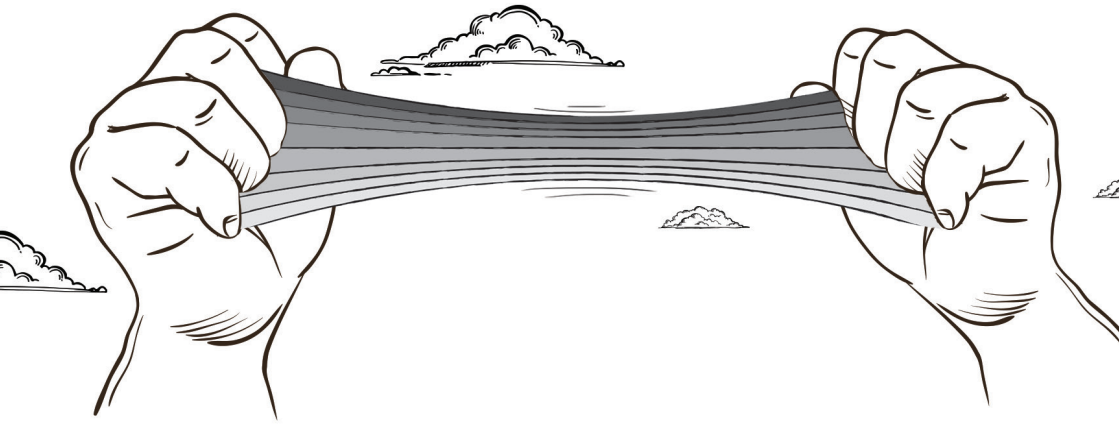

Spectrum Strife – The Struggle for the Profits Emanating from the Communications Sector's Miracle Ingredient

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Introduction

The communications sector has undergone unparalleled global change in the fifty years since the International Institute of Communications (IIC) was founded. This chapter describes the role in these events of the discovery, and exploitation, of the potential of spectrum to carry voice call and data services, which previously had been largely confined to wireline conveyance.

Of course, traffic moved in the other direction too, with content formerly only broadcast 'over the air' increasingly carried by fixed networks; but it was the birth, and rapid spread, of mobile communications – first voice and then data – that had the greater transformational effect. According to the International Telecommunication Union (ITU), by 2018 global mobile telephone subscriptions, at 107 per 100 inhabitants, outstripped fixed telephone subscriptions by a factor of nine, and active mobile broadband subscriptions numbered 69 per 100 inhabitants.

The local-access component of mobile networks is built on the foundation of a natural resource – the radio spectrum – understanding of which fifty years ago was largely confined to employees of a few engineering-based firms, a number of military personnel, and a very small number of government officials who allocated and assigned the resource to users.

The most prominent of such uses were civil and military radar, terrestrial broadcasting, and the very rudimentary voice communications then available. About half of the spectrum in use was allocated to the public sector, the lion's share of it for defence purposes. And the task of allocating it was made simpler by the fact that demand for it was not very intense. For example, although in the UK the number of free-to-air television services was very small – growing slowly from zero to only five in the fifty-year period after World War II – the reason for this parsimonious approach was not scarcity of spectrum, but broadcasting policy.

It is the change in this circumstance – the switch from general overall abundance of spectrum to acute scarcity in certain key frequencies – which has elevated spectrum management to a position of economic importance, both as a tool for achieving the spread of economic prosperity, and as a means of benefitting the government finances.

A natural resource like radio frequencies can be allocated in three fundamentally different ways: by making them freely available to all

comers – in the manner of an agricultural commons; by government fiat ('command and control'); or through a market process. Thus historically, scarce land has generally been the subject of market allocation since time immemorial. Water abstraction rights are usually assigned by governments, and not subject to market allocation in generally water-abundant areas (such as the UK), but are traded in water-scarce areas, such as the Middle East and Southern California.

In the last fifty years, management of high-value (mobile) spectrum has undergone a major switch in the allocation method employed, from command and control to the use of markets, as demand for the relevant services has snowballed. There are now signs that the pendulum may be swinging back. In this chapter I want to explore the reasons for, and consequences of, these changes, in terms of two kinds of effect. The first is the standard one of efficiency, which seeks to answer the question – what is the method of allocating spectrum which yields most benefit to the end-users of spectrum-using services? The second question, and primary focus here, is: as spectrum becomes scarcer and more valuable, how does the spectrum regulation process act to distribute the resulting profits (or 'scarcity rents') from the resource among the parties involved in spectrum use – which now comprise not only producers and consumers but also, increasingly, the government as an articulator of diverse public interests?

Rent-seeking Behaviour in Spectrum Markets: The *Ancien Régime*

Access to spectrum, which others do not possess, gives firms the potential to make a substantial profit in a downstream service market. This puts a lot of power in the hands of regulators making command and control decisions, and encourages competition for their favours. This fuels a demand for 'regulatory capture', which discretionary methods of allocating spectrum, such as 'beauty contests', can more easily permit than contests with more strictly defined, and transparent, rules.

Or it can be 'quasi-capture', achieved by bombarding the regulator with submissions and public messages designed to control its behaviour. The basis for this is the description of a regulator's dilemma by Paul Joskow.[1]

He points out that while firms have a clear objective of profitability, regulators' objectives are less well defined and more flexible:

> Given this fairly large amount of flexibility [for regulatory agencies] the general view taken here is that [they] seek to limit conflict and criticism appearing as "signals" in the economic and social environment in which they operate…

A more recent contribution uses in its title the vivid descriptive phrase 'minimal squawk behaviour' to convey broadly the same hypothesis, where the regulator is assumed to seek to quieten criticism by giving way to those with loudest voices – typically dominant incumbents.[2] As a result, regulatory decisions are taken to keep interest groups quiet and to keep mistakes out of the public eye. An able, self-confident or long-tenured regulator may have an incentive to gain reputation by pursuing the public interest: a less able one buys off squawk by generosity to noisy interests.

Regulatory intervention in spectrum markets can shift rents available in the market place in a number of ways, as well as offering privileged assignments to particular users. A regulator can further the interests of its incumbent captors by foreclosing competitors. The potential for this to occur is illustrated by two, somewhat ancient, spectrum allocation events in the US, described by Thomas Hazlett in his magnificent history of how the topic of this chapter has played out in the USA.[3]

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1 P. L. Joskow, 1973, 'Pricing decisions of regulated firms: a behavioral approach', *Bell Journal of Economics,* pp. 118–140

2 C. Leaver, 2009, 'Bureaucratic minimal squawk behaviour', *American Economic Review,* pp. 572–607

3 Thomas W. Hazlett, 2017, *The Political Spectrum,* Yale University Press, pp. 62–69 & 91–101

The first episode, beginning in 1937, involved the attempt to use FM (frequency modulation) frequencies for radio broadcasting, in competition with inferior AM (amplitude modulation) frequencies. A few FM stations came into operation before the outbreak of war in 1941.

After the war, the AM competitors persuaded the Federal Communications Commission (FCC) to rescind these assignments on scientifically spurious grounds relating to fear of interference associated with sunspots. Investment sunk by households in receivers and by broadcasters in transmission equipment was wiped out. The FM stations' power was also greatly reduced. AM broadcasters reigned supreme for decades afterwards.

A similar event occurred in US television broadcasting after World War II, when a fourth network, Dumont, was trying to establish itself. The FCC first froze the number of assignments for four years. It then chose a plan which favoured more localised services, but which reduced the number of markets in which more than three stations could co-exist. As Hazlett records, the Dumont network "which launched in 1946, went dark in 1955 – murder by spectrum allocation."[4]

These two events occurred 'before mobile', when alternatives to command and control had not seriously been canvassed. Thus in Europe, the US and elsewhere, spectrum assignments packaged with licences for advertiser-supported terrestrial broadcasting were typically assigned by command and control or administrative methods, such as 'beauty contests'. This despite their enormous commercial value; in the UK they were famously described in 1956 by a lucky holder[5] as a "licence to print money."

Famously, in 1959 Ronald Coase wrote his path-breaking article,

4 Ibid. p. 97

5 Roy Thompson of Scottish Television

criticising this practice and proposing a market-based alternative.[6] Its reception was characterised by a mixture of neglect and rejection, and another three decades or more were to pass before the auction case began to be widely accepted.

So when mobile licences were first issued in the 1980s – either a single licence or at most two – it was a natural step in many jurisdictions simply to assign one of them to the historic fixed monopolist. The take-up of early mobile voice operators was uncertain, and initially regulators nurtured them. This included regulatory tolerance of a substantial income stream for them, associated with high mobile-termination charges, initially transferred almost entirely from fixed subscribers.[7]

As demand for mobile ballooned, it became clear that more players could be supported in the market. As they became diverse in size, and as more frequencies were brought into play, the notion of assigning an equal amount of spectrum to all successful licence applicants gave way to assigning multiple lots, and to the accumulation (by operators) of spectrum portfolios. More importantly, it seemed increasingly incongruous for the enormous profits to be made out of scarce public spectrum to accrue to successful mobile applicants.

Probably the most significant people to reach this conclusion were finance ministers. Why should billions of euros in advanced countries – and often hundreds or tens of millions in poorer countries – go to fortunate, and often overseas, investors in mobile networks, when they might instead be used for essential public expenditure (...or be misused by politicians!). As discussed below, soon almost all high-value spectrum all over the world was being auctioned. For this and

6 R.H. Coase, 1959, *'The Federal Communications Commission', Journal of Law and Economics,* pp. 1–40

7 In the European Union this system survived until the implementation of the Termination Charge Recommendation in 2009, by which time incoming traffic on mobile was increasingly mobile-generated. See O. Bomsel et al., 2003, 'How mobile termination charges shape the dynamics of the telecoms sector', available at: https://pdfs.semanticscholar.org/2b46/dd56c33603b8b694a9d9a0b3f5a56d9e66ba.pdf

other reasons, by 2018 even China, one of the last bastions of spectrum command and control, was contemplating its marketisation.

The Auction Alternative

In 1989, New Zealand was the first country to authorise spectrum auctions, and the UK did the same in the following year. But tremendous momentum was given to the process by the decision of the US Congress in 1993 to authorise an auction.[8]

The inherent interest of problems of auction design, in combination with the large sums at stake, attracted the interests of some of the world's most distinguished economists in mechanism design, who developed a variety of ingenious approaches including, in particular, simultaneous multi-round auctions and combinatorial designs which allow firms to bid on alternative packages of lots. A recent study has shown that (standardised) auction revenues do vary with the design chosen.[9]

It is clear that a regime of effectively competitive auctions, possibly in combination with spectrum trading, could in principle find a price which both equates supply and demand, and distributes the available spectrum among operators in quantities which enable it to be used with maximum overall efficiency. In this competitive outcome, each market-clearing price would reflect the relative scarcity of each band. Put differently, prices would include 'scarcity rents', which would accrue to the auctioneer, normally the government.

A command and control assignment process at a lower (even zero) price would both jeopardise the efficiency property, and redirect some of the rents to the lucky beneficiary of the assignment.

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8 John McMillan, 1994, 'Selling spectrum rights', *Journal of Economic Perspectives,* pp. 145–162

9 P. Koutroumpis & M. Cave, 2018, 'Auction design and auction revenues', *Journal of Regulatory Economics,* pp. 275–297

For this outcome fully to materialise, the auction should in principle include all potential users of spectrum in a band, including firms that want to use it for different purposes. In practice, for good reasons associated with the avoidance of interference, and sometimes less-good reasons associated with regulatory capture or administrative convenience, the use to which the auctioned spectrum is to be put is pre-specified. There is one glorious exception to this – the so-called 'incentive auction' completed in the US in 2016, which effectively instituted a two-sided auction that linked broadcasters with a willingness to sell 600MHz spectrum, with mobile operators willing to buy it.[10] The auction process itself determined how much was traded, and hence how the spectrum was used.

What could possibly go wrong with auctions? Clearly, the operators involved in an auction might keep prices down by colluding in their bids.[11] Reserve prices are an imperfect remedy against this behaviour, but the threat of criminal prosecution, supported by leniency for the participant who first discloses it, may be effective here.

Secondly, the supplier of spectrum might itself seek a monopoly profit by forcing prices up – simply by withholding supply. Thus a government might hoard available spectrum to drive-up the auction price, and increase auction revenues. Consumers of spectrum-using services then pay for this exploitation in higher downstream prices. In the European Union (EU), it is unlawful for spectrum regulators to seek to maximise auction revenues. Such monopoly rents, unlike scarcity rents, are a clear form of detriment in the economy.

However the problems described above are compounded by the fact that the spectrum market is nested in a value chain that also includes the market for the services which the spectrum is used to make – in

10 FCC, 2017, 'Broadcast incentive auction and post-auction transition', available at https://www.fcc.gov/about-fcc/fcc-initiatives/incentive-auctions

11 Robert C. Marshall & Leslie M. Marx, 2014, *The Economics of Collusion: Cartels and Bidding Rings,* MIT Press

our case primarily mobile communications. A firm might be driven to distort auction outcomes in the spectrum market, to achieve its private-market power goals at the service level, at the expense of end-users there.

Suppose a firm is dominant in that downstream market. It might use some of its excess profits there to overbid in a spectrum auction, thus depriving its competitors of spectrum and weakening them in the downstream market. This is a classic form of foreclosure known as 'increasing rivals' costs'. If this happens, auction revenues are inflated and spectrum is inefficiently used. The standard, and widely-applied, means of controlling such behaviour is to impose a cap on the spectrum which larger users can acquire.

Conversely, on the supply side, a government or regulator can enhance revenues by designing an auction process which would assist the creation of an uncompetitive downstream market. In the extreme case it could offer to sell all the spectrum capable of supplying a service to a single buyer – thus in effect selling a spectrum licence which brings with it a monopoly right to exploit consumers downstream. This will clearly enhance its value, and the auction would accrue cash to the auctioneer, at the expense of consumers.

Less obviously, a tranche of spectrum for release can be packaged such that only two firms out of a larger number can acquire significant quantities. Such 'duopolists' should be capable of maintaining prices above the competitive level, to a somewhat lesser degree than a single firm, but with the similar effect of raising prices for end-users, lowering take up of the service, and restricting connectivity.[12]

Thus a combination of direct intervention in spectrum auctions (such as the use of caps and criminalisation of collusion) and the maintenance

12 Italy's 2018 3.6–3.8 GHz provides an example where asymmetric lots (2 x 80 MHz and 2 x 20 MHz) drove record auction prices, some seven times higher than the Spanish auction held a few months earlier, for the same amount of spectrum in a comparable band

of competition in downstream markets (through merger control and appropriate spectrum-assignment methods) has shown itself capable to-date of generating workably competitive outcomes which keep down end-user prices and encourage innovation. And for present purposes, the crucial point is that competitive auctions channel the scarcity rents away from sectional producer interests and into the hands of governments, which can deploy them for public purposes.[13]

Claims are sometimes made that high spectrum prices are associated with high service prices. As shown above, this is quite possible if an auction regime allows powerful bidders to hoard spectrum, or promotes an uncompetitive downstream market. Apart from such cases, there are good reasons in principle for believing that, if the bulk of auction proceeds are paid up-front (and hence sunk), they play little or no role in subsequent service pricing, which is guided by post-auction demand conditions and avoidable costs. This conclusion is supported by some, if not all, of the empirical research.[14]

A further important wrinkle is added by the fact that a government can plough some of the scarcity rents it receives from an auction of mobile spectrum back into the sector – through that very auction process. Thus, some spectrum licences can be associated with an obligation to extend network coverage into so-called 'non-commercial' areas. In effect, reduced auction revenues are paying for the extended coverage. And the competitive nature of the process should ensure that the licence, or licences, with the extra obligations go to those operators which can discharge them most economically. With proper enforcement of licence commitments, this process has worked very well.

This adds up to a considerable success story. The combination of a competitive spectrum-assignment process and a competitive mobile

13 As an extra bonus, it is well known that this source of government revenue is free from the adverse knock-on incentive effects of almost every kind of tax

14 C. Cambini & N. Garelli, 2017, 'Spectrum fees and market performance', *Telecommunications Policy*, pp. 355–366

market, where it occurs, has kept service prices down, promoted network expansion, and generated innovation. It has also left the natural resource scarcity rents where, arguably, they should lie – in the hands of the public, not of investors in mobile networks. By imposing transparency on assignment decisions it has limited regulatory discretion and, with it, the corrosive effects of regulatory capture.

Does 5G Change Things?

I have argued elsewhere that 5G networks will entail considerably more disruption than previous generations and the shift from voice-to-voice and data – for several reasons.[15] The advent of 5G is associated with a much more comprehensive digital transformation of all sectors of the economy, and not just communications. Demand will rise accordingly. This increases the stakes for the whole economy. Second, the required 'densification' of the network is likely to reduce the viable number of local-access networks (and may elicit tighter regulation). Third, the network slicing associated with network virtualisation may remove such networks from having their direct relationship with the final customer, and turn them into the suppliers of wholesale communications services to other firms.

There are signs that, in the case of 5G, governments are more inclined to take a more strategic and interventionist approach than in the past. The concern for underserved areas is maintained, but mobile is increasingly a weapon in governments' industrial or even international trade policies.[16] As well as unlocking financial subsidies, this has led to calls for spectrum assignments to be accompanied by additional, and more bespoke, licence conditions. This is a partial reversion to the predominance of decision-taking by government fiat (ie. command and control).

15 Martin Cave, 2018, 'How disruptive is 5G?', *Telecommunications Policy*, pp. 653–658

16 See *New Street Research*, 'Global 5G: Kicking over the chessboard', 5 June 2019

Some advocates have called for bidding processes which give credit for a combination of investment promises and financial contribution.[17] Another trend is towards more granular coverage obligations, formulated not in terms of the proportion of land area or of population to be covered, but in terms of specific transport routes or the elimination of coverage failures in narrowly identified locations. This is briefly illustrated in the two following cases.

Thus, the German 5G auction contains extensive coverage requirements and a provision to assign spectrum to separate verticals, which operators have appealed to the courts.[18] In June 2019, the auction closed with revenues of €6.5bn ($7.3bn) collected from four operators, including a new entrant, after 497 rounds of bidding.[19]

In Singapore, the regulator has proposed to license two standalone 5G networks. Operators must submit bids explaining how they will introduce 5G, in terms of network roll-out, design and performance – and their plans for wholesale service. There will also be a financial bid, which must exceed a base level.[20]

Can this be done in a way which retains the competitive tension of earlier auctions, or does it create more rent-seeking opportunities for operators? This depends on the number of potential suppliers of the government's or regulator's additional requirements. If it is as many as the number competing for the mobile customers' general spending, that may (depending on circumstances) be enough. If, on the other hand, the service has to be supplied by a single operator, we are in a bilateral bargaining situation involving the regulator and a single bidder, where the outcome is uncertain. And the regulator may

17 As formulated here, this risks rewarding firms, not for the outputs they produce, but for the inputs which they buy – which is usually ill-advised

18 The auction requires a 98% population coverage at 100Mbps and 50 Mbps along major transport routes, by the end of 2022

19 https://www.dw.com/en/5g-auction-in-germany-raises-65-billion-from-four-telcoms/a-49168657

20 *Policy Tracker*, May 9 2019

be poorly sighted in this situation since its knowledge of the cost of providing the necessarily idiosyncratic coverage, or other additional services, will be significantly less than that of the operator. The danger is that operators may be able to use this informational asymmetry to re-appropriate at least some spectrum scarcity rents.

Conclusion

Famously, in 1980, the consultancy firm McKinsey and Co. was asked by AT&T to project the number of mobile subscribers in the US in 2000. They estimated 0.9 million; in fact, it was 109 million. The point being made is intended, not as a reproach to the company, but to illustrate the unexpected, unprecedented, and even fabulous growth of mobile communications.

The focus of this chapter has been on how law-makers and regulators have addressed the associated massive revaluation of the natural resource which underlies this extraordinary revolution – the radio spectrum. It has been argued that, in the pre-mobile period of relative spectrum abundance, the command and control approach to assignment which prevailed was prone to regulatory capture and the appropriation of spectrum rents by licensees. The loss to consumers was limited by the relatively low commercial value which spectrum then had.

The coming of spectrum auctions transformed the situation. We learnt that they could be transparent and highly competitive. As experience grew, auction designs became more sophisticated. Pro-competitive features were added by spectrum caps, and distributional goals were accomplished by coverage constraints. It was not all plain-sailing. Some operators misbehaved, and so did some governments and regulators.

But the re-assignment of spectrum rents from investors to governments was a notable feature, and after 2000 it made a contribution to the gradual and painful process of reducing the rates of return in the sector

closer to its cost of capital. The stiff competition for recently auctioned 5G spectrum indicates a continuing willingness on the part of major and experienced operators, supported by their shareholders, to make substantial further investments. Operators regret the competitive process, but continue to bid up the competitive prices.

This outcome depends on the maintenance of competitive tension in the auctions. This tension can be observed, for example, in the German auction noted above. But care must be taken to prevent the spectrum-assignment process degrading into a grant of spectrum in return for imprecise commitments, or a series of bilateral negotiations between a better- and a worse-informed party. This would both risk the efficiency of the assignments and raise the prospect that private investors, rather than governments, might cash in on some of the large natural-resource rents associated with spectrum.

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