23.1 Introduction

Governments’ ‘main objectives’ to be met in allocating licences to the spectrum are 1) Making the licences available to whoever will make the best use of them 2) Making the price of licences for the spectrum represent “fundamental values” 3) Promoting a competitive industry 4) Raising some revenue for the government in a non-distorting fashion. The question is what method of allocation best meets these objectives. In Europe beauty contests and auctions have been used to allocate spectrum for the third generation cellular networks (UMTS). Many European governments chose auctions because they were considered quicker and more economical than beauty contests (administrative allocation).

Economic theory says that the main advantage of the auction is that it allocates licences efficiently. ‘Efficiency lies in assigning each licence to the bidder who values it most, because that bidder will have the most effective business plan for the licence’, and "auction transfers the judgement on who should get a licence to real expert the contestant themselves" (Binmore, 2000). When the bidders know their own value of the licence with certainty and the uncertainty about common value is low, auction of the spectrum leads to an efficient allocation. But when there is high uncertainty about the common value inefficiency could be expected (Goree and Offerman, 2002).

On the other hand there are no theoretical reasons why always prices set by market mechanisms, namely auctions, reflect better than administrative mechanisms, namely beauty contests, fundamental factors. When a bubble exists excessive prices "will arise," that are not justified by "fundamental factors". Prices are high today only because investors believe that the selling price will be high tomorrow. If auction of the spectrum led to excessive prices it would raise the prices that telephone service customers ultimately pay. If operators spend large sums obtaining a licence they will invest less in infrastructure and this will increase costs and decrease the quality of the service and will prevent the creation
of a competitive industry. In general when there are excessive prices investment resources will not be efficiently allocated. A qualified administrative body, on the other hand, will be less affected by the bubble and will look at fundamental factors to determine the right price of the licence.

The answer to this objection is that the auction is paid before any service is provided. It is therefore a fixed cost and does not affect the marginal cost of supplying the service; in a profit-maximizing firm price depends only on the marginal cost and hence the price of the mobile service will not be affected. This will hold only if markets are perfect. If the capital market is imperfect, the more firms borrow, the higher is the interest rate they have to pay. Then the extra debt added by the auction price could result in the firm investing less and having a higher marginal cost. Yet according to MacMillan (1995), an authority on auction, ‘It is unlikely, however, that this is large effect’.

As regard the fourth objective auctions have been seen as a better method to cream skim oligopoly rents expected from exclusive access to scarce spectrum.

Theoretical arguments in favour of auctions are undoubtedly quite strong with regard to the first objective but not with regard to the second or third.

The purpose of our paper is to test whether empirical evidence from the European UMTS allocation supports the above arguments in favour of auctions or beauty contests. The first part of the paper will examine how a licence is evaluated in a context of perfect information. Then we will analyse how a licence could be rationally evaluated in the UMTS market. UMTS experience shows that when the method of allocation was auction, the licence prices per head of population or GSM users were very different across countries. We find that the value of the licences determined in European auctions is negatively correlated to the degree of the concentration of the European GSM markets. Indeed, there is a very strong negative correlation between the value per head of licences paid in each country, in 2000 auctions, and the Herfindal index of concentration of the GSM markets. Rent obtained by the larger incumbents was much higher when the concentration in GSM market was high than when it was low and therefore the forecasted position of the new entrant was much weaker. A similar correlation is not found when the allocation method was the beauty contest. This result is not a proof of efficiency of auctions in the sense that the licences were given to the participants that had the highest valuation and that there was no losing entrant that had a value for a licence that exceeded that of the marginal winner, but the above correlation could support such a hypothesis.

On the other hand there is evidence that auctions lead to excessive prices during the bubble period. In the European UMTS auction bidding firms knew quite well the cost of the infrastructure to build (1), and probably the market share that they could get in the UMTS market (private value elements) but there was an high uncertainty about the technology of the new UMTS network and the new terminals, and overoptimism about market demand of UMTS services (a common value part). In the 2000-2001 there were expectations of double-digit growth in the telecommunications markets. Such expectations were the main causes of the
excessively high prices of many mergers and acquisitions in Europe and the United States. Due to such excessive prices the take-over companies have significantly written down in 2002 and in 2003 the value of acquired firms. By the same token, overoptimistic expectations resulted in an excessive value of licences for the participants at the UMTS auction. However, share-holders of the telecommunications companies involved in the auction process believed that they could sell their shares at a higher price after the acquisition of the UMTS licence, and hence did not appear to care much about the "true" value of the licence.

The beauty contest approach makes licence fees much lower than licences fees determined in auctions. Analysis of the UMTS experience shows that auctions fees of the licences were highly affected by the speculative bubble ending in 2000, but this did not hold for beauty contests. Indeed the price of licences was much higher for auctions than in the case of beauty contests in 2000 but not in 2001. Our paper shows that average differences between 2000 and 2001 were quite high in the auction, but there were no significant differences when the method of allocation was the beauty contest.

The last part of the paper shows that there is evidence for negative effects of the excessive prices of auctions on the development of a competitive sector of UMTS services. The debt ratings of Telecom operators have worsened more for the firms that spent most on licences and there is a negative correlation between change in market capitalization in the period 1999-2001 and the normalized amount of money spent for the licences. As the amount spent on the auctions is much larger than in the case of beauty contests, empirical evidence supports the argument that UMTS auctions increased the cost of debts and delayed the introduction of 3G commercial services.

The conclusion of the paper is that it is probably correct to say that the licence fees determined in the auction process in 2000 were too high and were determined by the bubble that affected the new economy, and that the large amount of money spent on licences delayed the commercialisation of 3G services.

23.2 The value of a UMTS Licence with Perfect Information

The UMTS auctions adopted by most European countries were simultaneous ascending auction (English auction). Multiple licences were sold in the same bid, and each bidder could obtain only one licence. Bidding occurs over rounds, with the result of each round announced to the bidders before the start of the next. The bidding remains open as long as in a round the number of bidders is higher than the number of licences.

Let us assume that there are seven competitors bidding for four licences of equal number of MHz. Let $F_i$ be the value of the licence for the bidder $i$. As depicted in Figure 23.1 the bidders have different valuations. Each bidder knows its value (or at least the probability distribution from which to draw its valuation; this distribution is the same for all players), given the number of licences the seller
has decided to sell simultaneously. We assume, initially, that knowing all other bids in advance would not change a player’s valuation (private value auction). If the licences are awarded via a simultaneous English auction the optimal strategy for player $i$ is to choose to remain an active bidder when bid $B$ is lower than $F_i$. When bid $B$ exceeds $F_i$, player $i$ will drop out of the bid.

Once the value of $B$ rises to $P^*$ only four bidders will be active and the price of the licence will be $P^*$. In Figure 1 $P^*$ is equal to the value of the licence of the fourth player, but this is not necessary. If the price rise in each round is small the final value of price $P^*$ will be a little higher than $F_5$, the value of the fifth player.

![Figure 23.1 - UMTS bidding using a simultaneous English auction](image)

If the number of licences sold in a bid is $n$ as long as there is sufficient competition (number of competitors greater than $n$) and each player knows its value with certainty biddings, in a simultaneous English auction. The bidding ends when the price reaches the valuation of the player with the $(n+1)$ highest valuation (the fifth valuation in Figure 23.1).

We now present a simple model that calculates the effect of the amount paid for the licences on prices and investments in the UMTS market.

Consider $n$ firms competing for $s$ licences with $s \leq n$. Firm $i$ knows that the structure of the post–auction market will be an $s$ oligopoly. The demand curve of firm $i$ is given by

$$X_i = X_i(V_1, V_i, V_5, p_1, p_i, p_s)$$

(1)

Where $p_1, p_i, p_s$ are the prices of firm 1, $i$, $s$, and $V_1, V_i, V_s$ are the amount of investments made by firm 1, $i$, $s$ to build their network. Our hypothesis is that the
higher the investment of firm \( i \), the higher is the coverage and quality of the network and the higher the quantity \( X_i \) demanded.

The cost function of firm \( i \) is given by

\[
C_i = F_i + c^i X_i + c^d V_i
\]  

(2)

where \( c^i \) is the variable cost of producing one unit of service \( X \) and \( c^d \) is the variable cost per unit of investment; \( F_i \) is the fixed cost of the licence. We assume that \( c^i \) and \( c^d \) are constant and are the same for all firms.

The profits of firm \( i \) is

\[
\pi_i = (p_i - c^i)X_i - c^d V_i - F_i
\]  

(3)

The number of licences awarded by the government affects the market structure of the UMTS industry (the number of firms) and the oligopoly equilibrium values. The equilibrium values of price, output produced and investments of firm \( i \) are \( p^*_i, X^*_i, V^*_i \). If we put \( \pi^*_i = 0 \) we get the maximum value \( F_i \) that a firm \( i \) would pay, in equilibrium, for the licence. This value is

\[
F^*_i = (p^*_i - c^i)X^*_i - c^d V^*_i
\]  

(4)

The maximum value that such a firm would pay for the licence is a function of the variable costs and of the oligopoly equilibrium values. Oligopoly equilibrium values are also a function of the kind of competition that firms expect will characterize the market (Cournot competition, Bertrand competition, collusive behaviour, etc.).

If there are \( N \) firms that participate in the bid, each of these will be characterized by a value of \( F_i \). We could rank the firms by their value of \( F_i \). In the English auction the licences will be given to the \( s \) firms that have the highest values of \( F_i \) and the price of the licence will be equal to that of firms ranking \( s \)th as value of \( F_i \). We call \( F_i \) the \textit{ex ante} value of the licence of the marginal firm. The value of the licence fee in an English auction will be \( F^* \), where \( F^*_e > F^*_s > \ldots > F^*_{s+1} \). The rent that each winning firm will expect to gain will be:

\[
R_1 = F_1 - F^*; R_2 = F_2 - F^*; \ldots; R_s = F_s - F^*
\]

Equation (4) determines the maximum value that a firm that looks to fundamentals would pay for the licence and \( R_i \) is the difference between the value of the licence and price paid \( F^* \). In a market that looks only to fundamentals the value of the shares of firms \( i \) will increase by \( R_i \). The question is why a firm would pay a price \( F^{**} \) higher than \( F^* \). A possible answer is that there is a bubble in the market and the purchase of licences may well affect beliefs about future share prices. If we call \( S_t \) the capitalization value of the shares before the purchase of the licence and \( E(S_{t+1}) \) the expected value of the shares after the purchase of the licence, the market value of the licence will be...
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\[ E(S_{t+1}) - S_t = F^{**} \]

This value could be higher than \( F^* \) and therefore it is possible that an excessive price will be paid. Evidence of excessive prices is given by the relatively large number of Telecom companies (Telefonica, Sonera, KPN, O2, etc.) that wrote down the value of 3G licences bought in the UK and German auctions. In May 2003 O2 announced a £10.2 billion pre-tax loss, and almost £6 billion went in writing down the value of 3G licences in Britain and Germany.

What would happen if excessive licence fees \( F^{**} \) were actually paid? Economic theory would suggest that decisions by firms, \textit{ceteris paribus} (same technology, same size of the market, same tastes, etc.), would not change. The oligopoly equilibrium value of prices, outputs, and investments of firms \( s \) will not change. The profit of the marginal firm before fixed costs (the value of the licence fee) is positive and the firm has no incentive to exit from the market.

\[ (p^*_s - c^i)V^*_s - c^dV^*_s > 0 \]

Now let us answer arguments against auctioning which repeatedly arise. One argument is that auctioning increases the price that telephone services customers ultimately pay and decreases the amount of investment made by the winners to build their network. Economists would argue that a firm that takes cares of profits bases its price on its marginal cost. The auction price is paid before any price is provided – it is a fixed cost – so it is not part of the marginal cost of supplying the service and does not affect the price incurred by customers. It is easy to show that the value of licence \( F \) does not affect equilibrium values of \( p_s^*, V^*_s \), and \( X^*_s \).

Once a firm \( i \) has paid the fixed price for licence \( F_i \), this price will not affect the equilibrium values. The above argument is correct if we could assume that the capital market is perfect, so there is no difference financing investments with own capital or with debt. But if the more the firm borrows the higher the interest rate it must pay, then the extra debt added by the auction price could result in the firm’s investing less and having a higher marginal cost. Variable costs, in this case, will be a function of \( F \) and hence also equilibrium values will be a function of \( F \).

Another argument is that an excessive price for the licence could change the kind of competition expected in the UMTS services market and therefore equilibrium values could change. This argument has been raised by Gruber (2002). Gruber considers an industry with \( n \) identical firms. Each firm in equilibrium will get the same profit. If excessive entry costs (licence fees) were paid firms would be threatened with bankruptcy. Suppose for example that two licences are offered. In a non-collusive equilibrium profits are less, for the two winners, than the licence fee paid. In this case there are two options for the firm: exit or collusion. With the exit of one firm the remaining firm could obtain monopoly profit and thus break even. If on the other hand the government could credibly precommit to a duopoly structure then firms need to collude to get the monopoly profits to repay the licence fee. High licence fees could therefore lead to higher prices than would be the case without licence fees. As such licence fees could be viewed as an
inducement for collusive behaviour and do not necessarily represent an allocation of scarce resources to the socially best use.

23.3 Evaluation of the Efficiency of UMTS Auctions

As MacMillan (1996) points out, only time could tell whether the licences were given to the right firms but it is possible to give theoretical and practical reasons that could determine an inefficient outcome of the auction. One of these is the problem of the winner’s curse (Klemperer, 2002, pp. 169-89). This problem could arise when there are interactions among different bidders’ valuations. In this situation a phenomenon called the ‘winner’s curse’ could arise.

If \( b_i \) is the price paid by the winner \( i \), and \( E(V_i) \) the bidder’s expectation about the item’s value after he knows that he has won and

\[
E(V_i) \geq b_i
\]

(5)

there is a problem of the winner’s curse. The mere knowledge that bidder \( i \) has won will cause a downward revision of this estimate (Milgrom, 1981,). This problem could arise when there is a correlation among bidders’ valuations, the common value model being a special case (3).

Another argument against UMTS auctions could be the following: UMTS auctions could favour an incumbent over a more efficient new entrant. We consider, as in the previous section, that two licences are awarded in an English auction. The competitors for the two licences are the monopolist in the GSM market and two new entrants. The three firms share the same technology and are equally efficient.

If the incumbent loses the auction, in the UMTS market there will be two new operators that will share the market. Both will get a profit \( \Pi_E ((1/2).X_{UMTS}) \), where \( X_{UMTS} \) is the quantity of services sold in equilibrium. If the incumbent obtains the licence, its profit in the UMTS market will be \( \Pi_M (\alpha .X_{UMTS}) \) where \( \alpha \) is the share of the incumbent in the UMTS market. We assume that it will continue to get a profit \( \Pi_M(X_{GSM}) \) in the GSM market. If the incumbent loses it will get only \( \Pi_M(X_{GSM}) \). Thus the incumbent’s incentive to buy the licence will be \( \Pi_M (\alpha .X_{UMTS}) \). In the GSM market there was only one firm and its share was equal to one. Hence it is reasonable to assume that its share \( \alpha \) of the UMTS market will be higher than \( \frac{1}{2} \) due to switching costs and so on. As \( \alpha > 1/2 \) the incumbent’s incentive to buy the licence will be higher than the new entrant’s incentive.

\[
(\Pi_M (\alpha .X_{UMTS})) > (\Pi_E ((1/2).X_{UMTS}).
\]

(6)

We assume now that the new entrants are more efficient and therefore have lower costs than the incumbent. We also assume that, due to switching costs, the incumbent is still able to obtain, if it is a winner, a share \( \alpha^* \) of UMTS subscribers
greater than \( \frac{1}{2} \), albeit lower than in the case where all firms share the same technology.

If the incumbent loses the auction the two entrants will share the market and the services produced will be \( X^\text{UMTS} \) and profits of each firm will be
\[
\Pi_E \left( \frac{1}{2} \right) X^\text{UMTS}.
\]

If the incumbent is awarded the licence because its costs are higher prices will be higher and services supplied \( X^{**\text{UMTS}} \) lower than services supplied when there are the two entrants in the UMTS market. Therefore when there are two entrants total profits in the UMTS market are greater than profits when there is only the incumbent and one entrant
\[
2(\Pi_E \left( \frac{1}{2} \right) X^\text{UMTS}) > (\Pi_M (\alpha X^{**\text{UMTS}}) + (\Pi_E \left( 1-\alpha \right) X^{**\text{UMTS}}) \quad (7)
\]

Equation 7 does not guarantee that the incentive to buy the licence will be higher for the incumbent than for the new entrants. The higher the value of \( \alpha \) and lower the difference \( (X^\text{UMTS} - X^{**\text{UMTS}}) \), the higher will be the possibility of the incumbent being awarded the licence even if it is less efficient than the new entrant.

\[
\Pi_E \left( \frac{1}{2} \right) X^\text{UMTS} \geq< \Pi_M (\alpha X^{**\text{UMTS}}) \quad (8)
\]

In this particular case of asymmetric bidders the highest-valuation bidder is not the efficient one, even if there is a simultaneous English auction.

Many economists think that the above theoretical case has not characterized UMTS auctions in Europe. The auctions in UK and Germany were considered a success of economic theory by many academics (Binmore 2000, Klemperer 2002) because, as in the case of UK and Germany, there was quite a large number of companies that participated in the auction and the sums paid were quite large. To criticism that the 22.47 billion raised in the UK at the auction was a huge sum and a large tax on the mobile telecom industry and would prevent operators creating a competitive and efficient industry, Binmore responded as follows:

‘Those tempted to weep for the shareholders should dry their tears, because they didn’t enter the auction with their eyes shut. They are hard-headed businessmen who figure that the odds are high that they will make a healthy return on their capital even after the Chancellor has their £ 22.47 billion in his pocket. They know perfectly well that they are taking a risk, but it is because entrepreneurs risk their capital that they are entitled to their profit when thing go well.’ (Binmore 2000). This opinion is based on the assumption that markets by themselves lead to efficient allocations and direct governments interventions will make people worse off.

Evidence of inefficiency could be found in the secondary market. A large number of licences being resold would suggest that the auction had produced an inefficient allocation, but the secondary market is too tiny to provide decisive evidence of efficiency 5. A large number of licence hand-backs could also be seen
The European UMTS Licences Allocation

9

an index of inefficiency. This is what happened in the case of UMTS. Several firms that received a licence decided to hand it back, forgoing the licence paid. In most cases such firms were new entrants. Broadband Mobile in Norway (beauty contest), Ipse in Italy (auction), 3G in Germany (auction), but probably also Mobilkom, that is close to bankruptcy, in Germany 6. Other firms have requested the postponement of the building of the network infrastructure. Orange, a new entrant in the Swedish market, asked the Swedish authorities to relax the terms of its 3G licence and to give it three extra years to build a network capable of providing national coverage. But not only are new entrants delaying the launch of 3G commercial services. Vodafone announced a delay to 2003 of 3G in Germany and has asked for an extension of the generation licence fee deadline in Ireland to decide whether or not to make the payment. In Portugal the four 3G licence holders, that were obliged to launch services at the start of 2003, said that they would welcome a delay in the scheduled launch of next generation services due to lack of 3G equipment. There are also technical problems that are delaying the offer of 3G commercial services.

We could summarize the situation in the UMTS European market. Weaker new entrants will hand back the licence to the regulator and larger incumbents would delay the launch of 3G services. It seems that only the new entrant Hutchinson has the interest and the resources to launch the new service as soon as possible. Unlike the incumbents Hutchinson does not get any income in the GSM market, and its interest is to start to earn revenue as soon as possible from the sale of 3G services.

Conclusive evidence on the efficiency of the different methods to allocate spectrum will come only after the firms have their UMTS services operating and this will take several years. But the empirical evidence (excessive licence fees and the large number of handbacks) does not support so far the hypothesis that UMTS auctions allocate licences efficiently.

23.4 Licensing Costs for UMTS Licences and Market Concentration

The model analysed in section 23.2 shows the main determinants, in the English auction, of the value of the licences: a) Number of licences issued; b) The expected size of the UMTS market; c) the expected market share of the marginal winner d) the expected competitive environment.

There are big differences in the amount of money paid for the UMTS licences in various countries whatever measure of size is used. In Table 1 we report total amounts paid to governments on 3G mobile licensing, in Western Europe and some Asian Pacific and American countries, either when the method of allocation was beauty contest either auction. We computed total amounts using the prices of licences that were originally determined during the auction or fixed by the governments in the licensing process via beauty contest. After the award of the licences, in some countries governments changed the conditions of the licences in a more favourable direction to the carriers and in some cases lowered their fees 7.
We believe that if we wish to compare the two methods of allocation it is more correct to consider the original amount to be paid and not the revised one.

The amount in national money was converted in ECU at the exchange rate existing at the time of the award of the licences. Population data are those of 1999. Table 1 shows that the licence fees paid for the use of electromagnetic spectrum for mobile telecommunications in Europe were higher when the auction method was used than when the allocation method was the ‘beauty contest’ and much more money collected by governments with auctions. This was true until the end of 2000 when there was a favourable business climate and the stock market experienced the bubble of the new economy. After the change in business climate, in 2001, there was not much difference between the two methods, in the amount spent per head on 3G licences.

But it is not just auction that can produce high licence fees. The French government used the beauty contest method but, guided by the results in the UK and Germany, set a high minimum fee.

Table 23.1 - Status of 3G Mobile Licensing

<table>
<thead>
<tr>
<th>Country</th>
<th>Award date</th>
<th>Amount (ECU 000’s)</th>
<th>Amount per head of population (ECU)</th>
<th>Country</th>
<th>Award date</th>
<th>Amount (ECU 000’s)</th>
<th>Amount per head of population</th>
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<td>Europe</td>
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<tr>
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<td>652.61</td>
<td>Finland</td>
<td>18/3/1999</td>
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<td>13/3/00</td>
<td>500000</td>
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<td>6/12/00</td>
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<td>11/4/01</td>
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<td>55.035</td>
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</table>

Source: Our calculation on UMTS Forum data
Another important consideration is that when the allocation method was beauty contest, there is not much difference, on average, in the amount per head of population before and after 2001 (Table 23.1). In the case of auction the difference was huge and the values much higher before 2001. This shows that values of licences in the auction process were highly affected by the business climate, but this was not true when the allocation method was beauty contest. In Table 23.2 we report the cost of the licence of the marginal operator on a per capita basis for the six countries that auctioned licences in 2000. We considered only auctions held in 2000 as the effect of the declining business climate in the telecom sector after 2000 could make comparisons not significant. We considered two different indicators: the cost of the licence for GSM users, and the cost of the licence per inhabitant. We have adjusted the two above indicators by the number of MHz allocated with each licence.

Table 23.3 shows the cost of UMTS licences in countries where beauty contest was used as a method to allocate spectrum. With the exception of France all licences were issued in 2000s. In France the issue date was May 2001 but two licences of the four licences issued were not assigned as there were only two participants. Table 23.2 and Table 23.3 indicate that a) the cost of licence per head, with the exception of France, was much lower when the allocation method was beauty contest b) the licence costs per head of population or GSM users are very different between the countries.

Why was the price of licence when the auction method was used higher than in the case of beauty contest? Government demanded a low price of the licence in the case of beauty contest because they expected that the money saved by avoiding an auction process would help the winners to better position themselves in the market, avoid huge debt and provide their countries with a better terrestrial coverage. In the auction mechanism the firm’s choice was seen between quitting the business and bear the price of not bidding for a licence or buy the licence and massively increase its debt. Therefore if we denote the profit when the company wins the bid as \( \Pi_i(B) \), and \( \Pi_i(0) \), if it does not, the maximum value for the bid could be seen as \( F_i = \Pi_i(B) - \Pi_i(0) \). In the very optimistic business climate of 2000 the expressed value of the licence fees discounted very rapid market growth. The overestimation of the value of \( \Pi_i(B) \) was also affected by the belief that buying the licence would have positively affected the share price of the firm, and a capital gain could result. The expected value of \( \Pi_i(B) \) was overestimated and \( \Pi_i(0) \) was underestimated by telecom executives and by shareholders. Hence the estimated value of the licence was highly overestimated.

The second fact that we must explain is why the licence prices per head of population or GSM users vary greatly between countries. We could understand that governments with different objectives fix different prices for licence fees in beauty contests but why do we find this difference in the case of auctions? The reason is that there is a very high correlation between the firm share of the GSM market and the expected share of the firm in the UMTS market. We must consider that incumbents have a mass of subscribers in the GSM market that, because there
are switching costs, incumbents will also continue to provide UMTS services, unless quality and prices are much worse than those of competitors. The cost of converting existing customers to 3G customers is likely to be much lower than acquiring a new customer. With most products and services it is much cheaper to sell a new service to an existing consumer than a new service to a new customer. Furthermore, incumbents could have better expertise at running a network

Table 23.2 - Cost of UMTS licences and index of concentration in GSM markets in European countries that used, in 2000, auction as a method to allocate spectrum

<table>
<thead>
<tr>
<th>Country</th>
<th>H/H index of the GSM market Year 2000</th>
<th>Cost of the marginal licence per inhabitant (euro)</th>
<th>Cost of the marginal licence for GSM users (euro)</th>
<th>Cost of the marginal licence per inhabitant by 1 MHz (euro)</th>
<th>Cost of the marginal licence for GSM users by 1 MHz (euro)</th>
<th>Number of licences issued</th>
<th>Number of firms taking part in the contest</th>
</tr>
</thead>
<tbody>
<tr>
<td>UK</td>
<td>0.2661</td>
<td>117.18</td>
<td>288.81</td>
<td>3.67</td>
<td>9.04</td>
<td>5</td>
<td>13</td>
</tr>
<tr>
<td>The Netherlands</td>
<td>0.3778</td>
<td>24.99</td>
<td>47.37</td>
<td>1.00</td>
<td>1.89</td>
<td>5</td>
<td>6</td>
</tr>
<tr>
<td>Germany</td>
<td>0.3592</td>
<td>102.57</td>
<td>434.18</td>
<td>4.10</td>
<td>17.37</td>
<td>6</td>
<td>11</td>
</tr>
<tr>
<td>Italy</td>
<td>0.4315</td>
<td>42.02</td>
<td>64.80</td>
<td>1.62</td>
<td>2.49</td>
<td>5</td>
<td>6</td>
</tr>
<tr>
<td>Austria</td>
<td>0.3606</td>
<td>13.96</td>
<td>18.83</td>
<td>0.69</td>
<td>0.93</td>
<td>6</td>
<td>6</td>
</tr>
<tr>
<td>Switzerland</td>
<td>0.5765</td>
<td>4.55</td>
<td>8.78</td>
<td>0.13</td>
<td>0.25</td>
<td>5</td>
<td>5</td>
</tr>
<tr>
<td>(\mu)</td>
<td></td>
<td>50.88</td>
<td>143.80</td>
<td>1.87</td>
<td>5.33</td>
<td></td>
<td></td>
</tr>
<tr>
<td>(\sigma)</td>
<td></td>
<td>47.60</td>
<td>175.91</td>
<td>1.64</td>
<td>6.69</td>
<td></td>
<td></td>
</tr>
<tr>
<td>(\sigma/\mu)</td>
<td></td>
<td>0.93</td>
<td>1.22</td>
<td>0.88</td>
<td>1.25</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Source: Our calculation on UMTS Forum data
Table 23.3 - Cost of UMTS licences and index of concentration in GSM markets in European countries that used beauty contest as a method to allocate spectrum

<table>
<thead>
<tr>
<th>Country</th>
<th>H/H index of the GSM market Year 2000</th>
<th>Cost of the marginal licence per inhabitant (euro)</th>
<th>Cost of the marginal licence per GSM user (euro)</th>
<th>Cost of the marginal licence per inhabitant by 1 MHz (euro)</th>
<th>Cost of the marginal licence per GSM user by 1 MHz (euro)</th>
<th>Number of licences issued</th>
<th>Number of firms taking part in the contest</th>
</tr>
</thead>
<tbody>
<tr>
<td>Finland</td>
<td>0.498</td>
<td>0.00</td>
<td>0.00</td>
<td>0.00</td>
<td>0.00</td>
<td>4</td>
<td>15</td>
</tr>
<tr>
<td>Norway</td>
<td>0.595</td>
<td>9.28</td>
<td>14.31</td>
<td>0.27</td>
<td>0.41</td>
<td>4</td>
<td>7</td>
</tr>
<tr>
<td>Sweden</td>
<td>0.387</td>
<td>0.00</td>
<td>0.00</td>
<td>0.00</td>
<td>0.00</td>
<td>4</td>
<td>10</td>
</tr>
<tr>
<td>Portugal</td>
<td>0.365</td>
<td>10.06</td>
<td>17.29</td>
<td>0.29</td>
<td>0.49</td>
<td>4</td>
<td>7</td>
</tr>
<tr>
<td>Poland</td>
<td>0.348</td>
<td>16.84</td>
<td>0.00</td>
<td>0.67</td>
<td>0.00</td>
<td>3</td>
<td>3</td>
</tr>
<tr>
<td>France</td>
<td>0.379</td>
<td>83.93</td>
<td>158.15</td>
<td>2.49</td>
<td>4.52</td>
<td>4</td>
<td>2</td>
</tr>
<tr>
<td>Spain</td>
<td>0.387</td>
<td>12.50</td>
<td>21.36</td>
<td>0.09</td>
<td>0.11</td>
<td>4</td>
<td>4</td>
</tr>
</tbody>
</table>

μ = 20.55, σ = 31.60, μ/σ = 1.54

Source: Our calculation on UMTS Forum data

compared with marginal operators in the GSM market or new entrants. Therefore it is clear that marginal operators in the GSM market or new entrants will be, at least in the medium term, the marginal operators in the UMTS market. Their valuation of the licence will determine the final results of the auction and we might expect that higher the degree of concentration in the GSM market, the lower will be the expected market share in the UMTS market of the GSM marginal operator or of the new entrants. The higher the concentration in the GSM market, the lower, ceteris paribus, will be the final price in the UMTS auction.

We calculated for six European countries (the UK, Germany, Italy, the Netherlands, Austria and Switzerland) where the spectrum is allocated through auction, the Herfindhal index of concentration in the GSM market in the year 2000, and we correlated this index with the licence paid by the marginal operator. We considered the cost of the licence of the marginal operators presented in Table 23.2.

Figure 23.2 and 23.3 show that there is a very strong negative correlation between the lower values of the licence paid in each country (the cost of the licence of the marginal operator) and the Herfindal index of concentration of the GSM markets i.e. in each country.

When the allocation method was beauty contest, it is not possible to find such a negative relationship. Our interpretation of Figure 23.2 is that the higher the concentration index, the lower the value of the licence of the marginal operator. A different interpretation, according to Klemperer (2002), is that the higher the concentration index the higher the probability that incumbent firms collude and
therefore the lower will be the auction price. ‘Finally, because an ascending auction often effectively blocks the entry of the weaker bidders, it encourages ‘stronger’ bidders to bid jointly or to collude; after all, they know that no one else can enter the auction to steal the collusive rents they create. In the “disastrous” November 2000 Swiss sale of the four third generation mobile phonelicences, there was considerable initial interest from potential bidders. But weaker bidders were put off by the auction form’ Klemperer (2002). Table 2 shows that an ascending auction could block the entry of the weaker bidders. The correlation between the concentration index and the ratio between the number of firms participating in the bid and the number of licences is negative and $R^2$ is 0.51. But this is not proof that the low price of the licence in Switzerland was caused by collusion. Our interpretation is that the very high concentration index in the GSM Swiss market led to quite a low value of the licence of the marginal operator (see Figures 2 and 3). Therefore the price was not caused by collusive agreements between stronger bidders but was the correct price of the marginal operators. We could repeat the same argument for two other third generation spectrum auctions that Klemperer (2002) considered a total (Netherlands) or a partial (Italy) fiasco. Only in the Austrian auction was the price much lower than the value estimated on the basis of the interpolation curve (black line in Figure 23. 2. Therefore we do not share the Klemperer (2002) hypothesis that in Italy, the Netherlands, Switzerland and Austria some kind of abuse of dominant position resulted in excessive low prices of licences.

![Figure 23.2 -The relations between the Herfindhal index and the cost of licences per head of population](image-url)

**Figure 23.2** -The relations between the Herfindhal index and the cost of licences per head of population
In section 23.3 we showed that auctions could favour the incumbent over new entrants (11) as the value of the licence is much higher for the incumbent than for the new entrant. Table 23.3 shows, on the other hand, that the beauty contest does not discourage participation when the GSM market concentration is high. The correlation between the concentration index and the ratio between the number of firms participating and the number of licences is positive (and not negative as in the auction method), and $R^2$ is 0.18.

However, there is not much evidence to suggest that auctions favour incumbents over new entrants (Table 23.4). The beauty contest shows a higher percentage of licences given to new entrants but there are no substantial differences in the share of the new entrants in the two cases. The reason was that in both cases the number of licences awarded was greater than the number of incumbents. In four cases one incumbent did not participate in the bid. Blue in Italy (auction), Meteor in Ireland (beauty contest), Sonafon in Denmark (auction), Bouygues in France (beauty contest). In all these cases these operators, except in the Danish case, were marginal operators with a very tiny share of the GSM market. However, the only country where the dominant operator did not win the licence was Sweden, where the method of allocation was the beauty contest (12).

**Figure 23.3 The relations between the Herfindhal index and the cost of 1MHz per GSM user.**

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The European UMTS Licences Allocation

15
## Table 23.4 - Distribution of UMTS licences between incumbents and new entrants

<table>
<thead>
<tr>
<th>Country</th>
<th>Auction date</th>
<th>Incumbent</th>
<th>New entrant</th>
<th>Country</th>
<th>Auction date</th>
<th>Incumbent</th>
<th>New entrant</th>
</tr>
</thead>
<tbody>
<tr>
<td>UK</td>
<td>27/04/00</td>
<td>4</td>
<td>1</td>
<td>Finland</td>
<td>18/3/1999</td>
<td>3</td>
<td>2</td>
</tr>
<tr>
<td>Netherlands</td>
<td>24/07/00</td>
<td>4</td>
<td>1</td>
<td>Spain</td>
<td>13/3/00</td>
<td>3</td>
<td>1</td>
</tr>
<tr>
<td>Germany</td>
<td>18/08/00</td>
<td>4</td>
<td>2</td>
<td>Norway</td>
<td>4/12/00</td>
<td>2</td>
<td>2</td>
</tr>
<tr>
<td>Italy</td>
<td>23/10/00</td>
<td>3</td>
<td>2</td>
<td>Poland</td>
<td>6/12/00</td>
<td>3</td>
<td></td>
</tr>
<tr>
<td>Austria</td>
<td>3/11/00</td>
<td>4</td>
<td>2</td>
<td>Sweden</td>
<td>16/12/00</td>
<td>2</td>
<td>2</td>
</tr>
<tr>
<td>Switzerland</td>
<td>6/12/00</td>
<td>3</td>
<td>1</td>
<td>Portugal</td>
<td>19/12/00</td>
<td>3</td>
<td>1</td>
</tr>
<tr>
<td>Belgium</td>
<td>2/03/01</td>
<td>3</td>
<td></td>
<td>France</td>
<td>31/05/01</td>
<td>2</td>
<td></td>
</tr>
<tr>
<td>Greece</td>
<td>13/07/01</td>
<td></td>
<td>Ireland</td>
<td>25/06/02</td>
<td>2</td>
<td>1</td>
<td></td>
</tr>
<tr>
<td>Denmark</td>
<td>20/09/01</td>
<td>3</td>
<td>1</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Australia</td>
<td>22/2/2001</td>
<td>4</td>
<td>2</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Total</td>
<td>32</td>
<td>12</td>
<td>Total</td>
<td>20</td>
<td>9</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Total %</td>
<td>0.73</td>
<td>0.27</td>
<td>Total %</td>
<td>0.69</td>
<td>0.31</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**Source:** Our calculation on UMTS Forum data

## 23.5 Auction and the Effects on Investments

One of the arguments against UMTS auctions was that auctions would reduce investments and would slow down the process of the introduction of 3G services. Empirical evidence seems to support this argument. One of the effects of UMTS auctions was a large increase in the Telecom operators' debt. Since 2000 the seven largest European phone companies have accrued more than $170 million in debt. Last year individual companies’ interest burdens doubled, on average. Most carriers have seen their credit rating downgraded, a few others are also likely to be downgraded. The burden of huge interest payments will reduce the cash flow. As a result dividends, acquisitions and much needed investments in technology and infrastructure are all expected to decrease. Best positioned are Telefonica and Telecom Italia that have not spent huge sums on their UMTS licence (see Table 23.5). The cover ratio of British Telecom, Deutsche Telekom, France Telecom, KPN, Sonera deteriorated till the end of 2002. Most of the debt is short term, meaning they must raise money on the market soon and they are expected to pay more because of the recent downgradings.

We computed the amount of money spent by each of the largest carriers in Europe to buy UMTS licences in Europe and the ratio between the amount spent
buying licences and the value of the assets in 1999 (before the start of the sale of the spectrum rights) /3.

Table 23.5 Debt*, market capitalization and ratings in European telecommunications companies

<table>
<thead>
<tr>
<th>Telecom Operators</th>
<th>Number of countries where they have licences (Europe)</th>
<th>Long Term rating 1999</th>
<th>Long Term rating 2000</th>
<th>Long Term rating 2001</th>
<th>Long Term rating 2002</th>
<th>(Total cost of licences)/assets 1999</th>
<th>% Change in market capitalization in the period 1999-2001</th>
</tr>
</thead>
<tbody>
<tr>
<td>Hutchinson</td>
<td>6</td>
<td>A3</td>
<td>A3</td>
<td>A3</td>
<td>A3</td>
<td>0.155</td>
<td>-0.2758</td>
</tr>
<tr>
<td>Vodafone</td>
<td>13</td>
<td>A2</td>
<td>A2</td>
<td>A2</td>
<td>A2</td>
<td>0.088</td>
<td>-0.6296</td>
</tr>
<tr>
<td>British Telecom</td>
<td>5</td>
<td>Aa1</td>
<td>A2</td>
<td>Baa1</td>
<td>Baa1</td>
<td>0.356</td>
<td>-0.6205</td>
</tr>
<tr>
<td>Deutsche Telekom</td>
<td>6</td>
<td>Aa2</td>
<td>A2</td>
<td>A3</td>
<td>Baa1</td>
<td>0.204</td>
<td>-0.7519</td>
</tr>
<tr>
<td>France Telecom</td>
<td>10</td>
<td>Aa2</td>
<td>A1</td>
<td>Baa1</td>
<td>Baa3</td>
<td>0.217</td>
<td>-0.8495</td>
</tr>
<tr>
<td>KPN</td>
<td>3</td>
<td>Aa1</td>
<td>Baa1</td>
<td>Baa2</td>
<td>Baa3</td>
<td>0.744</td>
<td>-0.7444</td>
</tr>
<tr>
<td>Telecom Italia</td>
<td>2</td>
<td>A3</td>
<td>Baa2</td>
<td>Baa1</td>
<td>Baa1</td>
<td>0.055</td>
<td>-0.3757</td>
</tr>
<tr>
<td>Telefonica</td>
<td>5</td>
<td>A2</td>
<td>A2</td>
<td>A2</td>
<td>A2</td>
<td>0.133</td>
<td>-0.2272</td>
</tr>
<tr>
<td>Sonera</td>
<td>5</td>
<td>A2</td>
<td>A2</td>
<td>Baa2</td>
<td>Baa2</td>
<td>1.129</td>
<td>-0.8888</td>
</tr>
<tr>
<td>T.Danemark</td>
<td>3</td>
<td>Aa3</td>
<td>Aa3</td>
<td>A2</td>
<td>A3</td>
<td>0.038</td>
<td>-0.6296</td>
</tr>
</tbody>
</table>


This ratio allows normalization of the amount spent by the size of the telecom operators. We have also computed the rate of change of the value of market capitalization of the operators in the period 1999-2001. These values are shown in Table 23.5. If the telecom operators had bought the licences at the right price we would have expected the money spent not to affect the change in market capitalization and the cost of debt. On the other hand if the prices of the licences were excessive operators that spent the most on UMTS licences, would have seen their market capitalization decreased further. A low market capitalization debt ratio makes it difficult to raise money to finance investments in the network. Table 23.5 shows that the debt rating has worsened more for the firms that spent most. Figure 23.4 shows that there is a negative correlation between changes in market capitalization in the period 1999-2001 and the normalized amount of money spent on licences. As the amount spent on auctions is much larger than in the case of beauty contests our empirical evidence supports the argument that UMTS auctions increased the cost of debts and delayed the introduction of 3G commercial services.
Figure 23.4 The relation between the percentage change in carriers’ market capitalization and L/A (the ratio between the money spent on licences and the value of assets).

23.6 Conclusions

Analysis of the UMTS market shows that, in all likelihood, licence fees determined in the auctioning process in the year 2000 were too high and were caused by the bubble that affected the new economy, and that the large amount of money spent on licences delayed the commercialisation of 3G services.

In July 2002 the situation of UMTS markets in Europe was the following:

a) Telecom operators as Deutsche Telekom, France Telekom, KPN and Vodafone that spent more acquiring licences in different European countries, had huge debt and very high negative profits. Vodafone, unlike Telefonica and Telecom, has not yet begun to amortize the licence fees because it does not want to worsen its already poor profit performance.

b) The project to create a continental network in Europe on a 3G standard is developing at a slower rate than anticipated. The high level of debt has slowed telecom capital spending in UMTS technology (building a high speed network, developing the software and handsets for 3G services). The commercialization
of 3G services will be delayed until well into 2003 for technical and economic reasons (14).

c) The demand for new services offered by 3G handsets is an example of the chicken-and-egg problem. Huge debt has slowed investments in UMTS technology. Due to the low investment in UMTS technology the demand for new services offered by 3G handsets did not emerge and expected profitable returns were shifted later in time. European telecom operators have slowly upgraded for faster data services known as GPRS, but promotion of such services has been scant. Telecom mobile operators are focusing on dependable revenue generators such as voice call and short-text messages (STM).

d) It is possible to forecast that the number of bankruptcies will continue and the number of network operators per country will decrease significantly, perhaps also relative to the GSM market structure. This will make an escalation of regulatory intervention necessary.

It is not correct to say that all these problems were caused by auctions. These problems were caused by the overoptimistic climate that drove Telecom operators to invest heavily both in physical and financial assets. The consequences are an excess in transmission capacity, huge debt and price wars. Auctions in Europe have contributed to this situation. When the market is bullish about the growth rate of services supplied, auctions result in overbidding. Managers seriously misjudged licence values as they were driven by a bullish stock market and they were sure of getting all the resources required. In this situation licence fees in beauty contests are not affected so heavily, as we have seen, by the overoptimistic climate. Auctions could be better methods than beauty contests if the situation is such that operators are well aware of the value of the object up for auction. Otherwise the method could lead to a poor allocation of resources.
Notes

1  In countries like Italy and the UK the expected costs of building the new infrastructure network is 5000 million euro.

2  Immediately after the auctions prices of telecommunications companies were not negatively affected. The loss of the licence would had such negative effect “If we dropped out our market cap would fall by more than the price of the licence” said an executive at Spain Telefonica at that time, Business Week ‘Tale of a bubble’, June 3, 2002.

Some entrepreneurs such as Bouygues thought that ‘shelling out billions just for a licence in an unproven technology was a tulipmania that would bankrupt the entire European Telecom industry’ Business Week, June 3, 2002. The operator Hutchinson Whimpan halfway through the German auctions left his partners NTT and Royal KPN and refused to enter in the bid. But for most telecom operators a loss in the auction was seen as a death sentence.

3  Milgron and Weber (1982) have shown that bids in the English auction have the effect of partially making public each bidder’s private information about the item’s true value, this lessening the effect of the winner’s curse. The English auction yields a higher expected value than the first–price sealed–bid auction, the second-price sealed-bid auction or the Dutch (Milgron-Weber, 1982).

4  We assume that when the incumbent is present only in the GSM market it will not try to be more competitive with firms that are in the UMTS market. Therefore $X_{UMTS}$ and $\Pi_M(X_{GSM})$ will be the same whether or not the incumbent is awarded a licence in the UMTS market. A more realistic hypothesis could be that if the incumbent is only in the GSM market it will try to be more competitive with firms in the UMTS market and its profit in the GSM market will be higher than $\Pi_M(X_{GSM})$ and the quantity produced in the UMTS market by the winning firms will be lower than $X_{UMTS}$.

5  In 1997 in FCC an auction of the spectrum was held. In 1999 winners defaulted on their payments. The rerun pulled in only 10per cent of the $54bn bid the first time round.

6  Only in UK has none of the winning firms decided to hand back the UMTS licence. This is probably due to the fact that in England in the GSM market the share of the four firms is about the same (Orange 24 %, T-Mobil 24 %, Vodaphone 28 %, O2 24 %). Therefore each operator and the new entrant (Hutchinson) have equal probability of obtaining a good share (about 20 %) of the UMTS services market.

7  The most striking case was that of France where the fees have been cut dramatically—from E 4.9bn to E619 million plus a one per cent charge on revenues generated by UMTS and the licence has been extended to 20 years from 15 years. In light of these new conditions a third operator, Bouygues, has submitted a bid on a 3G licence.

8  But such fees have not been paid. The failure of the beauty contest (there were only two competitors and four licences available) pushed the French government, after having awarded the two licences, to reduce substantially licence fees to allow the entrance of a new competitor.

9  Government used the ‘beauty contest’ method of allocation – instead of the auction style of distribution - in order to secure investment and quality coverage. Governments expected that the money saved by avoiding the auction process would help the winners to better position themselves in the market, avoid huge debt and provide the country with full terrestrial coverage in the shortest number of years.
10 Many specialized newspaper use the word fiasco to describe the situation of the 3G European markets. Speaking about the UK auction Business Week wrote ‘It produced a windfall for British coffers and a disaster for the industry’ Business Week ‘Tale of a bubble: how the 3g fiasco came close to wrecking Europe’, June 3 2002.

11 The UMTS Forum (19 October 2001) shows another effect of auctions. If one divides licences into three categories (Global players, regional players and local players) it is apparent that the share of licences obtained by local players (that are generally also new entrants) when auction was the method to allocate the spectrum is much lower than in the case of beauty contest.

12 Telia, the dominant operator, lost a UMTS licence on its home market. Telia’s setback was due to shortcomings in the commitments to building infrastructure.

13 We computed the effective amount spent on licences. When a telecom operator is not the full owner of the company that won the licences we computed the cost of the licence in proportion to its share of ownership in the consortium.

14 Hutchinson Whampoo, which is most determined to introduce 3G services as it is a new entrant and it has no alternative on the European mobile market, had been experiencing technical problems with its 3G trials which led to a delay in the marketing of 3G services.

15 On the other hand investors were all too willing to bid up the stock of the bidding companies and punish the company drawing for the bid.
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