A comparison of the different methods for assigning radio-electric spectrum

A REPORT FOR THE GSM ASSOCIATION

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Executive summary

The GSMA has commissioned Frontier to assess the strengths and weaknesses of the main methods of mobile spectrum allocation. To this end, we have reviewed academic literature and examined the outcomes of a number of spectrum allocation processes in a variety of countries. Our approach involves 3 steps:

- Step 1: Identify the broad objectives and criteria that governments use when allocating spectrum.
- Step 2: Identify strengths and weaknesses of different approaches used, both in principle and in practice.
- Step 3: Assess how effective each approach is in achieving a government's objectives/ criteria.

The views expressed in this report are those of Frontier Economics and may not coincide with the views of the GSMA.

The two key approaches to spectrum allocation evaluated in this report are auctions and beauty contests. An auction is an allocation method that awards licences to the highest bidders, i.e. to operators who value them the most. In a beauty contest a government ranks operators based on a number of criteria (geographic coverage, quality of service, etc.) and awards licences to the operators who achieve the highest scores overall.

Government's objectives

When allocating spectrum for 3G services, a government is likely to want to accomplish one or more of the following fundamental goals:

- Economic efficiency – to allocate the licences to the players who will use them most efficiently, i.e. will be able to generate most value.
- Promotion of competition – to provide a sound competitive market structure as an outcome of the spectrum allocation process.
- Fairness – to ensure a transparent and objective process of allocation, so that the applicants know in advance the basis upon which they will compete.
- Revenue maximisation – to maximise revenue to the government from the process.

Governments may also want to achieve service, scope and quality objectives such as:

- Specific requirements regarding geographic coverage, obligations relating to the speed and cost of rollout, and obligations relating to quality of service.
- Encouraging innovation and investment in the telecommunications sector.

For the purposes of this report we have not provided an assessment or analysis of the significance of the above objectives/ criteria, but rather assessed how each allocation method could be expected to perform in terms of contributing to the achievement of these objectives/ criteria.

Key conclusions

When deciding whether to use an auction or a beauty parade, the government should take into account the strengths and weaknesses of each method, relative to the objectives it wants to achieve.

The table below summarises a government's potential objectives and shows whether they are more likely to be achieved using an auction or a beauty parade.

Objectives	Auctions	Beauty parades
Efficiency	√√ - √√√	√ - √√
Promotion of competition	Require additional steps such as reservation of a licence for an entrant or offering regional licences	
Transparency	√√√	√ - √√
Revenue maximisation	√√ - √√√	√ - √√
Service, scope and quality	√ - √√	√√ - √√√

Table 1: Licensing approaches vs. government's objectives

The table shows that a well-designed auction is likely to lead to greater efficiency, be more transparent and raise higher revenue than a beauty parade. Beauty parades, on the other hand, score high on service and quality objectives, but lower on transparency and revenue maximisation. Hybrids, i.e. combinations of an auction and a beauty parade, in principle, could have scores in between those of auctions and of beauty parades. Whether this holds in practice is difficult to say, as there are relatively few well documented examples of hybrids.

Both an auction and a beauty parade can be designed such that they result in new entry or in maintenance of the status quo. If promotion of competition is considered a priority, there are a number of steps the government can undertake in order to achieve it, such as to reserve a licence specifically for a new entrant, or to offer both regional and national licences in order to encourage regional competition.

In practice, not all 3G auctions in Europe were successful. The mixed experience associated with spectrum auctions highlights the importance of auction design. Every aspect of an auction's rules must be correctly structured in order to create the right incentives for bidders, i.e. to encourage participation, overcome information asymmetries between operators, i.e. reduce the likelihood of incorrect bidding due to imperfect information, and prevent undesirable coordination.

Beauty parades allow regulators and governments to introduce specific requirements for the potential licences, but are considered to be less transparent and may not allocate spectrum efficiently. Despite being less appealing in terms of efficiency and transparency, beauty parades have been used in a number of European countries, both for 2G and 3G spectrum allocation. In these cases, governments typically opted for beauty parades to achieve some specific objectives (e.g., a certain level of coverage). Revenue maximisation was not among the top priorities in most beauty parades.

The experience of European 3G beauty parades demonstrates that not all objectives set by the governments were achieved. In some cases, the roll-out and coverage deadlines were postponed (Sweden) or even scrapped altogether (Spain). This highlights one of the main problems associated with beauty parades, namely limited enforcement mechanisms. If the government cannot fully assess the credibility of business plans and is unable to enforce their fulfilment, beauty parades could result in inefficient spectrum allocation.

Finally, no matter whether a government wants to allocate spectrum using an auction or a beauty parade, a transparent consultation between the government and the market players, well in advance of the allocation process, is considered a very important element of designing an award process successfully. Such a consultation will ensure that the government accurately gauges potential market interest for the licences on offer and provides a process through which it can clearly communicate its priorities to the potential applicants.

Methods of spectrum allocation

Auctions

In an auction, buyers are invited to bid for lots which have pre-defined rights and obligations attached to them. The bids are ranked by the seller and the lots are awarded to the highest bidders in monetary terms. Lots can be either licences or frequency blocks, where bidders could win more than one block. Alternatively, the seller may offer regional instead of national licences or a combination of both regional and national licences. Sellers must decide on the number and the size of lots to be offered, as well as on the rights and obligations that are attached to them.

There exist a number of auction formats. In practice, the simultaneous ascending auction (SAA) is the most common design in spectrum auctions. A SAA takes place over multiple rounds; in each round, bidders place increasing bids on licences. The auction closes when no new bids are submitted. The licence is awarded to the highest bidder. This auction format was originally developed by the FCC in the early 1990s and was used extensively in the recent 3G auctions in Europe. The other design that has been used is the sealed-bid auction. This auction format lasts for one round. Bidders submit a single bid that other bidders cannot see (hence, sealed bid). As in SAA, the licence is awarded to the highest bidder.

Each auction format has particular strengths and weaknesses, depending on the circumstances:

- When there is a high degree of interest amongst bidders and a low risk of coordination, the SAA appears to be preferable as it reveals more information and allows operators to adjust their bids.
- Conversely, when interest amongst bidders is lower, or there is a risk of coordination then the sealed-bid auction may stimulate more competition than the SAA. This is particularly relevant when a government is concerned that new entrants might decide not to bid against strong incumbents.

Beauty parades

Beauty parades have been used in a number of countries for 3G spectrum allocation (e.g. France, Sweden and Hungary.). In a beauty parade procedure, applicants are invited to submit financial and technical information, typically in the form of a business plan that covers a large set of criteria, including a company's financial resources and its ability to promote certain objectives, such as rapid introduction of service, wide geographic coverage and/or quality and reliability of service.

Beauty parades have been used by authorities where revenue was less important an objective, compared with other objectives, such as promoting competition, quality of service obligations, speed of rollout and technical innovation. Achieving the balance between promoting transparency, i.e. specifying a number of objectively defined pre-qualification criteria, and ensuring participation, i.e. making sure that the criteria are not overly onerous so as to represent a barrier to entry, is a key issue in the design of a beauty parade award process.

Hybrid approach

An auction and a beauty parade can also be combined to form a so called *hybrid approach*. Hybrid methods incorporate a monetary bid as one of the criteria in a beauty parade, with weights attached to each criterion. If bidders have a clear understanding of the evaluation criteria and a reasonable weight is given to the price component, this process could in principle produce a more efficient outcome than a pure beauty parade. Despite their potential benefits over pure beauty parades, there are relatively few well documented examples of hybrids.

Achieving government's objectives

Efficiency

There is a general consensus among economists that well-designed auctions are the most efficient way of allocating scarce resources. Efficiency is achieved because the resources are allocated to the bidders who value them the most and, therefore, will be able to use them most efficiently. However, not all 3G auctions in Europe were successful. Disappointing outcomes of some auctions (e.g., the Swiss 3G auction where the number of licences were equal to the number of bidders) have been typically explained by drawbacks in their design.

It is therefore important that every aspect of the auction's rules must be correctly structured in order to create the right incentives for bidders, i.e. to encourage

participation, overcome information asymmetries between bidders and prevent undesirable coordination.

In a beauty parade the outcome may not be efficient for two reasons:

- A beauty parade places a great deal of importance on the ability of the seller to specify and evaluate the right set of criteria for efficiency. If the criteria are not specified correctly, the outcome may not be efficient.
- The operators might be forced to exaggerate their ability to meet the requirements of the regulator and may try to renegotiate the conditions after licenses have been awarded. If the seller is unable to fully distinguish between credible and non-credible bids, efficiency is unlikely to be achieved.

Overall, it appears that an auction is a better choice for a government that wants to achieve efficiency, i.e. to allocate spectrum to the operators who will be able to generate most value, assuming that it can overcome issues of undesirable coordination by means of choosing an appropriate auction format. However, if the number of interested participants in an auction is low, it is unlikely to reveal the true valuation of bidders, due to the lack of competition. In terms of efficiency, if the number of participants is exactly equal to the number of licences, the seller could be expected to be indifferent between an auction and a beauty parade.

Promotion of competition

Both auctions and beauty parades can either be designed to try and generate new entry, or to have no pre-defined impact on the existing market structure. In order to encourage competition a government can undertake a number of steps. For example, it can use **a sealed-bid auction** as it has been done in Denmark or **reserve a licence** specifically for an entrant as it has been done in the UK 3G auction (2000) or in the Hungarian beauty contest (2004). In the UK, the government achieved its goal of encouraging new entry, while in Hungary no entry occurred. This may have been because of the fact that in Hungary the requirements attached to the licence were difficult to achieve for a new entrant.

Alternatively, instead of fixing the number of licences, the government may allow the bidders to decide on the most appropriate market structure. This can be achieved by means of **auctioning frequency blocks**, which the bidders can aggregate. This approach has been used in Germany and Austria for 3G spectrum allocation. In both cases new entry occurred. However, the overall experience has been somewhat mixed. In both cases, six operators received licences, an outcome that proved to be unsustainable in Germany, where two operators returned their licences later. Moreover, some commentators believed that in Austria the bidders might have coordinated, as the bidding stopped after two rounds and the final prices paid were only slightly above the reserve price.

Finally, in order to promote competition a government can offer **regional,** rather than national licences. In Europe all spectrum licences were national, while in the USA, India and Brazil a regional approach has been followed**.** This suggests that regional licences may be more appealing for larger countries. When deciding whether to offer national or regional licences, the government should take into

account the existing market structure and assess carefully costs (e.g. loss of economies of scale) and benefits (e.g. stronger regional competition).

One of the disadvantages of a regional approach, for operators who want to achieve national coverage, is the potential difficulties of aggregating regional licences. For example, in Brazil one of the biggest operators still does not have a licence in Minas Gerais, the third largest regional economy in the country. To overcome this issue, the regulator can offer both national and regional licences. In this case large operators would not incur additional costs associated with the aggregation of regional licences, while small operators could be able to provide services in the regions of their choice.

In summary, to promote competition, a government can use a sealed-bid auction, reserve a licence for a new entrant or, in a large country, offer regional licences. Auctioning frequency blocks rather than a fixed number of licences may also encourage market entry, but this auction format has had somewhat mixed results in practice.

Fairness and transparency

Auctions are considered to be a fairer and more transparent mechanism of spectrum allocation compared to beauty parades since all rules in an auction are straightforward and defined before the process commences. From the point of view of a bidder, especially a strong one, the higher the degree of transparency, the better, as this reduces uncertainty and makes it easier to develop and implement a bidding strategy.

Conversely, beauty parades are often viewed as being less transparent, and the process of choosing between operators on the basis of their business plans as being subjective. To increase transparency in a beauty parade, the regulator should make sure that its criteria are as clear and as straightforward as possible: for example, by publishing the criteria and the weighting attached to each of them well in advance of the start of the process. However, even where both criteria and weights are published, losing applicants may seek to challenge the government's decision. This could result in legal delays, with damaging effects for industry development and competition.

Revenue maximisation

Auctions tend to raise more revenue for the government than beauty parades because, in a well-designed auction, bid prices reflect underlying valuations. While high revenues are considered by many as an indicator of success, some governments and spectrum users have been concerned that auctions can "encourage" bidders to pay too much for licences. It is certainly true that auction outcomes may be affected by market sentiment, as happened in the UK and Germany 3G license auctions. Nevertheless, it is better to determine licences' value through an auction, rather than have governments set prices for them, because operators should have better information about the long-term value of licences than the governments do. Moreover, once licences have been awarded, licence payments are treated as sunk costs and should therefore not alter the

incentives of operators to invest in 3G network rollout, *as long as the cost of capital faced by the firms has not increased.*

It appears that many governments that chose beauty parades for spectrum allocation did not consider revenue maximisation as their top priority. In many cases, licence fees were set at a nominal level.

Service, scope and quality objectives

If a government wants to achieve some specific objectives such as minimum geographic coverage, quality of service or speed of roll-out, it is likely to opt for the increased flexibility offered by a beauty parade. The arguments in favour of a beauty parade in these cases are:

- The seller can specify its objectives explicitly and ensure that they are reflected in the companies' business plans.
- The seller has more control over the outcome compared to an auction where the outcomes are relatively more difficult to specify.

Whether a government's objectives are likely to be achieved or not, depends on (i) their feasibility and (ii) the ability of the government to enforce the fulfilment of the conditions it specifies in the licences. If operators are unable to meet the requirements, governments often have no choice but to change the targets or scrap them altogether.

Finally, no matter whether a government wants to allocate spectrum using an auction or a beauty parade, a transparent consultation between the government and the market players, well in advance of the allocation process, is considered a very important element of designing an award process successfully. Such a consultation will ensure that the government accurately gauges potential market interest for the licences on offer and provides a process through which it can clearly communicate its priorities to the potential applicants.

1 Introduction

The GSMA is conducting a review of the different types of licensing policies and procedures for allocating spectrum for 3G mobile use. The GSMA has commissioned Frontier to write a report that describes the main methods of spectrum allocation and provides an overview of their strengths and weaknesses. The views expressed in this report are those of Frontier Economics and may not coincide with the views of the GSMA.

Radio spectrum is a fundamental input in the provision of mobile telecommunication services. Spectrum is a scarce resource and, in the absence of regulatory intervention, demand for it is likely to exceed supply. Therefore, the regulator's role is to resolve the issue of conflicting demand and to allocate spectrum efficiently.

The choice of one allocation methodology and licensing structure over another depends on the objectives of the government. One objective is common to all governments, i.e. to allocate spectrum efficiently. However, there may be a number of other objectives that governments might want to achieve - to encourage competition in the telecoms sector, to achieve 100% coverage or to promote innovation, to name a few.

Therefore, a key element of the discussion in this report is the extent to which different allocation methods might be more or less appropriate, given different government objectives. We illustrate the interplay of objectives with allocation methods by drawing on a range of case studies where different approaches have been used in the past. The case studies highlight a number of 'learning points' which illustrate both 'best practice' and 'not-so best practice' when it comes to allocating spectrum for mobile services.

The report is structured as follows:

- Section 2 explains why spectrum allocation is an economic issue and what sort of assignment criteria are typically considered by governments when allocating spectrum;
- Section 3 describes the two main assignment methods commonly used: auctions and public tenders (or beauty parades);
- Section 4 discusses whether government's objectives are more likely to be achieved using an auction or a beauty parade; and
- Section 5 summarises and concludes.

2 Summary of assignment criteria

This section outlines the assignment criteria that are typically considered by governments in allocating spectrum, either by auction or public tender process. We begin with a brief discussion of why a formal allocation method is required followed by a discussion on the allocation criteria that are commonly applied.

2.1 THE REQUIREMENT FOR REGULATED ENTRY IN THE MOBILE TELECOMS SECTOR

Spectrum is a scarce natural resource, critical for the provision of mobile telecommunication services. In the absence of regulation, demand for spectrum is likely to exceed supply. It is widely accepted that in order to resolve the issue of excess demand, spectrum use must be regulated. In mobile telecommunication markets this regulation usually takes the form of licences being required in order to operate in the market.

In using radio frequencies for the provision of any services, two factors need to be taken into account:

- a certain degree of coordination between the different users is required in order to limit the interferences that would arise otherwise.
- there is a scarcity in the amount of the radio spectrum that is available.

Lack of coordination in the use of the radio spectrum would result in a high degree of interference. This would reduce the quality of the services that use radio frequencies as an input in their provision. Ultimately, such a lack of coordination would have a negative impact on the economic value derived from both the provision and use of mobile telecommunications services. In that case a regulator or government agency is needed in order to assign the available spectrum between users in order to eliminate the potential interferences arising from the uncoordinated use of the radio spectrum. This would preserve the potential economic benefits derived from the use of the radio spectrum.

In addition to the coordination problem, there is typically a limited amount of (suitable) radio spectrum available to provide mobile telecommunication services. Such scarcity results in a positive economic value assigned to the use of the radio spectrum. Regulators and government agencies, holders of the property rights in the use of the radio spectrum, generally manage such scarcity by seeking to assign the radio spectrum to the users that would be expected to maximize the economic value of its use. Clearly, this can also be achieved through spectrum trading, but the concept of full liberalisation and spectrum trading is not yet universally accepted.

2.2 EXAMPLES OF THE ASSIGNMENT CRITERIA TYPICALLY USED BY AUTHORITIES

When allocating licences, the governments or regulators may wish to accomplish the following fundamental goals:

- Economic efficiency – to allocate the licences to the players who will use them most efficiently.
- Promotion of competition – to provide sound competitive market structure as an outcome of the spectrum allocation.
- Fairness – to ensure a transparent and objective process of allocation, so that the applicants know in advance the basis upon which they compete.
- Revenue – to maximise revenue to the government. Spectrum is a scarce asset, which is valuable to the users. Selling it at a price significantly below the value that the operators place on it is equivalent to a subsidy. If the government has no intention to subsidise the industry, it should aim to price the spectrum correctly, i.e. in line with the operators' valuation.

Regulators might also have additional goals or obligations, such as:

- Specific requirements regarding geographic coverage, obligations relating to the speed and cost of rollout, and obligations relating to quality of service.
- Encouraging innovation in the telecommunications sector.

From looking at the case studies (see Annex 1) it is apparent that different jurisdictions have placed more or less emphasis on these goals in the past. For example, while it is obvious that no government will want to *not* promote competition in the allocation of licences, it is clear that some governments have taken a more explicit 'non-neutral' approach to achieving this goal. In the UK (2000) and Poland (2000, 2005), for example, licences were specifically ring-fenced for new market entrants. This is similar to the situation in Hungary (2004), where a fourth licence is currently being held in reserve for a new entrant until the commercial launch of 3G services has taken place.

While it is important for the government to state its objectives explicitly, one should bear in mind that accomplishment of *all* objectives simultaneously may not be feasible. For example, very stringent requirements regarding geographic coverage and the speed of roll-out may discourage new entrants from applying and, therefore, promotion of competition may not be achieved.

As a general point, it is worth noting that in almost all of the case studies examined the licensing authority has placed some rollout and coverage obligations on the licence holders.

In the next sections we describe the two main methods of spectrum allocation, i.e. auctions and beauty parades, identify their advantages and disadvantages and discuss whether an auction or a public tender (which usually takes the form of beauty parade) is more or less likely to achieve a government's objectives.

Summary of assignment criteria

3 Assignment methods: auctions and beauty parades

In recent years spectrum has been assigned using a variety of methods. For example, in countries such as the UK (2000), Germany (2000) and Denmark (2001) 3G spectrum was assigned by auction, each using a different auction format. In other countries, including Sweden (2001) and France (2001/02), spectrum was allocated using public tenders (beauty parades). More recently, additional 2G frequencies in Germany were assigned in an auction.

The key difference between these two methods is the priority that is given to various assignment criteria. In an auction, buyers are invited to bid for lots (licences) which have pre-defined rights and obligations attached to them[1]. Buyers are in effect required to place a value on these licences and to submit a bid based on this value. The bids are then ranked by the seller and the lots are awarded to the highest bidders.

By contrast, in a beauty parade buyers are typically invited to submit technical and financial information (business plans) that cover a range of non-monetary criteria such as geographic coverage, speed of roll-out and reliability. The business plans are typically assessed on all these criteria, and the licences are awarded to the firms that submit the business plans that achieve the highest scores overall.

3.1 REVIEW OF THE MAJOR AUCTION FORMATS

When designing an auction the seller has to decide what to offer for sale. In spectrum auctions it may include:

- the type of licences (e.g., licences vs. frequency blocks or national vs. regional licences); and
- the number of licences.

The number of licences offered for sale has an impact both on the future market structure and on the likelihood of competition in the auction. Indeed, if the number of licences is equal to the number of incumbents, the status quo in terms of market structure is likely to prevail. There are two reasons for this:

- incumbents could be in stronger financial position than potential entrants;
- incumbents could place a higher valuation on the bid because they are already in the market and would be able to provide the services at a lower cost. Cost advantages may arise due to brand recognition, better knowledge of the local market conditions, etc.

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1 For example, lots may be licences which grant the user the right to use a specified block of spectrum for a particular service nationally, subject to specified minimum service conditions.

Generally when the number of licences has been equal to the number of incumbents the level of 'competition' in the auction has often proven to be not very strong, as the chances that new entrants outbid incumbents are low. Knowing that, entrants may be discouraged from participation.

The government has also to decide what types of licences to offer, i.e. pre-packaged licences vs. frequency blocks or national vs. regional licences. This choice is equivalent to the choice between a fixed prize and a variable prize auction.

3.1.1 Fixed versus variable prize auctions

When the number of licences is fixed in advance, the auction is called a fixed prize auction. Alternatively, if frequency blocks can be aggregated and the number of licences is not predetermined, the auction is called a variable prize auction. In the case of allocating spectrum for 3G use, the most common approach has been to fix the number of licences. However, variable prize auctions were also implemented in some countries, for example in Germany and Austria.

In the German UMTS auction 12 frequency blocks were offered and bidders could win between 2 and 3 blocks each. Since at least 2 blocks were required to obtain a licence, the auction could have resulted in a variety of different outcomes, including an industry structure with 4 large competitors, 2 large and 3 small competitors, 6 small competitors, etc.

In a variable prize auction bidders are thus allowed more scope to determine the outcome of the auction than in a fixed prize auction. This may be desirable where it is unclear in advance how best to "package" spectrum. Allowing bidders to assemble their own preferred package of licences should, in theory, lead to more efficient use of spectrum than simply offering a predetermined number. However, in practice, this might not be the case (the reasons are discussed in Section 4.2 below). For example, in Germany six operators won two frequency blocks each. Later, however, it became clear that this allocation was not efficient: demand for 3G services was not sufficiently high to support six operators and two operators who failed to meet the coverage requirements had to return their licences.

From the perspective of bidders, an important distinction between fixed and variable prize auctions is that:

- In fixed prize auctions, bidders perceive lots as substitutes, meaning that the demand for one lot increases as the relative price of other lots increases.
- In variable prize auctions, on the other hand, lots may be complements, meaning that two or more lots are worth more together than separately. This may arise, for example, where there are benefits from obtaining two or more adjacent regional licences, or where operator needs two or more lots in the same region to offer a service.

The regulator should bear this difference in mind and, in case of variable prize auctions, should consider allowing bidders to place bids not only on individual lots but also on the combinations of lots.[2]

3.1.2 The choice of the auction format

The vast majority of spectrum auctions to date have been based on the simultaneous ascending auction (SAA) design. A sealed-bid auction design has also been used.[3]

Simultaneous ascending auction format

The simultaneous ascending auction (SAA) is a widely used format for spectrum auctions since its introduction by the Federal Communications Commission of the United States (FCC) in 1994. The auction takes place over a number of rounds. In each round bidders are invited to submit bids on individual lots that beat the current highest bid.

The SAA is an *open* auction in the sense that the highest bid on each lot is announced at the end of each round (the "standing high bid"). Bidders may not withdraw bids from one round to the next, but can outbid the current highest bid on a lot. In this way, the price of objects in high demand increases from round to round as bids are increased.

The auction continues until no new bids are placed on any object in a round. Each object is then awarded to the highest bidder in the final round, and successful buyers pay their winning bid for each object received. SAA auctions commonly have an *activity rule* to ensure that the auction proceeds reasonably quickly. For example, any bidder may be eliminated from the auction if it is not the current high bidder on any licence and it does not submit a bid in any round.

Sealed-bid auction format

In a sealed-bid auction buyers submit secret bids on individual lots. Once submitted, bids are ranked by the auctioneer and lots awarded to the highest bidders. For example, if four identical lots are offered these are awarded to the bidders who made the four highest bids[4]. There are two rules that are commonly used to determine what successful bidders must pay:

- In a pay-as-bid sealed-bid auction successful bidders pay what they actually bid for each lot won. This is also known as a first price auction if only one lot is offered.

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2 As it was done in the FWA auction in Nigeria.(2002).

3 Two other formats have also been discussed but not yet implemented, at least in the context of UMTS licensing in Europe. These are the dynamic combinatorial auction (DCA), which is a modified version of the SAA that allows for combinatorial bidding, and the Anglo-Dutch auction, which has two stages: the first stage is a SAA, the second – a sealed-bid auction.

4 If lots are not identical, the bids submitted for each lot are ranked separately and each lot is awarded to the respective highest bidder.

- In a uniform price sealed-bid auction all successful bidders pay the highest losing bid or the lowest winning bid.

The choice between a SAA and a sealed-bid auction is a difficult one as both formats have their strengths and weaknesses. The SAA has two main advantages[5]:

- It is simpler for bidders than the sealed-bid auction because bidders can adapt their bidding strategies as the auction proceeds. For examples, bidders can switch between similar lots in response to price movements. This can help to promote efficiency.
- In the SAA bidders can revise their valuations as the auction proceeds. For example, if bidding is unexpectedly aggressive a bidder may conclude that his initial valuation was too low. This helps to increase the accuracy of bidding and can result in higher revenues and greater efficiency.

However, there are also some disadvantages associated with the SAA:

- Entrants may not participate. As mentioned above, this is a particular concern when the number of lots is less than or equal to the number of incumbent operators. Unlike in a sealed-bid auction, strong bidders can observe and match any entrant's bid and push them out of the market. Anticipating this, weak bidders may not enter which could reduce auction revenue.
- It may be easier for bidders to coordinate in a SAA than in a sealed-bid auction. This is because bidders can observe each other's behaviour as the auction progresses.

Where promotion of competition is a particular concern, a sealed-bid auction might be a better choice. The Danish 3G auction (September 2001) is a good example of a sealed-bid auction which achieved its goal of encouraging entry. Section 4.2 provides further details on this case study.

3.2 REVIEW OF THE BEAUTY PARADE FORMAT

In a beauty parade procedure, applicants are invited to submit financial and technical information, typically in the form of a business plan that covers a large set of criteria, including:

- Company financial resources
- Commitment to meet specified investment targets
- Ability to promote certain objectives such as:
    - rapid introduction of service
    - wide geographic coverage
    - quality and reliability of service.

5 A more detailed description of various auctions as well as their strengths and weaknesses are presented as Annexe 2 to this report

Beauty parades appear to have been used by authorities where revenue was less important an objective, compared with other objectives such as: promoting competition, quality of service obligations, speed of rollout, and technical innovation.

Similar to an auction, in a beauty contest the seller has to specify how many licences are offered. But more importantly, the seller defines the criteria that applicants have to meet in order to participate in the contest. Qualification criteria may vary from specific requirements to very general rules. For example, in the French 3G beauty parade 14 criteria were introduced (and later significantly revised), whereas in Sweden (2001) the qualification requirements were specified more broadly.

It is possible that the vague formulation of the requirements leaves a lot of space for subjectivity and reduces transparency of the selection process. On the other hand, very rigid criteria may discourage potential participants. Achieving the balance between promoting transparency, i.e. specifying a number of objectively defined pre-qualification criteria, and ensuring participation, i.e. making sure that the criteria are not overly onerous so as to represent a barrier to entry, is a key issue in the design of a beauty parade award process.

3.3 HYBRID APPROACH

Almost all spectrum auctions have some pre-qualification requirements, i.e. an element of a beauty parade. It is common for governments to require that operators conform to certain qualification criteria in order to ensure that they are genuinely interested in participating in the market and also likely to pay the price of licence upon winning. Pre-qualification requirements might also require operators to commit to minimum licence conditions (e.g. with respect to coverage). This approach is considered to be superior to a pure auction (with no requirements) as it allows the government to be explicit about the criteria it believes to be important. However, if pre-qualifications conditions are too difficult to achieve, it could discourage operators from applying.

An auction and a beauty parade can also be combined and form a so called *hybrid approach*. Hybrid methods incorporate a monetary bid as one of the criteria in a beauty parade, with weights attached to each criterion[6]. If bidders have a clear understanding of the evaluation criteria and a reasonable weight is given to the price component, this process could produce a more efficient outcome than a pure beauty parade. Despite their potential superiority to pure beauty parades, hybrid methods have been rarely implemented in practice. The countries that tried them are Israel and Hong Kong.

6 For example, monetary bids can have a weight of 40%, while geographic coverage, speed of roll-out and quality of service - 20% each.

3.4 CONSULTATION PROCESS

No matter whether a government wants to allocate spectrum using an auction or a beauty parade, a transparent consultation between the government and the market players, well in advance of the allocation process, is considered a very important element of designing an award process successfully. Such a consultation will ensure that the government accurately gauges potential market interest for the licences on offer and provides a process through which it can clearly communicate its priorities to the potential applicants.

4 Auctions versus beauty parades

In this section we discuss whether the government's objectives (defined in Section 2) are more likely to be achieved using an auction or a beauty parade. For the purposes of this report we have not provided an assessment or analysis of the above objectives/ criteria, but rather how each allocation method could be expected to perform in terms of meeting these objectives/ criteria. We support our arguments (where relevant) with the examples from the case studies[7]. Note, however, that these examples are purely illustrative and should not be considered as a definitive proof.

4.1 ECONOMIC EFFICIENCY

Auctions

There is a general consensus among economists that well-designed auctions are the most efficient way of allocating scarce resources. Efficiency is achieved because the resources are allocated to the bidders who value them the most and, therefore, will be able to use them most efficiently. Players assess their own valuation of the asset offered for sale based on the information available to them. For example, in order to assess the value of the 3G spectrum, the companies would form a view about future demand conditions, costs and expected profits. The more efficient the company is, the higher will be its spectrum valuation and the more likely it is to outbid its less efficient rivals in a bidding process. It would be irrational for the players to continue bidding if the price is higher, than their valuation. Therefore, in a well-designed auction the asset is allocated efficiently.

However, undesirable coordination among bidders may hamper the efficiency of the auction. When choosing an auction format, the regulator should take this into account. Undesirable coordination arises when the participants can tacitly or explicitly coordinate their bidding to avoid pushing up prices. For example, in the SAA format, the bidders may be able to signal to each other how to share the lots and thus agree to stop pushing up prices (as was allegedly the case in a number of FCC spectrum auctions in the US in the 1990s). If coordination is likely to be a problem, a sealed-bid auction may be preferable to a SAA. This is because in a one-shot format bidders cannot observe each other's behaviour in the auction and so it is more difficult to coordinate bidding strategies than in a multi-round format.

Finally, if the number of interested participants in an auction is low, it is unlikely to reveal the true valuation of the bidders due to the lack of competition. If the number of participants is exactly equal to the number of licences, the seller is indifferent between an auction and a beauty parade. For example, in the Swiss 3G auction, there were four licences and only four bidders, who just paid the reserve price. This is equivalent to paying a licence fee in a beauty parade, no additional information is revealed.

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7 Detailed case studies are presented in Annexe 1

Beauty parades

In a beauty parade the operators might be forced to exaggerate their ability to meet requirements of the regulator and will try to renegotiate the conditions ex post. If the seller is unable to distinguish between credible and non-credible bids, the outcome of a beauty parade may not be efficient.

Looking at the case studies – the ability to meet requirements would appear to be an issue in some countries. For example, in Sweden (2001) the operators were unable to meet the coverage and roll-out requirements set by the regulator. The deadline for rollout was missed and the achieved coverage was below the requirement (87% achieved, compared with an initial target of 99.98%). In Spain (2000) the operators failed to meet the roll-out deadline twice. As a result, the regulator scrapped the deadline altogether, leaving the launch schedules up to the operators.

In addition, in a beauty parade the seller has to set the appropriate evaluation criteria. A beauty parade places a great deal of importance on the ability of the seller to specify and evaluate the right set of criteria for efficiency. For example, in Sweden (2001), in order to achieve efficiency and avoid network duplication, the regulator (PTS) obliged operators to share the roll-out costs (masts and sights sharing). It was expected that this measure would speed up the roll-out process. However, in practice, the roll-out has delayed, partly as a result of the operators finding it difficult to agree on the sharing conditions. In a beauty parade, it is therefore critical that government consults with all interested parties, including operators and other potential bidders at an early stage in the process, and carefully assesses the market characteristics and opportunities, in order to define appropriate evaluation criteria.

4.2 PROMOTION OF COMPETITION

In general, it is not possible to conclude that either an auction design or a public tender is more or less likely to facilitate entry and therefore enhance competition. Both auctions and beauty parades can generate new entry or have no impact on the existing market structure. The appropriateness of each approach is quite market specific and depends on the existing market structure.

There are a number of ways the government can promote competition:

- choose an auction format that is conducive to entry given the market structure and the number of licences on offer;
- reserve a licence for an entrant;
- choose a variable prize auction rather than a fixed prize auction;
- offer regional licences or both national and regional licences (where it is practical to do so).

We discuss these options in turn.

Use of sealed-bid auctions

The government can encourage participation in an auction by choosing a sealed-bid format. If the number of licences is the same as the number of incumbents, entrants are unlikely to participate unless there is a realistic prospect of success. The sealed-bid format can help in this regard because weaker bidders have some chance of outbidding strong bidders who decide to bid conservatively in order to keep prices down. Because of the one-shot nature of the sealed-bid format an incumbent cannot subsequently increase its bid.

A sealed-bid auction was successfully implemented in Denmark (2001). The two key objectives for the Danish auction were to achieve spectrum efficiency in a fair and transparent manner, while at the same time to promote entry and sustainable competition in the long-run. The sealed bid approach was considered a key element in attracting entry, particularly in the light of the poor market conditions that prevailed at the time[8]. The regulator decided to set the price for *all* four licences at the price of the fourth highest bid, ultimately €128m, because it considered it unfair for the winners to pay different prices for identical licences.

The auction succeeded in attracting a new entrant: four licences were sold, three to the 2G incumbents (Telia, TDC and Orange Denmark) and one to the entrant Hi3G. The fact that the winning bidders would only pay the fourth highest winning bid allowed the government to circumvent the possibility of the outcomes being perceived as being unfair.

Licence reservation

Both in an auction and in a beauty parade the government can promote competition by ring-fencing a licence for an entrant. In the UK 3G auction (2000), for example, the government used a SAA format, but made the rules conducive to entry: potential new entrants could bid for any of the five licences, whereas incumbent GSM operators could bid for any of the licences except licence A (the largest licence). Nine potential new entrants (and four incumbents) participated in the auction – significantly more than in other European auctions, where no licences were reserved for entrants. The larger, reserved licence A was won by Hutchison for £4.38bn, below the price paid by Vodafone for the smaller unreserved licence B (£5.96bn). Clearly, the auction achieved its objective of promoting entry.

In a beauty parade, the government can also reserve a licence for a new entrant. Whether this is sufficient for the promotion of entry depends on how onerous the government requirements are and how costly it is for entrants to participate in the contest. In Hungary (2004), for example, where the government planned to award a licence to an entrant, no applications were received possibly because the coverage and roll-out requirements set by the government were challenging to achieve.

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8 The Danish auction was amongst the final 3G auctions that took place in Western Europe, and, as such, was affected by the shift in the macro-economic climate that occurred over the 2000 – 2001 period, and most notably the telecoms downturn.

Licences vs. frequency blocks

Another way of promoting competition is to use a variable prize auction, i.e. to auction frequency blocks rather than licences and to allow operators to bid for more than one block. In such an auction, the number of winners is not pre-determined. This type of auction format was implemented in Germany (July – August 2000) and in Austria (November 2000). In both cases new entry occurred. However, the overall experience has been somewhat mixed.

In both auctions, the number of bidders was quite low relative to the number of blocks on sale. For example, in Germany there were only 7 bidders for 12 blocks of spectrum. As Klemperer (2004)[9] points out, the fact that it was an ascending auction may have discouraged other bidders from bidding. In Austria, there were 6 bidders for 12 blocks, fewer than in Germany. In both the Austrian and the German examples, authorities also suspected bidders of potential coordination– although the outcome in Germany seems to have been largely what the government set out to achieve initially, i.e. high revenues and an unconcentrated mobile phone market.

The Austrian auction shared all the characteristics of the German auction that had preceded it by mere three months, with one key difference - in the Austrian auction the reserve price was set at a very low level relative to the per capita price outcomes that had been achieved in both the German and the UK auctions (at around one-eighth of the auction per capita final prices paid in each of these auctions). This characteristic of the auction, combined with the fact that there were only six bidders for twelve lots, each of which only required two lots to become a licensee, resulted in low revenue. Some commentators have suggested that the bidders could have realised that in order to drive out any rivals in the auction and acquire more than two blocks of spectrum, the price paid would have to be bid-up significantly above the reserve price. This could imply that the six bidders had a strong incentive to coordinate and carve the market up into six lots. While there is no conclusive evidence of that, the final outcome could be interpreted as indicating that undesirable coordination may have been an issue. In the Austrian case the final auction price was only marginally higher than the (relatively low) reserve price – and less than one-sixth of the per capita auction revenue from the auctions in UK and Germany.

The main learning points of the German and Austrian experience, therefore, are:

- In theory variable prize auctions could allow for a more efficient outcome, where bidders know more than licensing authorities about how best to group the spectrum on offer;
- In practice, the variable prize approach has had mixed results, and in one of the two major examples (Austria) commentators suggested that the bidders may have coordinated;
- Furthermore, the added complexity of the variable prize approach could lead to higher costs for both bidders – thereby potentially reducing the number of

9 Paul Klemperer "Auctions: Theory and Practice", Princeton University Press 2004.

bidders – as well as higher costs for the licensing authority, reducing the potential gain to the public.

- This approach might have worked better if competition was stronger, i.e. if there were more bidders, competing for the licences. Both the German and Austrian auctions only had very limited number of bidders.

Regional vs. national licences

An alternative way of creating a more competitive market structure is to offer regional rather than national licences.[10] This would encourage competition at the regional level if there are operators who are sufficiently strong to compete in a particular region (where they already have local presence), but do not have enough resources to compete nationally.

When deciding whether to offer regional licences, a regulator should take into account the existing market structure and assess carefully the costs and benefits of this decision. Potential benefits of regional licences are:

- Stronger competition and higher revenue generated during the allocation stage as there could be more participants in regional auctions than in a national one.
- Stronger competition in the provision of 3G services as the number of licences can vary from region to region reflecting the existing demand. This is particularly important for countries with significant geographic or income variations.
- Flexibility for the operators to choose the regions where they would like to operate.
- Faster roll-out due to a smaller size of regional networks. In theory, national operators can do the same, i.e. build regional networks and agree on network sharing. However, in practice it may be difficult to achieve (e.g., Sweden).

Potential costs of providing licences regionally rather nationally are:

- Increased complexity of running multiple auctions for the regulator.
- Increased complexity of bidding for a number of licences for the auction participants. This is particularly an issue for national operators who aim to achieve national coverage.
- Potential loss of economies of scale. The regulator can rectify this problem by partitioning the country in such a way that regional operators would be able to achieve a minimum efficiency scale in each region.
- Interconnection agreements between operators may be costly and difficult to reach.

If it appears that the benefits outweigh the costs, it might be more efficient to allocate the spectrum on a regional basis.

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10 This approach was used in a number of large countries (e.g., USA, India and Brazil).

An alternative solution that would deal with some of the problems mentioned above is to offer both national and regional licences.[11] In this case large operators would not incur costs associated with the aggregation of regional licences, while small operators would be able to provide 3G services in the regions of their choice (subject to winning the licences).

It is worth noting that in Europe only national licences were offered. This is likely to be due to relatively small size of European countries, that would make the regional spectrum allocation less efficient. On the contrary, large countries, such as the USA, India and Brazil, all adopted the regional model.

The flip side of regional licenses is that operators with nationwide business plans may experience difficulties in assembling nationwide coverage. One of the biggest operators in Brazil, for example, still does not have a licence in Minas Gerais, the third largest regional economy in the country[12]. The problem of aggregation is likely to be explained by the fact that Anatel has distributed licences in a number of waves and used different definitions of regions for the purposes of different auctions.

In India, on the other hand, regional allocation of licences was more successful. More specifically, in 1991 the Department of Telecommunications (DoT) divided the entire country into 21 "circles", categorized as A, B, or C depending upon their revenue potential. The choice of "circles" as a unit of bidding was based purely on administrative convenience. For cellular services, DoT decided to have two operators per service area. The bidding was done as a two stage process: the first stage being a pre-qualification based on the evaluation of financial net worth (linked to the category of circle) and technical experience in service provision, and the second stage – evaluation of bids. The auction was a sealed-bid auction, with the award going to the highest bidder from those that satisfied the pre-qualification conditions. Twenty four operators received licences in 1991. However, later the industry went through a period of consolidation, and the number of operators was significantly reduced.

In 2001, when additional licences were offered for sale, only six operators participated in the auction. The rules of the auction were such that the existing licensees could not bid for their own service areas and foreign companies were not allowed to participate. The latter condition might explain why the number of participants was small.

The new entrant, Indmobile, participated in bidding for one circle only. Some companies that had been licensed in 1991 (such as Aircell Digilink and Spice Communications with two circles each and Aircell, Koshika, and Shyam Telecom with one circle each) decided not to participate in this auction at all as they did not feel strong enough to compete with other operators with a nearly pan Indian presence who could more easily achieve and exploit economies of scale.

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11 This approach has been used for allocation of FWA licences in Sweden.

12 See more on the experience of spectrum allocation in Brazil in Annex 1.

At the end of the bidding, five companies acquired 44 of the 51 cellular licences[13]. The winning bidders had specific strategies such as acquiring all metropolitan licences (Hutchison, Bharti), establishing regional presence (Escotel), establishing a pan-Indian presence (Bharti), or/and seeking overlap with the fixed service licence (Bharti, BATATA). The prices they paid varied by state. Bidders paid the highest price for New Delhi, a state that has the highest per capita income. The price per person was the least for Himachal Pradesh, a hilly state, which is likely to reflect the high cost of setting up the network there. Overall, the Indian experience demonstrates that the regional spectrum allocation could be appropriate for a large country – competition in almost all regions was strong, particularly during the first phase of spectrum allocation, before the industry went through the period of consolidation. Since competition in most regions was strong, the bids were likely to reflect the true valuation that the operators placed on the licences and the outcome was, therefore, efficient.

4.3 FAIRNESS AND TRANSPARENCY

Auctions are considered to be a fairer and more transparent mechanism of spectrum allocation compared to beauty parades since all rules in an auction are straightforward and defined *ex ante*. From the point of view of a bidder, especially a strong one, the higher the degree of transparency, the better, as this reduces uncertainty and makes it easier to develop and implement a bidding strategy.

Having said that, it is debatable how much information should be disclosed during the bidding stage. Regulators are often reluctant to provide full information, i.e. to report all bids, because they fear this could facilitate coordination between bidders. On the other hand, if very little information is disclosed, the bidders would not be able to overcome the information asymmetries. There has been significant variation in the degree of transparency in European spectrum auctions. For example, in the UK 3G auction full information was released, while in the German auction – only information on high bids and withdrawals from the auction.

Beauty parades are often viewed as being significantly less transparent, and attempts to choose between operators on the basis of their business plans can be viewed as being highly subjective and arbitrary. For example, the results of a beauty parade in Sweden (2001) were appealed by the losers who argued that their business plans were identical to the winning ones.

To increase transparency in a beauty parade, the regulator should make sure that its criteria are as clear and as straightforward as possible. For example, in Ireland the criteria for 3G licences were stated clearly in the Information Memorandum[14]. The regulator formulated its minimum requirements for coverage, speed of rollout and national roaming and made it clear that the applicants' business plans would be evaluated based on these criteria.

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13 Four circles received no bids

14 "Four licences to provide 3G services in Ireland" Document No. ODTR 01/96

But even where both criteria and weights are published, losing applicants may seek to challenge the government's decision. This could result in legal delays, with damaging effects for industry development and competition. For example, Ireland's award of a third 2G licence was delayed by around two years owing to legal challenge from a failed bidder over the selection criteria[15].

4.4 REVENUE MAXIMISATION

Auctions

Auctions tend to raise more revenue for the government than beauty parades. The key reason for this is that in a well-designed auction bids reflect underlying valuations. In the UK 3G auction, for example, five winners paid 39 billion Euros, while in Germany six winners paid 51 billion Euros, more than in any other European 3G contest.

While high revenues are considered by many as an indicator of success, some governments and spectrum users have been concerned that auctions "encourage" bidders to pay too much for licences. It is certainly true that auction outcomes may be affected by market sentiment, as it happened in the UK and Germany.[16] However, it is not clear why governments rather than operators are better placed to judge the long-term value of licences in the situation of fluctuating expectations. Moreover, as licence payments are sunk costs, they should not alter the incentives of operators to invest in 3G networks *as long as the cost of capital faced by the firms has not increased.*

Note that in all later auctions, the revenues were significantly lower than in the UK and in Germany. In some cases it can be attributed to the drawbacks in the auction design (for example, very low reserve price in the Austrian auction). But more importantly, the willingness to pay for 3G licences has fallen when the market conditions started to deteriorate. Therefore, the criticism that "auctions always result in over-payments" does not appear to be supported.

Beauty parades

In many of the beauty parades reviewed for this report, we find that revenue maximisation was not the first priority of the licensing authority. Both in Sweden and in Finland, licence fees were set at a nominal level to cover basic administrative costs. However, if revenue *is* an objective, it may be difficult to achieve using a beauty parade.

In a beauty parade the government will typically set the price of spectrum in advance on the basis of limited information. Since it is unlikely to know the true value that bidders place on spectrum to any degree of accuracy the likelihood is

15 There was a post-auction litigation in the UK as well, but it was of a different nature. The UK litigation was about the treatment of VAT on the licence fees paid by the winners and was not challenging the auction outcome.

16 The auctions there coincided with the peak of the telecoms boom when the operators were very optimistic about the prospects of the 3G technology.

that prices in a beauty parade are either lower than necessary or too high. If prices are too low then winning bidders may obtain large gains at the expense of taxpayers, whereas if they are too high there is a risk that some lots may remain unsold. The beauty parade in France (2001) is an example of licence fees which initially were set too high. The government hoped to achieve revenues comparable to those in the UK and set the licence fees at a high level (4.96 billion Euro) when the market conditions had already deteriorated. Since there were only two potential bidders (and four licences), the government reduced the fees to 619 million Euros. In the end, three licences were awarded to the incumbent operators, while the fourth licence remained unsold.

4.5 SERVICE, SCOPE AND QUALITY OBJECTIVES

If the government wants to achieve some specific objectives[17] such as minimum geographic coverage, quality of service or speed of roll-out, it is likely to use a beauty parade. In a number of countries where governments preferred beauty parades to auctions their arguments in favour of beauty parades included:

- The seller can specify its objectives explicitly and ensure that they are reflected in the companies' business plans.
- The seller has more control over the outcome compared to an auction where the outcome is difficult to predict.

Whether the governments' objectives are likely to be achieved depends on (i) their feasibility and (ii) the ability of the government to enforce the fulfilment of the conditions specified in the licences. As the examples of Sweden (2001) and France (2001/02) below demonstrate, that enforcement may be a problem. If operators are unable to meet the requirements, governments often have no choice but to change the targets or scrap them altogether.

The following examples are relevant:

- Sweden (2001) – Sweden, like many of the case studies, imposed a coverage and roll-out timetable on operators that were set out clearly in advance of the beauty parade (e.g. launch within two years of receiving the licence, amongst other obligations). A further condition was that the new 3G licence holders must share the costs of rollout, i.e. mast and site sharing agreements. The regulator (PTS) hoped that this would avoid potentially unnecessary and inefficient duplication of assets. The latter condition is quite unique and contributed to delays in the launch of services (over a year late), as operators found it difficult to agree on mast and site sharing costs without the repeated intervention of the regulator.
- France (2001/02) – the French licence conditions included roll-out and coverage obligations. The initial public tender in 2001 resulted in the sale of two out of the three licences. Following a revision to the licence conditions and characteristics (an extension of the licence duration from 15 to 20 years),

17 The underlying factors driving these objectives include regional disparities in population density and income levels, the necessity to develop the infrastructure or to modernise the economy

the third licence was allocated to a single bidder in 2002. The licence fees were also reduced significantly for the allocation of the third licence. The revised conditions and lower fees were retrospectively applied to the licences that were allocated over one-year previously.

5 Conclusions

When allocating spectrum, a government is likely to have a number of objectives, such as efficiency, promotion of competition, transparency, revenue maximisation, quality of service, etc. When deciding whether to use an auction or a beauty parade, the government should take into account the relative strengths and weaknesses of each method in the light of the objectives it wants to achieve.

The table below summarises a government's potential objectives and indicates whether they are more or less likely to be achieved using an auction or a beauty parade.

Objectives	Auctions	Beauty parades
Efficiency	√√ - √√√	√ - √√
Promotion of competition	Require additional steps such as reservation of a licence for an entrant or offering regional licences	
Transparency	√√√	√ - √√
Revenue maximisation	√√ - √√√	√ - √√
Service, scope and quality	√ - √√	√√ - √√√

Table 2: Licensing approaches vs. government's objectives

The table shows that a well-designed auction is likely to lead to greater efficiency, be more transparent and raise higher revenue than a beauty parade. Beauty parades, on the other hand, score high on service and quality objectives, but lower on transparency and revenue maximisation. Hybrids, in principle, could have scores in between those of auctions and of beauty parades. Whether this holds in practice is difficult to say, as there are relatively few well documented examples of hybrids.

There is no definitive recommendation regarding a government's objective of promotion of competition. Both an auction and a beauty parade can result in new entry or in maintenance of the status quo. If this objective is considered a priority, there are a number of steps the government can undertake in order to achieve it such as to reserve a licence specifically for a new entrant, or to offer both regional and national licences, in order to encourage regional competition.

In practice, not all 3G auctions in Europe were successful. The mixed experience associated with spectrum auctions highlights the importance of auction design. Every aspect of an auction's rules must be correctly structured in order to create the right incentives for bidders, i.e. to encourage participation, overcome information asymmetries i.e. reduce the likelihood of incorrect bidding due to imperfect information, and prevent undesirable coordination.

Beauty parades allow regulators and governments to introduce specific requirements for the potential licences, but are considered to be less transparent

and may not allocate spectrum efficiently. Despite being less appealing in terms of efficiency and transparency, beauty parades have been used in a number of European countries, both for 2G and 3G spectrum allocation. In these cases, governments typically opted for beauty parades to achieve some specific objectives (e.g. a certain level of coverage). Revenue maximisation was not among the top priorities in most beauty parades.

The experience of European 3G beauty parades demonstrates that not all objectives set by the governments were achieved. In some cases the roll-out and coverage deadlines were postponed (Sweden) or even scrapped altogether (Spain). This highlights one of the main problems associated with beauty parades, namely limited enforcement mechanisms. If the government cannot fully assess the credibility of business plans and is unable to enforce their fulfilment, beauty parades could result in inefficient spectrum allocation.

Finally, no matter whether a government wants to allocate spectrum using an auction or a beauty parade, a transparent consultation between the government and the market players, well in advance of the allocation process, is considered a very important element of designing an award process successfully. Such a consultation will ensure that the government accurately gauges potential market interest for the licences on offer and provides a process through which it can clearly communicate its priorities to the potential applicants.

Since 3G services in most European countries are still in their infancy, it is not yet possible to assess whether there is a strong link between the choice of an allocation mechanism and the market outcome. However, it may become possible to do in the future when more data are available, for example:

- level of investment;
- coverage;
- strength of competition (e.g. price level);
- time elapsed between spectrum allocation and commercial 3G service introduction.

One could then assess whether there is a causal relationship between these characteristics and the way spectrum was allocated. For example, one might test whether the level of investment was higher in countries where spectrum was allocated for a nominal fee and the operators implicitly received a subsidy.

However, one should bear in mind that the market outcome may be affected by a number of other factors such as:

- differences in demand for 3G services, and, in particular, whether the differences in bidders' ex ante valuation (in either auctions or beauty parades) were significantly different from ex post outcomes;
- differences in consumer income levels;
- timing of spectrum allocation - it is reasonable to expect some delays in countries, for example where licences were allocated early and 3G technologies were not yet well developed.

Conclusions

On the basis of the case studies reviewed in this report, it is not possible to make such an inference.

Conclusions

Annex 1 Case Studies

This section outlines the main characteristics of the licence allocation in a number of countries. The case studies focus on, but are not restricted to, the allocation of 3G licences. In certain useful examples e.g. Brazil, we also study the 2G licences.

We have relied on a number of criteria in selecting the case studies:

- **Allocation method** – auction *versus* public tender.
- **Period of Award** – is there a sufficiently long time period following the award of the licence to assess the award process and possible influence on market developments.
- **Geographic scope of the licensing regime** – in particular national *versus* regional licensing.

Various sources have been used to gather the information contained in this section. The main sources used are:

- The *Globalcomms* database at www.telegeography.com;
- EU Implementation reports: "Report on the implementation of the EU electronic communications regulatory package" (various years);
- Website searches of the various national regulatory authorities;
- Various documents published by the Electronic Communications Committee of the *European Conference of Postal and Telecommunications Administrations* website (http://www.ero.dk/ecc).

Each of the case studies is presented in the following format:

- We begin with by briefly outlining the main characteristics of the licence award process, as well as any relevant country characteristics such as population and country size.
- This is following by the presentation of a timeline, which highlights the major events and decisions both leading up to the award of the spectrum/licence, as well as the period afterwards. Where sufficient information is available, we have also described how the market has evolved since the award of the spectrum/licence.
- Finally, we outline the main reasons for the choice of allocation method, i.e. auction or beauty parade, and we also highlight any relevant issues that arose either during or after the award process itself.

SWEDEN – BEAUTY PARADE (2001)

Country characteristics: population 9 million; size 450,290km^2
Number of licences awarded: 4
Licence characteristics: Symmetric, national licences
Price paid: nominal, largely to cover administrative costs of the beauty parade.

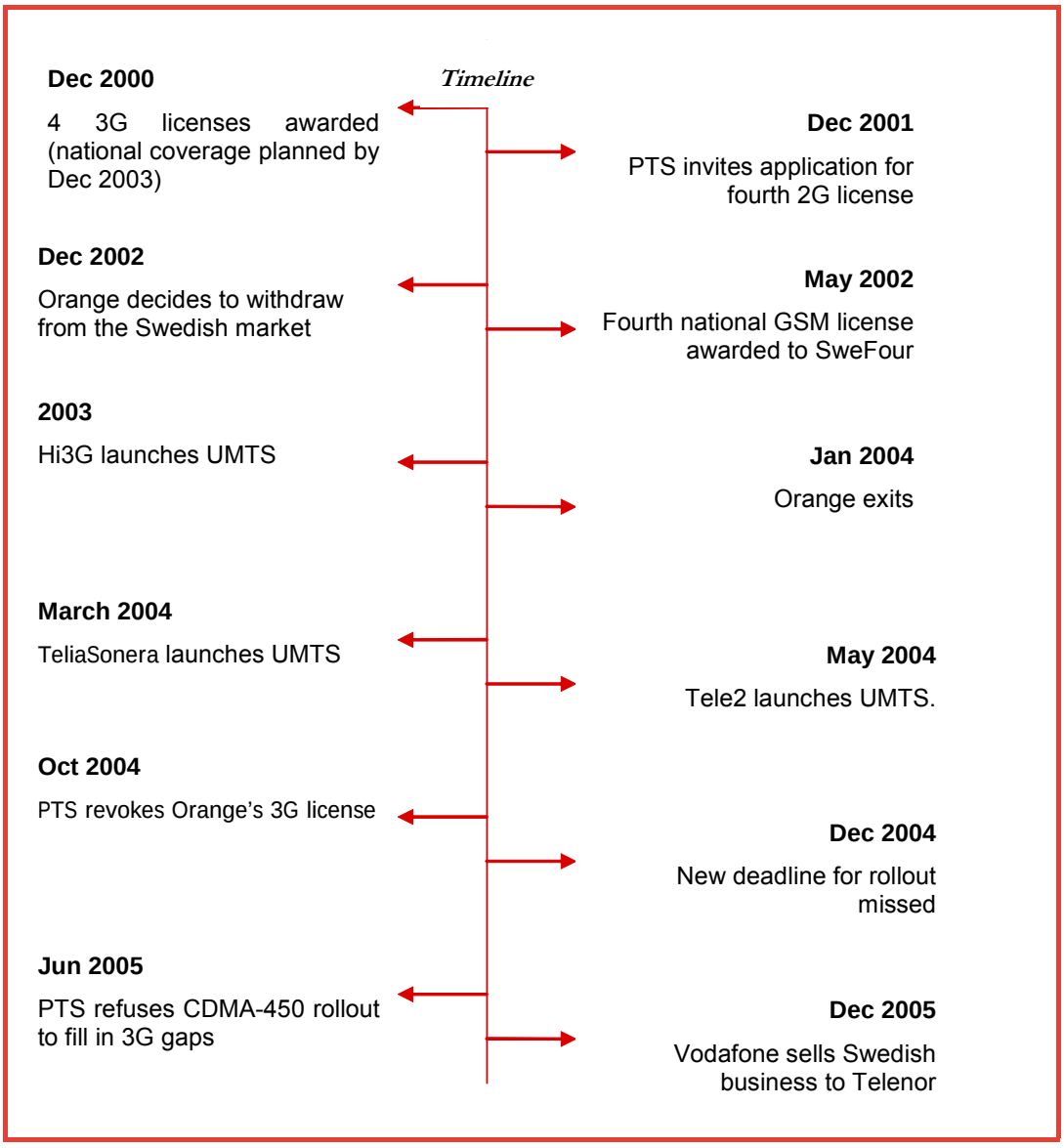

Figure 1: Timeline for issuing 3G licences in Sweden

Source: Frontier Economics

Reasons for choosing a public tender

- PTS wanted to ensure that the licence holders met the regulator's requirements in terms of the following criteria:
    - financial capacity;
    - technical and commercial feasibility; and
    - speed of coverage.
- The applicants that passed the initial criteria were then assessed on the extent and speed at which they offered coverage. Coverage was defined on three factors:
    - proportion of population covered;
    - territorial coverage; and
    - distribution throughout Sweden.

Outcomes and issues

- **Rollout Coverage**
    - *Speed:* Operators took three years to launch failing to meet the two-year target as set by the regulator.
    - *Proportion of population covered:* Actual coverage was 87% against the 99.98% set out in rollout conditions.
    - *Implementation problems:* Mast sharing, difficulties in obtaining national roaming agreements, delays in planning permission procedures and a lack of terminals and services. As a result of these problems the licensees were granted a six months extension on rollout and coverage obligations.
    - *Changes in licensing conditions:* TeliaSonera, Tele2, H3G and Vodafone proposed two changes to licensing conditions. Firstly they requested a lower signal strength requirements, secondly a change in the rollout timetable. The first request was accepted and the second rejected.
- **Transparency**: The PTS' decision on the licence allocation was challenged in court by Telia, Telenordia and ReachOut Mobile – they jointly claimed that the allocation process was unfair and lacking in transparency. The courts, however, backed the regulator's decision.
- **Changes in market structure**: In 2004 Orange withdrew from the market. Its 3G licence was subsequently cancelled by the PTS.
- **Was the allocation process market neutral?** No - the operators were obliged to share the rollout costs – mast and site sharing – as part of the licence conditions. The purpose of this was to avoid inefficient duplication of assets and on reduce the cost and time of the 3G network rollout in the Swedish market. Arguably, it had exactly the opposite effect. The roll-out was delayed because the operators could not agree on the sharing conditions.

UNITED KINGDOM – AUCTION (2000)

Country characteristics: population 60.2 million; size 243,610km^2
Number of licences awarded: 5
Licence characteristics: Asymmetric, national licences
Price paid: €39 billion (2000) for all 5 licences.
Auction method: multi-round, fixed prize auction.

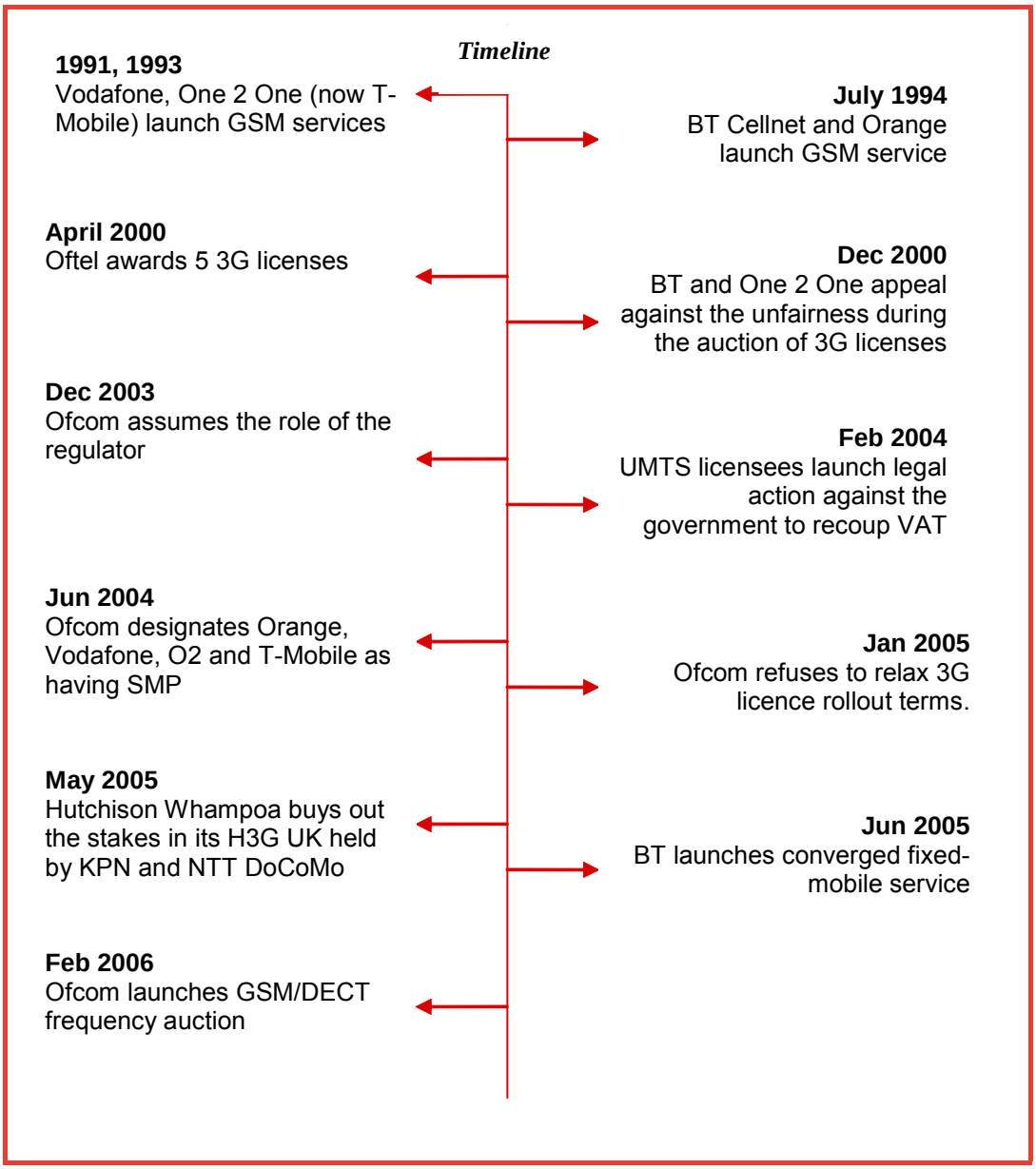

Figure 2: Timeline for issuing 3G licences in the UK

Source: Frontier Economics

Motivation/reasons for auction

The key objectives for the auction were:

- to utilise the spectrum in the most efficient way,
- to promote effective and sustainable competition, and
- subject to the above objectives, to realise the full economic value to consumers, industry and the taxpayer of the spectrum.

Outcomes/Issues

- **Rollout coverage**
  - *Proportion of population covered:* 70% of the population covered by 2004. The coverage appears to be on track to meet the target of 80% of the population by 2007.
  - *Implementation problems:* Regulatory 'wrangling', problems with the development of W-CDMA technology and equipment shortages.
- **Transparency**: BT and One2One sued the UK government for loss of interest on licence payments following the three-month delay in Vodafone and Orange paying for their licences at the completion of the auction.
- **Competition**: To ensure sustainable competition, bidding on Licence A (there were 5 licences A, B, C, D and E) was restricted to new entrants. Any firm, new or incumbent, could bid on the other four licences.
- **Inflated prices**: The auction occurred at the peak of the dotcom boom which resulted in high prices. Moreover, the auction involved thirteen bidders which also caused the revenue to rise beyond the original estimate of a total auction value of £5bn
- **Allocation and the existing 2G market structure**: As explained above, the award process was set-up to specifically encourage entry, with a single licence ring-fenced for a new entrant – H3G won this A-licence.

GERMANY – AUCTION (2000)

The German 3G auction, which took place in August 2000, was the third in Europe after the UK and the Dutch auctions which both took place earlier in the same year. The auction raised a total of €51 billion, and was considered a success in terms of promoting efficient use of the spectrum, raising revenues and ensuring a sufficient level of competition in the German Mobile market.

Country characteristics: population 82.4 million; size 657,021km^2
Number of licences awarded: 6
Licence characteristics: national licences with variable prizes
Price paid: €51 billion (2000) for all 6 licences.
Auction method: multi-round, variable prize auction.

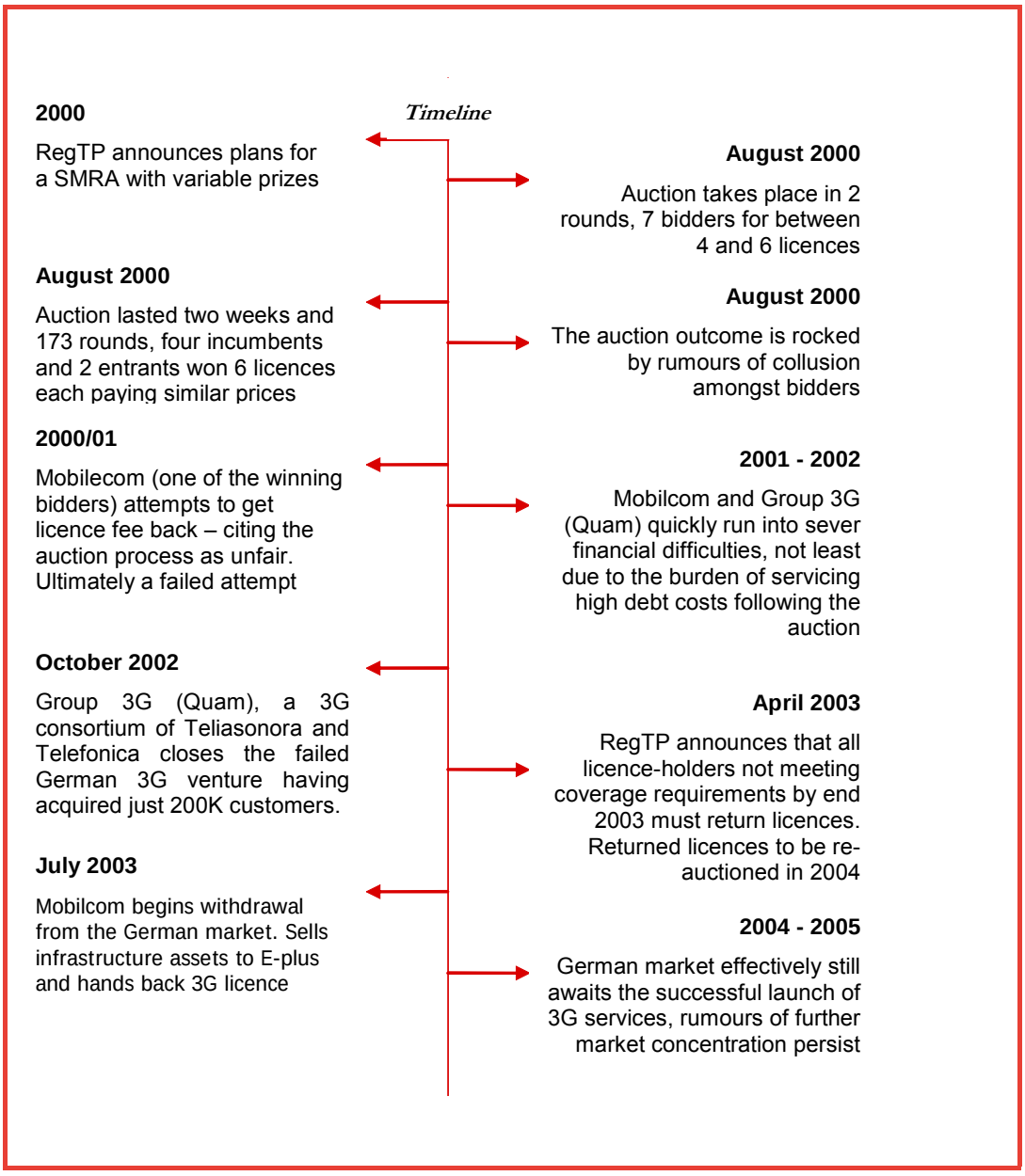

Figure 3: Timeline of issuing 3G licences in Germany

Source: Frontier Economics
Notes: SMRA: "Simultaneous Multi-round Auction".

Motivation/reasons for auction

The key objectives for the auction were:

- to achieve spectrum efficiency;
- allow the market (i.e. the auction outcome) to determine the structure of the 3G market;
- a general belief on the part of the regulator (RegTP) that bidders would be better informed as to how to group frequencies as licences and how to value such licences;
- consistent with the belief that 'the market knows best', RegTP did not set-aside a licence specifically for new entrants, as in the case of the UK auction that preceded it.

Outcomes/Issues

- **Rollout coverage:** the regulator placed a number of coverage and rollout obligations on the licence holders, including reaching 25% population coverage by end 2003. The failure to achieve this coverage obligation was one of the reasons RegTP pushed for both Mobilcom and Quam (Group 3G) to hand back the 3G licences in 2003.
- **Transparency**: despite the transparent reputation often attached to auctions, the German 3G auction is one that has attracted a number of criticisms, particularly on the transparency point. As pointed out in a number of papers (see for example Klemperer, 2004) the German auction was characterised by some 'unusual' bidding behaviour in later rounds, which is characteristic of coordination on the part of bidders. The ultimate aim of the alleged collusive behaviour – which some claim was to drive up prices and therefore create a barrier to entry for entrants, leaving the four incumbents each with three of the twelve spectrum blocks on offer – is still a matter of some debate. However, what is clear is that the high prices paid *did* place significant financial burdens on all market players. This is because the bidders largely financed the cost of the licences through debt.
- **Competition**: in terms of developing a competitive market for 3G services, the outcome in Germany has not been particularly good, although it is not clear to what extent that outcome can be linked to the fact that the allocation methodology was a simultaneous multi-round auction, as opposed to a beauty parade approach.
- **Inflated prices**: in contrast to the UK auction, where the final price paid was a direct function of the number of bidders, in Germany, prices continued to rise *even after* the seventh bidder had dropped out. The reason for this is that several bidders attempted to acquire three of the twelve spectrum blocks, as opposed to the minimum number of two that were required. Had the bidding stopped at the point when the seventh bidder dropped out, the

average price paid would have been around €5 billion, as opposed to the final price of around €8 billion that was paid.

- **Was the auction format market neutral:** it could be argued that the German auction was perhaps the *most* neutral with respect to what the structure of the 3G market should be going forward. The auction format allowed for different market outcomes - i.e. four, five or six licences – and there was not ring-fencing of licences for entrants.

DENMARK – AUCTION (2001)

The 3G auction in the Denmark took place in September 2001. It was the final 3G auction that took place in Western Europe, and, as such, was affected by the shift in the macro-economic climate that occurred over the 2000 – 2001 period, and most notably the telecoms downturn. We include the Danish example as a case study as the authorities deliberately choose a sealed-bid auction in order to encourage entry – i.e. as described in the text: in theory the sealed-format should give potential entrants a better chance of winning.

Country characteristics: population 5.5 million; size 43,3941km^2
Number of licences awarded: 4
Licence characteristics: national licences
Price paid: €500m billion (2001), or €120m for each licence.
Auction method: single round, sealed bid auction.

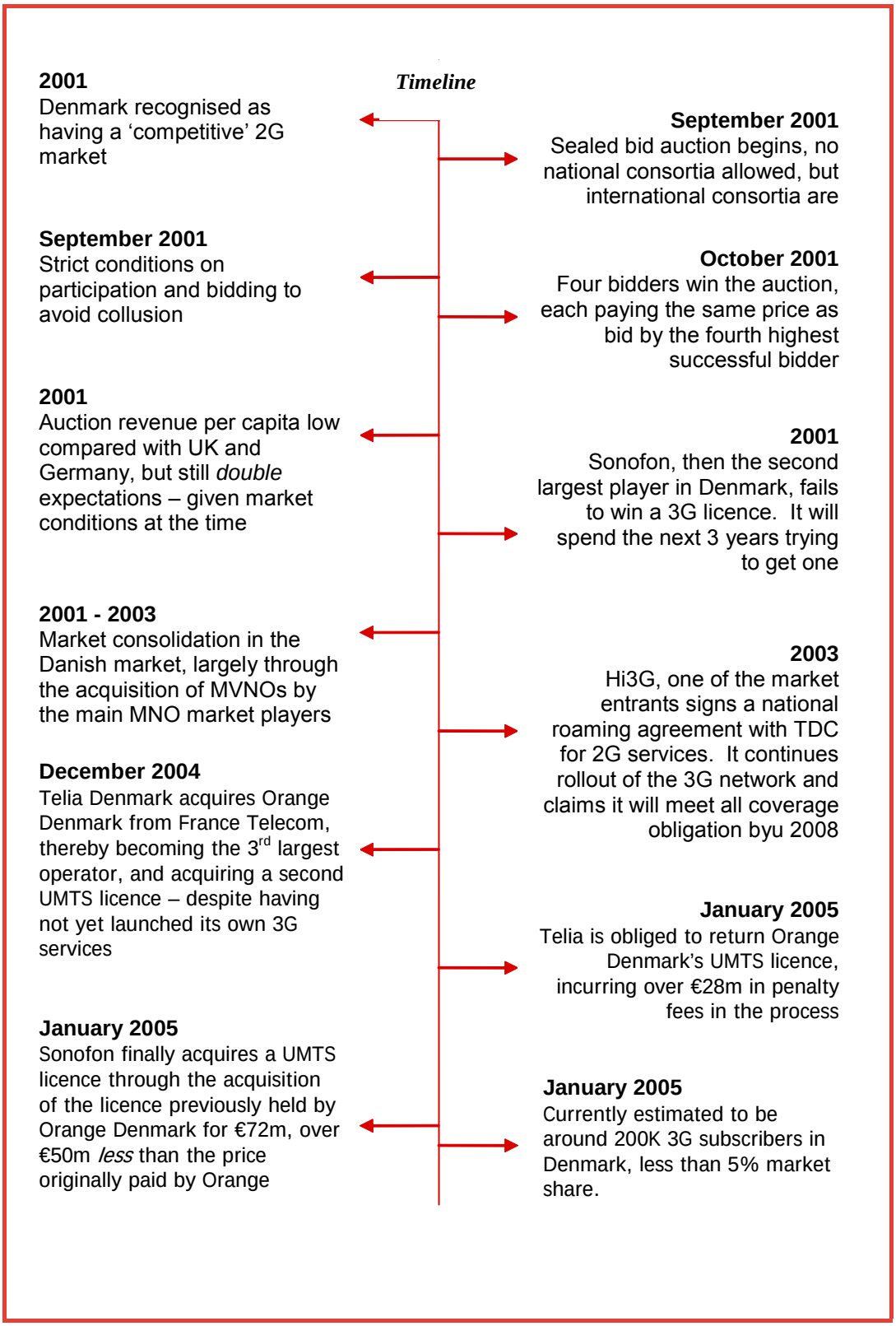

Figure 4: Timeline of issuing 3G licences in Denmark

Source: Frontier Economics

Motivation/reasons for auction

The key objectives for the auction were:

- to achieve spectrum efficiency in a fair and transparent manner;
- originally, the government had planned to allocate licences via beauty contest, but this was thought to be lacking in fairness and transparency;
- it was thought that an auction, with the right characteristics, was the most appropriate method for ensuring that the existing level of competition in the 2G market was sustained for the 3G market going forward;
- the sealed bid approach was considered a key element in attracting entry, particularly in the light of the poor market conditions that prevailed at the time – the government also considered a number of other approaches, including SAA and the Anglo-Dutch hybrid (see Annexe 2);
- in order to get around the potential problem relating to the revelation of information asymmetries through differential bids, the authorities set the price for *all* licences at the price of the forth highest bid, ultimately €128m.

Outcomes/Issues

- **Rollout coverage:** the regulator/government placed a number of technical conditions on the licences, including: consistency with IMT-2000 standards, population coverage of 30% by end-2004 and 80% by end-2008, a number of 'use-it-or-lose-it' conditions, and restrictions on network sharing and 3G roaming agreements in order to meet the obligations
- **Transparency**: The Danish auction was widely received as being both transparent and fair. The regulator and the government went to some lengths to avoid the prospect of undesirable coordination, with significant fines and threats of exclusion from the entire process if coordination was suspected.
- **Competition**: Government was keen to promote entry through the 3G licensing process, hence the emphasis on the sealed-bid approach. Another approach might have been to allow a fifth licence, or explicitly ring-fence one of the four licences for an entrant. However, following the extensive industry consultation – which was central to the entire process in Denmark – the regulator/government felt that four licences was suitable, despite the fact that there were only four incumbents.
- **Inflated prices**: Price paid per capita was lower than that in both the UK and Germany, largely related to the market conditions that prevailed. Also, bidders only paid the price of the fourth highest winning bid.
- **Was the auction format market neutral:** No – significant emphasis on promoting entry.

FRANCE – BEAUTY PARADE (2001/02)

Country characteristics: population 60.7 million; size 551,500km^2
Number of licences awarded: 3
Licence characteristics: national licences, symmetric
Price paid: €1.7 billion (2001/02), or €120m for each licence.

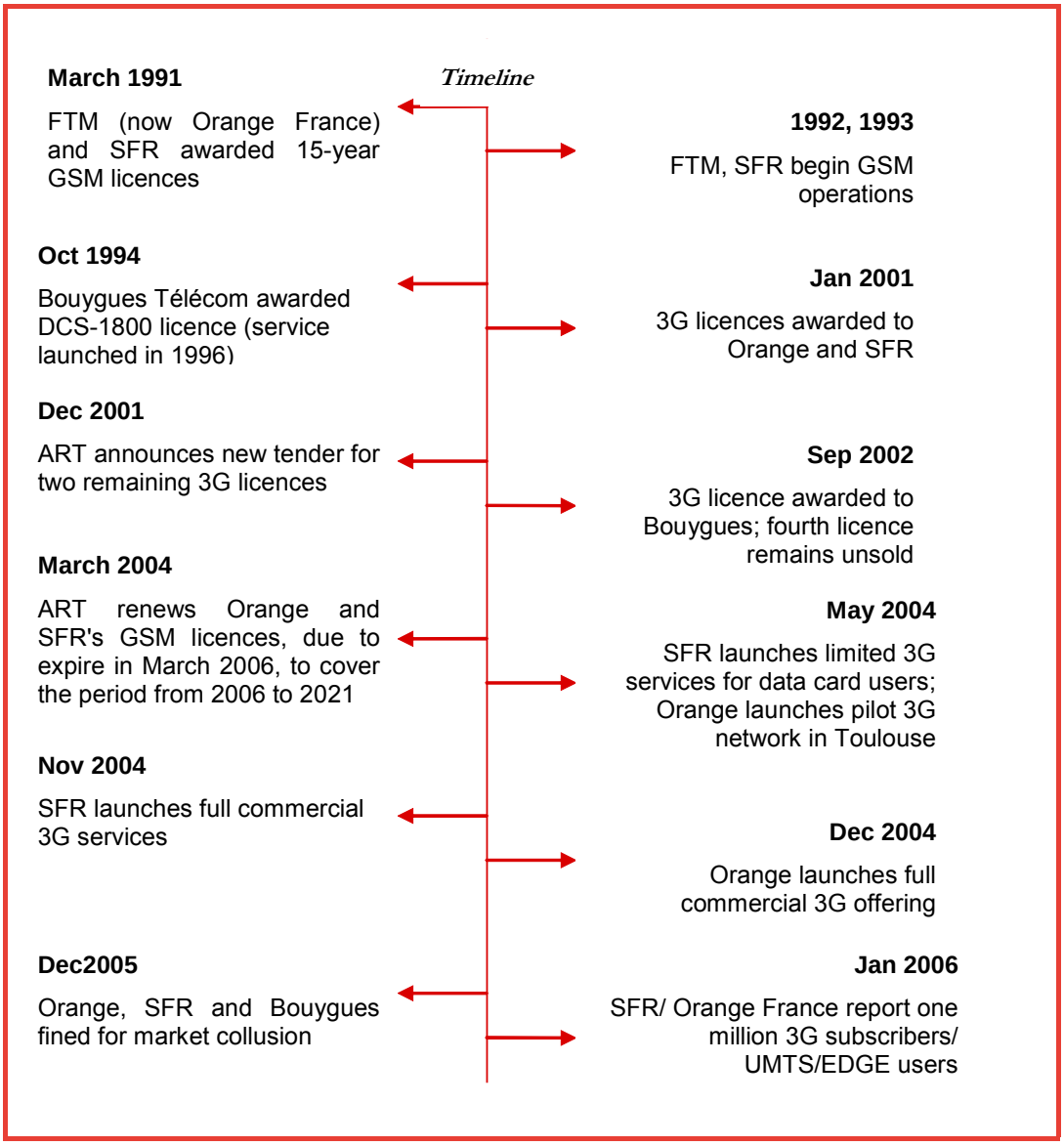

Figure 5: Timeline for issuing 3G licences in France

Source: Frontier Economics

Motivation/reasons for the beauty contest

To ensure that the licence holders fulfilled 14 criteria (500 points) covering:

- commercial criteria,
- technical criteria,
- financial criteria, and
- general coherence appreciation

Among the 14 criteria, the most important ones were:

- network and rollout coverage (100/500),
- business plan credibility (75/500), and
- services diversity (50/500)

Outcomes/issues

- **Changes in licensing conditions**: The licence fees were cut from EUR4.96 billion to EUR619 million, plus 1% of annual turnover, and the duration was extended from 15 to 20 years; these amendments were retrospectively applied to previous concession winners Orange France and SFR. In December 2001 Arcep re-launched the contest for the remaining two licences, and the sole bidder, Bouygues Télécom, was awarded a concession in September 2002.
- **Transparency**: Unsuccessful applicants challenged the beauty contest outcome in the courts.
- **Competition**: In April 2005 the French competition authority Conseil de la Concurrence and Arcep determined that there was insufficient competition in the country's mobile market and that the three network operators were making it too difficult for resellers to provide competitive products - the arguments were based on coordination and inflating prices.

HUNGARY – BEAUTY PARADE (2001)

Country characteristics: population 10.1 million; size 93,030 km^2
Number of licences awarded: 3
Licence characteristics: national licences, symmetric – one licence retained for a new entrant following launch of 3G services in Hungary in the future.
Price paid: €260 million (2004/05)

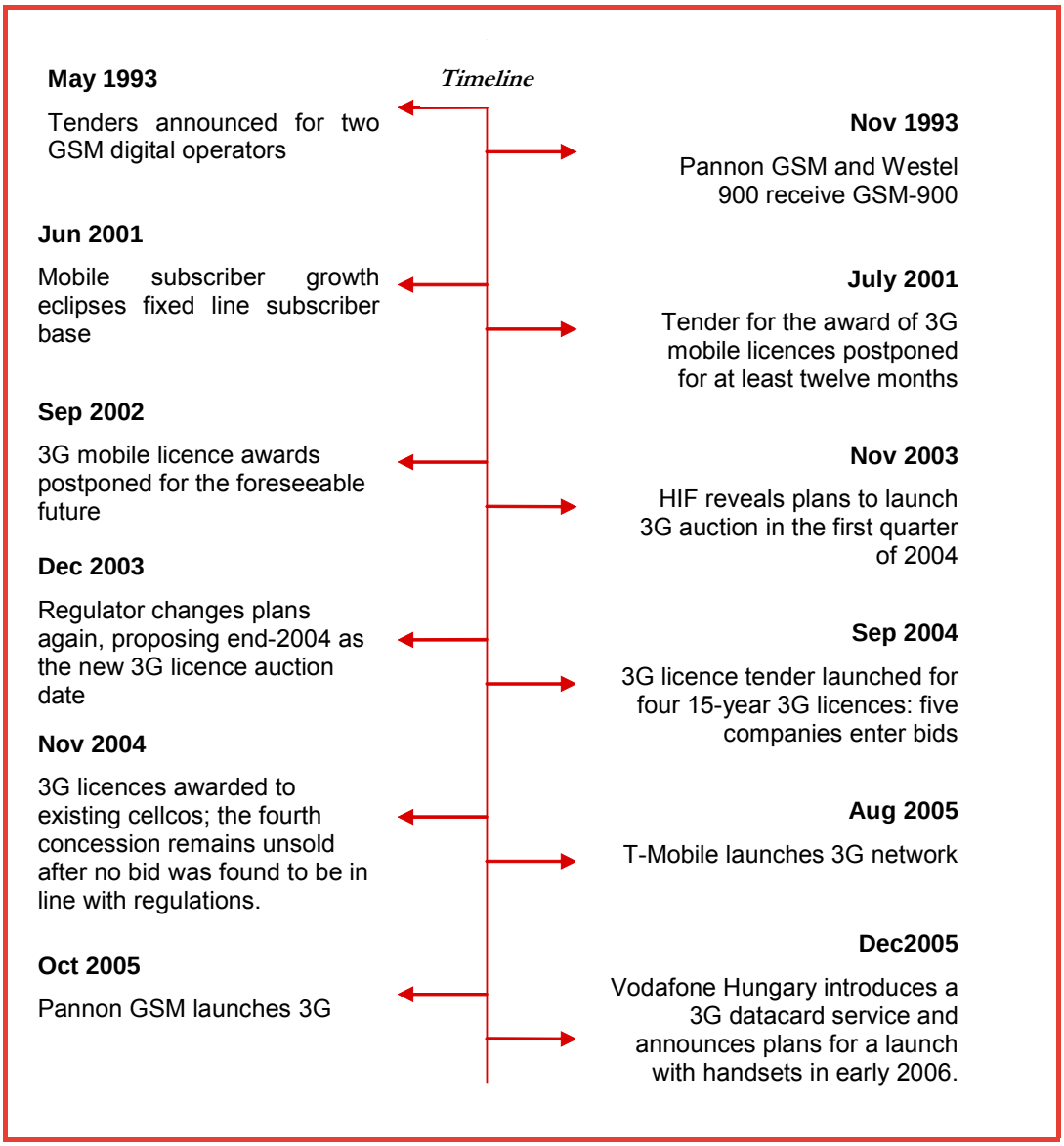

Figure 6: Timeline for issuing 3G licences in Hungary

Source: Frontier Economics

Motivation/reasons for the beauty parade

The government first announced plans for auction in 2001, but delayed the process after concluding that neither phone companies nor consumers were prepared for next-generation services, while the frail telecoms industry could not afford to invest in a market which had no guarantee of success.

The beauty contest type of selection suited both the market conditions and the legal background in Hungary in 2004. It was used in 1994 for GSM and in 1999 for GSM-DCS.

Outcomes/issues

- **Rollout coverage**: Target was set for Budapest to be covered by January 2006 and 30% population by 2008. Coverage seems to be on target as T-Mobile and Vodafone covered Budapest and Pannon covered 50% of population before 2006.
- **Competition**: 4th licence held in reserve until commercial launch of 3G services to ensure a new entrant.
- **Sustainability**: The success of 3G services in Hungary remains uncertain, however, as data-based mobile internet services are beyond the reach of the man in the street. 2G services were built on the strength of inexpensive voice services rather than data, pointing to a difficult time ahead for 3G service providers.
- **Market specific licensing:** As mentioned in the above section the licensing procedure reflected the market and legal conditions of Hungary. In addition the allocation method involved reserving a licence for a new entrant to encourage competition in the industry.

HONG KONG – HYBRID (2001)

Country characteristics: population 7 million; size 1,098 km^2
Number of licences awarded: 4
Licence characteristics: national licences, symmetric
Price paid: €26.4 million

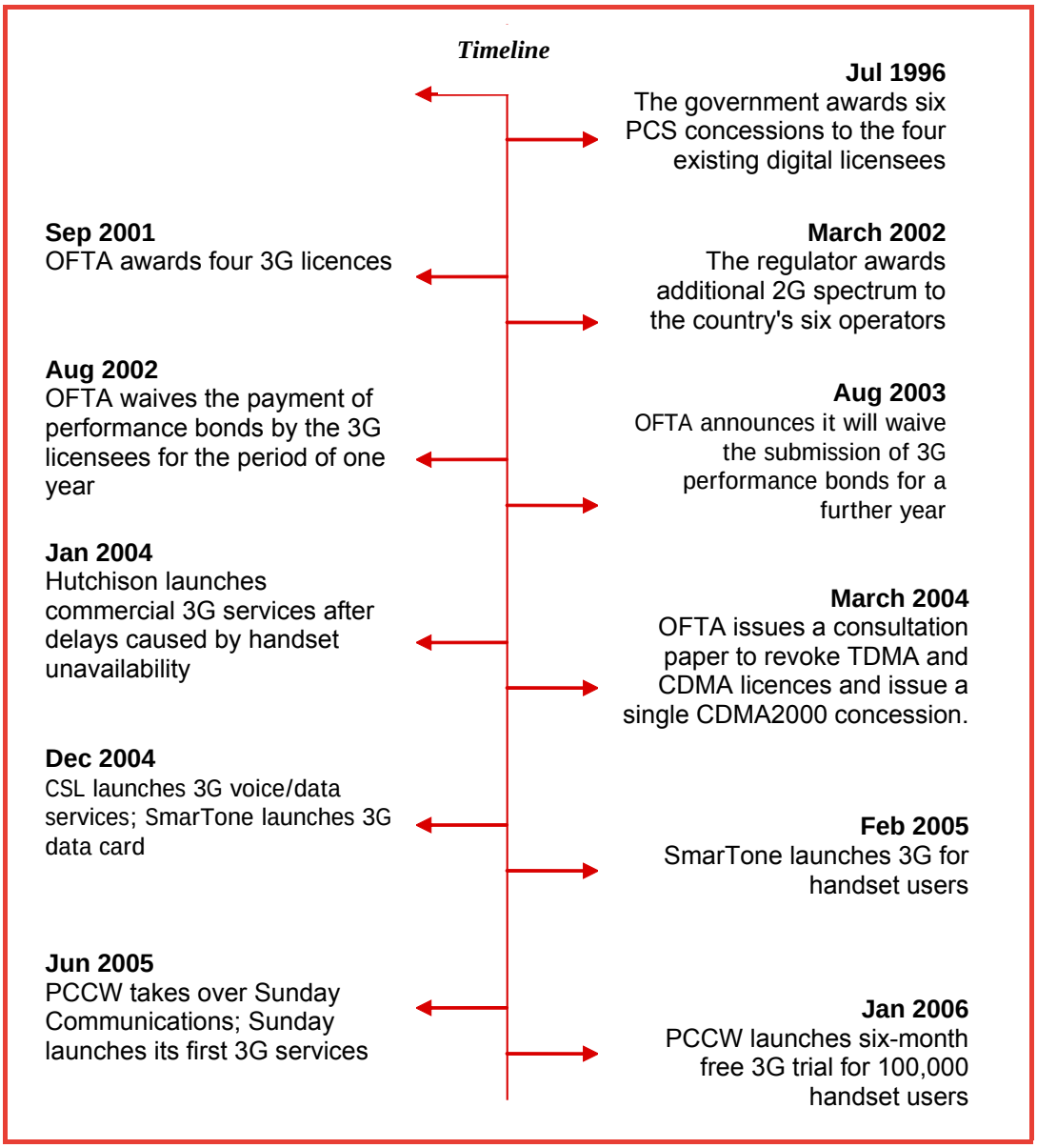

Figure 7: Timeline for issuing 3G licences in Hong Kong

Source: Frontier Economics

Motivation/reasons for hybrid auction

The auction method attracted only four bids for the four licences. Following this the concessions were allocated at a price of HKD50 million per annum for the first five years and 5% of each operator's annual 3G revenues for the remainder of the 15-year licence period.

In addition to the basic fee, Hutchison 3G Hong Kong paid HKD2.39 million to secure its preferred frequency band spectrum; SmarTone, CSL and Sunday offered HKD1.38 million, HKD288,000 and HKD10,000 respectively.

Outcomes/issues

- **Fee payment:** In October 2002 OFTA exempted the first payment of performance bonds for 3G licensees following the downturn in the global telecoms market. The next year it agreed to a further one-year postponement, on the basis that it would aid the telecoms industry as a whole.
- **Technological:** OFTA encouraged the participation of mobile virtual network operators (MVNOs) in the 3G market, with regulations stating that 3G licensees must make up to 30% of their network capacity available to such operators. According to OFTA guidelines, a 3G MVNO must undertake to provide its own switching and gateway for circuit and packet switched traffic, establish its own interconnection and roaming agreements, build its own billing and support systems, and issue its own SIM cards.
- **New entrant issue:** The regulator failed to award a new CDMA2000-based 3G licence when both operators' licences expired in 2005 due to strong industry opposition. It allowed Hutchison and CSL to retain up to a third of their original spectrum allocation until 2008, whereupon both must migrate customers onto alternative networks
- **Market specific licensing:** the award method chosen and the terms of licensing reflected the underlying 2G market structure.

BRAZIL – AUCTION (1997 - 2001)

Country characteristics: population 186 million; size 8,511,956 km^2
Number of licences awarded: 14 – 21 2G licences
Licence characteristics: regional licences, asymmetric
Price paid: N/A
Auction method: first price, sealed bid auction.

In terms of subscribers, Brazil's mobile market is the fifth largest in the world, behind China, the USA, Japan and Russia. Yet, although Brazil holds almost one third of all the mobile users in Latin America, its mobile penetration is lower than in Chile, Colombia, Argentina, Venezuela, and most of the Caribbean.

With the improved economic conditions throughout the Latin American region, the Brazilian mobile customer base has been steadily rising, driven by the popularity of prepaid phones, which account for around 81% of all mobile customers. According to a report by local consultancy Teleco, combined mobile telephone coverage in Brazil reached 88.6% of the population by early 2006.

In 1996, Brazil was divided into ten service provision areas and three regions for licensing purposes (as shown in Figure 8 below).

Figure 8: Mobile service provision areas

Source: "Brazilian strategy on mobile spectrum" Jose Leite Pereira-Filho

The ten areas were given at least one mobile company operating Band A and one company operating Band B services. Band A operators inherited their networks

from the former state telco Telebras. Each one of the eight operators that emerged from the privatization process was given one of the ten concession areas, except for Telesp Celular and Tele Celular Sul, which were licensed to operate in two areas. The cellular services of the government-owned, non-Telebras CTMR were combined with Telesc and Telepar under the control of Tele Celular Sul.

Area	Region	Operator	Trading name
1	3	Telesp Celular	Vivo
2	3	Telesp Celular, CTBC	Vivo, CTBC
3	1	Tele Sudeste Celular	Vivo
4	1	Telemig, CTBC	Telemig, CTBC
5	2	TIM Sul, Sercomtel	TIM, Sercomtel
6	2	TIM Sul, Celular CRT	TIM, Vivo
7	2	Tele Centro Oeste, CTBC	Vivo, CTBC
8	1	Amazonia Celular	Amazonia Celular
9	1	Tele Leste Celular	Vivo
10	1	TIM Nordests	TIM

Table 3: Band A mobile operators

Source: Paul Buddle Communication based on Anatel

As part of deregulation, and in order to foster competition, the Brazilian government auctioned cellular phone concessions in 1997 to private sector companies. These so-called B-Band operators had licences over the same ten concession areas as those of the Band-A operators. However, unlike the Band-A operators, these B-Band companies had to roll out their infrastructure from scratch.

Area	Operator	Trading name
1	BCP	Claro
2	Tess	Claro
3	ATL Algar	Claro
4	Maxitel	TIM
5	Global Telecom	Vivo
6	Telet	Claro
7	Americel	Claro
8	Norte Brasil TElecom	Vivo
9	Maxitel	TIM
10	BSE	Claro

Table 4: Band B mobile operators

Source: Paul Buddle Communication based on Anatel

For Band D and Band E licences a different regional structure was used. It was significantly more concentrated and resembled the regional structure used for the licensing of the fixed-line operators. Auctions for Band D and Band E commenced in January 2001, with operators limited to only one licence per operating region. Both Telemar subsidiary Oi and Telecom Italia Mobile (TIM) won the auctions for Band D frequencies. TIM also won the Band E auctions.

Oi paid US$556 million to buy its Band D licence for Region 1, which covers 16 states and around 92 million people. It commenced GSM/GPRS operation in April 2002.

TIM spent more than US$1 billion to buy its GSM licences. Yet, due to local regulations, it was barred from operating in Region 2 because its parent company, Telecom Italia, owned a controlling state in Brasil Telecom (the incumbent fixed-line operator in Region 2). Therefore, in August 2002, Telecom Italia sold 18% of its shares in Brasil Telecom, in order to allow TIM to launch nationwide GSM operations, which it did in October 2002.

After three failed attempts to sell surplus licences for Bands D and E, Anatel managed to gain US$262.2 million for the remaining Band D and E spectrum blocks sold at an auction in November 2002. In order to attract bidders, Anatel had eased the bidding rules (allowing the winners up to eight years to pay off their licences), increased the number of licences from three to ten, and reduced the upfront payment from 15% to 10% of the bidding price. The auction winners were: Claro (area 9), Vesper (areas 2, 3, and 8), and Brasil Telecom (areas 5, 6, and 7). Vesper's licences were returned in April 2003.

Anatel auctioned another six E-band licences in September 2004. The concession areas were as follows:

- Sao Paulo's metropolitan area;
- Sao Paulo's coastal region;
- Part of Sao Paulo state;
- The whole of the state of Minas Gerais, Brazil's second largest state;
- The Mineiro Triangle area, a small slice of Western Minas Gerais;
- Six states in the northeaster region.

There were only two bidders for the six licences:

- America Movil's Claro, through its subsidiary Stemar. Claro faced no competition and paid the reserve price of R$51.2 million for a licence to operate cellular phones in the whole of Minas Gerais;
- Telemig Celular, the mobile operator in the state of Minas Gerais. Telemig won a concession for Western Minas Gerais, paying R$9.7 million, representing an 80% premium over the reserve price.

In February 2006, Anatel again tried to find buyers for its GSM licences in the Sao Paulo state, and in six northeaster states. Local phone company Unicel was the only bidder for the Sao Paolo licence, but it was disqualified because it did not deposit a 10% guarantee as required by the bidding rules.

Area	Region	Operator	Trading name
1	3	TIM Celular	TIM
2	3	TIM Celular	TIM
3	1	TNS-PCS (Telemar)	Oi
4	1	TNS-PCS (Telemar)	Oi
5	2	TIM Celular, Telet	TIM, Claro
6	2	TIM Celular	TIM
7	2	TIM Celular	TIM
8	1	TNS-PCS (Telemar)	Oi
9	1	TNS-PCS (Telemar)	Oi
10	1	TNS-PCS (Telemar)	Oi

Table 5: Band D operators

Source: Paul Budde Communication based on Anatel

Area	Region	Operator	Trading name
1	3	None	
2	3	None	
3	1	TIM Celular	TIM
4	1	Stemar, Telemig	Claro, Telemig
5	2	Brasil Telecom Celular	Brt Celular
6	2	Brasil Telecom Celular	Brt Celular
7	2	Brasil Telecom Celular	Brt Celular
8	1	TIM Celular	TIM
9	1	Stemar	Claro
10	1	None	

Table 6: Band E operators

Source: Paul Budde Communication based on Anatel

Outcomes/issues

- **Regional *versus* National Licensing**: Intra-region competition achieved. Bands A and B present in each region. Moreover each region covered by at least 4 operators.
- **Market specific licensing**: The market has been divided into 10 areas, each sub-divided into 4 bands, for licensing purposes.
- **Market structure**: Three dominant players Vivo (controlled by Portugal Telecom and Telefonica), TIM (controlled by Telecom Italia) and Claro (merger of BCP, ATL, Americel, Tess Celular and Claro Digital) control 80% of the national market share. Telemar has a market share of 11%. There are also four other GSM companies - Amazônia/Telemig Celular (both units of Telpart Participaçoes), smaller regional players Sercomtel and CTBC Telecom, and relative newcomer Brasil Telecom GSM, which is controlled by the Citibank Group and launched services in September 2004.
- **3g licences**: 4/5 licences planned to be auctioned in 2006-2007.
- **Barriers to entry**: Competitive bidding for bandwidth increased the cost of entry into mobile telecommunications.

OTHER CASE STUDIES

India

- **Rollout coverage**: Despite regional licensing operators have failed to cover rural areas.
- **Regional *versus* National licensing**: The number of players with a national network footprint is growing, with Bharti, BSNL, Reliance and Tata all having a presence in 20 or more circles; third-ranked GSM provider Hutchison may soon be added to this list, as it has near-nationwide licence coverage via subsidiaries and joint ventures. Speculation that the regional players Aircel, Spice Communications and BSNL's sister company MTNL — may not be able to survive the price war and be forced out of business or bought out by rivals. Although, so far, they continue to grow independently.

Poland

- **Consistency and clarity in the allocation process**: The award method was changed from auction to beauty contest partly due to changes in auction terms driving the bidders away.
- **Conditions on entry**: Foreign investors required Polish partner (possibly deterred foreign investors from bidding).

Greece

- **Gauging bidder interest**: Auction of four licences attracted only three bidders.
- **External circumstances**: Licences awarded at the time when the Greek and international markets were unfavourable.

Annex 2 Auction formats

In this annex we describe the main spectrum auction formats and discuss their properties. As will be seen, each format has advantages and disadvantages, depending on the context.

Sealed-bid auction

In a sealed-bid auction buyers submit secret bids on individual lots. Once submitted, bids are ranked and lots awarded to the highest bidders. For example, if 4 identical lots are offered these are awarded to the bidders who made the four highest bids. There are two rules that are commonly used to determine what successful bidders must pay:

- In a pay-as-bid sealed-bid auction successful bidders pay what they actually bid for each lot won. This is also known as a 1st price auction if only one lot is offered.
- In a uniform price sealed-bid auction all successful bidders pay the highest losing bid. This is also known as a 2nd price auction if only one lot is offered.

Table 7 illustrates these payment rules using an example where there are 5 bidders and 4 lots. The second column shows the bids in the auction ranked in descending order, and it is assumed in this example that buyers bid "truthfully" in the sense that they bid their actual valuations. Bidders 1 to 4 each win 1 lot in the auction and bidder 5 does not win a lot. The third column shows the payment each bidder makes in the pay-as-bid version. The fourth column shows the payment each bidder makes in the uniform price version, which is equal to bidder 5's losing bid.

Bidder	Bid	Payment in pay-as bid	Payment in uniform price
A	5	5	1
B	4	4	1
C	3	3	1
D	2	2	1
E	1	-	-

Table 7: Payments in a sealed bid auction

Source: Frontier Economics

The sealed-bid format has two main advantages in terms of efficiency and revenue:

- Sealed-bid auctions can encourage participation by weak bidders against strong incumbents. For example, if the number of lots offered in a fixed prize auction is the same as the number of incumbent operators weaker bidders are unlikely to participate unless there is a realistic prospect of success. The sealed-bid format can help in this regard because weaker bidders have some chance of outbidding strong bidders who decide to bid conservatively in order to keep prices down. Because of the one-shot nature of the sealed-bid format an incumbent cannot subsequently increase his bid. Encouraging participation in this way can help increase auction revenues.
- Sealed-bid auctions can limit the risk of undesirable coordination between bidders and so increase auction revenue. This is because in a one-shot format bidders cannot observe each other's behaviour in the auction and so it is difficult to coordinate bidding strategies.

Sealed-bid auctions also have some disadvantages:

- Sealed-bid auctions are complex and risky for bidders since bids must be formulated in advance on limited information. In particular, bidders must estimate the bids of other participants in the auction.
- Sealed-bid auctions do not allow bidders to revise their valuations in the light of other's bids. This may lead to inaccurate bidding and inefficiency. It may also lead to low revenues if bidders bid less aggressively to avoid the risk of overpaying in the auction.

In a variable prize setting there are two other concerns with sealed-bid auctions:

- Large bidders may strategically underbid in variable prize auctions to try and reduce auction prices. Although underbidding is likely to lead to winning fewer lots in the auction, this may be economically sensible for a large bidder if the reduction in auction prices that results from underbidding is sufficiently large. The incentive to underbid is larger in a uniform price auction than in a pay-as-bid auction since any reduction in price applies to all lots that are won in the auction. From the seller's perspective, strategic underbidding is undesirable since it can result in a loss of economic efficiency and reduced auction revenue.
- Sealed-bid auctions can suffer from an exposure problem where lots are complements. This arises because bidders that try and fail to assemble a package of complementary lots face the risk that they may be left with a partial package whose total price exceeds its value. Faced with this risk it is likely that bidders will tend to bid less aggressively than otherwise would be the case, which can reduce efficiency and auction revenue. This exposure problem arises in any auction where lots are sold individually, and one possible solution is to allow bids on groups of lots as well as on individual lots (combinatorial bidding). Although theoretically attractive, combinatorial bidding in sealed bid auctions introduces a great deal of strategic complexity

for both seller and buyer and is generally regarded as impractical for spectrum auctions.

Simultaneous ascending auction

The simultaneous ascending auction (SAA) is the most widely used format for spectrum auctions since its introduction by the FCC in 1994. The auction takes place over a number of rounds. In each round bidders are invited to submit bids on individual lots that beat the current highest bid.

The SAA is an *open* auction in the sense that the highest bid on each lot is announced at the end of each round (the "standing high bid"). Bidders may not withdraw bids from one round to the next, but can outbid the current highest bid on a lot. In this way, the price of objects in high demand increases from round to round as bids are increased.

The auction continues until no new bids are placed on any object in a round. Each object is then awarded to the highest bidder in the final round, and successful buyers pay their winning bid for each object received. SAA auctions commonly have an *activity rule* to ensure that the auction proceeds reasonably quickly. For example, any bidder may be eliminated from the auction if it is not the current high bidder on any licence and it does not submit a bid in any round.

The SAA has two main advantages compared to sealed bid auction:

- The SAA is simpler for bidders than the sealed-bid auction because bidders can adapt their bidding strategies as the auction proceeds. For example, bidders can switch between similar lots in response to prices as the auction proceeds, and this can help promote efficiency and revenue.
- In the SAA bidders can revise their valuations as the auction proceeds. For example, if bidding is unexpectedly aggressive a bidder may conclude that his initial valuation was too low. This helps increase th accuracy of bidding and can result in higher revenues and greater efficiency.

The SAA has two weaknesses relative to a sealed bid auction:

- The main potential weakness of the SAA relative to a sealed bid auction is that weak bidders may not participate. As mentioned above this is a particular concern when the number of lots is less than or equal to the number of incumbent operators. Unlike in a sealed bid auction, strong bidders can observe and match any weak bidder in an SAA and push them out of the market. Anticipating this, weak bidders may not enter which could reduce auction revenue. One possible solution to this is to reserve a licence for a new entrant in an SAA, as was done in the UK UMTS auction (2000).
- The second weakness is that it may be easier for bidders to collude in an SAA than in a sealed-bid format. This is because bidders can observe each other's behaviour as the auction progresses in an SAA.

The SAA also suffers from some of the same weaknesses as sealed bid auctions in a variable prize context. In particular:

- There may be strategic underbidding by large bidders to try and reduce auction prices (see above).
- There may be an exposure problem in variable prize auctions where lots are complements (see above).

Dynamic combinatorial auction

The Dynamic Combinatorial Auction (DCA) is essentially a variant of the SAA that allows for combinatorial bidding. In other words, bidders can bid on both individual lots and groups of lots in each round. The main advantage of the DCA is that is can limit the exposure problem that arises in the SAA format when lots are complements.

The FCC plans to use the DCA for the first time later this year, and it is an open question as to how well it will perform in practice. One obvious concern is that bidders may find it difficult to cope with the increased complexity introduced by combinatorial bidding. In addition, there are concerns that the DCA may introduce other sources of inefficiency.

Anglo-Dutch auction

The Anglo-Dutch auction is a hybrid format that combines the SAA and sealed-bid formats in two stages. In the first stage bidders are invited to take part in an SAA which proceeds until the number of remaining bidders exceeds the number of licences by 1. In the second stage the remaining bidders then make "best and final offer" in a sealed auction.

This format may be suitable in circumstances where the number of licences offered is the same as the number of incumbent bidders. For example, it was considered in the UK UMTS auction (2000) when it appeared that only four similar licences would be available. There was a concern that new entrants would be deterred from bidding because of the likelihood that the four incumbent 2G operators would outbid them.

As discussed earlier, sealed bid auctions can promote entry but suffer from the problem that bidders cannot refine their valuations and bids by observing the behaviour of their rivals in the auction. The Anglo-Dutch format attempts to combine the entry-promoting feature of sealed bid auctions and the information-sharing property of the SAA.

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