

10-20% of the amount that telecommunications analysts had predicted that the auction would lead to. The approximate amount on a per MHz per pop basis is approximately \$0.0017 which is only slightly higher than the WCS (wireless communications services) auction completed in April 1997, which had a value of approximately \$0.0012 on a per MHz per pop basis.¹

A. Recent Auctions Results and Spectrum Value

10. The econometric results (after controlling for factors such as spectrum block size) demonstrate the declining trend in winning auction bids:

Table 1: Per Capita per MHz Winning Bids for FCC Auctions

<u>Spectrum Block</u>	<u>Date Completed</u>	<u>\$ per Pop per MHz</u>
Narrowband PCS	11/94	\$4.035
PCS A/B	3/95	\$0.467
PCS C	5/96	\$0.351
900 SMR	4/96	\$0.179
PCS D/E	1/97	\$0.130
PCS F	1/97	\$0.043
SMR Upper 200	12/97	\$0.120

¹ I note that the very low amounts raised in the WCS auction were blamed by the then FCC Chairman, Mr. Hundt, on the limited amount of time that bidders had to create business plans and raise lending commitments for the auction. Since the LMDS auction was delayed numerous times, bidders presumably had sufficient time to create business plans and secure lending commitments. Nevertheless, the amount raised in the auction is extremely low.

Note that these spectrum blocks are all for voice grade mobile services. Even after controlling for the smaller spectrum blocks in the PCS D/E/F auctions, the auction prices decreased significantly from the earlier PCS A/B/C results with the winning bids less than 1/3 the earlier amounts. Similarly, the SMR winning bids also dropped by about 1/3. Overall, if a time trend is included in the regression, the estimated coefficient is highly significant (t-statistic of 59.6) and the estimated effect is a decline of over 30% per year. The marked downward trend in the voice-use spectrum blocks in Table 1 and the estimated time trend in the regression both indicate further expected decreases in the future.

11. Significant technology uncertainty that previously existed has been resolved to a significant extent for mobile voice services.² Prior to about 12-18 months ago and subsequent to the PCS A/B/C block auctions, it was unknown whether a digital cellular technology called CDMA would work well. CDMA promises 5-10 times the capacity of current analog cellular technology and about 3 times the capacity of the alternative cellular digital technology, TDMA (GSM). If CDMA works well, the capacity for cellular and PCS voice grade service in a given metropolitan area would be approximately 20-25 million subscribers given current

² I discussed the importance of this technological uncertainty in

spectrum which is available. Even in the largest metropolitan areas such as Los Angeles this capacity would be more than sufficient to allow each person to have a mobile telephone. Now that CDMA has been in operation in Los Angeles and New York and appears to work well, significant technological uncertainty has been resolved and the demand curve for new voice spectrum usage has probably moved inwards.³

12. The supply of spectrum will also increase. While other more broadband uses of the spectrum will likely become available, note that another 100 MHz of spectrum below 3 GHz is required to be auctioned by the Balanced Budget Act of 1997 in addition to the 170 MHz of spectrum currently available for cellular and for PCS.⁴ The expected increase in the supply of spectrum will likely continue to cause future auction values for spectrum to continue to decrease. Thus, the combination of the resolution of significant technological uncertainty through the success of CDMA (and ESMR) and the expected continued increases in supply of spectrum via new auctions should lead to a continued downward trend in the value of spectrum on a per MHz per pop basis.⁵

my testimony before the House and Senate Committees in 1996.

³ Similarly, significant technological uncertainty existed over the success of the Nextel ESMR (MIRS) technology because of initial problems in deploying the technology. These problems have been resolved and Nextel is rolling out a mobile voice grade network.

⁴ Additional spectrum is available for ESMR, e.g. Nextel.

⁵ A 1997 study by the Congressional Budget Office comes to a similar conclusion that future auction prices will decrease over time. See CBO, "Where Do We Go From Here? The FCC Auctions and the Future of Radio Spectrum Management", April 1997, Chapter 3,

13. My second major econometric finding, a very large discount in auction results for services that face significant business and technological uncertainty, would also affect the auction value of spectrum for ancillary services. The WCS and LMDS auctions led to particularly low auction results. This outcome is to be expected given the necessity for substantial sunk cost investments in the presence of significant amounts of business and technological uncertainty. Since sunk costs are not recoverable if the investment is not successful, recent economic analysis has emphasized that a markup on the investment cost is required to take account of the uncertainty.⁶ This high degree of uncertainty in the presence of sunk costs will lead to significantly decreased auction results. A similar situation is present in ancillary service with respect to business and technological uncertain with significant sunk cost investments required to provide ancillary services. Thus, the combination of overall declining auction results over time and the significant business and technological uncertainty with respect to sunk costs would lead to an expected outcome of relatively low auction results for spectrum used for ancillary services.

pp. 29ff. The CBO states that improved technology and expected increases in price competition for mobile telecommunications services will lead to price decreases below the levels of the PCS auctions. (pp. 38-39) However, the CBO study does not distinguish between known changes in technology and the resolution of technological uncertainty. Only the latter development should significantly affect future auction prices.

⁶ See e.g. A. Dixit and R. Pindyck, Investment Under Uncertainty, Princeton U.P., 1994.

B. Fees for Ancillary Services

14. The NPRM recognizes that ancillary services may be offered simultaneously with other non-feeable services. The NPRM recognizes that consumer welfare provides the appropriate basis to determine balance between free and pay services. (p. 5) Thus, the economic basis would take into account both the dollars raised (i.e. spectrum fees) from ancillary services and consumer benefits from new services.

15. I have done academic research over the past few years that demonstrates that large amounts of consumer benefits that originate with new telecommunications services.⁷ The economic analysis demonstrates that the increase in consumer welfare is directly proportional to the revenue of the new service divided (approximately) by the price elasticity of the service. Successful new services lead to hundreds of millions or billions of dollars of increased consumer welfare. Thus, the Commission should be especially careful in creating a distortion that could limit the introduction of new ancillary services by DTV providers.

⁷ The methodology is developed in "Valuation of New Goods Under Perfect and Imperfect Competition", in T. Bresnahan and R. Gordon eds., The Economics of New Goods, Univ. of Chicago Press, 1997. I apply the methodology to new telecommunication services in "Valuation and the Effect of Regulation on New Services in Telecommunications", Brookings Papers on Economic Activity: Microeconomics 1997 and "Cellular Telephone, New Products and

16. From a business plan viewpoint, ancillary services are extremely difficult to value given that they are new and untested services. The situation is very different than PCS where a recognized demand existed from previous cellular market experience.⁸ Since spectrum value is determined by the present discounted value (PDV) of expected economic profits for the services to be offer, spectrum valuation for ancillary services will require a much higher discount rate than spectrum valuation for the PCS spectrum blocks. Thus, the value of the spectrum for the ancillary services is likely to significantly lower than it was for the PCS spectrum because of the increased uncertainty and because of the downward trend in winning spectrum auction bids.

17. Most importantly, given my academic research findings that consumers benefit so greatly from the introduction of successful new services, the FCC should be careful not to set rates too high of it will distort entry decisions for new ancillary services. The relevant tradeoff is marginal increases in revenues from slightly higher rates versus the attempted introduction of a new ancillary service, which, if successful, will created a significant increase in consumer welfare. Given this tradeoff and the high degree of uncertainty about the future success of ancillary services, the Commission should initially

the CPI, NBER Working Paper 5982, March 1997.

⁸ Indeed, the extremely low winning auction bids for WCS spectrum and LMDS spectrum likely arise, at least in part, from the uncertainty over demand for services to be provided in these spectrum blocks.

set low rates. The Commission can revisit the rates in the future and increase them, if ancillary services turn out to be highly successful.

II. Evaluation of FCC Proposals to Raise Revenue

18. A framework for analysis used in licensing agreements can be applied in the current situation. Most patent licenses are a combination of an upfront fee and a percentage royalty based on revenue. Note that an upfront fee does not create an economic distortion so long as entry occurs, since the upfront fee is a sunk cost, given the fact of entry. Once the upfront fee is paid, it does not effect future decisions, so no distortion in future economic activity arises. However, the upfront fee only solution has poor risk sharing characteristics since all of the risk is borne by the licensee, which is likely to deter entry in a situation of high uncertainty and significant sunk costs as arises with ancillary services. This situation explains why upfront payments are typically small or non-existent in patent license situations unless the product being licensed has already been proven to be successful in the market.⁹

19. Running royalties in patent licenses are typically based on a percentage of gross revenues. Running royalties have

⁹ The PCS spectrum auctions can be interpreted as an upfront fee, but note that PCS was already expected to be successful in the market given the experience of cellular in the U.S. and PCS in the U.K.

favorable risk sharing effects compared to an upfront fee arrangement. The running royalties will distort economic activity because they are applied to gross revenues. Thus, the usual effect is a decrease in output compared to the undistorted situation.¹⁰ However, a royalty based on gross revenue is typically used because of the monitoring problem since the licensor typically cannot accurately determine the licensee's net revenues. Monitoring gross revenues does not raise nearly the same degree of problems. Also, many patent licensors are competitors of their licensees. By using a royalty on gross revenues, they can decrease price pressure created by their licensees, leading to higher profits. Note that a running royalty does share the risk between the licensor and licensee so that it is the usual approach taken in patent licensing. The NPRM discussion of a "hybrid fee" (p. 6) has both of the elements of an upfront fee plus a running royalty.

20. Depending on the level at which they are initially set, running royalties based on gross revenues for ancillary services could lead to negative net revenues for a significant period of time, given the necessity for significant initial investment in developing the services.¹¹ Since the initial investments are sunk costs with a high degree of uncertainty, a too high fee on

¹⁰ In certain oligopoly situation, the somewhat perverse result of an increase in output can occur. However, this outcome is not usually expected.

¹¹ Indeed, almost all internet based services continue to earn negative profits because of the necessity for significant

gross revenues could severely distort and decrease entry decisions for producers of ancillary services.¹² The NPRM recognizes that depending on costs of different feeable services, the choice of the type of feeable services will be affected. However, it is also true that the quantity of feeable services may be diminished because the fee is applied to gross revenues. Consumer welfare will thus be adversely affected by too high a fee on gross revenues, with the decrease in consumer welfare proportional to the square of the fee rate if the service is offered. If the service is not offered because of the fee, the losses in consumer revenues will be significantly greater.

21. The NPRM then considers a fee based on a percentage of net revenues. The Commission correctly recognizes that a fee based on net revenues again has favorable risk sharing properties compared to an upfront fee approach. A net revenue approach is better for entry as the NPRM recognizes (p. 8) because a fee is based only on economic profits after costs, including the costs of capital, are subtracted from gross revenues. However, the NPRM evinces concern about the accounting complexity associated with the allocation of joint and common costs. While these concerns could be eliminated if the Commission did not include joint and common costs in the cost basis for net revenues, this approach could lead to serious economic distortions, to the

investment in developing the services.

¹² A fee on gross revenues can be interpreted as a negative investment tax credit which will discourage new investment.

extent that joint and common costs are a significant cost factor.

22. All else being equal, a fee based on net revenues would lead to higher consumer welfare than a gross revenue approach because the economic distortion is less. To the extent that the cost of capital is included in the cost calculation, no economic distortion is created, since the fee is based only on economic (pure) profits.¹³ Thus, neither output nor entry decisions are affected by a fee on net revenue so long as the cost of capital is estimated accurately. A fee on net revenues avoids the economic distortions of the gross royalty approach with respect to both entry and output decisions. Thus, it is likely to lead to the greatest increase in consumer welfare from the availability of ancillary services.

23. Lastly, the hybrid fee considered in the NPRM is a combination of an upfront fee and a gross revenue or net revenue based approach to fees. Given that the ancillary services will be new services with a high degree of risk, any significant upfront payment as part of a hybrid fee approach is likely to have a potentially large distortion on entry decision, which would significantly decrease consumers welfare.

¹³ This result has long been known in the public finance literature. See e.g. A.B. Atkinson and J.E. Stiglitz, Public Economics, McGraw Hill, 1980, p. 132.

IV. Setting the Percentage Fee Rate

24. The usual approach to this type situation is the use of an "Edgeworth box" approach that has long been used in economics.¹⁴ The Edgeworth box depicts the possibilities for trade between two sets of economic agents, here consumers who are potential buyers of ancillary services and firms who are the potential producers of ancillary services. Trade between the two sets of agents makes both sets better off since consumers benefit from new ancillary service and pay a price to buy them and the ancillary service providers made a profit from the production of ancillary services. The Edgeworth box demonstrates that trade between the two sets of agents will lead to the maximum degree of economic efficiency gains to the U.S. economy and welfare gain to consumers.

25. The FCC has been directed by Congress to try to approximate the auction value, while at the same time creating increases in consumer welfare. Thus, the FCC should attempt to achieve the results of the Edgeworth box, subject to the direction of Congress. Providers of potential feeable services desire to pay as little in spectrum fees as possible. Consumers receive large benefits from new ancillary services, but they also desire to pay as low as price as possible. If the Commission sets a relatively high spectrum fee based on gross revenues, the price to consumers for ancillary services will be significantly

¹⁴ See e.g. A. Mas-Collell, et. al., Microeconomic Theory, Oxford

higher since ancillary service providers will pass on the fee in terms of a higher price for their ancillary service offerings. These considerations set the limits of the Edgeworth box within which the Commission should attempt to find the solution that maximizes consumer welfare. A major consideration in the current situation is the high amount of risk given the absence of proven demand for ancillary services and the effect of the fee on entry.

26. The NPRM considers a flat fee in the range of 1% to 10%. I suggest that the Commission initially begin with a fee toward the low end of the range, especially if the fee is based on gross revenues. Indeed, the Commission might consider initially setting the fee at 1% (or less) and consider adjusting it at a later point in time to allow for favorable entry properties of the fee structure. A "wait and see" approach by the Commission would permit the considerable business and technological uncertainty to be resolved, before final rates are determined. This approach would likely lead to more entry and more new services for consumers.

27. Given the potentially large gains in consumer welfare from new services and the likelihood that new services will have a very high degree of risk, the Commission should initially set a very low rate to encourage entry. Alternatively, if the fee amount is based on net revenues, rather than gross revenues, the

initial fee percentage does not need to be as low to lead to similar gains in consumer welfare so long as the cost of capital, correctly taking into account risks of new ancillary services, is included in the calculation of net revenues.

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 Director, MIT Telecommunications Economics Research Program, 1988-
 Board of Directors, Theseus Institute, France Telecom University, 1988-1995
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