Working Paper

No 127

**Auctions and Precautions: Overbidding in
spectrum auctions and its possible impact**

Contents

Preface

How to allocate frequencies for the third generation mobile telephony? The Dutch government, like several other governments, has opted to auction the frequencies. Telecom operators oppose the idea of auctions, claiming that auctions lead to higher prices for consumers and less investment.

The Dutch Ministry of Finance asked CPB to look at the pros and cons of auctions. More specifically, the study analyzes whether auctions lead to overbidding and if they do, what the consequences of overbidding may be.

The study was conducted by Matthew Bennett (University of Warwick and CPB) and Marcel Canoy. Comments by numerous CPB colleagues, André de Jong, Eric van Damme and Jan Potters are highly appreciated.

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Leidt veilen tot overbieden? En zo ja, wat zijn de consequenties?

(Summary in Dutch)

samenvatting van CPB Werkdocument 127: 'Auctions and Precautions: Overbidding in spectrum auctions and its possible impact', dat donderdagmiddag 15 juni 2000 wordt gepubliceerd.

Op verzoek van het Ministerie van Financiën heeft het CPB een analyse gemaakt van de mogelijkheden tot overbieden bij het veilen van UMTS-frequenties en de gevolgen voor de marktontwikkelingen indien partijen inderdaad zullen overbieden. De belangrijkste bevindingen zijn:

1. In een markt voor mobiele telefonie waar vijf marktpartijen elkaar beconcurreren zal onder normale omstandigheden oligopoliewinst behaald worden. Deze winst ontstaat doordat de vijf marktpartijen een oligopolie vormen en toetreding van een zesde aanbieder is uitgesloten. Beperking van het aantal partijen in deze markt is maatschappelijk efficiënt omdat toekennen van frequenties aan vele partijen tot duplicaties van vaste kosten zou leiden.

2. Een veiling zorgt ervoor dat partijen bieden wat ze er voor over hebben om op deze markt te mogen opereren. Op die manier vindt door de veiling een overheveling plaats van de oligopoliewinst naar de Nederlandse bevolking. Na deze overheveling behoudt de onderneming een winstniveau dat correspondeert met de normale beloning voor risicodragend kapitaal en ondernemerschap.

3. Er zijn geen aanwijzingen dat veilen leidt tot *belangrijke* verstoringen, zoals sterke overbiedingen, hoge consumentenprijzen of lage investeringen. Met overbieden bedoelen we dat het bod hoger is dan rationeel te verantwoorden, gezien de bij normale (oligopolie-) marktverhoudingen te behalen winst op de activiteiten waarvoor de licentie wordt verleend. Deze 'normale' winst is dan gelijk aan (de contante waarde van) de eerder genoemde oligopoliewinsten.

Reputatie-effecten kunnen het rationeel te verantwoorden bod verhogen. Zittende marktpartijen hebben immers een groot belang om de veiling te winnen. Er ontstaat reputatieverlies indien zij de veiling verliezen, wat ook andere activiteiten van de onderneming schaadt.

4. Overbieding kan optreden bij informatieproblemen. Dit kan worden beperkt door een efficiënte organisatie van de veiling. Goede informatie leidt tot transparantie en damt daarmee de biedingen in tot een rationeel verantwoorde hoogte.

5. De hoogte van de veilingprijs is normaal gesproken niet van invloed op consumentenprijzen of op investeringen van de onderneming na de veiling. De betaalde bedragen zijn verzonken kosten. Prijs- en investeringsbeslissingen zijn daarentegen gericht op het behalen van winst in de toekomst. Hoge veilingbiedingen kunnen niettemin enige invloed hebben omdat zij gefinancierd worden op de kapitaalmarkt. Een lage prijs leidt tot een gunstiger financieel risicoprofiel, waardoor de kapitaalkosten van toekomstige investeringen afnemen. Dit kan van invloed zijn op investeringsbeslissingen. Dit is echter geen reden om oligopoliewinsten bij de onderneming te laten, dat wil zeggen de winst bovenop het normale rendement van kapitaal en ondernemerschap.

6. In bijzondere omstandigheden kunnen ondernemingen proberen een hoge veilingsprijs af te wentelen op consumenten. Dit kan gebeuren wanneer ondernemingen in een financieel kwetsbare positie terecht komen en daardoor een riskantere strategie kiezen, bijvoorbeeld door samen te spannen met andere ondernemingen om op die manier overwinsten te realiseren. Dit is echter in strijd met de Mededingingswet. Aangezien overwinsten (dat wil zeggen: winsten hoger dan normale oligopoliewinsten) onder normale marktverhoudingen weggeconcurreerd worden, kan een situatie waarbij vijf marktpartijen voor een langere periode overwinsten realiseren duiden op samenspanning. Indien telecomaanbieders aankondigen dat ze de veilingkosten aan de consumenten doorberekenen, zeggen ze daarmee impliciet: we gaan samenspannen. De prikkel om samen te spannen is er ook zonder veilingen en overbiedingen, maar wordt vergroot indien aanbieders hebben overboden.

7. Bij vijf telecomaanbieders moet de markt normaal gesproken zijn werk doen zonder dat prijzen of netwerktoegang door toezichthouders gereguleerd hoeven te worden. Toch kunnen er situaties ontstaan waarbij toezichthouders moeten optreden, namelijk indien aanwijsbaar niet-concurrerende prijzen ontstaan. De toezichthouders kunnen dan via de Mededingingswet acties ondernemen om te verhinderen dat eerdergenoemde samenspanning plaatsvindt. Een zekere mate van samenspanning zal evenwel niet verhinderd kunnen worden. Dit komt door informatie-asymmetrie (toezichthouders kunnen kosten moeilijk observeren) en eveneens doordat het politiek en juridisch niet acceptabel kan blijken als alle overbiedende telecombedrijven failliet gaan. Wel zou het acceptabel kunnen zijn als door het toepassen van de Mededingingswet het minst efficiënte bedrijf failliet gaat. Tijdige aankondiging van een dergelijke beleidsopstelling is gewenst en kan een disciplinerende werking hebben op het bieden in de veiling.

8. Het voorgaande betekent dat veilen een aantrekkelijk instrument lijkt om frequenties te verdelen. De risico's van overbieden zijn redelijk beperkt en met verstandig beleid terug te dringen. Een 'schoonheidswedstrijd' organiseren lijkt geen redelijk alternatief. Er zijn diverse voordelen verbonden aan een veiling boven een schoonheidswedstrijd. We noemen de selectiekracht van een veiling (efficiëntste spelers winnen) en de transparantie van het selectieproces. Omdat de telecommunicatiemarkt in toenemende mate internationaal is en in het V.K. en de V.S. al veilingen hebben plaatsgevonden, kan men zelfs betogen dat de schoonheidswedstrijd in landen als Finland en Frankrijk lijkt op een verkapte vorm van staatssteun.

9. Gezien de eerder genoemde reputatie-effecten zou het aantal van vijf nieuwe licenties bij vijf zittende marktpartijen ertoe kunnen leiden dat er geen nieuwe toetreder op de markt komt. Toch lijkt nieuwe toetreding niet onwaarschijnlijk, omdat er zich grote potentiële toetreders gemeld hebben en er kleinere zittende marktpartijen zijn, die bovendien nog geen lange staat van dienst hebben (en dus minder reputatie op het spel hebben staan). Een nieuwe toetreder op de markt verlaagt de kans op samenspanning en daarmee de prikkel tot overbieden.

Summary

Auctions are unlikely to lead to substantially higher consumer prices or lower investment levels relative to a free license or beauty contest unless firms are able to collude. If the firms bid anything up to the 'efficient' level equal to oligopolistic post auction profits, output and price is independent of the level of the license bid price. With the possible exception of the cost of capital, it is therefore not the auction that generates inefficient increases in price, but firms bidding at a level higher than expected profits or valuations via an increased incentive to collude in the post-auction market.

Bidding past the post auction oligopoly profits may occur due to a number of reasons.
- Firstly, managerial incentives may favor a successful acquisition of a license at a cost out of line with expectations of subsequent profits due to managerial preferences for firm size or scope of control rather than shareholder returns.
- Secondly, expectations of collusive profits will drive higher levels of profits and hence bidding past the non-collusive valuation of profits.
- Thirdly, the incumbent's loss of return on previous reputation investment through not receiving a license, may create significant incentives to bid above the profitable level for the license to take account of this opportunity cost.
- Lastly, because of the relationship between reptuation effects, incumbents, entrants and licenses, a mismatch between the number of licenses and incumbents will increase the probability of bidding above the level of expected profits ('past-profit' bidding).

Assuming that bidding past expected profits takes place, what will be the impact on post-auction prices? The sole means to regain profit losses derived from past-profit license bidding is through (tacit) collusion in the post auction market. Only through collusion will firms be able to charge higher prices than the non-auction case. All market states have some incentive to collude. Overbidding increases these incentives past the normal level when the firms are able to offset bankruptcy losses onto banks that supply their bid capital. Where it is possible to remove the ability to collude in the post auction market, the incentive to overbid via expectations of collusive profits is reduced.

We suggest two ways to mitigate incentives to overbid. Firstly, pre-announcing that competition will be vigorously upheld by the government allowing firms that make losses to leave the market and sell their licenses on, may ensure overbidding does not intentionally take place. Secondly pre-announcing that an uncompetitive market will be opened up to mobile virtual network operators (MVNOs) through access to the

incumbent's license holders networks will further reduce the likelihood of post auction collusion and hence overbidding. By writing a joint letter to the government stating that license costs must be passed onto the consumers, the incumbents have implicitly indicated that they will collude in the post auction market as only colluding allows the pass-through of the auction cost. The government must make it clear that any prices above the non-collusive level and hence involving the pass through of license costs, will be interpreted as collusive and not tolerated.

The incentive to past-profit bid via reputation effects is difficult to reduce, as the firm rationally bids up to its valuation of the license even though this is higher than the level of profits in the post auction market. However this past-profit bidding through reputation effects may be mitigated where there are at least as many incumbents as there are licenses. This is because the incumbent receiving the license will only pay marginally above the entrant's valuation. It is probable that incumbents have substantial synergies that reduces their costs and allows them to bid higher relative to the entrants, whilst still making a profit.

Finally, we comment that beauty contests are similar to state aid. Governments using beauty contests have chosen to allocate licenses for less than their free market value at the expense of both competition and consumers. A rational firm when receiving its license via a beauty contest does not provide a cheaper product, it simply increases profits at the expense of consumers. These favored incumbents are able to use the substantial profits accruing from their cheaper license to cross subsidise competition for auctioned licenses in other countries.

In reality, unless the auction has been poorly planned, it is doubtful whether the incentives to bid above the level of post auction profits will be strong enough to outweigh the benefits of insuring the least cost and most efficient firm supplies consumers. As all auctions planned to date include as many licenses as there are incumbents competing for them, we consider the incentive to overbid or bid past expected profits small. Consequently we do not expect to see significantly higher prices than the non-auction level unless the firms are able to collude in the post auction game. Even taking account of increases in the cost of capital and the small possibility of overbidding, the welfare gains from an auction are likely to outweigh these losses as long as the government can ensure collusion in the subsequent market is not possible.

Background

The Ministry of Finance has asked CPB to work out if overbidding for the third generation mobile licenses is likely. If overbidding seems feasible what will be the economic impact on consumers, producers and society? It is important to first define what we mean by overbidding:

> *Overbidding takes place where the firm's bid for the license is greater*
> *than its valuation of the license in a competitive post auction market.[1]*

Under normal market conditions five competing firms can achieve oligopoly profits in the post-auction market. Not taking into account any pre-auction activities by firms, a firm will rationally bid not more than the value of the post-auction profits. If it bids higher than these oligopoly profits we call it overbidding. We attach no judgement on this term whatsoever. One of the reasons is that overbidding does not need to be *foolish or irrational*, as we will explain later.

In the last two months there has been huge interest within European governments and telecommunications firms in the auctions for third generation (UMTS) mobile licenses. The UK auction completed on the 27th of April 2000 raised over £22.5bn of finance. This was several times more than expected and prompted an initial wave of interest in auctions across European governments, subsequently replaced by a backlash against them due to the perceived tendency to overbid and the ability to pass-through the license costs. This backlash against auctions has, to a large degree, been driven by telecommunications firms declaring that the high license costs will force them to price at unnecessarily high levels causing a slow down in the adoption of this new technology.

This paper looks closely at these recent claims, examining the theory and evidence that auctions encourage overbidding and result in excessively high prices for the new 3G mobile products. Whilst we comment briefly on some specific arguments for using an auction versus a lottery or administrative processes ('beauty contests'), existing literature discusses the general arguments in greater depth and we do not attempt to duplicate this work here.[2] Likewise, although we discuss the relative benefits of different auction designs in the overbidding context, for a full discussion the reader should turn to one of

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[1] Note that 'competitive' does not entail perfect competition, only that the firms do not collude.

[2] See the first text box for a brief summary of these arguments. Existing economic literature covers these arguments in much greater detail, for example van Damme (1997) or McMillan (1994).

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the many papers in the economic literature which discuss auction designs in detail.[3] Implicit in our discussion is that the auction has been designed efficiently, we acknowledge that where this does not take place, the conclusions from this paper may not necessarily hold. We believe, however, that the design of auctions is well addressed, both in the literature and in practice, up to the level where it is relevant to talk of an efficient auction for the current design.[4]

The structure of the paper is as follows: the first section looks at the conventional argument that the amounts bid in the auction for licenses will be passed through to consumers via prices in the subsequent mobile market. We find that this license cost pass-through will only occur when the firm has overbid, the possibility of which is increased when collusion within the post auction mobile market is possible. However, according to standard theory the likelihood of overbidding is remote. Section two looks at other reasons for overbidding such as: differing pricing strategies or managerial incentives. A firm may also bid past its profit level for reputational reasons attached to not securing a license. In section three we assume overbidding has taken place, and examine the ability for firms to pass overbid license costs through to the consumer. Section four discusses other arguments for and against auctions. Finally, the paper concludes with a summary of the likelihood of overbidding and the possible impacts.

The pros and cons of an auction versus a beauty contest are not addressed in detail here, but for a summary see the box below.

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[3] See the second text box for a brief discussion on design. Again, existing economic literature is thorough on the topic of auction design, for example see Klemperer (1999) or Milgrom (1998) for literature surveys.

[4] See Milgrom (2000) for a discussion of the efficiency of these simultaneous ascending auctions.

Auctions versus Beauty Contests

Whilst the primary purpose of this paper is to study the overbidding incentives and the ability to pass through license costs, we allude to many of the arguments for auctions versus a beauty contest in our paper and for convenience briefly summarise them here:

- Auctions are the fairest way to allocate scarce resources, as an auction reveals how valuable a bidder believes the license to be, and which bidder values it the highest.
- Auctions are transparent. All auction rules must be explicitly stated before the auction. This transparency mitigates lobbying and influences, preventing impropriety and even corruption (see McMillan 1994, for examples of where beauty contests fell short of the criteria for independence and fairness).
- Auctions are both efficient and flexible. They can be used to promote other policies as long as they are announced before the bidding takes place; i.e. a precondition of the auction could be the government wants the infrastructure in place within one year. Auctions allow firms to adjust their valuations given these other desired policies.
- Auctions are quicker and more economical than administrative allocation.
- The broadcast spectrum is a scarce good owned by the entire nation and thus it is not for a limited number of firms to exploit and extract the maximum profit without some level of compensation.

Within our paper, when comparing auctions with other mechanisms, we assume for simplicity that firstly the auction has been well designed and secondly that the auctions and other mechanisms will pick the exact same firms. Although (as we discuss in section one), in reality auctions are likely to result in firms with the highest levels of efficiency winning the licenses.

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1 Overbidding in standard economic theory

In this section we analyse firstly if the conventional argument that the amounts bid in the auction for licenses will be passed through to consumers via prices in the subsequent mobile market holds. Secondly, if overbidding can be consistent with standard economic theory.
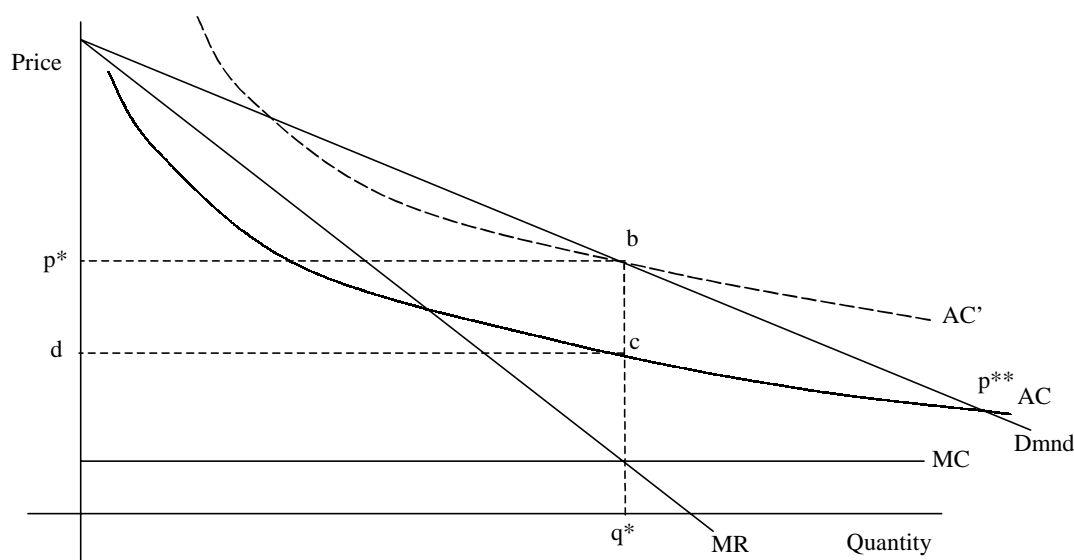
Pricing Under Auctions
The central argument of many telecommunication firms is the cost of a license is just another cost that must be recovered through the price for mobiles or service. Any auction that forces them to bid against each other, raises the cost of the license and will correspondingly increase the price of 3G mobiles and services to consumers. Analysing this argument first in the context of standard theory: the size of the bid should make no difference to either the price of service, or the incentive to invest. The bid is a one off sum, in economic terms a sunk cost which must be paid regardless of the price game in the second stage. Price and quantity in the second stage are determined by strategic interaction, whilst the sunk cost of the auction license simply redistributes any supranormal profit that the firm makes.[5]

As long as the auction bidding does not exceed the expected level of profits (i.e. no overbidding), the price and quantity decision is independent of the total amount bid (including the 'beauty contest' case where the license price is zero).

Firms attempt to maximise their profits given the behaviour of other firms. The optimal price is determined by the strategic interaction of the firms within the market and leads top oligopoly profits. This is illustrated on the following simplified diagram of the post auction mobile demand for a single firm:

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[5] Supranormal profit is defined as the level of profit over a market rate of return on the cost of capital. Zero supranormal profits (or the 'normal' profit level) includes a fair rate of return on capital invested, and hence include some degree of 'profits' as they are commonly perceived. We term this 'supranormal' to ensure the reader understands it is profit derived at the expense of consumer surplus.

Fig 1: Post Auction Product Market Under an Efficient Auction

This figure should be interpreted as the result when players compete in prices within a differentiated product market, resulting in a Nash equilibrium. When illustrating the firm's demand diagrammatically as above, point b (resulting in p*,q*) is the symmetric Nash equilibrium. For points where prices are not symmetric, the above demand and marginal revenue functions do not hold. This simplification is purely for illustration purposes allowing us to display the firm's demand and marginal revenues as linear rather than a series of complex reaction functions. Most importantly, our analysis does not rely on the fact that costs and demands away from the symmetric Nash equilibrium are identical.

When only the fixed costs unassociated with the auction license cost are considered, the resulting average cost curve is illustrated (AC). The firm knows its end product demand and hence the marginal revenue (MR) associated with an increase in production (given symmetrical competitor's reactions). Likewise it knows its marginal costs (MC).[6] The individual firm's profit is maximised where marginal revenue is equal to marginal cost,

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[6] The case where a firm does not know its costs or demands has been studied by Leland (1972) resulting in the profit maximisation where expected marginal revenue equals expected marginal cost. We also relax the assumption of marginal cost pricing in section 2.

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resulting in the symmetric Nash equilibrium price of p* and quantity produced at q*. It is important to note that the profit maximising level of production decision is independent of the average cost (AC) and hence the license amount bid. The average cost (and hence bid price) does not determine the level of price or output, only the level of supranormal profit the firm makes. In figure one the total supranormal profit is p*bcd, we will term this π_n for the symmetric Nash level of profit.

Introducing an auction for licenses ensures that firms compete against each other, raising their bids to the firm's true valuation of the license. Increasing the bid level (we term the bid level 'B') shifts the average cost curve up and to the right of the initial curve AC. An efficient auction ensures that firms bid up to their valuation of the license (i.e. up to the level of supranormal profit that it will make, $B = \pi_n$). This shifts the average cost curve from AC to AC' reducing the level of supranormal profits to 0.[7] The auction has ensured that the license fee is equal to the firms valuation of the license fee, which is equal to the level of supranormal profit in the market (π_n). In this context, the firm will never rationally bid to points above AC' (where Nash profits are negative) as post auction it will make less than the market return on capital. Where cost curves are identical amongst bidders, it is unable to win the license with a bid lower than π_n as a competitor can profitably increase the bid to π_n making Nash profits and capturing the license. We reiterate the fact that at a license cost of up to π_n, the quantity (q*) and price (p*) are identical to those in giving away the license free. An efficient auction merely removes the supranormal level of profits accruing to the firms. The Nash levels p* q* resulting from both an auction and a beauty contest, are not welfare optimal. Yet, the welfare optimal levels are not feasible. A social planner would give the license for free but create a harsh regulatory regime for the post auction market, leading to zero profits for all firms. Because such regulation is very costly in practice, governments have decided to rely on the number of competitors to maximise welfare, auctioning any excess profits rather than using an explicit form of regulation.

Investment under Auctions
The Nash profit level includes a fair rate of return on existing investments. Future investments offering an equal or higher rate of return to the market are encouraged, increasing the level of profits made. However, investments offering returns below the market rate are discouraged, as these reduce the expected profit (π_n) and hence the level a

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[7] Where cost functions differ, the efficient auction sells the license at a price just above the next highest bidder's. This will still allow some level of supranormal profits to be made by the winner depending on how much lower both its fixed and variable costs are relative to the next highest bidder, a point important for determining the impact of overbidding.

firm is able to bid to. Firms and some economists have argued that in the long run some degree of monopoly profits is necessary to allow innovation and research and development. This forms the basis of the Schumpeterian belief that competition may be destructive through the inability to both perfectly compete and innovate simultaneously.[8] However, generally the network service providers bidding on licenses do not have large research and development departments.[9] Investment tends towards the uptake of existing innovations such as new data compression techniques or installment of optical switches used to reduce costs or improve the product. The risk factor of such investments is smaller than that of research and development, reducing the need for large amounts of capital for uncertain gains. Investment in the networks will take place as long as the return on the investment is greater or equal to the market rate, which renders the use of the Schumpeterian argument invalid.

Another powerful argument against the claim that auctions are bad for investments was very recently made in the Financial Times:

> "The cost of the infrastructure needed to operate the just-granted third generation licences has been estimated at £12bn. Analysts had expected that investment to be made quite cautiously. Now they are thinking again. "Deploying only in the hot spots works well until you spend £5bn for a licence," says Marcus Nash of UBS Warburg. "If you have got only 20 years to make the returns on that stack up, then maybe you have got to roll it out more quickly." The rate of investment may, in fact, speed up rather than slow down."[10]

Even where an investment requires large amounts of capital (such as the 3G mobile service infrastructure will), firms are able to turn to the market for funding either via share rights, or corporate bonds. These lending markets are well developed and will ensure that investment at or above the market level will be funded. Where large amounts of capital is required this may be secured through the debt market although potentially at the expense of slightly raising the cost of capital (discussed in section 3). We believe that

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[8] For further information on the relative incentives to innovate for monopolists and competitive firms see Dasgupta and Stiglitz (1980).

[9] Even where the firms are innovators, Arrow (1962) shows that the competitive firm has a stronger incentive to innovate than the monopoly. This is conditional on receiving a patent granting the sole production of the new product allowing the competitive firm to become a legal monopoly.

[10] Financial Times, Mobile 'scourge' rings in an economic boom: June 5th 2000

far from discouraging all investment, an auction encourages judicious investment, whilst deterring inefficient investment.

Criticism has been directed at the auction for 'seizing' profit from firms, declaring that governments should not exhibit a 'grabbing mentality' and maximise revenue. There are three arguments against this: Firstly, previous discussion has shown that the profit discussed is supranormal, above the market rate of return on capital. The efficient bid at $B = \pi_n$, still allows Nash profits and judicious investment.

Secondly, more fundamentally, the radio spectrum is a scarce good owned by no single individual. It is a limited valuable resource owned by everyone and thus susceptible to overuse. In the absence of government allocation there is a clear incentive for firms to overuse the spectrum by using the same frequency bandwidths, this causes interference between calls and results in a sub-optimal service to society. As such the quantity of this scarce good must be allocated to the most efficient level by the government. Using an administrative process or beauty contest to allocate the spectrum allows the relatively small minority of shareholders to derive all the supranormal profit from the public good. An auction where the supranormal profit accrues to the government, which can then redistribute it to the entire population, is likely to greatly improve the distribution of wealth in society relative to favoring a smaller number of shareholders.

Lastly, an auction may also increase the total level of welfare over that derived through a free license via the selection procedure. An auction ensures only the firm with the lowest costs, hence the highest valuation of the license and greatest ability to bid, will win. This results in higher allocative efficiency. The lower marginal cost of the bidder drives lower prices, higher quantities and the highest welfare gain to society, in the post auction market. In addition, because the entire supranormal profit (π_n) is bid away by the firm to win the license, this increases the incentive to lower future costs and create profit though dynamic efficiency. Both these points strengthen the argument that the total level of efficiency will increase as the result of an auction. The above is under the assumption that the auction is designed efficiently, whilst we do not go detail here, we present a summary of the merits of mechanism design in the box below.

In summary, standard theory shows that as long as the bid price does not exceed the expected levels of supranormal profit (π_n), an auction leads to post auction prices and quantities that are identical to an administrative process or 'beauty contest'. Note this assumes identical players are selected via the beauty contest as the auction, where this is not true post auction prices are likely to be lower due to lower cost firms being selected. There is no rational reason for firms to overbid past this level and push subsequent prices

and quantity into inefficient outcomes. The next section examines whether other incentives to overbid, not accounted for in standard theory, exist.

Auction Mechanism Design

The design of the auction has important ramifications for the efficiency of the auction. Whilst we discuss the impact of changing some elements of the designs such as the number of incumbents and the licenses, we leave debates such as whether a single closed envelope methodology is better than the sequential methodology to other authors. Although this is an extremely complex area there are a number of excellent articles expressing exactly what impact these methodologies have on the auction's outcome. Most recent work by Milgrom (2000) has concentrated on the efficiency of the simultaneous sequential auctions used for the current spectrum allocations, finding that in practice, like theory, the designs are well addressed.

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2 Arguments for overbidding

In this section we look for other possible motivations for inefficient outcomes relative to an efficient auction and find that two types of overbidding exist. Firstly, we consider the incentives for firms to bid above their valuations, as per our definition of overbidding, finding that these generally are the result of market imperfections. Secondly, we consider that firms bid to their valuations, but for various reasons their valuation of the license is greater than the expected profit in the subsequent market. For clarity we do not call this overbidding, as the firm rationally and knowingly bids up to its valuation, instead we term it "past-profit" bidding. As we show, the impacts of these two outcomes are the same, potentially resulting in inefficient prices or losses for the firm.

Manager versus Firms Incentives
The standard theoretical model in section one assumes that the firm maximising profit has identical preferences to the managers that run the firm and make the bidding decisions. What happens if the managers/consultants that bid on behalf of the firm's shareholders have separate and different utility functions from the shareholders? There is a long literature on the separation of firm's and manager's incentives which we will not discuss

in detail here.[11] The central question is why should managers have the incentive to overbid? This could be due to a number of reasons. Firstly, managers may want to maximise the overall geographic share, scope of control or simply the power of the firm, all of these generally can involve bidding at levels above π_n (overbidding) to ensure the firm remains in the market. Secondly, the downside for managers losing the bidding process may be much lower than zero, the firm's loss if they lose the bid assumed in standard theory. Managers risks losing their reputations, signaling the managerial market that the managers were part of an unsuccessful attempt to move into the market. This increases the incentive to overbid above the profit maximisation level to ensure a license. Even if this incentive pushes costs above the level that subsequent sales can recoup, the slow process of bankruptcy may give the chance for the manager to leave the firm with his reputation intact.

Clearly in a perfect world where all information, manager's preferences and actions are perfectly observable to shareholders, it is relatively simple to create an efficient managerial incentive system to reduce the desire to overbid to zero. However, equally obvious is that reality does not subscribe to this world of perfect information. Given managerial incentives to overbid, and informational asymmetries, there are two broad strategies the government may pursue. Firstly it may promote further links between managerial remuneration schemes and share price, bringing manager's incentives back into line with shareholder's thus reducing the incentive to overbid. Secondly, encouraging shareholders to provide representatives on the bidding team will further ensure the union of shareholders and bidding incentives.

Where shareholders are short termist inline with managers then it is not clear why the regulator or government should bail out a company that has made a bad judgement. Arguing that shareholders are short termist, and do not consider the longer-term losses that overbidding a license will produce brings us into the possibility of inefficient markets. This section of literature relies on imperfectly informed or irrational investors and although these possibilities increase the incentives to overbid, we remain with the belief that shareholders are rational.

Generally, as the markets for these 3G mobile services develop, both companies and shareholders will have a more informed view of the correct level of bid. Managers may find it more difficult to significantly bid above the value and depart from the efficient

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[11] See Baumol (1962) for an early analysis of this problem or Demski, Sappington and Spiller (1987) for discussion of the discipline that the stock market may impose on managers via takeovers.

level without being doubly penalised, first via the stock market through a falling share price and potential takeover, and second via a reprimand from the shareholders that sit on the firms board.

Higher Profit Expectations

The previous paragraph shows that where manager's and shareholder's preferences differ, this may create overbidding in an imperfectly informed world. In this subsection we analyse differing expectations of profits, looking at the possibility that higher expectations of profits will drive firms to overbid past the symmetric Nash solution. Present telecommunications firms have enjoyed returns on capital significantly in excess of other industries. One of the reasons cited for this is because the previous licenses were given away at far below their actual costs. The US Department of Commerce estimates that the aggregate value of share prices of those firms receiving a free license during the 1980's was increased by \$46bn.[12] Recent announcements by the incumbents have committed them to strong rate of returns even taking account of the license costs.[13] If the incumbents really believe this, as opposed to just attempting to reassure shareholders, it creates expectations of profits in excess of the Nash solution both for the market and for the bidders. The higher expectations of profits allows the firm to bid up to levels greater than the Nash equilibrium level (π_n).

Clearly there remains the question as to how the incumbents will maintain their rate of return in the face of the auction costs. The only way is to increase profits, reducing costs or increasing prices to a more profitable level may do this. Reducing costs increases welfare for the firm without reducing welfare for the consumers but we will assume that costs are already at the lowest level. Raising prices above the Nash level may only be sustained profitably through collusion. We term the highest level of profit in the market where all the firms are colluding as collusive profit. Bids based on collusive profits are termed overbid, that is at levels greater than the Nash competitive level of profits, however they are not bid past their expectations of collusive profits, as the collusive profits are greater than the Nash level of profits. We concentrate on the firm's ability to collude in section three. Note that like overbidding based on managerial incentives, the firm will need to rely on collusive profits to sustain profitability. However unlike the other argument, it is the expectations of collusive profits that drives the bidding over the

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[12] See US Department of Commerce (1991), "U.S Spectrum Management Policy: Agenda for the Future" Washington D.C NTIA pp. D6

[13] "Vodafone AirTouch chief executive Chris Gent (announced) his group expected a 'very acceptable' rate of return from its investment in a third-generation mobile network in Britain despite the high cost of the licence". The Guardian, United Kingdom, May 31, 2000

level of the efficient auction, that forces the firms to price higher than the efficient auction, at the collusive level in the post auction market. Thus in this case, collusive expectations drive overbidding and collusive prices. Breaking these expectations breaks the incentive to overbid.

As we will discuss in the reputation subsection, the firm may place additional externalities in winning a license. For example, if there are synergies that exist between the new technology and existing technologies. Within the paper framework we consider this as increasing the profitability of the market to the firm and hence the bid. However, in itself this is not overbidding by our definition as long as these externalities or synergies are derived from Nash competitive profit sources. Where synergies result from the ability to collude or restrict other markets through the control of a third generation license, then bidding reflecting these can be termed overbidding.[14]

Mark-up pricing

As discussed in section one, overbidding past total supranormal profit (p*bcd), is not consistent with a rational firm's profit maximisation strategy assuming no other distortions. However, recent work has questioned whether the marginal condition for profit maximisation is actually used within real businesses.[15] More in particular, telecom operators often use numerical examples which includes a fixed mark-up on avegare costs, assuming that this is how they price in reality. It is argued that many businesses use a basic cost plus markup pricing methodology as even when they have an understanding of where their own marginal revenue and costs are, it is highly unlikely that they know their competitors costs and hence the location of the Nash equilibrium solution. This is relevant in the context of the oligopolistic end market we are facing here, in which unlike monopoly and pure competition, firms have to think of the strategy of other players when they set their price.

Because of these informational constraints, firms may use a basic cost plus markup pricing methodology as a rule of thumb. Even where simple price markup rules are used, these are unlikely to be completely exogenous from the absolute level of price. In reality the level of price markup will be a function of average costs. Where the license cost is

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[14] One externality that holding a license creates is increasing the number of calls terminating on the network, because these have historically been at higher than the Nash competitive price (see later Vodaphone footnote). This higher expectation of profits increases the value of the bid, however it increases it above the level of the Nash competitive profit and is considered overbidding in the same way as collusive expectations.

[15] See Offerman and Potters (2000) for a more detailed analysis of this specific question.

free and hence average costs are low, the firm is able to place a large markup on costs, increasing the degree of profit whilst still maintaining demand. Where the license cost is close to the total level of profit estimated, the firm will know that a large price markup will result in price being greater than demand, and will make large losses. Thus supposing the rule of thumbs such as markups are used, these are likely to be used with reference to the demand at each level of cost, thus approximating a marginal profit maximisation rule.

Overly simple rules of thumb such as the average cost plus a constant 10% markup independent of the level of price, will give rise to inefficiencies within an auction due to pricing above or below the Nash equilibrium. These inefficiencies are more problematic where the rule of thumb leads to over-pricing and hence overbidding, that is where expectations of profits are higher than reality. Under-pricing and hence underbidding reduces the amount of profits transferred to the government but this may increase welfare due to increases in quantities sold. Thus we analyse overbidding only. When examining these pricing rules, it is not clear why even under an extreme rule of thumb such as a simple cost plus constant markup should lead to overbidding any more than other rules such as profit maximisation.

Whilst a firm may not know the optimal Nash price and quantity to charge in the post auction product market, it will have an estimate of its total predicted profits given the pricing rule it intends to use. This total profit estimation can be separated into the level of profits deriving from the constant 10% markup (in the simplest case) and the remaining level of profits that may be used in bidding for the license fee. It is irrational for firms to make a best estimation of the total expected profits first bid up to this level, then expect to make higher profits on top of this best estimation by adding an additional markup. This double markup and overbidding increases the average cost curve to above the level of its original expectation of profit. Consequently the firm has knowingly bid its license cost to its estimation of total profits and then expects further profits! Naturally the first, best estimation of profits cannot be the best estimation if there are further profits to be made. Thus bidding under such a naïve price rule not only results in losses to the firm but is irrational.[16]
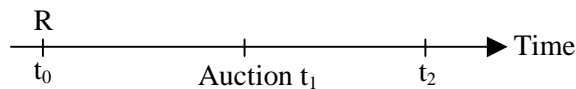
In light of this, the overbidding outcome is only reached when the rule of thumb is naïve enough to consistently over estimate the profit maximising price, and hence consistently

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[16] Notice that subsequent to overbidding, pricing at levels above p* may only be profitably sustained through collusion. We discuss the feasibility of this in section three with reference to the impact of overbidding.

overestimate the degree of supranormal profit achievable. Firstly, the likelihood of consistently making such a mistake is no greater than overestimating the classical profit maximisation rule and hence cost mark up pricing per se should not increase the likelihood for overbidding anymore than profit maximisation. Secondly more fundamentally, whether a firm can rely on any pricing rule that consistently overestimates profits and still be able to survive within a market where other firms bid correctly is highly doubtful. Lastly, supposing that firms do make such estimation mistakes in the short term. These 'overly' high prices will only be profitably sustained through collusion, thus policy recommendations should be directed at ensuring credible regulatory commitment to prevent this (discussed in detail in section three).

Asymmetrical Reputation Effects (the incumbent's downside)

The previous managerial incentive argument assumes that shareholders' and managers' incentives are out of line, with only managers facing a utility loss when they are unable to secure a license. However a similar, more general loss argument can be constructed for firms. Let us consider that an incumbent firm is able to invest in its reputation, this reputation creates a brand image for its products and increases the utility that consumers derive from buying the incumbent's product. We also consider that this reputation investment is not undertaken by the entrant as it not present in the industry at time $t = 0$. We suppose that the incumbent has anticipated a new technology at time $t = 1$, that will last until $t = 2$. The incumbent believes that the status quo of beauty contests will ensure it receives a license for the future technology. Thus at time $t = 0$ it invests R into the industry, with an expectation of getting a return at least equal to this investment R over the time period until $t = 2$.

For simplicity we assume that the discount rate is 0, the lengths of all periods are the same, and at time t_1 the firm has recovered exactly half of the sunk cost of the reputation, with the expectation of recovering the other half over the future time period. To complete this simple model we consider there are some sort of synergies and cost differences existing for both the entrant and incumbent that result in higher profit expectations relative to the simple case (π_n). One way to think of these synergies are as profits above the Nash level π_n simply resulting from more efficient operations. We label the incumbent's synergies $\pi_{s,i}$ and the entrant's $\pi_{s,e}$.

Suppose that the bidding has progressed until the license cost is equal to the Nash level of profits in the market without synergies, π_n. If the firm withdraws from the auction at this point, we assume that it will not be able to make a return on the outstanding reputation that it expected to make in the new technology market, resulting in a loss of $\frac{1}{2}R$. The sunk cost nature of the reputation of the incumbent may create an incentive to bid at higher than its total valuation of profits in the market $(\pi_n + \pi_{s,i})$. Why is this and under what circumstances? We consider four cases:

First, the entrant and incumbent have identical synergies $(\pi_{s,i} = \pi_{s,e})$ and hence identical expectations of profit in the final market. In this case the incumbent and entrant bid up to the total level of expected profit $\pi_n + \pi_{s,i=e}$, above this level the entrant without the reputation invested will withdraw from the auction, leaving the incumbent to receive the license at a level not higher than $\pi_n + \varepsilon$ where ε is the smallest incremental bid possible. In this case the incumbent has bid fractionally above its expectation of profit. For practical purposes we consider the amount ε that the firms loses to be negligible.

In the second case we consider that the incumbents synergies are greater than the entrants, $\pi_{s,i} > \pi_{s,e}$. We start where the bid is equal to π_n, above this level the entrant will continue to bid until the point $\pi_n + \pi_{s,e}$ equal to its total expectation of profits. The incumbent is able to bid higher as $\pi_n + \pi_{s,i} > \pi_n + \pi_{s,e}$, resulting in the incumbent winning the license at a cost of $\pi_n + \pi_{s,e} + \varepsilon$. Because the bid is less than $\pi_n + \pi_{s,i}$ the bid is neither above the incumbents valuation of the license, nor the level of expected profits that it expects to make. In this case the incumbent is able to make supranormal profits ε lower than the difference between the entrant's and its synergies, i.e. $\pi_{s,i} - \pi_{s,e}$. The result is that the incumbent wins the license, makes supranormal profits and neither firm has bid over either its valuation or the expected subsequent market profits.

In the third case, the entrant's synergies (or cost savings) are higher than the incumbent's and the incumbent's synergies plus its reputation effects. Thus both the incumbent's and entrant's synergies are greater than 0 with $\pi_{s,i} < \pi_{s,e}$ and $\pi_{s,i} + \frac{1}{2}R < \pi_{s,e}$. Consider where the bid is equal to π_n, clearly both the incumbent and entrant have an incentive to continue bidding due to the synergies. Now consider where the entrant's bid is equal to $\pi_{s,i} + \pi_n$, will the incumbent bid higher? The incumbent knows that losing the license will lose it the return on reputation equal to $\frac{1}{2}R$. As long the loss from bidding past its expectation of profit remains less than the reputation loss $\frac{1}{2}R$, the incumbent will continue to bid. This allows the incumbent to bid up to $\pi_n + \pi_{s,i} + \frac{1}{2}R$ where it will makes a loss of $\frac{1}{2}R$ in the subsequent market. However because the entrant's basic profit and synergy combined are greater than this, the entrant is able to fractionally raise the incumbent's final bid to win the license at a cost of $\pi_n + \pi_{s,i} + \frac{1}{2}R + \varepsilon$. Clearly the

incumbent has bid past the level of future profits although not lower than its valuation, whilst the entrant has not. Because the entrant wins the license we are unconcerned that the incumbent has bid past its expectation of profits. In fact, although the entrant who has received its license at a premium of ½R over the non-reputation case may not be pleased, the reputation effect allows the license to be sold at closer to the entrant's true valuation and thus increases the auction's efficiency.

Now consider the fourth case, where both firm have synergies but the entrants synergies are higher than the incumbents although less than the incumbent's combined synergy and reputation effects, thus, $\pi_{s,i} < \pi_{s,e}$ and $\pi_{s,i} + \frac{1}{2}R > \pi_{s,e}$. Once again both the incumbent and entrant have an incentive to bid past π_n due to the synergies. The incumbent will again bid up to its valuation of profits in the subsequent market at $\pi_n + \pi_{s,i}$, up to this point neither party has bid above the level of profits in the subsequent market. At this point the entrant can still make positive profits as $\pi_{s,i} < \pi_{s,e}$, thus continues to bid until it reaches its total expectation of profits, $\pi_n + \pi_{s,e}$. Above $\pi_n + \pi_{s,i}$ like the third case, the incumbent will continue to bid as long as the total losses in the subsequent market are less than the return on the second part of the reputation, ½R. Unlike the third case, because $\pi_n + \pi_{s,i} + \frac{1}{2}R < \pi_n + \pi_{s,e}$ the incumbent is able to bid higher than the entrants highest bid of $\pi_n + \pi_{s,e}$. In this last case the incumbent has bid above the entrant, and the its own total expected profits to win the license.

This fourth case is of interest because the incumbent has bid over its level of total expected profits, and thus incurs a loss in the subsequent market. Notice that the firm has not bid higher than its valuation nor does the bidding rely on market irrationalities, as the level of the incumbent's bid ($\pi_n + \pi_{s,e}$) is still less than its valuation of the license $\pi_n + \pi_{s,i} + \frac{1}{2}R$ as $\pi_{s,i} + \frac{1}{2}R > \pi_{s,e}$. However, the firm will be making a loss and thus has bid over the expected profits in the subsequent market, because of this loss we term this 'past-profit' bidding.

In only one out of the four cases will past-profit bidding result in winning the license. However it is useful to discuss the likelihood of this case in reference to the others. In the simplest instance where entrants are brand new to the market, it is unlikely that the entrant will have higher synergies than the incumbent's. This is because the incumbent is working in the current domestic second-generation market and will likely possess important knowledge crossovers and also have some central administration features already in place, where as the entrant is required to create these from the start. This rules out the possibility of cases one, three and four meaning that it is unlikely that incumbents will bid over the level of their profit expectations when the marginal bidder is an entrant. A more realistic view may be that the entrants have had long experience in other markets

potentially more mature and more advanced than the incumbent. For example it is likely that the incumbents in the early 3G markets such as the UK or Finland, will be the entrants in the later markets, for this reason the entrants may well have greater synergies than the incumbents and create the possibility of the fourth being a viable outcome. Even with this possibility notice that in three out of the four cases, without reputation effects for the entrant, the incumbent wins the license. This creates strong predictions that an incumbent will generally win the license.

Lastly the above model assumes that the marginal bidder is an entrant. What happens where the marginal bidder is another incumbent? In this case one may well imagine that both firms' synergies are identical as are their reputation investments. This would result in the winning incumbent bidding up to the level of the losing incumbent's marginal bid, which of course would include the opportunity cost of its reputation, ½R. Thus an incumbent bidding against an incumbent greatly increases the likelihood of past-profit bidding and creating losses in the subsequent market. This creates a clear need to ensure that there are at least as many license as incumbents, an issue that we discuss in the next section.

This reputation effect argument is an area that many of the more recent papers in auctions have not explored. The existence of a sunk opportunity cost for firms that don't secure licenses may account for the under-predictions of experiments conducted prior to the UK auctions in examining the likely bidding levels. Binmore (1999) in helping the UK government to design the spectrum auction mechanism, used a number of different experiments to test various modifications of the US auction structure.[17] However like other work these experiments have not factored in some degree of reputation effect that can not be regained where a license is not obtained. In consequence this omission of negative utility may explain why the experiments have significantly under predicted true bid levels.

The Number of Incumbents and Licenses Available
The reputation effect argument of the previous subsection makes it clear there is a relationship between the number of licenses for auction and the number of incumbents. Where there are more incumbents than licenses we predict that the possibility for past-profit bidding is significant. Where the number of licenses available are greater than the number of incumbents we would expect that the incentive to bid past profits is dramatically reduced and its possibility is probably not significant. The outcome where

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[17] See http://www.spectrumauctions.gov.uk/ucag/documents/ucag(99)17.htm for the minutes of the UK spectrum authority and a brief description of Binmore's experiments.

the number of licenses is equal to the number of incumbents (such as the current situation in the Netherlands), is much harder to predict in general. With the five licenses and five incumbents within the Netherlands, the reputation argument predicts strong competition in bidding where an entrant is determined to enter due to high synergies. However past-profit bidding will only be likely where the entrant has high synergies. Due to the match between licenses and incumbents and the entrant's knowledge that incumbents have an increased incentive to win, there is some danger that the entrants will not attempt to enter this market. The time and effort required in bidding for a mobile auction is significant with firms incurring these in vain where a license is not obtained. Consequently, if entrants believe that the auction outcome is a forgone conclusion, they may decide not to enter. An auction of five bidders for five licenses is highly unlikely to secure license revenues coming even close to the firm's true valuations of worth. So in theory there are some dangers of equaling the number of licenses to the number of incumbents.

The situation in the Netherlands with regards to deterring entrants from bidding is more favorable due to considerable differences in the sizes and ages of the incumbents. KPN and Libertel both have large portions of the total market share for the second-generation mobile market, translating into large downsides if a license is not achieved. The other three competitors are much more recent entrants, with smaller market shares, less reputation at stake, and in some cases smaller parent companies. As such these less established incumbents are not likely to deter other entrants from bidding when one bears in mind that the possible new entrants to the 3G market are often large incumbents in 2G markets.

Even when the foreign incumbents are identical in size and power, entrants may still bid for strategic reasons although not expecting to secure a license. Both the incumbent and entrant firms operate across many markets and will encounter each other in a number of third generation mobile auctions across the world. Bidding up the price of a license in one market reduces the incumbent's ability to use resulting supranormal profits to subsidise large bids in another. This strategic bidding argument is often cited as a problem with auctions. However, contrary to popular opinion we see this not as a problem of auctions but as an asset. Even where the outcome of the auction is likely to result in the incumbents receiving the licenses, the strategic bidding of possible entrants will prevent collusion between the incumbents allowing the seizure of large supranormal profits. Will this strategic bidding push the incumbents into overbidding? It is improbable that an entrant will be willing to risk bidding significantly above its own valuation and into the realms of the incumbent's valuation for fear of winning the license and facing a huge 'winners curse'.

Whether the Netherlands needs another license to guarantee six competitors is doubtful. There is a trade-off between the number of competitors and the bandwidth assigned to the licenses. Economically, increasing the number of licenses involves increasing the number of networks and consequently duplicating fixed costs. *It is important to note that we assume here that the frequencies available will not be changed in the near future.* If more frequencies do become available in the near future we clearly face a very different situation. Technically, firms need a minimum amount of bandwidth out of some finite total to effectively operate the services they desire (such as video). Splitting the total bandwidth into more than five licenses may be inefficient and unnecessary.[18] On the plus side an entrant to the bidding two main purposes. During the auction stage, it plays an essential role in ensuring that incumbent's bid up to their true valuation, thus minimising the level of supranormal profits accruing to incumbent firms. In the post auction game, an entrant is an asset, whose presence may mix the existing market reducing the possibility of collusion.[19] In conclusion there is a strong probability that entrants will bid in the auction due to both the differing size of the incumbents and hence the real possibility of securing a license, and the incentive to strategically bid.

Over or Past-Profit Bidding in the U.K.?
Empirical evidence that stock market short termism drove the UK auction to over, or past profit, bidding is difficult to find. On one-hand BT shares post auction did not differ significantly from the FTSE-100, strengthening the argument that BT was expected to secure license. However, Vodaphone's shares increased strongly on the news of achieving a license, even though one would expect this to be already discounted into the share price. Subsequent to this initial jump, the shares quickly fell as shareholders began to question the amount that Vodaphone had paid. The fact that the new entrant's (TIW) share price jumped over 10% on the day after the announcement with heavy buying, (although rapidly slipping back to the pre-auction rate) may indicate that winning the license was not factored into the entrant's share price unlike the incumbent's. Where there is evidence of stock market short termism it is likely that this will fade in the longer term. As previously mentioned, with greater experience, it will become more evident that a given bid value is too high or low, and the firm's shares will adjust after the auction to reflect this. Potentially some degree of short termism may have existed in the UK

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[18] Five licenses appear to be the preferred number in Europe, balancing the trade off between the minimum requirement of bandwidth for a license and competition. Recent announcements in France suggest that the government is also considering five licenses even though there are currently only three incumbents.

[19] The Economist 06/05/00 provides a nice discussion of this point in reference to the UK and German auctions.

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example as demonstrated by a reduction in many of the firms share prices, but this short termism is unlikely to be persistent into other markets. Subsequent auctions will benefit form both increased knowledge and experience to indicate to shareholders when a bid is over the efficient level and the firm is unable to sustain collusive prices consequently creating losses, an issue we return to.

The UK auction may well have raised a previously unimagined amount of finance, but generally the bidders firm's shares have remained on the buying list of industry analysts. This indicates one of three things, either the firm has overbid and analysts and shareholders are simply naive, the firm has overbid but believe that the regulator is not credible in its goal to ensure competition, or the firms have not overbid. A recent report by Lehman Bros 'Short Term Pain for Long Term Gain' declares that the fundamental outlook for the European mobile industry is "extremely positive" reiterating that the short, medium and long term prospects are good.

Whilst the auction prices of around £370 for every person in the UK may seem like a huge figure, discounted over the 20 years of the license for a constant mobile coverage of 50% of the population, this works out to be under £5 per month.[20] Even adjusting for a license span of 10 years the amount is under £8 per month. We reiterate that this £5 per month cannot be passed through to consumers unless the firms are able to collude, the £5, under an efficient auction, is simply the reduction in the profits to bring the firm's return down to the market rate of return.[21] All these underlying facts coupled with the theory in the previous section and the structure of the auction, support the view that whilst the UK auction generated huge revenues, these revenues are probably not the result of over or past-profit bidding, but a reflection of the belief in the profitability of this new market. Whether these beliefs will come to fruition is uncertain, whilst the amounts that have been paid for the licenses present certainties that have to be accounted for. This difference between the cost certainty and the benefit uncertainty could well be driving the shares down until the uncertainties surrounding the new technology and firm's business plans become clearer.

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[20] Other permutations of coverage and license timescales can be calculated using the standard Present Value (PV) formula where $PV = x\left(\dfrac{1-(1+i)^{-n}}{i}\right)$, PV is the license amount per person, i is the discount rate, n is the number of years the license runs for and x is the amount per month that the firm requires to cover the license.

[21] When we use the term 'collude' we refer to tacit, as well as explicit collusion.

Summarising, managerial incentives and profit do, to a certain extent, point towards overbidding incentives. Asymmetrical reputation effects for the incumbents and the number of licenses don't strictly speaking create incentives to overbid past their valuations, but it does create incentives to bid past-profits. Whilst there is a difference here (the first relying on imperfect markets, whereas the second does not), we find that the result from overbidding or past-profit bidding is the same. The simple markup-pricing rule however, is an unlikely explanation for either type of bidding, relying on firms estimating profit incorrectly, a mistake that will be punished by the market in the longer term.

3 The impact of past-profit or overbidding

Section one showed that where licenses are bid at levels at or below the symmetric Nash profit level (π_n), the firm still maximises profit (given strategic interactions and no collusion) by producing at the same price p* and quantity level q* as the non-auctioned license. Thus price and quantity subsequent to the auction is independent of the bid level. Section two has shown that there is some possibility of overbidding via managerial incentives and expectations of profit, and past-profit bidding via an increased downside of the incumbent firms versus the entrants. This section starts with the assumption that over or past-profit bidding will take place, then looks at whether it can generate higher prices and lower quantities, relative to both the efficient auction and free license levels of (p*, q*).
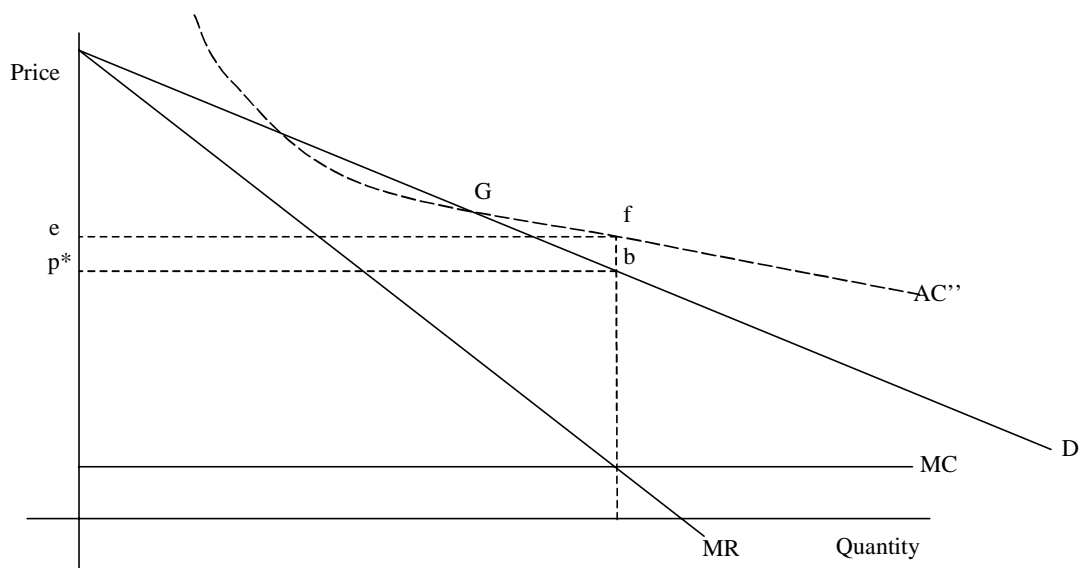
Incentives to Collude

Firstly, separate from the arguments developed in the next paragraphs, there is a possibility that the probability of collusion is further increased due to the auction process. Offerman and Potters (2000) find that collusive incumbents are more likely to win an auction due to the earlier profits they have made in the pre-auction stage (the equivalent of the second-generation mobile market). However in subsequent auctions the selection effect of the first (3G) auction was found not to have a significant impact on the average price level. In effect the auctions create a more level playing field for subsequent competition.

Bidding past the firm's valuation of the Nash supranormal profit in the market (π_n) shifts the average cost curve to above the Nash equilibrium pricing level (p*). Likewise bidding past the expected profits (π_n) has the identical impact. For ease of analysis and to prevent repetition, we assume in the subsequent section that both overbidding and past-profit bidding increases the bid price to the same level above the expected profits, (although in

reality the overbidding level is likely to be greater than the past-profit bidding level). Faced with average cost above the Nash equilibrium level, (where price and quantity are determined via a 'Cournot like' price game) the firm makes losses. This is shown in the market demand diagram Fig 2:

Fig 2: Consequences of past-profit or overbidding

Once again note that the diagram has been simplified to show demand and revenue under the assumptions that all firms charge identical prices at all point along the demand curve. This enables us to represent the individual firm's demand curve in a simple linear fashion that would not be possible taking account of the more complex reaction functions. We reiterate that this simplification does not extend to the analysis, and is used simply to facilitate the diagram.

Where the auction price has bid the average cost up past the level of symmetrical Nash profits (π_n), this results in an average cost greater than the level under a symmetrical Nash equilibrium, thus the firm makes losses of p*ebf. In an efficient auction where firms have identical valuations of the license (and hence identical downsides) then this loss p*ebf will be exactly equal to the reputation loss (π_r) if a firm does not receive a license. However, by restricting output (or raising price) above the Nash equilibrium, the firm can

move to a point G or beyond where it will make some profits.[22] This restriction of output is only possible where it is able to collude with its competitors to ensure all firms increase their prices and there is no undercutting of prices. At prices above the Nash equilibrium, a competitor can undercut price, taking a larger proportion of demand and increase profits at the expense of the other firms. For prices above p* this implies that undercutting is profitable. Likewise the initial firm may undercut this lower price until they return to the standard Nash equilibrium p* where each firm makes a loss, but each firm is conducting its best response given the other firm's price. Thus prices higher than p* may only be reached through jointly colluding in restricting output.

One difficulty in colluding is determining the price firms will tacitly collude at. Where firm's costs are identical, the point G becomes a focal point for collusion. Clearly no firm will want to undercut this point risking retaliation and losses for all. Thus the fact that a point such as G exists and is common or similar to all, increases the likelihood that collusion will take place. Even where a common focal point such as G does not exist (due to differing costs and hence reaction functions) the presence of a market leader's price (such as KPN) is likely to create a focal point for the smaller firms to follow, allowing tacit collusion.

Clearly, according to standard literature, firms are able to increase profits in the non-auction market by also colluding and hence an incentive to collude will be present regardless of the way the license is disposed of. However it is possible to show that the incentive for the firm to collude may be higher when over or past-profit bidding has taken place.[23] This enhanced incentive may be derived from different sources including via an increasing probability of being caught with higher absolute profits, or an incentive for the firm to engage in risky collusive behavior knowing that it will be able to shift the risk of bankruptcy onto the banks that have supplied the debt for the license. The mechanics of this argument can be shown by a simple numerical example:

Suppose that under the competitive Nash Equilibrium, each firm makes 5 profits. We consider that the firms pay a bid level B for their license, resulting in net profit of 5-B.

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[22] To make clear that this level of profits is higher than the symmetric Nash equilibrium level we term them collusive profits. That is the level of output where the firms are able to collude and maximise joint profits.

[23] Note that all the standard economic arguments relating to the difficulty of sustaining a cartel apply here. Thus differing costs, a relatively large number of firms, and differentiated products as present in the mobile industry all increase the difficulty of colluding and hence reduce the incentive to overbid.

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Collusion allows them to increase it to 10-B, but incurs some probability p of being caught and fined F. Thus the payoff for non-collusion is 5-B versus 10–B–Fp for collusion. Yet, from above if losses are not too big, firms are able to shift losses to the banks. This makes their collusive profits equal to max{0, 10-B-Fp}. Assuming the losses are small enough for banks to bail them out, collusive profits cannot become negative. Since each bid above 5 makes Nash profits negative, firms will collude if they had overbid.

This example is very simple in the sense that it shows the intuition why collusion occurs when overbidding (or past-profit bidding) has taken place. In reality, the situation will be more complex. Firms will incur some losses after detection of the collusion and uncertainty can create an environment where managers take more risks when they have overbid. Hence it is quite likely that the probability of collusion positively relates to the level of overbidding (or past profit bidding).

From this simple example we can see that there are two ways the regulator is able to dissuade collusion: Firstly via increasing the monitoring of firms and hence the probability that collusion will be caught. If firms really collude they are less likely to be bailed out, because 10-B-Fp is more likely to become so negative that banks decide on breaking the firm up rather than bailing it out. Secondly, by increasing the fine imposed on the collusive firm when it is caught. This has exactly the same effect as increasing p. We consider the feasibility of these in the next subsection. In summary whilst we acknowledge collusion incentives will be present regardless of the license cost, we argue that the collusion incentives will be much greater when firms have overbid for their licenses.

The Credibility of Competition/Regulatory Authorities
As the mobile market is designed to be a 'competitive' oligopolistic market (where firms compete the level of prices and quantities to the Nash equilibrium solution p* q*), no formal or explicit regulation, such a price cap, is required. This is due to the belief that the welfare losses through regulatory burden may well be higher than the benefits that it bestows, as mentioned previously. Within this oligopolistic market, if the regulator subsequently feels it is collusive or one or more players have significant market power, then it can refer the market to the competition authority. The competition authority then investigates and has the power to impose some sort of regulatory outcome if evidence of significant market power or collusion is present.[24]

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[24] An example of this took place in the UK in 1999 where the regulator Oftel referred Cellnet and Vodaphone to the Competition Commision to investigate whether they had significant market

As discussed in the previous sections, firms may have various incentives to overbid which increases the incentive to collude. Some of these rely directly on collusion being possible in the subsequent post auction market (such as the profit expectation argument), whilst some rely more indirectly (reputation effects and managerial incentives). Pricing at the Nash equilibrium level p* results in losses after over or past-profit bidding, hence firms have an incentive to restrict output to an inefficient level (less than G) below the efficient auction or free license level q*, resulting in higher prices. Although an incentive for collusion exists, whether this incentive is outweighs the Nash outcome depends on the competition and regulation framework. In particular it relies firstly that the regulator is able to detect collusion (p) and secondly that the regulator is able to impose the fine necessary (F) to dissuade collusion. How likely is the regulator to be successful?

Firstly, there is substantial asymmetry in cost information between the firm and the competition authority that creates incentives for the firm to engage in strategic behavior. Notice though, that this strategic behavior also exists without auction or over/past-profit bidding.[25] Secondly, the welfare loss through time and the monetary costs via bankruptcy, disruption and reallocating the licenses, may outweigh the loss in welfare from firms pricing slightly above the symmetric Nash level p*. However, whether the firms are able to use this disruption to sufficiently increase prices to the profitable level depends upon the both the level of over/past-profit bidding and the switching costs of consumers. Thirdly, even if the competition authority has the informational knowledge needed to impose competitive prices, it may find it extremely hard to impose competition post auction after over/past-profit bidding has occurred. This will force the firms to make losses by producing at the Nash equilibrium level which may not be optimal for the competition authority ex-post. The firms will eventually leave the market forcing the reallocation of licenses and causing political as well as legal problems. Whether the government is be able to challenge firms forcing them to consistently make losses and leave the market, and in the process admit that the much praised auction system failed, is questionable. In particular if all firms are identical, resulting in identical bids and post auction prices, the costs of letting them all go bust will be very high.

This is a moral hazard problem: firms know it may not be a credible threat for the competition authority to impose an equilibrium solution and hence create losses once the

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power. The Competition Commision found evidence of such power and recommended a one off price reduction on the terminating call price to mobiles.

[25] This information asymmetry has been discussed elsewhere and consequently we do not dwell on it here. (see Armstrong, Cowan and Vickers 1994 for a summary of this branch of literature)

auction is completed. The firms know the competition authority, if all firms are in identical positions, will have to turn a blind eye to collusion, this allows them to bid prices to levels higher than the efficient level whilst still making some degree of profits but reducing welfare. There are three possible policy antidotes to this problem, the last incorporating a reason why the likelihood of over/past-profit bidding may not be substantial

The first relies on the competition authority and government announcing that regulation will be imposed post auction to ensure firms are competitive. Clearly the announcement counts for nothing if the regulator or government does not have some credibility behind it. Whether this credibility exists will depend upon the past reputation of both the regulator and the government, indeed there may be some inconsistency between the optimal policy of the government before the auction and after the auction.[26] Even when the competition authority is credible, there may be some scope for the firms to appeal to an independent organisation such as a judicial review. These reviews often base their findings on whether the price charged is a fair level, based on the market rate of return on the cost base (although the level of the cost base is often disputed and arguably should not contain the license cost). Consequently one may find that the collusive result based on the restrictions of quantity and increases in prices post auction may be lawfully upheld using regulatory methods currently in practice.

The second policy is to state *before* the auction, that should the market not be considered competitive by some future date, the regulator will introduce mobile 'virtual' network operators (MVNOs) with access to the incumbent's spectrum. These MVNOs will not own the radio spectrum, but at a minimum may lease the use of the radio interface and switching station to route the call to their fixed network. At the other extreme a MVNO may use the entire incumbent network owning only the SIM card and mobile network code. MVNOs have recently been introduced into the UK market for second-generation mobiles and although the issue of interconnection price has been hotly debated agreements have been made to enable this form of competition to exist.[27] Unsuccessful bidders in the UK auction scheme have already expressed an interest in buying bulk capacity from the licensee's networks to set up their own virtual networks. It is possible that this solution will firstly reduce the tendency to overbid, and secondly allow the

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[26] We do not consider this inconsistency here, as it is beyond the scope of this paper. However, one may envisage that where the preferences of the government changes before and after the auction some kind of time inconsistency problem similar to the central banking case may exist.

[27] See 'Oftel Statement on Mobile Virtual Network Operators' (09/1999) on Oftel's web site for a discussion of MVNOs and their implementation in the UK.

regulator and competition authority to credibly pre-commit themselves to ensuring collusion can not take place in the post auction market. This competition pre-commitment, combined with allowing firms to make losses should over/past-profit bidding take place, may well remove the ability to collude thus charging higher prices and reduce the incentive to overbid.

Lastly, the moral hazard credibility argument is largely dependent on the assumption of identical costs. Where costs between firms differ, as previously discussed, their valuations and hence bid prices for the licenses differ. Given these differing bid prices it is likely that whilst some firms will overbid others will bid correctly. Where all of them have overbid, the levels of over/past-profit bidding are likely to vary across firms. The subsequent equilibrium prices will then create losses of differing sizes. Whilst it is clearly not possible for the government or regulator to let all the firms leave the market, by permitting at worse only limited collusion and thus a small deviation from the equilibrium price, the government may allow only the highest cost firm to leave the market ensuring the others remain. The firm leaving the market does so because it has overbid, and will be forced to sell its license at a lower level to a new entrant further increasing the level of competition as discussed in section two. Allowing this single departure from the market is credible where multiple departures may not be. Although this strategy will not completely remove the incentive to collude, it will mitigate both the incentive and the inefficiencies of colluding and strengthens the regulator's credibility.

It is important to note that the first two policy remedies (maintaining a reputation for credibility, and allowing MVNO's) will only directly work with regards to the profit expectation argument. Managers will always have short run incentives to overbid where their utility is not closely aligned to shareholders. As previously mentioned share options are one means of re-aligning the two utility functions in the short run. Whilst differing costs are obviously not a policy prescription in themselves, they will mitigate the problem of asymmetrical reputations. As we noted different costs ensures that the winner of the license will only pay marginally above the entrant's valuation. As section two stated, the entrant's valuation of the license is not as susceptible to reputation effects as the incumbent's, thus given that π_r for the entrant will be very small, the level of over/past-profit bidding will also be small. This problem may be removed completely if the incumbent has synergies not present in the entrants allowing them to bid above the entrants valuations of post auction profit but still within their own. The means to ensure that the bid is made at the entrant's valuation rather than another incumbent's rests with the number of licenses and incumbents. This greatly strengthens the need to ensure that there are at least as many licenses as there are incumbents.

In summary we find that, although there is always some incentive to collude regardless of the level of bid. Over/past-profit bidding leads to an increase in these incentives relative to both the efficient auction and free license outcomes. Where the regulator or competition authority can credibly commit itself to ensuring a competitive outcome in the post auction market, the firm's incentive to overbid for profit expectation reasons is reduced, knowing that this will incur significant losses. In this credible regulatory case, over/past-profit bidding may still be derived from managerial incentives or reputation effects, however the latter may be mitigated by managerial contracts and the former by differing costs and the number of licenses.

4 Other Arguments for and Against Auctions

This final section discusses some other frequently used arguments for or against auctions and brings the auctions into the context of international competitors with some history within their domestic country.

Cost of Capital
It is important to briefly mention the practicalities of financing a license regardless of whether it is bid to the efficient level or overbid. Sums like four billion pounds are not readily available to firms, and will generally, either directly or indirectly, necessitate some sort of financing. Debt financing is common, but large amounts of financing reduces the investment rating of a firm and correspondingly increases their cost of capital.[28] This increases the debt repayment for firms and whilst not directly associated with quantity and hence a marginal cost, it increases the marginal cost of investment and thus future average cost. Where the firm is bidding inline with the markets profit expectations (and not overbidding), this problem is likely to be small, as the market has in the past regarded the license as an asset readily disposed of and thus increases the equity of the firm in line with the debt. Where the license has been overbid (relative to market perception), this may increase the cost of capital above the market level. This occurs because the market discounts the extra risk of needing to dispose the license costs at a level greater than the market value. One may argue that because over/past-profit bidding greatly increases the cost of capital, this mechanism will provide additional incentive not to overbid, a third (and quite natural) remedy against over/past-profit bidding.

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[28] Firms may be reluctant to dilute managers share options through issuing more equity, especially when the market for technology stocks is depressed as recently.

Some of the incumbents have also stated that the Dutch capital markets are relatively less perfect than other countries, however we do not see this as a valid argument where the multinational incumbents have access to US and other countries capital markets as currently. Despite the reduction in the incentive to overbid, financing the bids through debt is still likely to increase the cost of capital. This increase in the cost of capital is inescapable, although the net impact may be small. Other separate factors such as discussed in previously sections may ensure that the benefits of auctions remain significant even when compared to the loss through higher cost of capital. Firstly, differing costs will ensure that the firm pays just over its competitors valuation of the license rather than its own, which will permit supranormal profits on this difference. This profit may compensate the firm for the increased cost of capital. Secondly, the increased innovation incentive to secure supranormal profits for the firm, may counteract the reduction in incentives through the increase in the cost of capital. In conclusion, whilst the cost of capital will undoubtedly rise through increased debt financing, it also checks over/past-profit bidding firms. The total effects are expected to be fairly insignificant.

Subsidised National Carriers?
Before concluding, we have a political context to add to the literature of auctions versus 'beauty contests'. The current bout of European 3G auctions are different from many past auctions as the players attempting to enter the markets are increasingly international firms (compared to US auctions where most of the firms competing were US companies). Unsurprisingly, firms originating from that country (often the old public monopoly such as BT, KPN, or Sonnera) directly or indirectly own most of their country's incumbent mobile operators. Likewise unsurprisingly, the incumbents have been the largest supporters of beauty contests and biggest opponents of auctions, as through previous beauty contests they have been allocated licenses and earned the supranormal profits that accompany them. An interesting example was the 1994 French contest for the third supplier of mobile services. Out of the three (French) firms competing, the winner Bouygues, was the owner of the leading French television channel, "a far from negligible asset in a pre-election period" noted the newspaper 'Liberation'.[29] In such an international arena as telecommunications, one may view the 'beauty contests' and the nearly inevitable outcome of favoring the national incumbent, as a type of government subsidy championing their firms. These government subsidies guarantee the incumbents such as France Telecom, high revenue streams and supranormal profits (unchecked by license costs). These revenues may then be used to cross subsidise bidding in other nation's auctions, such as the Netherlands or Germany, where the incumbent does not have this supranormal profit advantage. Those countries using beauty contests for selection of

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[29] Example taken from McMillan (1994 pp 7)

licenses, are in effect subsidizing their national telecom carrier. This money can then be used to cross subsidise competition in other countries at the expense of domestic consumers and international competition, an action that may be considered illegal under the WTO.

Some journalists, politicians and economists claim that to ensure a level playing field all European firms should give the licenses away free, turning around the above argument. However this completely overlooks the fundamental point that giving away the licenses is distributionally questionable, also raising the possibility that the firm most effective in lobbying European governments will win, rather than the most efficient and hence welfare maximising firm. Secondly, non-European firms such as TIW or AT&T will find it impossible to achieve licenses where a nationally favored incumbent is present. This once again returns us to the argument that Europe may be illegally subsidising its national carriers at both their consumers and other non-European's competitors expense and as such may legitimately be reported to the WTO.

5 Conclusions

Auctions are unlikely to lead to substantially higher consumer prices or lower investment levels relative to a free license. If firms bid anything up to the efficient level (π_n) where post auction profits are 'normal', output and price will be independent of the level of the license bid price. Where firms bid efficiently it is clear that small increases in the cost of capital will be largely outweighed by the gains in allocative and dynamic efficiency. With the possible exception of the cost of capital, it is therefore not the auction that generates inefficient increases in price, but the increased incentive to collude via over or past-profit bidding.

Over or past-profit bidding may occur due to a number of reasons. Firstly, managerial incentives may favor the successful acquisition of a license, due to preferences out of line with the firms. Secondly, expectations of collusive profits in the post auction market drives higher future levels of profits and hence an incentive to bid past the competitive valuation of profits. Thirdly, the incumbent's losses via reputation effects when not receiving a license may create significant incentives to bid above the profitable level for the license. Lastly, because of the relationship between reputation, incumbents and entrants, a mismatch between the number of licenses and incumbents will increase the probability of past-profit bidding.

Starting with the assumption that over or past-profit bidding takes place, what will be the impact on post-auction prices? The sole means to regain overbid or a past-profit license cost is through (tacit) collusion in the post auction market. In principle the current market framework of the mobile industry should be sufficiently competitive not to require explicit regulation via the regulator, relying like most other industries on standard competition law. However, all market states have some incentive to collude. Overbidding increases these incentives past the normal level via a fine proportional to the level of post auction profits. Where it is possible to remove the ability to collude in the post auction market, the incentive to overbid through expectations of collusive profits is reduced, knowing that over or past-profit bidding will ensure significant losses in a competitive Nash equilibrium. To this end, governments and regulators must find ways to credibly pre-commit themselves to competition before the auction takes place. This credibility not only prevents an inefficient outcome should over or past-profit bidding occur, it also reduces the incentive to bid past the expected level of profits (as firms believe the regulator will enforce the Nash equilibrium outcome).

Means to credibly pre-commit are difficult and rely on the past performance of the regulator. However we suggest two ways to mitigate the incentive to overbid via collusive expectations of profits. Firstly, pre-announcing that competition will be vigorously upheld and the government will allow firms that make losses to sell their licenses and leave the market may ensure overbidding does not intentionally take place. Secondly pre-announcing that an uncompetitive market will be opened up to mobile virtual network operators (MVNOs) through access to the license holder's networks will further reduce the likelihood of post auction collusion and hence overbidding. There are other reasons why tacit collusion is unlikely to be easy. When an entrant is successful in the auction, it will often have to gain reputation first, making tacit collusion more difficult to maintain. Finally the fact that capital has a significant and increasing cost attached to it, will further reduce the incentive to collude.

By writing a joint letter to the government stating that license costs must be passed onto the consumers, the incumbents have implicitly indicated that they will collude in the post auction market. The government must make it clear that any prices above the Nash competitive equilibrium and hence involving the pass through of license costs, will be interpreted as collusive and not tolerated. This need for credibility seems to have been acknowledged by very recent (June 13, 2000) comments by Competition Commissioner Monti quoted in the Financial Times:

> 'Monti accepted that the prices paid were "considerable." But he made
> clear that no allowances will be made for them. "We shall not consider

the huge investments made in acquiring the licenses as a justification for unacceptable concentration levels," he said.'

The incentive to past-profit bid via reputation effects is difficult to reduce, as the firm is rationally bidding up to it's valuation of the license even though this is higher than the level of profits in the post auction market. However, the past-profit bidding through reputation effects may be mitigated where there are at least as many incumbents as there are licenses. This is because the incumbent receiving the license will only pay marginally above the entrants valuation and the incumbents may also have substantial synergies that reduce their costs and allow them to bid higher than the entrants valuations whilst still making a profit.

In reality, unless the auction has been poorly planned, it is doubtful whether these incentives to over or past-profit bid will be strong enough to outweigh the possibility of pushing the firm into bankruptcy and managers into unemployment. Consequently we do not expect to see significantly higher prices than the efficient level unless the firms are able to collude in the post auction game in which case it is collusion and not the auction that is driving them. Even taking account of increases in the cost of capital and the possibility of overbidding and collusion, the welfare gains through ensuring the lowest cost firm (both allocatively and dynamically) receives the license are likely to outweigh the potential losses through over or past-profit bidding.

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Abstract

Recently there has been a huge interest within European governments and telecommunications firms in the auctions for third generation (UMTS) mobile licenses. This paper looks closely at claims by the incumbents that auctions will result in higher costs to consumers. Within standard theory we find that unless firms are able to bid above the level of profits in the subsequent market, the optimal non-auction price and quantities will be unchanged. As standard theory does not account for such bidding, other non-standard possibilities for overbidding or post-profit bidding such as: differing pricing strategies, managerial incentives or reputation effects are considered. We find that although there is some likelihood of overbidding and inefficient price and quantity outcomes, this likelihood is small where the auction has been designed carefully, in particular where there are as many licenses as incumbents. In conclusion, we believe the benefits of an auction derived from ensuring the most efficient firm receives the license, will outweigh any small costs of overbidding as long as the government is able to ensure a non-collusive post auction market.