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A tale of two auctions

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Abstract: Advocates for a 'different and innovative approach' to conceptualizing markets have argued that it is possible to reengineer markets to deliver any number of salutary public policy goals. These 'consulting engineers for the market economy' have supported their ambitions by referring to the participation of game theorists in the design and implementation of spectrum auctions. However, the variegated and inconsistent lessons drawn from their participation indicate that the role game theorists actually played in the auctions is not well understood. The confusion appears to stem from significant omissions in the available (mostly first-hand) accounts, which are boastful in taking credit for the performance of the auctions but strangely demure in recounting the precise measures undertaken to bring it about. In this paper, I provide an unexpurgated account of the circumstances surrounding the participation of game theorists in the most celebrated of spectrum auctions, those held under the auspices of the US Federal Communications Commission (FCC). Using the FCC's archival records, I recover the suppressed role of the commercial funding of economic research in determining both the extent and the nature of the economists' participation. This analysis emphasizes the crucial importance of the method of funding in determining how economic research is brought to bear on public policy.

1. Auction theory to the rescue?[1]

The successes of game theory in developing the US and British spectrum auctions have been trumpeted far and wide by governments, the media, and even Hollywood. So, too, have these stories been repeated within all tiers of the economics discipline, from the dense valleys of popular undergraduate texts to the rarified air of its journals. In the immediate aftermath of these two auctions, almost every available account poured praise upon the efforts of the game theorists who had participated as consultants in the auctions, and marveled at the unprecedented involvement of academic economists in forging

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1 Apologies to S. Abu Turav Rizvi (1994).

public policy. Since then, these auctions have become the textbook[2] exemplar of a 'different and innovative approach' to markets that argues it is possible to reengineer markets to deliver any number of salutary results, whether it be to reverse global warming, improve access to health care, redress racial and gender discrimination, or even accomplish 'free lunch redistribution', while at the same time promoting allocative efficiency (McMillan, 2001, 2002, 2003; Milgrom, 2004). This approach has proven to be a hit not only within the economics profession, where it goes under the names 'market design', 'microeconomic engineering', and 'applied mechanism design', but also with groups normally thought to be antagonistic to orthodox microeconomics, where it goes under the names 'economic performativity' and 'building economic machines'.[3] To better maintain focus, it will be rendered throughout this paper as 'auction theory'.

Those who find their interests piqued by auction theory and want more in the way of concrete details about how it was successfully applied are able to consult a handful of widely cited accounts written by the academic game theorists who participated in the spectrum auctions. While the specifics of their accounts vary, they all do tend to hew to the same overall storyline, which, without much injury, is possible to summarize in the form of three lessons:

[1] ***The decision to auction off electromagnetic spectrum licenses led to scientific considerations acquiring significance alongside political considerations.*** '[T]he [FCC] auction design process was driven not by politics, but by economics' (McMillan, 1994: 147). 'Auctions, unlike administrative hearings, are transparent' (McMillan, 1995: 194). '[A] well designed auction is the method most likely to allocate resources to those who can use them most valuably . . . [and avoid] political and legal controversy, and the perception, if not the reality, of favoritism and corruption' (Klemperer, 2004: 170).

[2] ***The role of game theory in [1] demonstrates its practical relevance for public policy.*** 'The analysis of how auctions work is one of the successes of modern mathematical economics. Developed to try out new ideas in game theory, auction theory has turned out to have considerable practical content . . . When the theorists met the policy makers, concepts like Bayes–Nash equilibrium, incentive-compatibility constraints, and order-statistic theorems came to be discussed in the corridors of power' (McMillan, 1994: 146). 'The FCC auctions provide a case study in the use of economic theory in public policy' (McMillan *et al.*, 1997: 429). 'The economics profession as a whole certainly deserves a lot of credit for using game theory to develop the discipline of mechanism design that we use when designing a new auction' (Binmore, 2002: 2).

2 One such textbook discussion is given in (Parkin, 1998).

3 Michel Callon (2007) has looked to the FCC auctions for support of his 'economic performativity' thesis, which argues that 'the role of the sociology of economics and the anthropology of economics is precisely to design tools' in order to 'influence or structure institutions' (Callon in Barry and Slater, 2002: 300). For a critique, see (Mirowski and Nik-Khah, 2007).

[3] ***The most compelling evidence of [2] can be found in the high revenues produced by the auctions, though game theorists can reengineer markets to bring about any number of salutary outcomes.*** '[T]he theorists' designs had powered worldwide sales of more than $100 billion . . . [T]hirty-five years of theoretical economic research about fine details of market design was suddenly bearing very practical fruit' (Milgrom, 2004: 1–2). '[O]ur theories work like clockwork. How else would it be possible to design the big telecom auctions that recently amazed the world by generating billions of dollars of revenue apparently from nowhere?' (Binmore, 2004: 481). 'I led the team that designed the big British Telecom auction that raised £22.47 billion for the taxpayer – enough money to fund 400 new hospitals' (Binmore, 2002: 1).

Given the fact that economists and non-economists alike routinely gesture to the spectrum auctions and echo these lessons whenever discussing the practical relevance of economics, one might be forgiven for mistakenly assuming these three lessons enjoy overwhelming support. However, a careful perusal of the entire literature on the spectrum auctions, one that includes authors other than the participating game theorists, reveals that several variegated and inconsistent lessons have been drawn from the game theorists' participation, some quite critical of their involvement. Most of the critical accounts have argued that the wrong scientific precepts came to inform the policymaking process (Benkler, 1998; Galambos and Abrahamson, 2002; Hazlett, 2001; Hazlett and Muñoz, 2004; Ledyard *et al*., 1997; Plott, 1997), with many emphasizing to various degrees the failure of game theorists to eliminate political considerations (Hazlett, 2001; Hazlett and Muñoz, 2004; Plott, 1997). Some have argued that revenues were not actually maximized (Ledyard *et al*., 1997), while recent events in America and across Europe have confirmed to others that maximizing revenues was never a good idea, anyhow (Galambos and Abrahamson, 2002). Though an adequate discussion of all these distinct positions would itself require an entire paper (see, however, Nik-Khah, 2005), it is sufficient for the present purposes to stress that the three lessons (hereafter 'folktale' lessons) enjoy something far less than universal assent. Not only is there a lack of consensus on both the role of game theory and on the performance of the spectrum auctions, but many of the lessons drawn from the auctions are mutually negating: game theory was/was not successfully applied; game theory was/was not the appropriate methodology for spectrum policy; revenues did/did not provide good indications of the auctions' success. Yet one routinely encounters gestures to the auctions as if their lessons and monumental achievements are self-evident.

What is needed is an explanation of how game theory led to the final materialization of the spectrum auctions, and how their specific features delivered the desired outcomes, yet a detailed explanation that spells out the act of applying game theory to the auctions is precisely what is missing from the literature. Game theorists' first-hand accounts are replete with invocations of the folktale lessons,

and have tended to proclaim the auctions 'a triumph for game theory' (McMillan, 1994: 146). However, taking such assertions to constitute a promise to provide insight about *how* to apply game theory or mathematical economics learnt in graduate school is likely to lead to disappointment with such opaque remarks as 'Judgment and guesswork were needed' and 'the real value of theory [was] in developing intuition' and '[although] theory does not validate the auction form the FCC chose to implement . . . [this requirement] imposes too high a standard' (McMillan, 1994: 151; McAfee and McMillan, 1996: 172; McMillan *et al.*, 1996: 429). While the literature provides examples of the reasoning used to support one auction form or another (McAfee and McMillan, 1996; Milgrom, 2004), the most basic details pertaining to the application of economics to public policy – a clear statement of what participants believed were the most important issues raised by the spectrum auctions, why supporters of the various inconsistent auction proposals believed they had addressed the important issues, and how these disagreements were actually resolved – are conspicuously absent from the available accounts. Unfortunately, the critical evaluations of the spectrum auctions appear to miss the mark as well. One must admit that many of their authors tend to use the auctions as a pretext to address parochial concerns, whether it be to promote more laboratory experimentation (Plott, 1997), or to praise the 'entrepreneurial' function of certain well-run corporations (Galambos and Abrahamson, 2002), or – even at this late date – to refight the socialist calculation controversy (Hazlett, 2001), to name but a few, at the expense of any close examination of the circumstances surrounding the participation of economists, and so they, too, are unhelpful.

This paper endeavors to provide an unexpurgated account of the role that economics actually played in the most celebrated of spectrum auctions, those held under the auspices of the US Federal Communications Commission (FCC). Relying on the FCC's archival records, I argue that the evidence fails to support *any* of the three folktale lessons currently circulating about spectrum auctions. I therefore propose replacing them with three lessons supported by the record: quite different from a triumph of scientific considerations, the commercial interests of a handful of large telecommunications firms came to acquire significance; rather than game theory's practical relevance, it was its ability to promote these interests that constituted its success; and rather than capturing enormous revenues for the treasury, it is closer to the truth to credit game theorists with delivering licenses to these telecoms at bargain prices.[4] Contrary to widespread belief, auction theory failed to promote public policy. This failure, I will argue, was the natural outgrowth of an underappreciated aspect of auction theory: auction theorists harbor the ambition to establish themselves as 'consulting engineers for the market economy' (Roth, 2002b),

4 These true lessons can also be found expressed obliquely in the literature. I will point out where in Section 5.

and it is therefore an imperative of auction theory that it deliver its clients – in this case, a handful of large telecommunications companies – a valuable service.

2. The corporate ratification of game theory

In 1994, the US Federal Communications Commission (FCC) commenced for the first time the practice of auctioning spectrum licenses to the highest bidder.[5] The process of determining the best method of selling off rights to control certain frequencies of the electromagnetic spectrum was marked by another innovation: the heavy involvement of academic game theorists, practitioners of one of the most abstract mathematical fields of economics, often thought to exist at a remove from practical problems. Once the first set of auctions was complete, and the dollar tally came in, those economists gleefully took credit for what was initially perceived as a highly successful performance.

It is commonplace for the first-hand accounts of the FCC auctions to begin with a discussion of the stipulation of several goals for the auctions by the US congress. In fact, congress charged the FCC with (USC, 1993: Title VI):

I. the development and rapid deployment of new technologies, products, and services for the benefit of the public, including those residing in rural areas, without administrative or judicial delays;
II. promoting economic opportunity and competition and ensuring that new and innovative technologies are readily accessible to the American people by avoiding excessive concentration of licenses and by disseminating licenses among a wide variety of applicants, including small businesses, rural telephone companies, and businesses owned by members of minority groups and women;
III. recovery for the public of a portion of the value of the public spectrum made available for commercial use and avoidance of unjust enrichment through the methods employed to award uses of that resource; and
IV. efficient and intensive use of the electromagnetic spectrum.

The list represents the outcome of a prolonged debate over the role of government in promoting access, innovation, competition, and 'competitiveness'. The FCC, however, would eventually take the position that all these complicated considerations involving industrial organization, macroeconomics, and distributional equity should ultimately be reduced to the narrower 'economic efficiency', and that the most appropriate goal to pursue should be to award licenses to their highest valued users (FCC, 1993: ¶34, 1994: ¶70). One participating economist noted that, while there was some controversy over the drastic collapse of multiform intentions to drab uniformity, the decision represented the adoption of an economist's criterion (Milgrom, 2004: 4). My first observation is that the criterion adopted was certainly not universally respected

5 Prior to the auctions, the FCC relied on comparative hearings and lotteries to assign spectrum licenses.

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by economists across the board, but was broadly consistent with the preferred understanding of game theorists.

By replacing the goals of congress with their preferred 'efficiency' criterion, the FCC staff economists[6] were able to ground their policy analysis in game theory, the true significance of which was not, as has been commonly asserted, the substitution of political with 'scientific' considerations, but rather the enrollment of a specific group of academic game theorists into the FCC's policymaking process. Academic game theorists were first invited to participate following the FCC's release of a *Notice of Proposed Rulemaking* (NPRM) for Personal Communications Services licensing. In every rulemaking process, the FCC is required to ask for comments from 'interested parties' – broadcasters, telephone companies, equipment manufacturers, industry groups, government agencies, and to a far less extent consumer groups – that would be affected by changes in administrative rules. This particular set of rule changes would be met with heated debate, as congress punted the most contentious political issues to the FCC (Galambos and Abrahamson, 2002: 163–164). In response, FCC Chairman Reed Hundt hit upon the idea of calling for the involvement of game theorists.[7] The appearance in the NPRM of a call for game theoretic analysis of how best to award licenses to the highest valued user was unprecedented, and it gave certain interested parties the idea of hiring academic game theorists to further their objectives.

Those hoping to ground controversial public policy in uncontentious science would be disappointed, as the enlistment of an increasing number of economists to the market design process would result in a remarkably diverse array of inconsistent proposals, and ultimately a failure to produce any clear-cut recommendation. One plan for the auction of licenses called for a sequence of English auctions (Weber, 1993a, 1993b), a second called for a sequence of Japanese auctions (Nalebuff and Bulow, 1993a, 1993b), and a third called for simultaneous sales of licenses (McAfee, 1993a, 1993b; Milgrom and Wilson, 1993a, 1993b).[8] Some proposals insisted on admitting bids for bundles of geographically linked licenses, whereas others favored restricting bids to individual licenses only. The sticking point was that game theory supplied no global discipline with regard to the type of recommendations tendered: a game theorist could legitimately support any of an array of auction forms by stressing one set of information properties over others. Game theory is not and has never been a unified theoretical tradition (Mirowski, 2002). Participating game theorists did display

6 The FCC's Office of Plans and Policy were handed the task of drafting recommendations for the auction. Accounts from this perspective are provided by (Kwerel and Rosston, 2000; Kwerel in Milgrom, 2004).

7 Hundt provides details of his participation in his autobiography (Hundt, 2000).

8 An English auction is one for which prices increase, with the bidder placing the highest bid winning the item. A Japanese auction is similar to an English auction, but all participants are considered active bidders until they drop out. Studies of the formal properties of ascending auctions frequently substitute the Japanese auction for the English auction.

a penchant to conceptualize an auction as a Bayesian learning game; this tended to focus attention on the release of information during the auction, which would better promote knowledge of the licenses' true value, hence promoting efficiency. Generally, the favored version of game theory dealt with a single good, and assumed knowledge of the 'true value' of this good to be distributed stochastically among participants; the state of play is conceptualized as information being released during the conduct of an auction, which will promote the participants learning the true value of the good. There was, however, no conventionally accepted standard for determining the precise value of the information provided by a given auction, much less the 'true' value of any good, which constituted a problem for attempts to generalize existing results to an environment with multiple heterogeneous goods, or in the argot of game theorists, multiple-good environments with 'multidimensional types' (Banks *et al*., 2003; Goeree and Offerman, 2003).[9] Game theorists therefore supported their recommendations not with their own conventionally accepted standards of mathematical proof, but with loose analogy and piecemeal analysis, mooted in seemingly clear but frequently contradictory catchphrases as 'the more open, the better', or 'make sure participants get quality information', or 'avoid free rider problems'.

Participants in the runup to the spectrum auctions have acknowledged that game theory was unable to provide a knock-down argument for the optimality of a specific auction form (McAfee and McMillan, 1996: 171; McMillan *et al*., 1997: 429). While they attribute the lack of a determinate recommendation to a local disagreement over the magnitude of various effects, this does not begin to get to the heart of the matter. The lack of a determinate recommendation was less a disagreement over the significance of various learning effects than it was a disagreement over the *aims* of the auction. The first source of disagreement was a methodological clash between two approaches to auction theory: a game theoretic approach and an experimentalist approach. This point requires careful development because every single account until now of the FCC auctions has failed to take note of it. For present purposes, it is possible to reduce the differences between game theorists and experimentalists to three primary areas of disagreement:

[1] *Whereas game theorists tend to represent markets as Bayes–Nash games, experimentalists represent them as combinatorial optimization procedures*. Experimentalist market theory has roots in Walrasian general equilibrium theory, and particularly in efforts searching for determinate, Pareto optimal, price adjustment processes. They were concerned with the existence of a

9 An environment is said to have 'multidimensional types' when bidders' valuations of the items for sale are comprised of both 'common' (i.e. objective) and 'private' (i.e. case specific) elements. These environments present problems for inferring the true value of a license from bids because of the 'impossibility of efficient aggregation of multidimensional information in a one-dimensional bid' (Mikoucheva and Sonin, 2004: 278). See also Jackson (1999).

competitive equilibrium in the presence of complementarities, and noted that complementarity produces a nonconvexity, which, if serious enough, rules out the existence of a competitive equilibrium (Banks *et al.*, 1989: 2–3). In the absence of a competitive equilibrium, prices no longer suffice to coordinate agents to optimal allocations (Ledyard *et al.*, 1997: 656). The attainment of competitive equilibrium is generally not a concern for game theorists. What absorbs their attention, rather, is the putative mendacity of participants, who are the ultimate sources of information about the economy. For game theorists all the action happens in the mind of the participant, modeled as an inductive machine assumed to 'learn' through Bayesian inference; for experimentalists most of the action happens in the price adjustment process, conceived as a price discovery device.

[2] *Game theorists want to improve the 'price system' by increasing the amount of information it provides, whereas experimentalists seek improvements in its capacity for information processing*. Game theorists focus on methods for discovering and publicizing the information that they assume to be already dispersed in the minds of participants, for the purpose of reducing the probabilistic uncertainty surrounding their valuations. While experimentalists are undeniably interested in the same information, they focus their efforts mostly on finding procedures – or 'smart markets' – that will effectively cope with the computational complexity of processing this increased information (McCabe *et al.*, 1991). This focus on construction of a tractable optimization program (a problem for integer programming problems because they are computationally burdensome) encourages experimentalists to treat the market rules as an algorithm.[10] There is no such equivalent imperative for game theorists, who provide only the most stylized descriptions of markets (Ashenfelter, 1989). While these experimentalists tend to black box cognitive processes to study features of the exchange process, game theorists tend to black box the exchange process to focus on treating the mind as an inference engine.[11]

[3] *Whereas game theorists generally judge the success of a market by how it assists learning, experimentalists tend to judge it by the reliability of the successful execution of trades*. This is reflected in the different criteria used by the two groups. Game theorists pursue the criterion of *ex post* Pareto optimality (the bidder who would create the most value from owning the license wins it); experimentalists pursue *ex ante* Pareto optimality (the bidder who values the license highest at the outset acquires it).[12] These differences

10 Combinatorial optimization problems are NP complete. Though it remains unproven that NP complete problems are intractable, they are regarded as too computationally burdensome to solve directly, with the implication that one needs to employ a simpler approximation algorithm (Garey and Johnson, 1979).

11 Game theorists displayed no appreciation of the computational features of the market. This provides a way of understanding why some auction theorists have felt it is necessary to make an explicit call for computational methods (Roth, 2002a: 1372–1374). The ways in which experimentalists tend to neutralize the vagaries of the minds of their subjects are discussed in (Lee and Mirowski, forthcoming).

12 Banks *et al.* (1989) is explicit in choosing the ex ante over the ex post criterion. Banks *et al.* (2003) discusses the rationale.

Table 1. Rival approaches to auction theory

	Game theory	Experimental economics
Market	Bayes–Nash auction game	Combinatorial optimization problem
Solution	Decrease probabilistic uncertainty	Reduce computational complexity
Welfare criterion	Ex post Pareto optimality	Ex ante Pareto optimality

in criteria are responsible for different styles of arriving at a 'solution': the experimentalists' prescription is frequently described as the product of a balancing act between 'full central processing' of information, which relies on the processing algorithm to use the information, and 'decentralization', which relies more on participants to use information (McCabe *et al*., 1991; Porter *et al*., 2003). Because game theorists are concerned only with the 'processing' that takes place in the heads of the participants, they are concerned only with producing a form that maximizes the amount of information given to the participants.

The controversy that erupted during the intermediate stage over the combinatorial auction provides perspective from which to observe the rival approaches at work. Both game theorists and experimentalists were concerned with the presence of interdependent values of different geographic spectrum allocations, but they understood the problem they posed in a radically different way. Experimentalists argued that the only sort of market algorithm that could be counted on to produce a dependably 'optimal' allocation of licenses required a method for collecting information on the value of *packages*, or combinations of licenses, in addition to the value of individual licenses. They concluded the presence of indivisibilities and complementarities would create an 'exposure' problem, whereby the absence of a competitive equilibrium price vector leads bidders looking to acquire a package of licenses either to pay too much or, if they are sophisticated enough to foresee the problem, to refuse to participate at all (Bykowsky and Cull, 1994: 25–31; Bykowsky *et al*., 2000; Ledyard *et al*., 1997: 656). The auction would then be biased against package bidders. Experimentalists judged the allocation problem to be formally equivalent to a 'knapsack' problem in combinatorial optimization, called for package bidding, proposed a decentralized smart market to cope with the resulting processing complexity, and supported this recommendation with laboratory evidence for its (*ex ante*) optimality (Bykowsky and Cull, 1994). By contrast, the game theorists who opposed package bidding[13] argued that merely asking for information on package values would ultimately *reduce* the amount of information collected. They accused its supporters of ignoring a 'free rider' problem (referring to the well-known problem for public goods) that occurs when bidders focus myopically on the price of the single license they want to acquire. Game theorists argued package bidding would remove the incentive to bid on single licenses, reducing information on license values, suppressing the prices of

13 It will become apparent below that some game theorists supported package bidding.

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individual licenses, and ending ultimately in a failure to displace a high package bid (McAfee, 1993a: 12–14; Milgrom and Wilson, 1993a: 8–13, 1993b: 4–5). The auction would then be biased in favor of a package bidder. To summarize, experimentalists drew on the Walrasian concept of competitive equilibrium, argued for a combinatorial auction, and proposed a method for getting bidders to help with the complex processing task. Game theorists concentrated on bidders' incentives to release private information within a highly stylized Bayes–Nash auction game, and proposed independent license bidding.

To avoid a tempting misunderstanding, it is important to stress that the degree of attentiveness to strategy does *not* distinguish between the two approaches. Experimentalists evinced an interest in strategic behavior – viz., the exposure problem – but believed game theory to be insufficiently developed for use in the FCC auctions (Bykowsky and Cull, 1994: 32; Bykowsky *et al.*, 2000: 208). They rejected the argument against package bidding, not because they were unconcerned with the impact of bidder strategy on the final outcome, but because they believed its conclusion followed from an incorrect analogy: unlike the classic free rider problem where it is a dominant strategy to never contribute to the provision of a public good, under package bidding it is often individually rational for individual license bidders to bid sufficiently high to result in a optimal distribution (Bykowsky and Cull, 1994: 48; Bykowsky *et al.*, 2000: 219–221). From this perspective, information problems should never be addressed by eliminating package bids, since that would merely reintroduce the exposure problem, but instead by employing communication devices such as 'stand-by queues' to encourage optimal bidding.

But the availability of different approaches to auction theory cannot fully explain the diversity of proposals, since most were drafted by game theorists who tended to model auctions as Bayesian learning games and there was no consensus within that narrower group, either. Those who viewed auctions as Bayesian learning games did tend to agree on the efficacy of multiple round auctions to improve bidder information (Harris and Katz, 1993a: 14–15; McAfee, 1993a: 4–6; Milgrom and Wilson, 1993a: 6; Nalebuff and Bulow, 1993a: 12; Weber, 1993a: 3, 12). But they nevertheless advanced very different proposals.[14] While there was ample room for disagreements over the efficiency properties of the auction proposals, or even the appropriate methodology for auction theory, firms' narrowly constituted interests clearly played a major role:

> [T]he business world was fully aware of [the strategic significance of] the rulemaking process and had engaged many groups of consultants to help them position themselves. Businesses understood that the rules and form of the auction could influence who acquired what and how much was paid. The rules of the auction could be used to provide advantages to themselves or to their competitors. Thus a mixture of self-interest and fear motivated many

14 This paper will focus on differences pertaining to package bidding and sequencing below.

> different and competing architectures for the auctions as different businesses promoted different rules. (Plott, 1997: 606)

The most prominent 'consultants' used by businesses to 'position themselves' were game theorists hired by the large telecoms. Several firms responded to the FCC's NPRM by lobbying for preferred sets of auction rules, and some – mostly Baby Bells[15] and their progeny – enlisted economists to draft supporting comments. The telecoms went on a hiring spree: Nynex hired Robert Harris and Michael Katz of California-Berkeley; Telephone and Data Systems[16] (TDS) hired Robert Weber of Northwestern; Bell Atlantic hired the Yale economist Barry Nalebuff and Jeremy Bulow of Stanford; Airtouch[17] hired R. Preston McAfee from the University of Texas; Pacific Bell hired Paul Milgrom and Robert Wilson from Stanford. Despite a shared enthusiasm for reducing probabilistic uncertainty and selling licenses to the highest bidder, the comments produced by these economists were remarkably diverse.[18]

It is clear that many aspects of the proposals funded by the telecoms were determined by their narrow acquisitive strategies. The most transparent example is provided by the assortment of comments pertaining to the use of a combinatorial auction. While all participants were in agreement that package bidding would ease the aggregation of licenses, detractors characterized this easing as 'biased' while supporters characterized it as 'efficient'. For example, one proposal (Milgrom and Wilson, 1993b: 2) used the 'free rider' rationale to argue package bidding would harm 'regional' bidders and help 'nationwide' bidders. In this and other recommendations, firm interests were never far from the surface:

> The long distance company MCI lobbied for a *nationwide* license which, it claimed, would enable cell phone companies to offer seamless coverage across the entire country . . . *regional* telephone companies such as Pacific Bell lobbied for licenses covering areas that fit well with their own business plans but poorly with the plans of MCI. (Ausubel and Milgrom, 2006: 79–80, emphasis added)

Firms seeking nationwide coverage – not only MCI,[19] but also Bell Atlantic and Nynex (Andrews, 1994; Galambos and Abrahamson, 2002; Skrzycki, 1993) – supported nationwide package bidding (Harris and Katz, 1993a, 1993b;

15 The Baby Bells were (monopolistic) regional wireline telephone service providers created from the 1982 breakup of AT&T. As a condition of the breakup, the Baby Bells had also received licenses to operate the previous generation of mobile telephones in their own geographical areas, and therefore held a commanding position in wireless telephony as well. The Bells tended to view the acquisition of additional licenses as a way of expanding the wireless side of their businesses, while at the same time keeping out potential entrants.

16 TDS today goes under the marketing name of US Cellular.

17 At the time Airtouch was a wholly owned subsidiary of Pacific Bell with plans to spin off prior to the auctions.

18 The proposals are fully reviewed in (Nik-Khah, 2005).

19 MCI was not a Baby Bell, but rather a long-distance service provider, and was therefore a newcomer to mobile telephony. MCI was almost universally regarded as the most formidable of the potential entrants.

Nalebuff and Bulow, 1993a, 1993b), while firms pursuing regional strategies – Pacific Bell and Airtouch (Galambos and Abrahamson, 2002; Kwerel and Rosston, 2000: 262; Thelen, 1995) – supported licenses covering regional areas, and opposed package bidding (McAfee, 1993a, 1993b; Milgrom and Wilson, 1993a, 1993b). In between the two groups stood TDS, which favored package bidding, but only for regional groupings across license bands and not for a nationwide license (Weber, 1993a, 1993b). Interestingly enough, the TDS proposal used the 'free rider' argument against nationwide packages, yet supported package bidding for regional combinations (Weber, 1993b: 5–6). TDS was pursuing a regional strategy and had no intention to seek a nationwide collection of licenses (Murray, 2002: 270; Weber, 1997: 534).

The interests of the telecoms similarly informed recommendations addressing how to sequence the auctions.[20] Those favoring more simultaneity argued it would best allow bidders to take advantage of information revealed during the auction (Milgrom and Wilson, 1993a: 5–6, 1993b: 14), whereas those favoring more sequentiality disputed this belief (Nalebuff and Bulow, 1993b: 16) and argued that sequencing would actually do a better job of revealing information (Weber, 1993b, 1994). While it is certainly true that game theory would not conclusively settle such a complicated issue, to attribute disagreement to 'theoretical virtues against practical feasibility' (McMillan, 1994: 153) is incomplete to the point of being misleading. Here, too, firms' interests played a crucial role. TDS believed a 'hub and spoke' strategy of securing licenses surrounding major metropolitan areas would best serve its interests, and sequencing the auctions from highest to lowest population would best facilitate its regional strategy. The TDS proposal sparked a debate among the game theorists:

> The primary advantages of this order of sequencing are that it facilitates regional 'hubbing', and that it brings substantial valuable information (concerning both pricing and licensee identity) into the public domain quickly. The information will help applicants bidding for [smaller] licenses . . . to refine their acquisition strategies, and hence will enhance the efficiency of the final allocation of licenses. (Weber, 1993b: 6)

> [S]uppose that the Commission chose to auction spectrum for the New York City area first due to its population size, with other areas following. As auctions progress, participants will learn more about what is going on. Hence, participation in early rounds may be riskier. But a firm like NYNEX might have no choice but to bid in its home region. Therefore, if the Commission does adopt sequential auctions for different geographic areas, it should proceed in random order across trading areas within each block. (Harris and Katz, 1993a: 17)

20 With over 2,000 licenses to sell, the relevant question was not only whether or not to use a 'simultaneous' auction (as implied by McMillan, 1994), but which licenses to sell simultaneously and in what sequence to sell the resulting groupings.

The debate over sequencing auctions renders the commercial considerations informing the proposals obvious. Weber argued his sequencing proposal would facilitate the strategy of 'hubbing', which was unique to his client TDS, while Harris and Katz argued it would disadvantage their client Nynex. Such arguments abandoned any distinction between social welfare and the welfare of their clients.

The proposal authored by Mark Bykowsky and Robert Cull provides a vantage point from which to view the possible alternatives for auction design that would have been attainable if other entities had funded the research. Their smart market offered the possible benefits of increasing auction revenues and improving allocative efficiency over the alternatives by increasing bidding competition, solving the complex matching problem, and perhaps assigning a nationwide license along the way. The entity sponsoring the research, the National Telecommunications and Information Administration (NTIA), had no strategic acquisition concerns, and did not care whether the Baby Bells, MCI, or some other entity emerged victorious, but was most concerned with gaining credit for helping implement a successful auction, which it tended to understand in terms of maximizing auction revenues (Irving, 1995: 44). The experimentalists' smart market was therefore a good fit for the NTIA – proponents had repeatedly cited the revenue maximizing potential of their smart markets – but not for the telecoms who would bid in the auction.[21]

In accepting their role as consultants, economists participated at the pleasure of their clients:

> [Pacific Bell Attorney James] Tuthill, who organized PacBell's lobbying before the FCC, knew it would be crucial to hire an expert who could figure out where, amid the highly technical details of the auction proposal, PacBell's interests lay . . . During the summer before the FCC released its auction plan, Tuthill's staff drew up a list of games [sic] theorists . . . Milgrom was assigned the lead role because he was willing to lobby. (Thelen, 1995)

The requirements that economists would have to figure out where their clients' 'interests lay' and must be 'willing to lobby' deepened the controversy over auction form, while decoupling proposals from the pursuit of anything resembling the public interest. The absence of a global theory of auctions provided opportunity for disagreement, as did the inability of the Bayes–Nash approach to provide any conclusive results for a multiple-good, multidimensional value environment. But the high-stakes setting within which the design process took place – along with the establishment of consultant relationships with most of the theorists – virtually ensured it.

21 Experimentalists have since that time offered a not-so-veiled accusation that corporate imperatives quashed package bidding (Ledyard *et al.*, 1997: 656–660). I have arrived at this interpretation of events as a result of a conversation with John Ledyard.

In an ironic twist, the task of determining the public version of what game theory ultimately dictated fell to the FCC. The multiplicity of aims and proposals forced the FCC to display some creativity in conjuring a 'consensus' recommendation for the auction form – the simultaneous-multiple round-independent auction [SMRI] – given that it was the one that most economists opposed.[22] Experimental economists appeared to demonstrate that the combinatorial auction was more effective than the simultaneous-multiple round-independent auction. But the SMRI auction did possess the virtue of being broadly consistent with the concerns of a distinct group of large telecoms who were united by their fear of being leapfrogged by MCI, which would assume a commanding position if it acquired a nationwide license. In a development that was arguably anticipated in the experimentalists' exposure problem, MCI dropped out of the auction, eliminating the Bells' most feared adversary (Thelen, 1995).

3. A steep price for admission

The FCC's selection of the SMRI left a lot to be settled: while one could *name* the 'simultaneous-multiple round-independent auction' by combining types of 'design elements' into one cumbersome phrase, *building* such an auction would require combining the 'elements' in some operational way. A carpenter takes wood, nails, and glue and makes from them a chair; but it was unclear how the FCC could take 'simultaneity', 'multiplicity of rounds', and 'independence' and make from them an auction. The concrete features of the auction had yet to be settled, and, crucially, the game theorists who proposed the auction possessed no method of aggregating their preferred design elements into an operational whole.

Working out the details of the never-before implemented SMRI turned out to require far more elaborate competencies and redoubled efforts beyond those deployed in the initial rounds of the public policymaking process. Consequently, experimental economists were recruited to participate in the design of the auction. There persists a widely shared impression that the work of experimental economists was limited to corroboration of theorists' conjectures and determining the relative importance of the various contradictory effects postulated by the game theorists (e.g., Milgrom, 1995; McMillan, 1994). In actuality, it was the adoption of a seemingly innocuous proposal of some game theorists to computerize the auction that unwittingly endowed experimentalists with their most important role, and put the process on track to build some real markets. Though the FCC initially regarded computerization as unnecessarily adding complication to the auctions, they were ultimately persuaded by an experimental auction demonstration at Cal Tech that the provision of auction

22 The FCC eventually enlisted the services of John McMillan, who produced a report for the FCC that was published in revised form as (McMillan, 1994). For a discussion of the controversial aspects of this report, see (Nik-Khah, 2005).

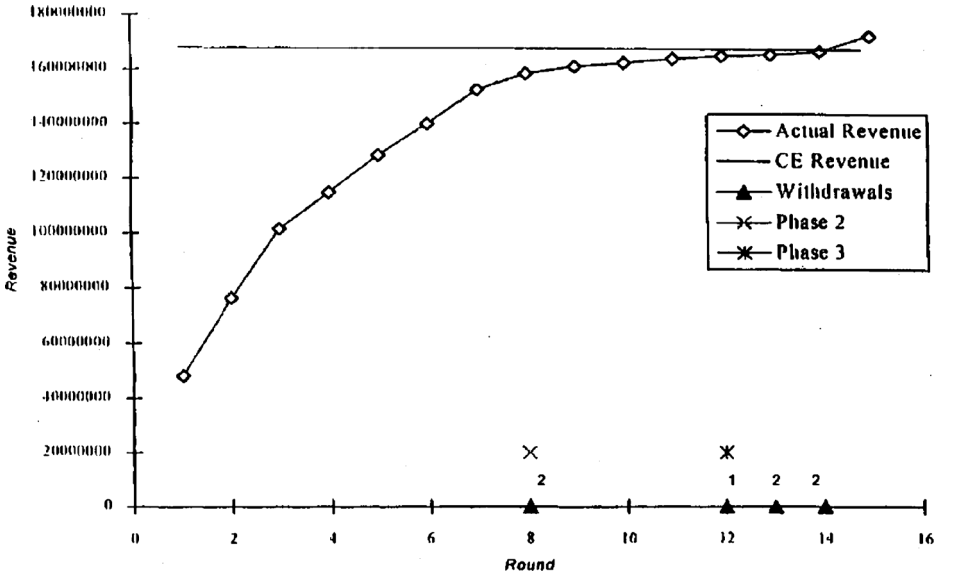
software would be a relatively straightforward matter. The FCC would soon discover otherwise, as attempts to produce a prototype auction failed.[23] The FCC was thereby induced to seek help from the experimental economists responsible for the original Cal Tech demonstration, and it devolved to them to accept major responsibility for coding the auction.

Game theorists had very little interest in operationalizing their proposals, and were unprepared to do so anyhow, arguing in effect that incremental changes in policy could be subjected to game theoretic analysis (McAfee and McMillan, 1996) and that implementing the auctions could be contracted out (Milgrom and Wilson, 1993b). When confronted with problems that arose in further developing the hybrid auction, game theorists responded by suggesting the addition of more design features: when some argued that bidders should be able to correct for bidding mistakes, they suggested allowing 'bid withdrawals'; in response to worries that bidders would not bid until the end of the auction, game theorists proposed an 'eligibility rule'; in response to concerns that such a rule would prevent firms from switching from one license acquisition pattern to another, they modified the rule; when some pointed out bidders might need to skip a round of bidding to reevaluate their bidding strategy or to acquire additional financing, theorists responded with 'bidding wavers' (Plott, 1997: 608–609). The rules for the FCC spectrum auctions eventually swelled to over 130 pages, covering numerous issues never considered in the decades over which auction theory had developed – conditions for bid submissions and bid withdrawals, minimum bid increments, activity rules, stopping rules, and the information that would be publicized during the auction, to name a few. Emendations of the design elements carried on somewhat in the fashion of adding plug-compatible peripherals to an existing core platform. Unfortunately, because there was as yet no such core platform, these patchwork fixes multiplied the problem of creating a consistent and complete auction (629), ultimately frustrating efforts to make a working prototype and forcing the FCC to seek assistance from a group better versed in the creation of electronic markets.

The experimentalists ultimately failed to convince the FCC to resort to the combinatorial auction, but when charged with the computerization of the auction, they took over responsibility for determining what criteria the algorithms would meet, significantly diminishing game theorists' effective participation in building the markets. Banished were concerns with issues of learning, and the criterion of *ex post* Pareto optimality came to be trumped by 'technical' issues of computation and practical imposition of coordination and the criterion of *ex ante* Pareto optimality. In coding and testing the market, experimentalists found many of the patchwork policy fixes offered by game theorists to be so ill-conceived as to be useless from an operational standpoint (Ledyard *et al*., 1994). Whereas the game theorists thought the SMRI to be a

23 The extent of this failure is on vivid display in Ledyard *et al*. (1994).

Figure 1. FCC auction test, 20–26 September 1994
Source: Ledyard *et al.*, 1994.



simple auction, the experimentalists found it to be very complex (Bykowsky *et al.*, 2000: 226), and at least one participant credited the experimentalists with implementing the electronic auction (Kwerel in Milgrom, 2004: xxi–xxii).

It is imperative for this narrative that the role of the experimentalists would not be confined to mere software engineers. The inclusion of the experimentalists to the design process confirmed the displacement of the goals attributable to imperatives associated with the Bayes–Nash program. References to 'Bayes–Nash equilibrium, incentive-compatibility constraints, and order-statistic theorems', along with the 'learning' and *ex-post* optimality, so characteristic of the game theorists' approach, were replaced by appeals to the pursuit of smooth convergence to a 'competitive equilibrium' revenue level within an acceptable time period, the elaboration of the precise nature of the information to be communicated by the market, and the use of an *ex ante* criterion to judge the success of bidders in using that information effectively.

Figure 1, which is taken from the experimentalists' report to the FCC, indicates the debt of the auction design process to concepts proper to the experimentalist program in auction theory. The axes clearly show the importance of revenue and auction duration; the graph illustrates convergence of actual revenue to a point near 'CE [competitive equilibrium] Revenue'. And it demonstrates the ability to evaluate the impact of introducing plug-compatible options – in this case, bid withdrawals and the progressive modification of eligibility requirements through stage changes. It represents, in sum, the specific facility of the experimentalist

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program to produce fully functional decision technologies, and displays the range of criteria experimentalists use to evaluate them. Although it is difficult to know what to make of a revenue path from the standpoint of Bayes–Nash game theory, the trajectory assumes the very precise meaning of an empirical demonstration of the convergence of an optimization program within the idiom of computational mathematics, and can be given an economic interpretation by appealing to the Walrasian notion of competitive equilibrium (Plott, 1997: 621–625).

Lest the lessons of this handoff of the auction design to the experimentalists be lost amidst details pertaining to their unique expertise in software engineering, along with their employment of new performance criteria, it is important to make clear at this point that the shift in the criteria cited by the experimentalists does not so much indicate a shift in the overall goals selected for the spectrum auctions, but instead offers further evidence of the extent to which the dictates of the Bayes–Nash program in auction theory ultimately did not matter to the overall auction design process. *Corporate imperatives demonstratively played the decisive role in determining the auction*. As with the Bayes–Nash program, the imperatives of the experimentalist program would only matter to the extent that they could be made to seem compatible with corporate strategies. Experimentalists would be allowed to address communication within markets so long as such communication was consistent with strategies common to the Baby Bells; they would not be permitted to implement a smart market. They wanted to deploy their preferred *ex ante* efficiency welfare criterion to decisively determine the best auction form, but found severely limited opportunities to do so: only that laboratory evidence construed to be unfavorable to package bidding found a favorable reception,[24] while Porter and Ledyard's results were ignored. It should be apparent that none of the economists was in the position to freely deploy his preferred approach to auction theory to implement public policy.[25]

4. Making game theory fit for consumption

Game theorists have been loudly trumpeting their success in 'designing [the FCC auctions] for multiple goals' for over a decade now (Milgrom, 2004: 3), leading directly to the explosion of auction theory (Maskin, 2004: 1103). And their claims have gone more or less unchallenged despite considerable evidence built up

24 Charles Plott was hired to run experiments by Pacific Bell. One purpose of these experiments was to compare the performance of a combinatorial auction with an independent auction. The results were deemed by Pacific Bell to be supportive of its preferred auction form, and were then presented to the FCC (Milgrom, 1995). Although the results tended to be interpreted as supporting an independent over a combinatorial design, the Pacific Bell experiments did not actually examine the Bykowsky–Cull smart market, and instead only examined a much different Japanese-combinatorial auction.

25 The significance of this observation for the work of Francesco Guala (2001), whose aim is to use the FCC auctions in a philosophically motivated intervention to the debate on rational choice theory, cannot be considered presently. See, however (Mirowski and Nik-Khah, 2007).

in the interim to the contrary. It is demonstrably false that the spectrum auctions satisfied the congressional goals.[26] Many businesses buying licenses defaulted on their down payments (Murray, 2002: 274–275), leading to considerable 'administrative delay' in re-awarding licenses.[27] The lion's share of licenses won by 'small' and 'entrepreneurial' businesses went to entities bankrolled by large telecoms, representing a failure to get licenses into the hands of a 'wide variety of applicants'.[28] The auctions have not lived up to their promise to promote 'rapid deployment [in] rural areas', as both large telecoms and smaller firms have tended to concentrate their effort on large metropolitan areas (Copps, 2004; Meister, 1999: 76–77). Overall, the allocation of licenses produced by the auctions proved to be unstable, as the industry has gone through a spate of mergers, acquisitions, and bankruptcies, ultimately leading to a high degree of license concentration (Murray, 2002: 289–291). Commenting on some of these events, one anonymous FCC official candidly observed, 'this certainly does make us look like a bunch of idiots' (Labaton and Romero, 2001). True, the auctions did capture a tidy sum for the government coffers – more, anyhow, than 'beauty contests' or lotteries would – but perhaps they did so at the expense of any solid foundations for the economic health of the industry over the medium term.

The strangest aspect of the efforts gone into trumpeting the revenues of the auctions was that revenue maximization was the only goal that congress explicitly ruled out as a basis for telecom policy (USHR, 1993: Title V, Sec. 5203; USC, 1993: Title VI). This focus on the billions of dollars in bids draws attention away from the role the consultants played in *decreasing* auction revenues. The consultants' efforts achieved their most spectacular result in the decision of MCI to drop out of the December 1994 auction as a result of the successful persuasion by economists of the FCC to reject nationwide bidding (Thelen, 1995), but they participated in many other efforts. Consulting economists argued against a smart market mechanism, which in experiments had produced higher revenues (Ledyard *et al*., 1997). They advised their clients on forming consortia that had the effect of reducing competition in the auctions (Helm, 1994). On occasion the consultants became involved in the auction process very directly. Immediately prior to the December 1994 auction, Paul Milgrom appeared on *CNN Business Morning* (1994) and proclaimed, 'Pacific

26 This case is made in much greater detail in (Nik-Khah, 2005).

27 The original plan called for allocating licenses in three auctions, to be conducted over a two-year period. The FCC was eventually forced to conduct eleven auctions over a ten-year period. The process of re-auctioning finally concluded in February 2005 – a full decade after the auctions commenced.

28 The success of large telecoms in circumventing the FCC's 'designated entity' provisions, most notoriously by establishing shell companies (Cramton *et al*., 2002; Labaton and Romero, 2001), goes some way to explain why certain large telecommunications firms would voluntarily extol the FCC's highest valued user criterion, so long as it was interpreted as 'willingness and ability to pay the most' – and they were not required to pay as much as they were willing and able (Mirowski and Nik-Khah, 2007).

[Bell] expects to win licenses in California. We expect the other bidders to have an opportunity to become discouraged when they see how determined we are.' After the auctions had concluded, Milgrom reported that his appearance did 'successfully discourag[e] most potential competitors from even trying to bid'. Because he there (2004: 23) argues that 'marketing a sale is often the biggest factor in its success' and acknowledges that attempts to 'discourage others from bidding, hoping to get a better price' undermines efforts to market a sale, it is difficult to understand this recollection as anything but an acknowledgment of a willingness to place the interests of the client first. Rather than assigning credit to economists for raising large revenues for the treasury, it is probably closer to the truth to credit economists for helping their clients to acquire licenses at bargain prices (Thelen, 1995).

Despite the failure to implement public policy, the FCC auctions were, as one participant noted, 'a huge success for the auction theorists involved' (Cramton, 2002: 3). One of the most interesting upshots of the auctions was the development of companies – with many of the key participant game theorists taken on as partners – devoted to the construction of markets.[29] Participating economists did therefore succeed in privatizing of a branch of research that had earned a reputation for operating at the height of abstraction. Once this 'innovation' of repackaging game theory as a commodifiable expertise in market construction and bidding is situated within the larger context of the commercialization of the university (Slaughter and Rhoades, 2004), one comes to understand why auction theorists have deemed the cultivation of new sources of patronage an outcome worthy of celebration: as Alvin Roth (2002b) has noted, the FCC auctions opened up 'a new way for game theorists to earn their livings, as consulting engineers for the market economy'.[30]

Of course, the accompanying imperative that auction theory must deliver its clients a valuable service did play a role in undermining the congressional goals. Yet its relationship with the state remains nonetheless strong. To understand why, one needs to appreciate how game theorists' advocacy of 'auction theory for privatization' has struck exactly the right tone for a sustained relationship with a state under the sway of neoliberalism.[31] Often conflated with laissez-faire economics, neoliberalism actually calls for an activist government because it believes successful markets must be actively constructed by the state. The constructivism of *neo*liberalism is to be contrasted with the naturalism of *classical*

29 Market Design Incorporated (www.market-design.com) 'offers consulting services in the design of auction markets'. Criterion Auctions (www.criterionauctions.com) 'provides strategic advice to governments who design auctions or firms who participate in those auctions'. And Spectrum Exchange (www.spectrum-exchange.com) boasts it is 'creating value through the efficient exchange of spectrum'.

30 Or, as the information economist Eli Noam puts it, 'The FCC auctions have . . . benefited from the contributions of game theorists grateful for a field of recognition after the end of the Cold War' (Noam, 1995).

31 The following discussion has benefited from the extensive comments of an anonymous reviewer.

liberalism, which regards the market as a 'quasi-natural' reality, and therefore calls only for a 'nightwatchman' state (Barry *et al*., 1996; Burchell *et al*., 1991). Although neoliberalism endorses 'privatization', this rarely entails a shrinking of the state, but instead refocuses its efforts toward displacing (what they view as) unwarranted political interference with corporations (Mirowski and Plehwe, forthcoming). By reserving a role for themselves as agents of privatization, auction theorists have secured the neoliberal state as a client, while as a bonus have preserved more traditional channels of state support in the form of NSF grants (Milgrom, 2004: 3). Auction theory's success should then be understood as a byproduct of the changing relationship between the university, the state, and the market: it is what happens when you take a handful of economists, subject their universities to massive restructuring, place them in a neoliberal policy context, and 'encourage' them to act as entrepreneurs.[32]

5. What happens when you can't tell science from advertisement?

To review, the folktale holds that the application of game theory to the spectrum auctions led to scientific imperatives assuming prominence and rewarded the treasury with billions of dollars, thereby demonstrating the practical relevance of such research. But the evidence supports no such reading of the FCC auctions. It is far too simplistic to proclaim practical relevance the primary virtue exhibited by game theory in the FCC auctions. Game theory was demonstrably irrelevant to most important aspects of the construction of markets, as evidenced by the need of the FCC to call on experimentalists, though game theorists did prove themselves quite relevant to the business strategies of a handful of telecoms.

I therefore propose replacing the folktale with three lessons consistent with the historical record:

[1] ***The decision to auction off electromagnetic spectrum licenses led to the commercial interests of a handful of large telecoms acquiring significance alongside both political and scientific considerations.*** 'In the US telecommunications spectrum auctions, sophisticated bidders anticipated the effects of packaging on the auction and lobbied the [FCC] for packages that served their individual interests' (Ausubel and Milgrom, 2006: 79–80). '[T]he business world was fully aware of [the strategic significance of] the rulemaking process and had engaged many groups of consultants to help position themselves . . . a mixture of self-interest and fear motivated many different and competing architectures for the auctions as different businesses promoted different rules' (Plott, 1997: 606).

[2] ***The role of game theory in [1] demonstrates its ability to deliver clients a valuable service.*** '[Pacific Bell Attorney James] Tuthill, who organized

32 To wit: 'Shaping markets for the twenty-first century is both a task for government and an opportunity for entrepreneurs' (McMillan, 2002: x).

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PacBell's lobbying before the FCC, knew it would be crucial to hire an expert who could figure out where, amid the highly technical details of the auction proposal, PacBell's interests lay . . . Milgrom was assigned the lead role because he was willing to lobby' (Thelen, 1995). '[I]f efficiency is allowed to take a back seat to self-interest, then bidders should be expected to argue for the simultaneous auction [and against package bidding], while the seller should be expected to argue for the inclusion of package bidding' (Ledyard *et al*., 1997: 660).

[3] ***The most compelling evidence of the success of [2] is the game theorists' delivery of licenses to their clients, relatively cheaply.*** 'When the gavel fell, [Milgrom's] . . . client was holding exactly what it set out to obtain – the Los Angeles and San Francisco area licenses . . . Milgrom says [Pac Bell's] board of directors regarded the final price of $696 million as a "good deal"' (Thelen, 1995). '[F]or the firms that want to get their hands on a sliver of the airwaves, their best bet is to go out first and hire themselves a good game theorist' (*The Economist*, 1994: 70).

Unfortunately, getting the lessons straight represents only a first step in dispelling the confusion surrounding the FCC auctions. The folktale has assumed a life of its own, as various commentators have focused too narrowly on their own subdisciplinary concerns. Those captivated by auction theorists' claims to have developed a new approach to markets should cease looking to the FCC auctions: they will find instead an approach tailored for a neoliberal policy context. Observers who marvel at how the FCC auctions have opened up 'a new way for game theorists to earn their livings' are responding less to a new approach to markets, or even an improvement in public policy, than to the success of game theorists in attracting a sizeable and stable client base. Though it is perfectly understandable why participating game theorists would display such enthusiasm for this form of 'success', economists should temper their own enthusiasm in light of the failure of auction theory to implement public policy. Yes, the successes of the FCC auctions have been trumpeted far and wide, and the best academic journals are carrying the tune. But when the tune begins to sound like an advertising jingle, one hopes economists would not merely hum along.

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