=\frac{37}{20}\phi \qquad (3.8)$$

$$Where..\phi=\frac{2+9\gamma-11\gamma^2}{4+23\gamma+3\gamma^2} \qquad (3.9)$$

Box 3.5 The derivation of a representative model to express the costs as functions of γ.

We are now able to use these functions to determine how the firms interact with each other. Later in our study we will apply the model on two different scenarios and will need to make some slight modifications in our assumptions.

[6] Previously discussed in chapter 2.5.

3.3 Graphical representation

We have chosen to make two different graphical representations of how the level of differentiation (γ) affects the market. The first one is describing the relation between γ and the production costs *(c),* and the second describes how the profit-maximizing quantities *(q)* change when the level of differentiation changes from zero to one at given marginal costs.

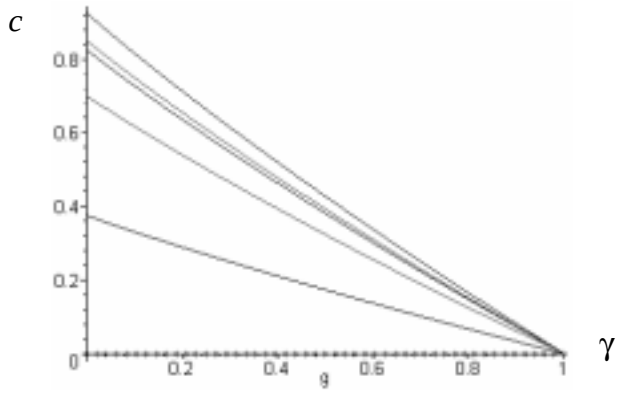

Fig. 3.1, The graphical representation, γin relation to the market.

3.3.1 The costs as functions of gamma (γ)

With the seven costs as functions of γ, ($c = f(\gamma)$), we can plot the information in a cost/differentiation graph, shown in *fig. 3.1.* In the cost graph, firm one is represented by the red circles on the floor because of the assumption of zero marginal cost. Firm four and five are represented by the same line, since they are equal cost producers.

In *fig. 3.1* above we see how the marginal costs are forced to be lowered as the market moves towards lower product differentiation and closer to perfect competition.

3.4 The Herfindal-Hirshman Index

We will use the Herfindal-Hirshman index (from now on denoted by I_{HH}-measure) to determine the market concentration. The I_{HH} is derived from the sum of the squared market share of each and all firms on the market (Shy [1996, p 173]).

$$I_{HH} \equiv \sum_{i=1}^{N} (s_i)^2 \qquad (3.10)$$

Box 3.6, The Herfindal-Hirshman model regards all N firms in the market (Shy [1996, p 173])

The US legislation is strictly depending on the I_{HH} to determine whether it is legal or not for two firms to merge. The European laws are not strictly defined by this index but the I_{HH} is a frequently used tool to determine the concentration on a market during an investigation on whether a merger is to be allowed or not[7] (Shatek).
In our analysis we will use the I_{HH}-measure to study the changes in market concentration because it brings us a very "hands on" picture of the changes in concentration.

$I_{HH} < 1000$	Merger is allowed	
$1000 < I_{HH} < 1800$	Merger is allowed if $\Delta I_{HH} < 100$.	(3.11)
$I_{HH} < 1000$	Merger is allowed if $\Delta I_{HH} < 50$.	

$$\Delta I_{HH} = (s_1 + s_2)^2 - \left[(s_1)^2 - (s_2)^2\right] = 2s_1 \cdot s_2 . \qquad (3.12)$$

ΔI_{HH} = The change in the market concentration.

Box 3.7, The US merger criteria (Shy [1996, p 210])

[7] The European merger legislation will be discussed further in chapter 4.1

4 LEGAL ASPECT

In this chapter the European Competition laws will be presented to let the reader acquire more insight to what might affect the concentration levels on the market.

4.1 The European competition laws

The European Merger Regulation, in force since 1990, is the first attempt in Europe to care for a healthy amount of competition on the market (www.europa.eu.int). While there have been anti-trust laws since 1890 in the US, the view of market efficiency has been very different in Europe and coalitions have even been encouraged. The positive effects that competition has on general welfare and consumer surplus, was not taken into account until the mid eighties (Braunerhjelm [2002, p 82]).

As the merger regulation was developed its main goal was to make sure that the competition in the European Union (EU) was not to be distorted. The European Commission (in the future referred to as the Commission) interpreted this as hindering any one party from gaining market dominance and abusing it. The regulation states that a planned merger must be reported to the Commission for investigation if the combined turnover in the entire world equals 5000 million euros or if the combined turnover of two of the companies equals 250 million euros in the EU. After a merger has been reported the Commission will investigate what effects it will have on competition and prices on the market. There are however both possibilities to appeal the decisions of the Commission and to apply for exemption. The regulation states that mergers between companies who have a combined market share of 25 percent, or lower, do not risk having a negative impact on the competition and such mergers will therefore be granted exemption and approved (Merger regulation [1989]).

In comparison to the US laws, that are based on the $I_{HH,}$ it is interesting to note that this implies a difference in view of which levels of concentrations that are acceptable as a merger like the one presented in chapter 5.3, most likely would not be approved in America.

A firm is market dominant if it can act independently of competing firms, customers and suppliers (Häckner [2001, p 81]). Since only abuse of market dominance is forbidden the Commission can approve mergers that gives a dominant actor on the market if that firm will not be able to abuse its power. To determine this, the Commission is to take into consideration the companies' current position on the market and their financial and economic strength as it investigates the possible effects a merger could have. The Commission also needs to look into

the situation of suppliers and customers to assess the characteristics of the demand and whether there is any entry deterrence. In addition to this the Commission is to consider possible effects on economic and technologic development. If the product is a substitute product it might not be able for any one firm to change the prices on the market even if the firm is very large since this would mean having customers switching to a similar product instead. If this is the case the Commission can grant a merger, if not it can demand adjustments that would restrict the merged firm's freedom (Merger regulation [1989]). The Commission have also approved group exemptions allowing for vertical agreements and mergers that improve such things as technology and distribution (Braunerhjelm [2002, p 89]).

4.2 Critique against the European system

It is important to be aware of the fact that the Commission who decides on mergers is not an institution specialized on competition, but a political one and the Commission can consider such facts as improved integration of the union. Due to this, decisions on restricting or allowing a merger might not be because of improvements for the consumers but political agendas.

As the Commission investigates it might take up to five years for a merger to be able to take place if the initial decision gets appealed. A merger is a very costly affair to go through for any company and knowing that it might take this long could discourage companies to take a merger into consideration (Braunerhjelm [2002]).

When the Commission investigates the effects of a proposed merger they assess the geographical market that is the market of the product. Often the situation occurs that different countries in the union are regarded as separate markets. As the market appears small a merger might get a decline. This affects large companies in small countries. Another, similar issue, is that the Commission has decided to not go through each merger as individual and therefore leaving such things as cost reduction, and with it a falling price, out of the picture (Braunerhjelm [2002]). This even though the merger regulation states that the Commission should take technological and economic development into account (Merger regulation [1989, p 6]).

A reform of the merger regulation was adopted in December 2002 and hopefully some of these problems can be solved (Reform of EU merger control [2002]).

5 APPLYING THE MODELS

To draw any conclusions about the differentiation and concentration on this market we need to apply the models presented in chapter 3 and try to analyse the results. First we will present the market situation as it is today and then we will discuss two possible future scenarios.

5.1 The profit maximizing quantities as functions of gamma (γ)

In *fig. 5.1* we plot the seven different profit-maximizing quantities in relation to γ. As the differentiation is getting lower (γ moves towards one) the small firms' quantities are getting smaller. This phenomenon is explained by the lower price the customers are willing to pay since all products are getting more alike. When a firm's quantity is getting below zero, it means that this firm is starting to make negative profit; it does not mean that the company is stopping their production or leaving the market at once. Most companies will probably try to change their situation by cutting costs or by increasing marketing before leaving the market.

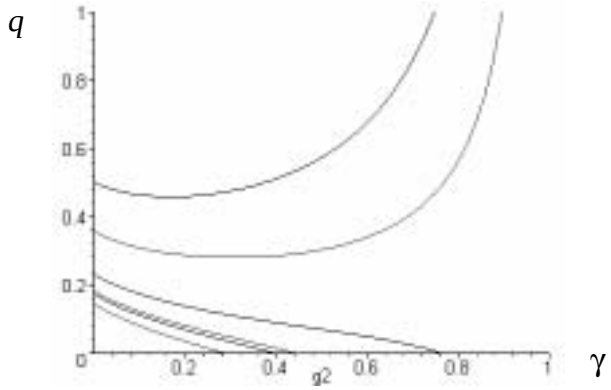

Fig. 5.1. The graphical representation, γ in relation to the profit maximizing quantity.

5.2 Current situation

It is known that the market is changing since the product has become increasingly standardized and therefore it is correct to assume that the value of γ is increasing. We now see a differentiation level of approximately 0.4 as discussed in chapter 3.1.1. The relatively low level of differentiation lets us assume that a large proportion of the market power lies in the hands of the suppliers, meaning that they have some control over the prices as it is costly for operators to switch suppliers once they have begun collaboration although the product is becoming increasingly homogenous.

As becomes clear when the I_{HH} index is applied the concentration is very high, another thing that shows that the suppliers have a great deal of market power. Just a few

players leave the operators with little to choose from when it comes to signing a contract. If the American Federal Trade Commission guarded the market it is unlikely that any actions leading to an increase in the concentration level would be allowed but as we will see the European Commission view the situation somewhat differently.

Company	**Market share (%)**	**Squared Market share (%^{2})**
Ericsson	40	1600
Nokia	25	625
Siemens	12	144
Motorola	7	49
Alcatel	7	49
Nortel	6	36
Lucent	3	9
(Checksum)	100	
Concentration $I_{HH} \equiv \sum_{i=1}^{N} (s_i)^2$		2512

Table 5.1, Current market situation

5.3 Market Exit

A market exit means that one actor is leaving the market. In our case that leaves us with six companies instead of seven. The exiting firm in our scenario is Lucent, with a market share of three percent. Solving the quantity equation using a 0.4 level of γ we can see that the profitable quantity for Lucent to produce is below zero. This implies that Lucent will leave the market, as they are no longer able to profit from staying on the market. As the level of differentiation declines no operator will be willing to pay the high price Lucent is asking for their products since other suppliers offer acceptable substitutes.

The reason for them to stay this long, although they have been loosing money for quite some time, might be that they are active on other parts of the telecommunications market and therefore need to show that they have a wide spectra of products including the GSM. Lucent's three percentages are after the exit divided among the remaining companies. To determine how the percentages are being picked up by the others we need to return to the quantity functions again and solve[8] for γ equal to 0.4.

[8] Detailed calculations are found in appendix A.

5.3.1 New market shares in the six player market

Table 5.1 presents the theoretically derived market shares after the exit. Since Ericsson and Nokia are the largest actors on this market, they are not only expanding their market shares with the three percentages that Lucent left open after their exit, they also collect percents from the four smaller companies. This phenomenon looks strange but the larger market shares strengthen the two companies even more in relation to the small ones. With larger quantities produced they collect market shares because of the positive returns to scale that lead to lower production costs.

Company	**Market share (%)**	**(%$^{2)}$**	**Market share after exit (%).**	**(%^{2})**
Ericsson	40	1600	46,8	2 193,6
Nokia	25	625	27,9	775,5
Siemens	12	144	11,4	129,8
Motorola	7	49	5,1	25,6
Alcatel	7	49	5,1	25,6
Nortel	6	36	3,8	14,4
Lucent	3	9	0	0
(Checksum)	100		100,00	
Concentration $I_{HH} \equiv \sum_{i=1}^{N} (s_i)^2$		2512		3 164,53
ΔI_{HH}				652,53

Table 5.2, Market exit scenario.

The exit leads to a large change in the I_{HH} index. A market exit implies that the market is getting more concentrated, a more concentrated market leads most of the times to higher prices trough a lower level of competition (Shy [1996]).

5.4 Two Firm Merger

In our study we will concentrate on horizontal mergers, i.e. mergers within the same industry, between companies producing identical or similar products in the same geographical market (Shy [1996, p 173]). Because of the global approach of this industry we will regard a merger between two companies for example in the Nordic, as a merger in the "market".

Since Motorola only produces the Radio Base Stations[9] there are rumours that Motorola will merge with Siemens (Gustafsson). The merge would result in Motorola exiting the market; Siemens takes over the solutions department, letting Motorola focus on their

[9] The Radio Base Stations are the transceiver devices in a GSM network.

mobile phone production. A reason for this might be that Motorola finds it too costly to offer solutions as they have a relatively high cost and a rather low demand whereas Siemens could supply both the quantity demanded by them and by Motorola at a lower cost.

5.4.1 New costs and market shares after merger

Using the calculations presented in chapter 3.2, we solve for the costs. But since Motorola now has access to the better production technology trough the merger with Siemens, they now produce according to the same cost function as Siemens. With the same cost function, the two companies also produce according to the same quantity function.

In the plot below, we express the costs as functions of gamma from zero to one. In this plot Siemens and Motorola have the same cost function and are thereby represented by the same line, the second counting from the x-axis (Ericsson follows the x-axis, Nokia intersects with the y-axis at around 0.36).

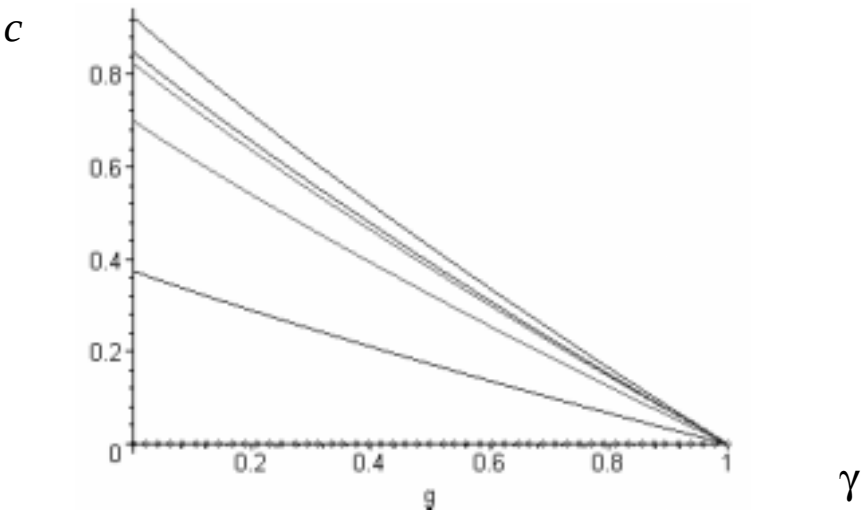

Fig. 5.2, The costs after merger as functions of γ

When the merger comes, we assume that the merger company has the total production of both Motorola (with new "better" cost function) and Siemens. The merger brings a very large shift in the sensitivity to the product's differentiation, which also means that the profit maximizing quantities change. We look at the six companies' market shares as γ reaches the value of today.

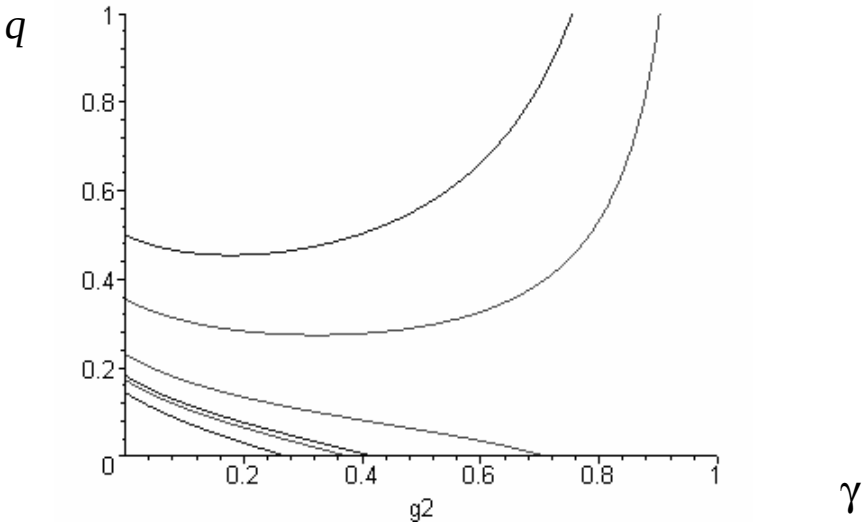

Fig 5.3, The profit maximizing quantities as functions of γ

It is important to remember that the level of γ is still 0.4 but as the market shares do not alter at the exact moment that γ alters, it is somewhat lagged, we have to look on what the market shares distribution is for different scenarios, as it is not possible for us to know exactly at what point we are, or would be, today.

As we go from the point where the weakest company, Lucent, starts to make negative profit[10], to the point where we estimate γ to be today, we see that only the three largest companies now make profit from producing. We also see that the concentration increases from 3121 to 3948 I_{HH} index points *(see table 5.2)*.

The predictions made in the Bertrand model, that says that as the number of firms together with the level of differentiation decreases, only the marginal cost of production will decide the sizes of the market shares, become obvious.

[10] Detailed calculations are found in appendix B.

Looking at *table 5.2* we see that as the smaller companies leave the market, Ericsson collects the greater parts of their market shares. Nokia increases its market share but by less than four percent. The newly merged company initially increases the combined market shares with 2.4 percentages but as γ reaches the value of 0.4 the market shares declines to the sum of the respective market shares the companies had before the merger. If the differentiation continues to decrease and the companies fail to lower their marginal costs, even the merged company will leave the market and Ericsson and Nokia will become the sole producers on the market[11].

Company	**Market share (%) γ at 0,27**	**(%^{2})**	**Market share (%) γ at 0,4**	**(%^{2})**
Ericsson	44,0	1940,2	52,4	2 743,7
Nokia	26,2	685,9	28,6	816,2
Siemens	21,4	459,2	19,0	362,5
Motorola	0	0	0	0
Alcatel	4,8	22,7	0	0
Nortel	3,6	12,8	0	0
Lucent		0	0	0
(Checksum)	100		100	
Concentration $I_{HH} \equiv \sum_{i=1}^{N} (s_i)^2$		3120,7		3 947,96
ΔI_{HH}		608,75		1 435,96

Table 5.2 The market concentration when we go from γ equals 0,27 to 0,4.

5.4.2 Legal aspect on a potential merger

Under the assumption that the European Commission's most important interest in the market is to make sure that no one party gains and abuses market dominance there seems to be no reason for them to oppose a merger between Motorola and Siemens. The two companies are very large and an investigation would therefore be conducted, but as Siemens only have 12 percent of the market the merger is immediately approved due to the rule allowing mergers where the parties together have a market share of 25 percent or less, as is stated in chapter 4.1.

It becomes obvious that the impact the merger will have is greatly depending on the level of differentiation, our assumption is still that γ is 0.4 and that is what we base our discussion on. Our calculations show that a merger will have a great impact on the concentration level on this market *(table 5.2)*, but whether or not this will have result in higher prices is difficult to say. The product is rather easy to substitute and that the level of

[11] See calculations for γ equal to 0.6 in appendix B.

differentiation is constantly decreasing which leaves a company that gains market dominance little room to abuse it. It is also important to remember that the market is in a transition from 2G-technology to 3G-technology. The GSM market that we have studied in this paper will most likely not exist ten years from now, it will then have become a new market with a new technology. This implies that even if Ericsson manages to crowd out the other companies as differentiation decreases, there will be no market left to dominate. Ericsson, who is an active part on the 3G-market as well, would gain little from abusing market power in a situation where they are trying to sign contracts for the new technology. It is interesting to note that this merger that is automatically approved in the EU would have great difficulties to get approved in the US as the concentration increases by approximately 1436 index points to begin with (*table 5.2)*. Whether the American or the European view on competition has the best effect, only time can tell.

5.5 Discussion of the credibility of the result

When creating a mathematical model of a market you first have to characterize the market and attach it to either the Bertrand[12] or the Cournot market structure. Our model is based on the Bertrand market structure, due to the fact that no market behaves exactly like one or the other; this is our first compromise. Second, the data provided: The only data we have from this market is the actual market shares. We assume that the company with the largest market share is a zero marginal cost producer, and that the market shares are in direct relation to the respective firms marginal costs. This assumption is probably not far from the truth, but still, our second compromise. When deciding a value for γ to get fixed numeric figures of the costs, we assume that the costs were set in the late eighties, when differentiation was high in the market and γ was low. We let γ be 0.2, based on our knowledge of the market at this time[13].

Even though or model has it's flaws, we still think it gives a representative picture of how the market reacts to a change in concentration and differentiation, you really do see how the profit-maximizing quantities are getting smaller for the small companies as the larger companies are getting larger. The model also shows how the market reacts to changes in concentration, all according to the Bertrand model.

[12] See chapter 3.1 Cournot vs. Bertrand
[13] We base this assumption on the interviews with Bernt Högberg, Radio Components AB and Mathias Gustafsson, Market analysist Ericsson AB.

6 CONCLUSIONS

We can establish that the GSM Solutions market seems to be following the Bertrand market structure, i.e. at a high level of homogenised products and market concentration, only the large, low-cost producers will gain profits from producing and putting products into the market. Much like other mature markets, this market is also going into a state of higher concentration as a result of the fact that the product is getting more and more standardized.

We believe to have found reasonable connections between our model and the rumours about a market exit by Lucent Telecom. We find it likely that Motorola and Siemens will merge in the GSM Solutions department, which was the other possible scenario discussed in the paper, and that they, if the decrease in differentiation does not accelerate, will keep their 19 percent of the market as long as the market remains. Both scenarios lead to an increase in concentration but we do not believe that it will result in higher prices as the suppliers have little to gain from raising the prices in a time when they are trying to sign contracts for the future and the differentiation level is constantly decreasing.

In our interviews we have also experienced that the general opinion is that the European market today only consists of three major actors; Ericsson, Nokia and Siemens, this opinion is also more or less confirmed by our study. If γ is higher than 0.4 as we assumed, or even close to 0.6, this will probably be the case in just a couple of years.

We see the importance of low marginal costs in production, as products are getting more and more alike, the large firms with positive returns to scale have much to gain from a more standardized product and on the contrary, the smaller high-cost producers are forced to leave the market since they no longer can meet the low prices on the market.

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8 THANKS TO

- Mathias Gustafsson
- Jonas Häckner
- Bernt Högberg
- Kristina Shatek

APPENDIX A

Derivation of the current situation, and then let Lucent exit the market APPENDIX A

Assignment of variables:

$$c := \text{array}(1 .. 7, [\ ])$$

$$cs := \text{array}(1 .. 7, [\ ])$$

$$q := \text{array}(1 .. 7, [\ ])$$

$$s := \text{array}(1 .. 7, [\ ])$$

$$n := 7$$

$$a := 1$$

The seven different quantity equations:

$$qk_1 := \frac{((1-c_1)(19g^2+15g+2)-(5g+1)g(6-c_2-c_3-c_4-c_5-c_6-c_7))(5g\cdot$$
$$(1-g)(4g+2)(6g+1)(11g+2)$$

$$qk_2 := \frac{((1-c_2)(19g^2+15g+2)-(5g+1)g(6-c_1-c_3-c_4-c_5-c_6-c_7))(5g\cdot$$
$$(1-g)(4g+2)(6g+1)(11g+2)$$

$$qk_3 := \frac{((1-c_3)(19g^2+15g+2)-(5g+1)g(6-c_1-c_2-c_4-c_5-c_6-c_7))(5g\cdot$$
$$(1-g)(4g+2)(6g+1)(11g+2)$$

$$qk_4 := \frac{((1-c_4)(19g^2+15g+2)-(5g+1)g(6-c_1-c_2-c_3-c_5-c_6-c_7))(5g\cdot$$
$$(1-g)(4g+2)(6g+1)(11g+2)$$

$$qk_5 := \frac{((1-c_5)(19g^2+15g+2)-(5g+1)g(6-c_1-c_2-c_3-c_4-c_6-c_7))(5g\cdot$$
$$(1-g)(4g+2)(6g+1)(11g+2)$$

$$qk_6 := \frac{((1-c_6)(19g^2+15g+2)-(5g+1)g(6-c_1-c_2-c_3-c_4-c_5-c_7))(5g\cdot$$
$$(1-g)(4g+2)(6g+1)(11g+2)$$

$$qk_7 := \frac{((1-c_7)(19g^2+15g+2)-(5g+1)g(6-c_1-c_2-c_3-c_4-c_5-c_6))(5g\cdot$$
$$(1-g)(4g+2)(6g+1)(11g+2)$$

The seven market share equations:

$$s_1 := \frac{qk_1}{qk_1 + qk_2 + qk_3 + qk_4 + qk_5 + qk_6 + qk_7} = .4000000000$$

$$s_2 := \frac{qk_2}{qk_1 + qk_2 + qk_3 + qk_4 + qk_5 + qk_6 + qk_7} = .2500000000$$

$$s_3 := \frac{qk_3}{qk_1 + qk_2 + qk_3 + qk_4 + qk_5 + qk_6 + qk_7} = .1200000000$$

$$s_4 := \frac{qk_4}{qk_1 + qk_2 + qk_3 + qk_4 + qk_5 + qk_6 + qk_7} = .07000000000$$

$$s_5 := \frac{qk_5}{qk_1 + qk_2 + qk_3 + qk_4 + qk_5 + qk_6 + qk_7} = .07000000000$$

$$s_6 := \frac{qk_6}{qk_1 + qk_2 + qk_3 + qk_4 + qk_5 + qk_6 + qk_7} = .06000000000$$

$$s_7 := \frac{qk_7}{qk_1 + qk_2 + qk_3 + qk_4 + qk_5 + qk_6 + qk_7} = .03000000000$$

$$t := c_1 = 0$$

We solve the costs from the market shares as functions of gamma (here denoted by g) under the assumption that Ericsson's marginal cost (c_1) is zero:

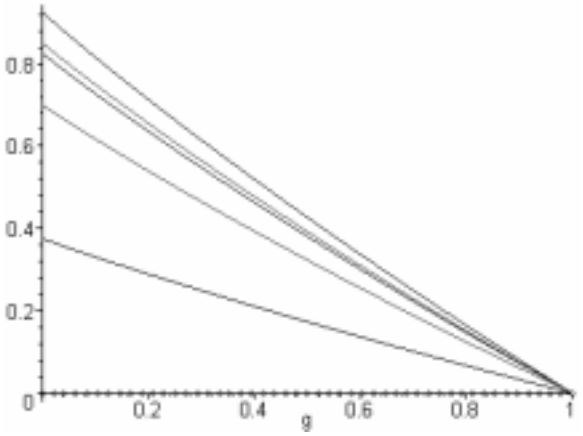
$$c_1 := 0$$

$$c_2 := -.75\,\frac{11.\,g^2 - 2. - 9.\,g}{4. + 23.\,g + 3.\,g^2} \qquad c_3 := -1.4\,\frac{11.\,g^2 - 2. - 9.\,g}{4. + 23.\,g + 3.\,g^2}$$

$$c_4 := -1.65\,\frac{11.\,g^2 - 2. - 9.\,g}{4. + 23.\,g + 3.\,g^2} \qquad c_5 := -1.65\,\frac{11.\,g^2 - 2. - 9.\,g}{4. + 23.\,g + 3.\,g^2}$$

$$c_6 := -1.7\,\frac{11.\,g^2 - 2. - 9.\,g}{4. + 23.\,g + 3.\,g^2} \qquad c_7 := -1.85\,\frac{11.\,g^2 - 2. - 9.\,g}{4. + 23.\,g + 3.\,g^2}$$

Then we plot the costs as functions of gamma from zero to one.



We decide a value for gamma based on our knowledge of the market (see chapter 2.4.1).

$$g := .2$$

Which gives us seven (in relation to each other) numeric values of the costs:

0

.2889908257 .5394495413 .6357798165

.6357798165 .6550458715 .7128440367

We use these costs in the quantity function that gives us the quantities as functions of gamma only (gamma is here denoted by g2 since we assigned g to be 0.6 to get a numeric value for the cost):

$$q_1 := \frac{(19\,g2^2 + 15\,g2 + 2 - 2.532110091\,(5\,g2 + 1)\,g2)\,(5\,g2 + 1)}{(1 - g2)\,(4\,g2 + 2)\,(6\,g2 + 1)\,(11\,g2 + 2)}$$

$$q_2 := ((13.50917431\,g2^2 + 10.66513761\,g2 + 1.422018349 - 2.821100917\,(5\,g2 + 1)\,g2)\,(5\,g2 + 1))/((1 - g2)\,(4\,g2 + 2)\,(6\,g2 + 1)\,(11\,g2 + 2))$$

$$q_3 := ((8.750458715\,g2^2 + 6.908256880\,g2 + .9211009174 - 3.071559633\,(5\,g2 + 1)\,g2)\,(5\,g2 + 1))/((1 - g2)\,(4\,g2 + 2)\,(6\,g2 + 1)\,(11\,g2 + 2))$$

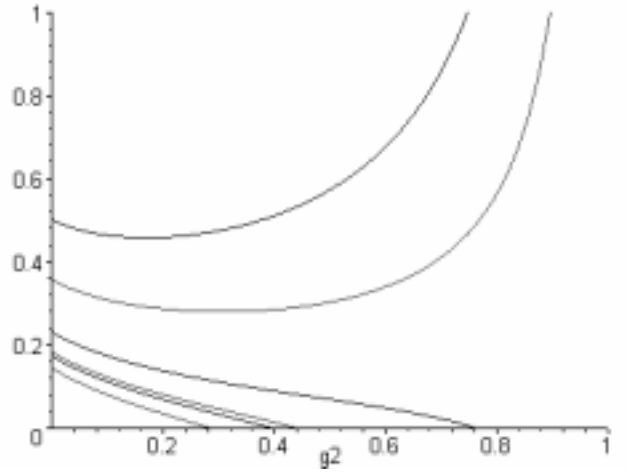
$$q_4 := ((6.920183486\,g2^2 + 5.463302752\,g2 + .7284403670 - 3.167889907\,(5\,g2 + 1)\,g2)\,(5\,g2 + 1))/((1 - g2)\,(4\,g2 + 2)\,(6\,g2 + 1)\,(11\,g2 + 2))$$

$$q_5 := ((6.920183486\,g2^2 + 5.463302752\,g2 + .7284403670 - 3.167889907\,(5\,g2 + 1)\,g2)\,(5\,g2 + 1))/((1 - g2)\,(4\,g2 + 2)\,(6\,g2 + 1)\,(11\,g2 + 2))$$

$$q_6 := ((6.554128442\,g2^2 + 5.174311928\,g2 + .6899082570 - 3.187155963\,(5\,g2 + 1)\,g2)\,(5\,g2 + 1))/((1 - g2)\,(4\,g2 + 2)\,(6\,g2 + 1)\,(11\,g2 + 2))$$

$$q_7 := ((5.455963303\,g2^2 + 4.307339450\,g2 + .5743119266 - 3.244954128\,(5\,g2 + 1)\,g2)\,(5\,g2 + 1))/((1 - g2)\,(4\,g2 + 2)\,(6\,g2 + 1)\,(11\,g2 + 2))$$

We now plot the quantity equations as functions of gamma to see how the firms produced quantity depend on gamma. This to be able to decide how much gamma has to rise before Lucent leaves the market.



To determine where Lucent produces zero quantity, we solve equation q_7 for gamma equals zero.

$gamma\_at\_exit := \{ g2 = -.2000000000 \}, \{ g2 = .2854714444 \}, \{ g2 = -.1868174998 \}$

Since the quantity equations have several roots we get three answers, but only the one in the interval zero to one is interesting to us.

$$g2 := .2854714444$$

This value for gamma is used in the second set of quantity functions, which gives us the new relative quantities in the six-player market, which we use to decide the new market shares.

$$s2_1 := .4683544304$$

$$s2_2 := .2784810126$$

$$s2_3 := .1139240505$$

$$s2_4 := .05063291139$$

$$s2_5 := .05063291139$$

$$s2_6 := .03797468355$$

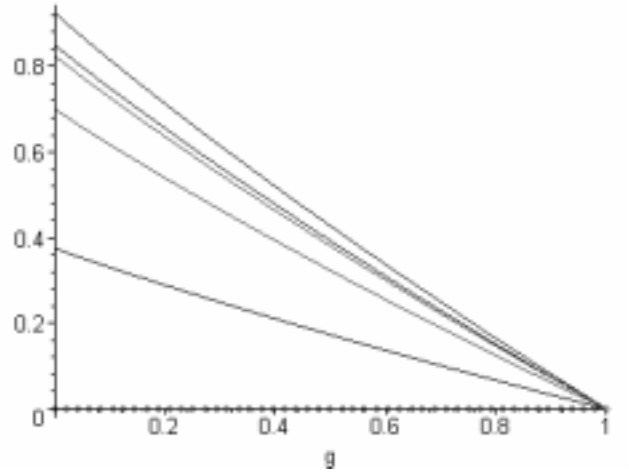
$$s2_7 := 0.$$

APPENDIX B

Derivation of the situation after the market merger by Motorola and SIEMENS and later market exits APPENDIX B

In this derivation everything remains the same except that we give Motorola the same cost-function as Siemens. Motorola will now have access to the better production technologies that Siemens can provide, and therefore achieve the lover production costs.

Then we plot the costs as functions of gamma from zero to one. In this plot Siemens and Motorola have the same cost function and are thereby represented by the same line, the second counting from the x-axis (Ericsson follows the x-axis, Nokia intersects with the y-axis at 0.36).



We decide a value for gamma based on our knowledge of the market (see chapter 3.2 for further explanation).

$$g := .2$$

This gives us seven (in relation to each other) numeric values of the costs:

0

.2889908257 .5394495413 .5394495413

.6357798165 .6550458715 .7128440367

We use these costs in the quantity function that gives us the quantities as functions of gamma only (gamma is here denoted by g2 since we assigned g to be 0.2 to get a numeric value for

the cost). Since Siemens and Motorola now are producing according to the same cost function, they also produce equal quantities (q_3 and q_4):

$$q_1 := \frac{(19\,g2^2 + 15\,g2 + 2 - 2.628440367\,(5\,g2+1)\,g2)\,(5\,g2+1)}{(1-g2)\,(4\,g2+2)\,(6\,g2+1)\,(11\,g2+2)}$$

$$q_2 := (13.50917431\,g2^2 + 10.66513761\,g2 + 1.422018349 - 2.917431193\,(5\,g2+1)\,g2)$$
$$(5\,g2+1)/((1-g2)\,(4\,g2+2)\,(6\,g2+1)\,(11\,g2+2))$$

$$q_3 := (8.750458715\,g2^2 + 6.908256880\,g2 + .9211009174 - 3.167889907\,(5\,g2+1)\,g2)$$
$$(5\,g2+1)/((1-g2)\,(4\,g2+2)\,(6\,g2+1)\,(11\,g2+2))$$

$$q_4 := (8.750458715\,g2^2 + 6.908256880\,g2 + .9211009174 - 3.167889907\,(5\,g2+1)\,g2)$$
$$(5\,g2+1)/((1-g2)\,(4\,g2+2)\,(6\,g2+1)\,(11\,g2+2))$$

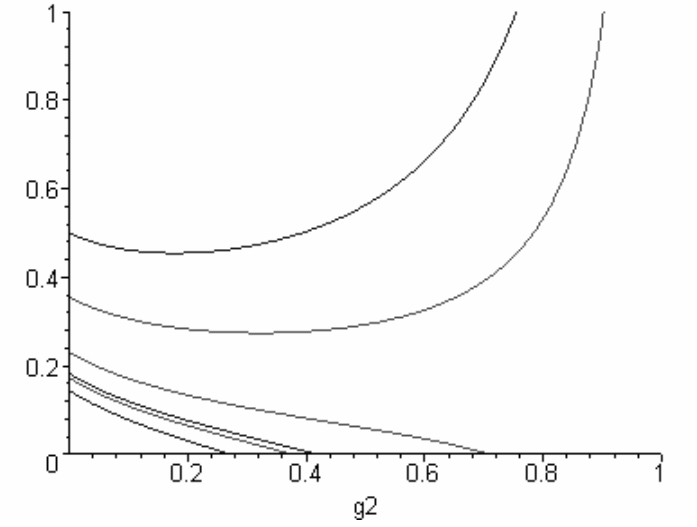
$$q_5 := (6.920183486\,g2^2 + 5.463302752\,g2 + .7284403670 - 3.264220183\,(5\,g2+1)\,g2)$$
$$(5\,g2+1)/((1-g2)\,(4\,g2+2)\,(6\,g2+1)\,(11\,g2+2))$$

$$q_6 := (6.554128442\,g2^2 + 5.174311928\,g2 + .6899082570 - 3.283486239\,(5\,g2+1)\,g2)$$
$$(5\,g2+1)/((1-g2)\,(4\,g2+2)\,(6\,g2+1)\,(11\,g2+2))$$

$$q_7 := (5.455963303\,g2^2 + 4.307339450\,g2 + .5743119266 - 3.341284404\,(5\,g2+1)\,g2)$$
$$(5\,g2+1)/((1-g2)\,(4\,g2+2)\,(6\,g2+1)\,(11\,g2+2))$$

Market shares:

When the merger comes, we assume that the merger company has the total production of both Motorola (with new "better" cost function) and Siemens. The merger brings a very large shift in the sensitivity to the product's differentiation; we look at all the different market shares after the companies start making negative profits one by one.



Looking at gamma = 0.2

If gamma is equal to 0.2, that is if the differentiation has not changed since the beginning of the market, we see that we get a dividing of the market where all companies still produce.

$g2 := .2$

$s2_1 := .3862199746$ $s2_2 := .2402022755$ $s2_3 := .2273072062$

$s2_5 := .06498103665$ $s2_6 := .05524652342$ $s2_7 := .02604298356$

Testing checksum:

1.000000000

Lucent Exits the market at 0,27:

We solve for gamma at the point Lucent makes negative profit.

$gamma\_at\_exit := \{g2 = -.2000000000\}, \{g2 = .2729148945\}, \{g2 = -.1870468362\}$

This equation has three roots, but only one in the interesting gap where gamma = [0..1].

Looking at gamma = 0.4.

When gamma reaches 0.4, we see that the profit maximizing quantities give the following market shares. We see that it is no longer profitable for other companies than Ericsson, Nokia and the merger company (Siemens/Motorola) to produce!

$g2 := .4$

We get another set of market shares where Alcatel has a market share very close to zero:

$s2_1 := .5290954486$ $s2_2 := .2917669997$

$s2_3 := .1721646897$ $s2_5 := .006972862007$

Testing checksum:

1.000000000

Looking at gamma = 0.6

If gamma reaches a value as high as 0.6, we see that the two large companies is dominating the market, even the new merger company is close to leaving the market.

$g2 := .6$

We get a third set of market shares:

$s2_1 := .6253358110$ $s2_2 := .3081506185$ $s2_3 := .06651356984$

Testing checksum:

.9999999993