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Spectrum auctions:

Distortionary input tax or efficient revenue instrument?

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Abstract:

Spectrum license auctions are widely recognized by economists as more efficient than lotteries or administrative approaches to allocate exclusive rights to spectrum. But whether spectrum auctions are *the most* efficient spectrum policy still generates debate, in part because the answer may vary depending on exactly what is being optimized, what else is assumed or held constant, and the policies to which one is comparing spectrum auctions. This paper examines the complex confluence of U.S. spectrum policy and fiscal policy, including the competing and complementary objectives of spectrum allocation efficiency, tax efficiency, and administrative efficiency. It concludes that tax and tax-like effects arise from several distinct spectrum policies, including tax interaction effects from regulatory scarcity rents, capital gains lock-in from gratis spectrum allocation, and a tax-like burden on new entrants and technologies in the absence of robust secondary markets. Properly constructed pricing systems for spectrum rights, including auctions, can be efficient revenue instruments, but overall efficiency requires that the government devolve the efficient set of rights bundles, allow secondary markets, recycle revenue optimally, and account for transaction costs and political economy factors.

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1. Introduction

Spectrum license auctions are widely recognized by economists as more efficient than lotteries or administrative approaches to allocate exclusive rights to spectrum.[2] But whether spectrum auctions are *the most* efficient spectrum policy still generates debate, in part because the answer may vary depending on exactly what is being optimized, what else is assumed or held constant, and the policies to which one is comparing spectrum auctions. In particular, discourse continues about the efficiency of spectrum auctions in generating federal government revenue. If spectrum revenue replaces revenue from other tax instruments (or reduces the budget deficit, thus incrementally reducing the requirements for tax revenue in the future), we call this "revenue recycling." This paper examines the complex confluence of spectrum policy and fiscal policy, including the competing and complementary objectives of spectrum allocation efficiency, tax efficiency, and administrative efficiency. A central objective of this paper is to paint a more complete picture of the tradeoffs across spectrum and fiscal policies so as to better envision what overall efficient spectrum policy would look like. Policy challenges discussed in this paper include constructing an efficient rights portfolio, revenue recycling, and distributional considerations. This work leaves to a separate literature to detail the most efficient design for spectrum auctions. See for example Crampton (2002) for a review of that literature.

- **Key points of this paper**

The fiscal efficiency of spectrum auctions has been conflated with the relative merits of unlicensed and licensed spectrum regimes and other policy debates. For example, in his support for an unlicensed approach, Noam (1998) argues that spectrum auctions "inevitably deteriorate into revenue tools," and that before long spectrum auctions may become "technologically obsolete, economically inefficient, and legally unconstitutional." Although the need for revenue ultimately drove the political acceptability of license auctions in the U.S. in the 1990s, the political exigency of auctions is separate from whether auctions represent economically efficient fiscal policy.[3] This paper seeks to clarify policy discussions about spectrum auctions and economic efficiency by elaborating several key points.

1. The overall economic efficiency of the spectrum policy system depends on (among other things) whether and how much it raises revenue for the government, but also importantly on the quantity and quality of the rights that are allocated and what happens to the revenue. Raising revenue by itself does not guarantee economic efficiency, but in the right circumstances a revenue-raising approach may be the

[2] See Crampton (Handbook chapter)
[3] See Hazlett (1998) for a history of FCC license auctions.

most efficient. On the other hand, an approach that maximizes revenue by restricting spectrum supply is virtually guaranteed to be inefficient.

2. The *design* of the spectrum rights system raises issues of economic efficiency that are substantially different than those of the *subsequent allocation system* for those rights, although both must be efficient to achieve overall efficiency.[4] For example, one may believe that exclusive rights are over-allocated relative to unlicensed spectrum, but that does not mean that auctions for exclusive rights are inefficient instruments to devolve those rights.

3. Important tax and tax-like issues abound in spectrum policy, including tax-like and tax-interaction effects of regulatory scarcity rents, capital gains lock-in from gratis spectrum allocations, and an effective tax on new entrants and technologies in the absence of robust secondary markets. However of all the potential spectrum policies that could produce tax-like effects, spectrum auctions are unlikely culprits.

4. The *economic efficiency* and the *distributional effects* of the spectrum allocation system are importantly distinct. The presumed unfairness of spectrum "windfalls" or "giveaways" tells us nothing about whether such an allocation is economically inefficient.[5]

Section 2 defines economic efficiency and graphically illustrates the policy challenge of spectrum allocation. It also discusses the first order policy challenge of devolving the efficient portfolio of spectrum rights. The section highlights the tax-like effects that inefficient spectrum allocation creates, and ways it can exacerbate existing distortions in the labor market. Section 3 examines spectrum pricing strategies and the role of markets. Section 4 considers spectrum as a potential government revenue source. Section 5 examines how spectrum allocation policies can distort (or not) rights holders' economic incentives through the capital gains tax. Section 6 discusses the efficiency implications of transactions costs and distributional considerations, including broad approaches for tailoring distributional effects so as to best ensure an efficient ultimate allocation. Section 7 concludes.

2. Economic Efficiency and Spectrum Policy

- **Economic efficiency and social optimality**

[4] The problem is recursive in that the efficiency with which licensed rights can be allocated and managed influences the optimal partitioning across rights regimes. For example, the less costly it is to enforce rules for unlicensed rights, the greater their optimal share, all else equal. Similarly, the more efficient the regulatory parameters or allocation methods for exclusive licenses, the more spectrum that should be licensed, all else equal.

[5] For illustrative debate regarding spectrum "windfalls," see Ornstein and Calabrese (2003) and Hazlett (2004).

When economists use the term "*economically efficient*," they generally mean Pareto efficient, an allocation of resources in which it is not possible to reallocate resources such that someone is better off and nobody else is worse off. Pareto efficient production occurs when inputs cannot be reallocated so that more of one good can be produced without producing less of another good. An economically efficient allocation of spectrum, then, is one in which there is no way to get more use out of the resource without giving up something else.

Another look at optimal policy is s*ocial optimality*. It is a (Pareto efficient) allocation of resources in which a social welfare function (a function that aggregates the welfares of each individual) is maximized. The socially optimal use of a resource occurs when the incremental net social benefit produced using the resource is equalized across all of its uses. For example, if using a little more of a resource X in Use A produces a higher incremental benefit than it would in Use B, greater total social benefits could be achieved by moving some of resource X from Use B to Use A. The maximization of social welfare concept can also include social priorities such as democratic institutions, environmental protection, and the desired level of transfers from one group (such as the rich) to another (such as the poor). Socially optimal spectrum policy means that, taking into account all of the costs and benefits to society from spectrum dependent services (monetizable or not), the resource is allocated across users and uses so as to achieve the greatest possible total benefit for society. How individuals or groups gain or lose from a resource allocation policy is its *distributional effects*, and these effects are usually considered separately from economic efficiency. This paper focuses mainly on linkages between public policies and efficiency in the Pareto efficient sense, but it also addresses the distinctions between and tradeoffs across economic efficiency, distributional effects and social benefits.

The U.S. and other industrialized economies allocate most resources (such as labor, goods, and services) by market forces within certain rules. In general, markets do a good job of allocating resources efficiently, especially when the rules take into account market imperfections.[6] Indeed, competitive markets are unsurpassed as the most efficient means to allocate resources.

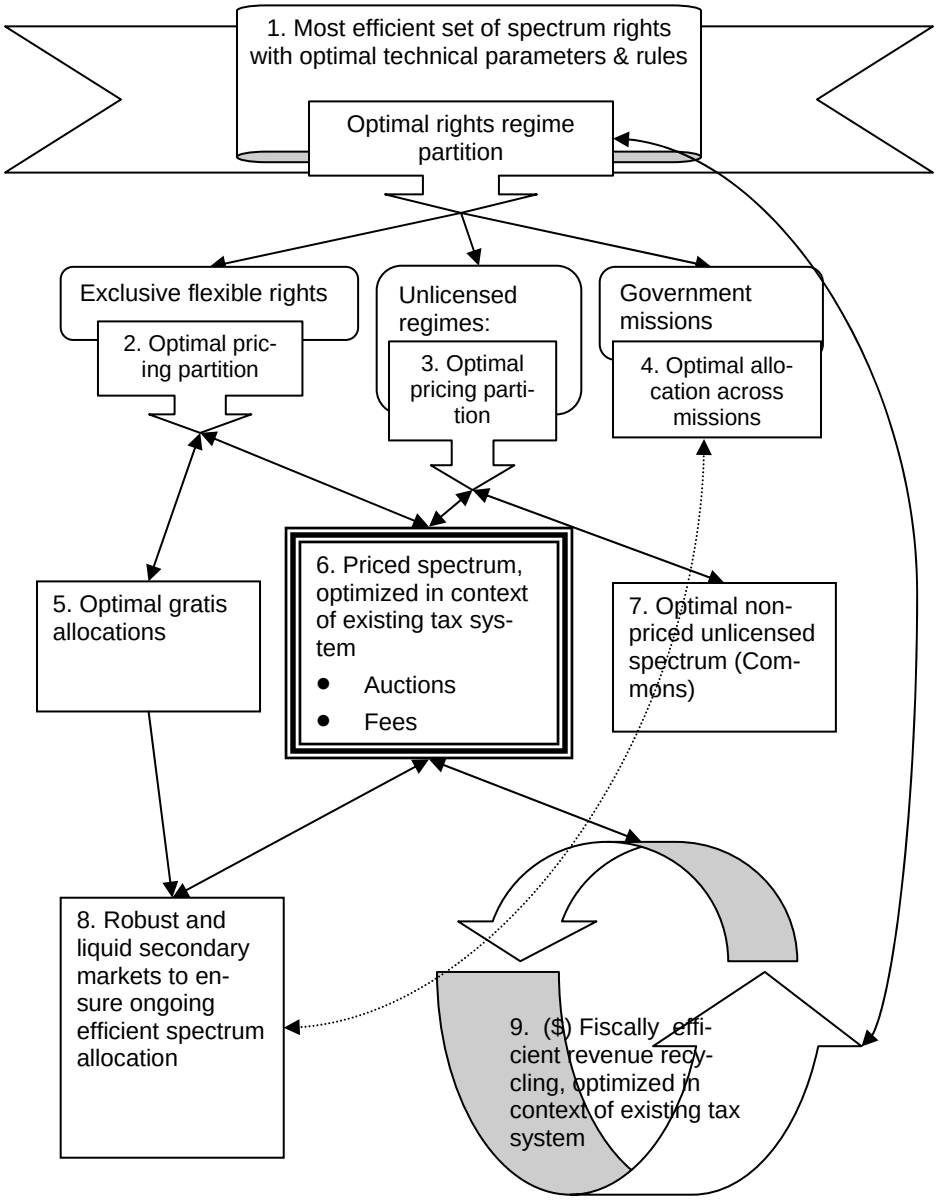
- **A graphical representation of globally efficient spectrum policy (Figure 1)**

A spectrum policy that is efficient overall optimizes a number of distinct sub-policies. **Figure 1** is an attempt to depict this graphically, with the main objective to demonstrate how complex the network of inter-related policies is. **Figure 1** elaborates the regulatory optimum presented in Hazlett and Munoz

[6] See CBO (1997), pp. 8 – 9 for more discussion on efficiency and market failures pertinent to spectrum.

(2004) (p. 22), especially with regard to interactions of spectrum policy with the existing fiscal system. Although **Figure 1** depicts the sub-policies as a hierarchy, in reality the optimization of each policy depends on the outcome of other policies.

Figure 1. Graphical Representation of Efficient Spectrum Policy



Let us break **Figure 1** down into simpler parts to consider in detail the sub-policies that overall efficiency entails.

Figure 2. The optimal portfolio of rights

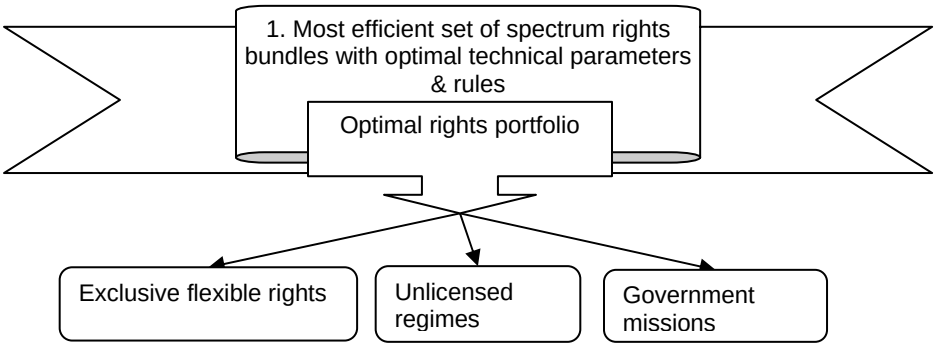


Figure 2 illustrates the first order policy challenge of creating the optimal portfolio of spectrum rights, including the allocation of rights across different rights regimes. This figure depicts three stylized components of an overall spectrum policy portfolio: exclusive flexible rights (a.k.a. licensed), unlicensed (a.k.a. spectrum commons or clubs), and government mission (rights allocated to government agencies for their primary use, such as defense applications). The government complements the rights with all the relevant technical parameters and rules and regulations about how rights are enforced, transferred, and so on. The government chooses this portfolio as an initial allocation of spectrum rights across rights regimes, and from time to time may update its partition or rules. The government's objective is to dynamically optimize its allocation of spectrum rights so as to maximize the returns to society. The first order policy challenge depicted in **Figure 2** is arguably the most difficult, the most economically important, and the one in which the current system in the U.S. is most far from economic efficiency.

The policy decisions described in **Figure 2** are rife with daunting uncertainties and costly adjustment. These include profound uncertainties about how best to set technical parameters and rights bundles, how much (and which) incremental spectrum to put into unlicensed use, and how best to accommodate the evolving requirements of government users. Uncertainties derive from rapid technological change, the difficulty of predicting scarcity in unlicensed environments, and changing threats to national security. Rapid technological changes in particular mean that historical average returns from spectrum in a given use might not reflect future marginal returns.

The government invokes a high opportunity cost if it sets up the wrong partition across rights regimes, but even if policymakers know how to improve the partition, adjusting it may be very costly. For example, if the FCC establishes an unlicensed regime in certain bands, and a capital stock specific to that band and

that rights regime accrues, then for practical purposes it becomes very difficult for the FCC to convert that band back to an exclusive license regime. Given the significant uncertainties involved in making policy and the rapidity with which technology changes, it may be efficient to foster new technologies that are more flexible in order to lower the cost of policy changes. In addition, adjustment costs can be reduced with ample time for transition so that producers need not scrap as much capital stock prematurely.

Other important implications of the policy decisions in **Figure 2** derive from the way the government bundles rights for allocation. In particular, Hazlett and Munoz (2004) note that how rights are bundled can affect the number of competitors in the output market, which in turn affects consumer and producer surplus through the usual competitive forces.

Observers argue whether more or less spectrum should be in flexible exclusive licensure versus unlicensed, but economists are as unanimous as they ever are about two things. First, at minimum the spectrum rights that *are* exclusively held by the private sector should be allocated as much as possible by market forces. Second, achieving an efficient outcome depends on rights holders' flexibility (within their rights and the associated technical parameters) to produce services of their choice and sell, subdivide, aggregate, and otherwise package their assets for secondary market transactions.[7] Under market forces, the bundles of exclusive spectrum rights traded would vary endogenously by duration, time, place, frequency, level of protection from interference, rights of interruption, and other parameters. With appropriate flexibility, market forces would allow exclusive spectrum rights to be goods that vary along quality dimensions just like other goods, and prices would reflect the relative values of those qualities.[8]

- **Tax and tax-like aspects of a sub-optimal rights portfolio**

Economists have argued that one especially costly aspect of incomplete spectrum allocation and markets is the creation of excess scarcity rents. In the context of existing distortions in capital and labor markets caused by the tax system, the efficiency cost of excess license rents may be even higher than previously recognized, and is likely worsening. First, as widely noted, regulatory restrictions on licenses create ex-

[7] See for example Hazlett and Muñoz (2004) and Rosston (2001). One possible qualification to the endorsement of market forces is that it may be appropriate for the government to retain a power of eminent domain in cases where rights must be aggregated in order to achieve a more efficient allocation. Use of such power may be best confined to cases analogous to similar interventions in other markets (such as transportation infrastructure), where positive network externalities or core public goods objectives pertain. Another case may be national emergency situations.

[8] Some believe that spectrum rights are unlike other capital and should be regulated to include public service requirements. Such social welfare goals may be an important part of telecommunications policy, but they may be much more efficiently obtained by means other than attaching limiting conditions to spectrum licenses.

cessive privately-retained scarcity rents which in turn create inefficiently high prices for spectrum-dependent services. These extra-normal profits act like a tax on spectrum-dependent services.[9]

By raising overall price levels, the "tax" from an inefficient spectrum rights system lowers the net real wage, lowers the level of work force participation and work effort, and thus amplifies the deadweight loss from existing taxes on labor. It also lowers wage tax revenue. To maintain revenue levels, labor taxes must be slightly higher than they would be otherwise, resulting in another efficiency loss. The combined loss from shifted-back labor supply and higher marginal labor taxes is known as the "tax interaction effect." Although the efficiency losses may be small on the margin, they operate across the entire labor macroeconomy and thus may aggregate to significant overall costs.[10]

Parry (2003), Fullerton and Metcalf (2001), Goulder (1997), and others have analyzed the tax interaction effect in the context of pollution control, especially potential new limits on the greenhouse gas carbon dioxide. Instituting a tradable pollution permit system creates new regulatory scarcity rents for emitting activities, along with incurring costs for pollution abatement. Results show that the resulting increase in prices can produce a tax interaction effect so costly that it may even negate the social gains from controlling emissions. The net efficiency loses are higher than necessary if the government forgoes the opportunity to auction the marketable permits (and recycle the revenue) and instead grants them gratis to existing polluters or households. Thus the net benefits of the pollution control strategy may depend critically on whether the permit system raises revenue that offsets other distortionary taxes.

The lessons from the environmental economics literature for spectrum policy are clear. Regulatory scarcity rents interact with existing taxes on wage income in a way that could carry significant efficiency costs to the economy in addition to the efficiency losses in the markets for spectrum-dependent services. While this may seem an academic point, the data suggest it is increasingly important. Prices of spectrum-dependent services have an increasing role in determining overall price levels, for example as measured by the Consumer Price Index (CPI). The relative importance of wireless phone services in the 2003 CPI using weights from 1999-2000 was about .22.[11] In contrast, weights from the 2001-2002 basket of consumer goods, just two years later, report an almost 300% increase in relative importance of wireless

[9] For discussions of explicit taxes on wireless communications, see Mackey (2004) and Ingraham and Sidak (2004).
[10] The tax interaction effect is pertinent to economies such as the U.S. with relatively competitive labor markets. It would not extend the same way in economies with greater labor market rigidities.
[11] Data from the U.S. Bureau of Labor Statistics. "Relative importance of components in the Consumer Price Indexes: U.S. City Average, December 2003." Table1 (1999-2000) weights and Table 1 (2001-2002) weights. Web sites: ftp://ftp.bls.gov/pub/special.requests/cpi/cpiri99-00_2003.txt and ftp://ftp.bls.gov/pub/special.requests/cpi/cpiri99-00_2003.txt, respectively.

phone services in 2003 (.65). To put in context, this is a basket share greater than airline fares (.63), household appliances (.31), or fresh fruits (.48). Wireless phone services are gaining rapidly on the basket share of long distance land line communications (.76), which dropped slightly in relative importance over the two weighting periods. According to the CTIA wireless industry association, although average local monthly bills for mobile wireless phone consumers dropped from about $69 at the end of 1992 to about $50 in 2003, the number of subscribers increased from about 11 million to 159 million, and industry revenue increased from about $8 billion to $88 billion.[12] As wireless applications burgeon, their share in the average consumers' basket of goods rises, and so do the labor market efficiency costs of regulatory limits on spectrum.

How large are the tax interaction effects of spectrum policy likely to be in practice? It is most straightforward to analyze how the tax interaction effects amplify the tax-like effects of regulatory scarcity rents in the primary market for spectrum services. Parry (2003) summarizes the relevant literature on the marginal excess burden of labor taxation and cites a reasonable range of the marginal excess burden of labor taxation of between 0.1 and 0.5, with a consensus value of about 0.25. Thus, tax interaction effects could amplify the primary efficiency costs of regulatory scarcity rents by about 25%.[13]

Establishing fully flexible and competitive spectrum markets would end both monopoly rents and the consequent exacerbated labor market distortions. To be sure, that does not mean that there would be no economic rents from spectrum. On the contrary some economic rents may be large because desirable spectrum may be naturally limited in supply, especially in the short run given fixed technology. As long as spectrum rights markets are efficient, the value of those economic rents will be capitalized into the price of spectrum rights. In fact, since spectrum is inelastic in supply (at least in the short run), then its equilibrium competitive price will equal the present discounted value of the expected stream of net economic rents.[14] Economic rents (not artificially boosted by regulatory limitations) provide efficient incentives to invest in technologies that cost effectively improve the productivity of spectrum as an input to production.

Without license flexibility and efficient secondary markets, auctions and their refinements are likely to be relatively minor improvements to a grossly inefficient system. However, to the extent that auctions create

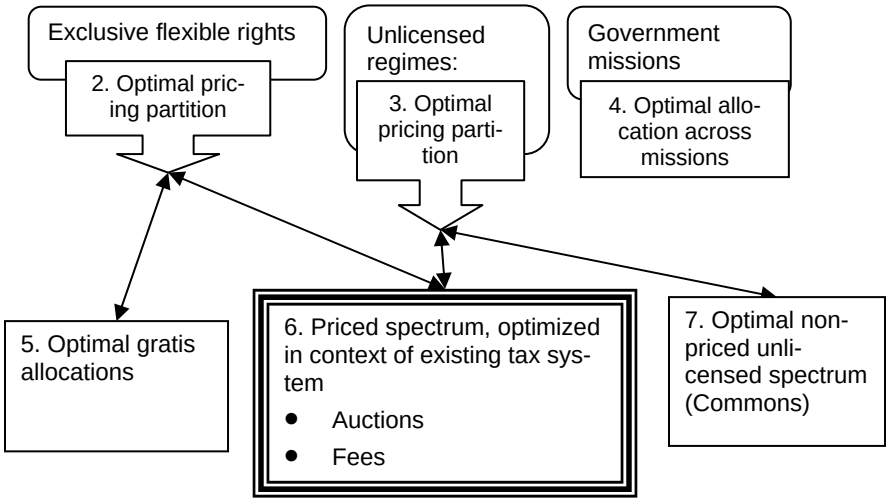
[12] CTIA (2004).
[13] This follows from Parry (2003), p. 4-7, by deriving the ratio of the tax interaction effects to the primary costs assuming no revenue recycling from auctioning scarcity rents. The resulting ratio is simply the marginal excess burden of labor taxation, M.
[14] Pindyck and Rubinfeld (1989), p. 508.

the possibility of reductions in other taxes, to a limited extent they can offset the tax-like inefficiencies of regulatory (excess) scarcity rents.

3. Pricing Spectrum

The second tier of policies includes how and whether to use prices to allocate spectrum rights. **Figure 3** represents this set of sub-policies.

Figure 3. Partitioning spectrum rights across pricing schemes



Although we normally think of exclusive rights as the kind most suited to market pricing, the price of spectrum access need not be zero in any of these rights regimes. For example, unlicensed systems could involve a fixed or variable administrative fee for access, such as a congestion fee that clears the access market. The federal government could also charge user agencies fees for spectrum use, or lease out spectrum that it temporarily does not need. In cases where there is no congestion or interference, an efficient price would be zero because no scarcity exists. In other cases, scarcity arises and the government must choose between price and non-price policies to resolve it. The most efficient approach to pricing takes into account the efficiency-enhancing opportunities of government revenue, but also administrative costs, transactions costs, and the political economy considerations that may make it preferable from an efficiency standpoint to give away spectrum rights rather than try to extract rents by pricing them.

- **Gratis exclusive spectrum**

Box 5 in **Figure 3** represents the case where the optimal policy is to give spectrum rights gratis and allow subsequent resale in a secondary market. Gratis rights policies include: spectrum lotteries, administrative allocations, and new license flexibilities granted to incumbents who hold more limited rights. Each firm that receives gratis rights makes a profit maximizing decision whether to keep the spectrum rights and produce services with it or to sell it to another firm to use. The firm may also lease the spectrum temporarily, in whole or in part. After receiving the gratis spectrum rights, the recipient firm decides what to do with them by comparing options:

1. the expected present discounted value (EPDV) of after-tax returns from offering spectrum services; and
2. the EPDV of the after-tax profits from alternative investments that could be funded from full or partial spectrum resale.

- **Portfolio of pricing strategies**

Box 6 in **Figure 3** includes all methods of allocating initial rights that generate revenue for the government. Almost anything that can be priced initially could theoretically be subsequently resold in a secondary market. Importantly in both the initial market and secondary markets, spectrum is priced. Thus, any arguments that government pricing of spectrum is inefficient should make clear whether there is something special about government pricing that makes it inefficient in a way that secondary market prices are not.

The government uses many different price systems to allocate resources. For example, the U.S. government auctions leases for offshore oil and gas drilling, and then collects a royalty (generally16% of production). Other resources, like grazing rights on federal lands, are fixed fees per resource unit (e.g., animals grazed per acre per month). The government also sets usage fees, such as for entrance to parks with surcharges for extra services like camping. Any of these pricing models could apply to spectrum, depending on the nature of the rights allocated and the commercial risks involved. For exclusive rights over significant bandwidths and time periods, the overwhelming consensus of economists is that the most efficient pricing scheme is auctioning. For unlicensed spectrum access, more work remains to identify efficient pricing strategies. One place to start would be to apply the existing economic literature on the optimal pricing of excludable public goods.[15]

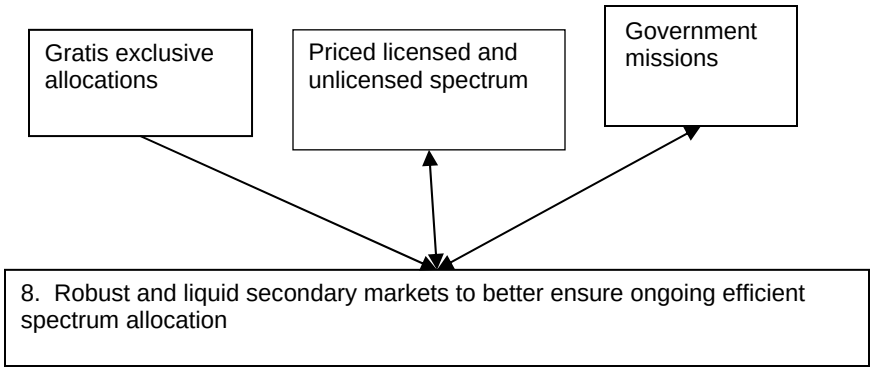
[15] For example, see Blomquist and Christiansen (2001).

The optimal auction design depends on the potential for collusion, the number of potential market entrants, the degree of uncertainty in projected revenues and many other factors. Assuming no oligopolistic behavior, a firm's willingness to pay for spectrum access is the present discounted value of its expected after-tax economic rents from production using the spectrum. Rights holders regularly analyze whether to hold or sell their spectrum rights, as they would with any other asset.

For complete efficiency, markets for spectrum rights and spectrum dependent services must be competitive. With appropriate oversight, ordinary business rules can address monopolistic behavior in the spectrum market and the relevant output markets. Any significant excess license rents could be addressed with full license flexibility and appropriate anti-trust enforcement.

- **Secondary markets**

Figure 4. Optimal secondary markets



Box 8 in **Figure 4** depicts the important role of secondary markets in priced spectrum. Once the government allocates initial rights, secondary transactions (to the extent they are allowed) will blur the distinctions between the categories. For example, licensed rights holders could establish unlicensed-type temporal or geographic zones. Government users could lease out unneeded exclusive rights to non-government users or allow unlicensed underlays that conform to specific standards.

The greater the ability (and lower the transactions cost) of secondary markets to refine the allocation towards greater efficiency, the less it matters what the initial allocation is. If the government impedes or prohibits secondary markets, several inefficiencies arise. First, as is widely noted, auctions produce an efficient allocation at the time of the sale, but the world of wireless services is hardly static (no pun intended). Over time, inefficiencies arise as economic factors evolve and the auction allocation becomes sub-optimal. Second, in the absence of appropriate secondary markets, potential new entrants face a dra-

matically reduced supply curve for spectrum. This acts like a tax on new firms and new applications relative to the economic activity of incumbent firms and existing applications. Such discrimination against technological change is likely very costly over the long run.

Even though secondary markets limit the government's role to the preliminary allocation, the initial partitioning across rights regimes is very important for two reasons. First, the initial allocations (and the method used to achieve them) determine winners and losers in a high stakes system. Second, not all rights are easily transferred from one rights regime to another, no matter how robust the secondary markets.

4. Spectrum as a government revenue source

- **Absolute and relative efficiency in the federal revenue system**

Inefficiency in the U.S. government revenue system derives mainly from the fact that taxing a productive economic activity such as working or saving discourages that activity. Those distorted incentives impose an economic cost over and above the revenue that the tax brings in, a cost known as deadweight loss, excess burden, or welfare loss.[16] The most economically efficient means to finance government spending minimizes the deadweight loss associated with collecting a given amount of revenue.

Absolute efficiency

A tax (or a subsidy, which can be thought of as a negative tax) can be decomposed into two parts: the income effect and the substitution effect. A tax may transfer significant sums from one group to another (an income effect), but if the tax does not induce a change in behavior away from the taxed activity (a substitution effect), then it produces no excess burden and is perfectly efficient. Such a tax is called a *lump sum transfer*. It is not distortionary because it does not affect prices, and therefore does not affect economic incentives to allocate resources on the margin. Put another way, it does not lower utility (aggregate well-being) any more than necessary to raise a given amount of revenue.

[16] A simple example of deadweight loss from a tax is the cost incurred by people who go the long way around to avoid the toll on a bridge. Their actions are costly and generate no revenue. Excess burden also results from the costs of administering, complying with, and enforcing tax laws. Those welfare costs, while perhaps significant in total, are unlikely to be large on the margin for most taxes. For example, the cost to you of preparing your income tax return is unlikely to change much if your marginal tax rate were to change slightly.

Substitution effects arise when a tax or subsidy changes relative prices in the market for the taxed good and/or in related markets, and then those price changes induce people to change their behavior. For example, one purpose of liquor and cigarette taxes is precisely to reduce consumption of those goods.

In contrast to the "sin taxes," some taxes fall on activities we do not want to discourage, like working or saving. Since wireless applications are economically beneficial, discouraging their use is likely to be poor economic policy. Critics worry that auctioning spectrum (or otherwise pricing it) could increase the price of spectrum-dependent applications, induce substitution away from them, and reduce welfare. The key to whether spectrum auctions are efficient or distortionary (in absolute terms and relative to other means to raise revenue) lies in the extent to which firms are likely to pass along the costs they incur at auction to customers for their services, their suppliers, or anyone else, and the extent to which consumption patterns in those markets are sensitive to any such price changes.

If auctioning (or otherwise pricing spectrum access) rights raises the price of spectrum-dependent services, then giving it away free should lower those same prices. Giving spectrum rights away free would certainly make the stockholders of recipient firms better off (an income effect), but would those firms pass along the savings in the form of lower prices for their services (a substitution effect)? Would they increase wages to their workers or pay more per unit purchased to providers of other inputs? If the answer to any of these questions is yes, then again spectrum auctions are distortionary taxes on an important factor of production.[17] Otherwise we can conclude that spectrum auctions extract economic rents in a non-distortionary, lump sum fashion.

Relative efficiency

Regardless of whether spectrum auctions impose a distortionary tax in telecommunications markets, which I shall later argue in the negative, spectrum auctions may still be *relatively* efficient when compared to existing revenue sources. This is because the existing tax system already imposes distortions, and adding spectrum auctions into the mix may decrease the total welfare costs of the revenue system. For example, numerous authors have noted that revenue from spectrum auctions can provide considerable benefits to U.S. taxpayers by reducing (or reducing a need to increase) their tax burdens now or in the future.[18] This kind of revenue recycling carries both an income effect (a transfer from whoever bears the

[17] The key here is relative prices, not equilibrium output. Even if spectrum auctions are distortionary, firms may not necessarily use less spectrum than they would if spectrum were given gratis. Rosen (2005), p. 312, explains excess burden and the important difference between compensated and uncompensated demand.

[18] See for example Crampton [2001], p.5.

cost of winning spectrum bids to taxpayers) and a substitution effect (inducing, for example, more labor if auction proceeds allow a reduction in marginal income tax rates). That substitution effect may enhance efficiency. Thus it is possible for spectrum auctions to impose an excess burden, but still be efficiency enhancing (relative to gratis spectrum allocation) in the overall context of the fiscal system to the degree that they offset even greater excess burden from other taxes.

- **Lump sum vs. tax on the margin: the role of capital market imperfections**

Noam (1998) asserts that a spectrum auction is a tax on the communications sector and its users. This paper has argued above that an exclusive rights system that prevents efficiency-enhancing secondary transactions or does not devolve an efficient set of flexible rights imposes tax-like effects on spectrum dependent services. Indeed this paper has argued that it is entirely possible for the wrong set of rights portfolio to act like a tax on the communications sector, but that is an inefficiency distinct from the potential distortions due to the subsequent allocation system for the rights. The question in this section is whether auctioning exclusive rights itself acts like a tax, independent of the potential tax-like effects of a sub-optimal rights portfolio.

Consider auctions in the context in which all other spectrum policies optimized. For example, let us assume that the government devolves the optimal set of spectrum rights, including the optimal share and construction of exclusive flexible rights. Let us also assume that a secondary market exists. Thus firms who have spectrum rights, no matter how they got those rights, face an opportunity cost of retaining them. If a firm keeps the rights, it forgoes the potential revenue from them. If it considers acquiring more rights, then it faces the direct cost of existing spectrum prices. Thus the opportunity cost a rational firm uses to assess all of its business decisions regarding spectrum is the current (and anticipated) after tax price of spectrum rights, *not what it or anyone else originally paid for them.*

As Prat and Valletti (2001) point out, *ex ante* firms decide how to bid based on their expectations about their potential net revenues from the spectrum investment. *Ex post*, the license fee is an irrevocable sunk cost. Rational firms make pricing decisions based on forward-looking costs and returns given the likely behavior of competitors. Thus, the spectrum cost, even if it is depreciated over time for tax and accounting reasons, is irrelevant to firms' forward-looking output price strategies. That is not to say that the spectrum cost and output prices are uncorrelated (they are), but the direction of causation goes from output prices to spectrum rights. Higher expected output prices, all else equal, induce higher bids at auction.

Noam (1998) argues that auction revenues are not lump sum transfers because firms must accrue significant debt to acquire spectrum rights, and capital markets are imperfect. Imperfections in capital markets are thought to arise from credit rationing. Moral hazard and adverse selection, two kinds of asymmetric information problems, may lead lenders to ration credit, that is curtail how much they lend rather than increase interest rates to a level at which supply and demand are equal and the market for credit clears. Moral hazard arises when bankruptcy laws protect the borrower and raise the risks to the lenders as interest rates rise. Adverse selection occurs when high interest rates weed out more risk-averse borrowers, leading to a pool of remaining borrowers with an abnormally high average tolerance for risk – a worse pool from the lenders' perspective.

Importantly, credit rationing arises from the cost that lenders must incur to ensure that borrowers behave themselves, not from the underlying investment risks to capital. To the extent that spectrum rights are risky investments, a high cost of capital does not reflect capital market imperfections, but rather the perceived real risk to capital. If the investment risk varies non-linearly with the total price of the spectrum, then we expect the cost of capital for spectrum financing to be non-linear in an efficient credit market.

Imperfect capital markets are likely to affect all firms in an industry to the extent that they need to raise capital. Thus credit rationing is as likely to apply to firms in a secondary spectrum market as they are to firms bidding at auction, and they are as likely to apply in markets for physical capital as in markets for spectrum.[19] So it is not auctions *per se* that may theoretically affect the prices of spectrum-dependent services, but *any* price on spectrum – including secondary market prices. Prat and Valletti (2001) point out that even if capital market imperfections do apply in spectrum auctions (implicitly assuming that secondary market transactions are difficult) the alternative is that the government should decide to whom to allocate the resource. It is unlikely that the government has superior information about potential recipients' prospects than commercial credit markets. Furthermore, to the extent that regulatory policy impedes secondary transactions, much worse inefficiencies arise than the possibility that imperfections in the capital markets fall idiosyncratically on firms bidding for spectrum at auction. McMillan (1995, p.197) also argues that auction prices do not affect the price charged to customers. He asserts that capital market frictions are not likely to be high enough to create a large output price effect.

Capital market imperfections (such as they exist) obviously apply only to spectrum purchasers and not to gratis recipients who do not have to raise capital to acquire spectrum. Capital market imperfections shift

[19] Capital market imperfections can also theoretically apply in unlicensed spectrum regimes to the extent that physical capital, such as closely spaced towers, substitutes for licensed spectrum rights.

back the secondary market demand for spectrum rights because firms have an impaired access to financing. Thus any capital market imperfections that do arise would have a tendency to amplify the distortions caused by capital gains lock-in described above by further impeding efficiency-enhancing reallocations.

Given that capital market imperfections might be possible (if not probable), empirical work can be helpful to demonstrate whether spectrum rights pricing is indeed distortionary. Kwerel (2000) examined data on the prices for cellular phone services in 29 markets between 1985 and 1998. He makes three key findings: (1) within a given market, prices charged by cellular operators who purchased their licenses are not generally higher than those of firms that acquired their licenses for free; (2) within each market, cellular service prices are no higher after a license sale than before; and (3) markets in which licenses were not sold did not have faster-falling service prices than markets in which licenses were sold. The study focused on one output market for spectrum services, and did not consider markets for goods related to spectrum, such as complementary inputs. However, it does strongly suggest that in one particularly important output market, spectrum auctions (and secondary market prices) are not distortionary. These results are consistent with the theory that market pricing depends on supply and demand for a good, not on historical costs.

- **The optimal level of spectrum revenue**

Recent literature has debated policy approaches that may seek to maximize government revenue from spectrum.[20] For all the reasons that apply to the private sector, pure monopoly behavior on the part of the government is inefficient. Instead, the most efficient revenue objective of the government would balance efficiency gains from revenue recycling with efficiency losses from any spectrum withheld to boost prices. It is an empirical question whether shifting back spectrum supply from the maximum in order to recycle greater auction revenue is efficiency enhancing on net. In the presence of perfect spectrum markets and revenue recycling, there exists a theoretical possibility, depending on crucial elasticities, the marginal deadweight loss of existing taxes, and the marginal social benefit from additional spectrum that some shift back from the total available spectrum would produce a net increase in efficiency.

However, given existing regulatory impediments on spectrum rights the marginal social benefit of additional spectrum is likely to be very high. That combined with the uncertainty with which additional revenue would actually be recycled optimally, it is very unlikely that supply restrictions in addition to current regulatory limitations would provide net efficiency gains.

[20] See for example Hazlett and Muñoz (2004) and Rothkopf and Bazelon (2003).

Another wrinkle may be that the potential for revenue may actually spur government efforts to devolve more spectrum rights. In this case there may be an efficiency gain (in a sort of third-best sense) to having a less-than-exhaustive devolvement of rights because that larger projected revenue induces the government to devolve the rights in the first place.

- **The disposition of spectrum revenues and optimal revenue recycling**

The overall efficiency of spectrum policy depends on what happens to the revenue the auctions or usage fees generate. If, say, spectrum revenue is earmarked to finance incrementally more of a public good that is currently undersupplied, then the net social returns from the earmarked auctions could be positive and significant. On the other hand, if the government "squanders" the revenue, then (from the perspective of the transfers involved) the auctions produce a net social loss. In that case, the economy would be better off if the government gave the spectrum rights away free to the girl scouts, households, or anyone else, provided that the recipients resold those rights in the secondary market.

We can consider four archetypal approaches to the disposition of spectrum, although in practice the result is likely to be a combination of them. Spectrum revenue could:
(1) offset other taxes, dollar for dollar (a "revenue neutral tax shift");
(2) be earmarked or otherwise tied to specific spending initiatives;
(3) result in scaled up general spending, dollar for dollar; and
(4) be transferred back to households lump sum.
Each of these approaches has different efficiency implications and net social benefits. By definition, the socially optimal approach is the one that maximizes net social benefits.

How might the social optimum be achieved? To assess the economic efficiency of a revenue recycling scenario we need to compare the marginal deadweight loss of spectrum auctions to the marginal deadweight loss of the revenue instrument they offset. In the discussion above, I argued that the marginal deadweight loss of spectrum auctions is likely to be very low, so all else equal conducting spectrum auctions and revenue recycling to reduce other taxes is likely (in general) to be more efficient than allocating spectrum in a way that generates no revenue. The marginal deadweight losses of a tax can depend greatly on whether it is a broad-based tax (the bulk of the US revenue system) or a more narrow tax, such as the Universal Service fee. All else equal, a narrow tax is likely to be more distortionary than

a broad tax because it concentrates the substitution effect into a more limited slice of the economy.[21] The most efficient revenue recycling approach would offset the most distortionary taxes first, but in practice U.S. auction revenue is funneled to the general treasury.

Spectrum auction revenue that goes towards reducing the budget deficit (without increasing current or future spending) reduces the need for future revenue to payoff and/or service the debt. Thus auction revenue applied to the budget deficit produces real efficiency dividends, albeit over time.

Any approach that spends auction revenue rather than recycles it incurs the opportunity cost of not offsetting the existing excess burden in the tax system. For example, a rough consensus on the marginal excess burden in the tax system is about 30%, meaning that an incremental dollar of revenue raised produces a net economic loss of 30 cents.[22] Then the net social returns of a dollar spent on earmarked purposes must be over 30 cents to be more beneficial than simply reducing other taxes by a dollar.

For example, suppose a dollar of spectrum revenue is earmarked for certain government spending. That dollar must produce social gain of $1.30 to be more economically efficient than lowering taxes by a dollar. This is hard to ensure. For one thing, we do not know how much would have been spent on the targeted activities in the absence of the additional revenue. Did the additional dollar of government spending crowd out other spending, including private funds? Second, the social returns of many public goods and other programs are hard to measure, presenting a challenge for optimally earmarking spectrum revenue. For example, the benefits from quality children's programming, digital technologies for schools, free air time for political candidates, environmental protection, aid for the poor, and the like are very hard to monetize (however substantial). What is certain is that if the social returns for incremental investments in those public goods are sufficiently high, then the government should be spending more general revenue on them already, irrespective of spectrum policy. In other words, the availability of auction revenue is independent of whether certain spending increases are socially optimal. Finally, there is no reason to believe that the level of revenue from spectrum auctions is in any way related to the optimal level of spending on any particular program. The difficulty in rationalizing spending when it is tied to a specific revenue source is one reason why economists are often skeptical about earmarking revenues.

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[21] One caveat to this discussion is that some evidence suggests that more efficient tax systems may be related to larger, more inefficient governments. Becker and Mulligan (1998) find cross-country empirical support that "since government spending affects behavior and the amount of spending depends on the tax system used to raise revenue, an efficient tax system may not minimize the total dead weight costs of government activities." If their cross-country results hold for the U.S., the long run impact of an efficiency-enhancing (and ostensibly revenue-neutral) tax shift may not be spending neutral.

[22] See for example Ballard et al (1985).

If auction revenue is transferred lump sum back to households, then (abstracting from administrative costs) the auction/spending system is a one-for-one income transfer and the net social benefits are zero.[23] To the extent that auction revenue simply scales up general spending, then the social benefit of the auction/spending system is the weighted average of the marginal net social benefit of spending on existing programs, whatever that is.

- **How much revenue does spectrum actually generate?**

In addition to the direction of the efficiency gains from spectrum auctions, we may also care about the magnitude. Calculating the total net revenue that spectrum auctions generate for the government may involve several adjustments to the gross auction revenues, some of which are quite complicated. Most obviously, auctions involve administrative costs, including administering auctions and supporting the bureaucratic infrastructure for them, enforcing payment, and resolving legal disputes when auctions go awry. Some potential revenue has remained uncollected due to bidders' default.

In addition, license payments can be deducted or depreciated against corporate income, thus lowering the net revenue from corporate income tax on license holders.[24] One caveat regarding such deductibility is that we do not know what investments would have been made (by spectrum-using firms or others) without the auctions. Firm and investor behavior regarding dividends, retained earnings, and capital gains realizations (and all the consequent taxable events) may all depend on how spectrum is priced. Appendix A discusses this further.

5. Spectrum allocation and the corporate income tax

As we have seen, although gratis spectrum may provide efficiency gains in a political economy context, it carries the opportunity cost of recycling revenue to create a more efficient tax system. This section explores another distortion in the ultimate allocative efficiency created by gratis spectrum rights, also in the context of the existing tax system: the capital gains lock-in effect. The lock-in effect arises because capital gains are not taxed until realized. Taxpayers who are considering switching or selling capital assets

[23] This statement implicitly assumes constant marginal utility of income and an additive social welfare function. In that case all pure transfers are welfare neutral in aggregate. If instead we assume the marginal utility of income declines, then auction revenue transfers may be socially beneficial or detrimental. For example, if the auction/lump sum payment system results in a net income transfer from rich stockholders (with relatively low marginal utility) to poor households (with relatively high marginal utility) then the net social returns to the transfers could be positive. See Rosen (2005) pp. 148-151, for more on social welfare functions.

[24] See Noam (1998), footnote 26.

face a tax liability if they do so, meaning that they may have an incentive to keep a less productive asset simply because the after tax returns of doing so are higher.

This is how the lock-in effect would apply to spectrum. A recipient firm (Firm A) receives a bundle of spectrum rights free from the government. The bundle has a cost basis of zero. If Firm A sells some or all of those rights to another firm (Firm B), then Firm A realizes a capital gain in the amount of the entire value of the spectrum sold.[25] Firm A must then pay a corporate income tax of up to 35% on the value of the sales. Firm A can make another investment with the after-tax proceeds (65% of the sales price), but must again pay up to 35% corporate income tax on any profits from that investment. Because both the full asset value of the spectrum and the income from investments made from its sales are taxed, Firm A has a significant incentive to keep the spectrum asset rather than sell it. See **Appendix A** for a numerical example.

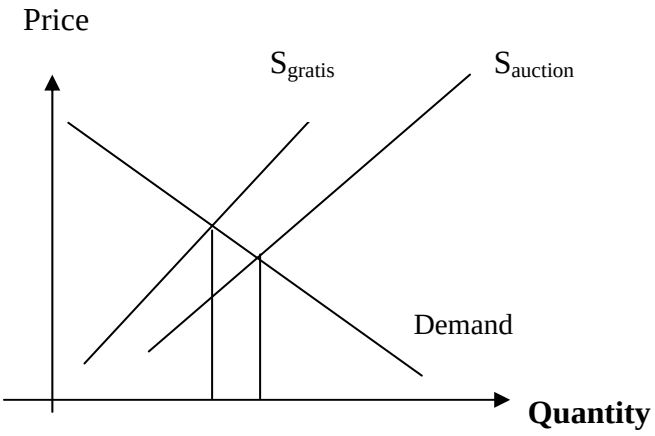
The capital gains lock-in effect has long been discussed in the public finance literature, especially with regard to the effect of capital gains taxation on the behavior of individual investors.[26] A newer literature has examined capital gains lock-in for corporate assets. For example, Desai and Gentry (2002) analyze the lock-in effect of corporate capital gains taxation. Their empirical results suggest that "the corporate capital gains tax regime appears to significantly influence the decisions of firms to dispose of assets and realize gains and losses." Any time capital values increase, the capital gains tax induces some lock-in, but the effect is likely to be particularly profound for gratis spectrum wherein a highly valuable asset has a cost basis of zero.

Another way to visualize the inefficiency created by the lock-in effect is through the supply curves for spectrum (**Figure 5**). The total market supply curve is the horizontal sum of individual firm supply curves. All else equal, a firm will supply less spectrum at a given price if it received the spectrum free than if bought the spectrum at auction because the after tax receipts to the firm are lower for spectrum with a lower (or zero) cost basis. So even if the government grants only some spectrum free, the lock-in effect could produce a market spectrum supply curve that is shifted back relative to the supply curve that would have obtained under an auction approach. This means the price of spectrum traded in the secondary market would be higher under a gratis approach than under an auction approach. Likewise the equilibrium quantity traded would be lower, and both consumer and producer surplus would be lower. *Thus*

[25] Strictly speaking, depending on certain factors FCC licenses may be treated as "franchises" under the U.S. tax code rather than capital assets. Corporate capital gains and ordinary income are taxed at the same rate, so the distinction is not important for this discussion. Relevant U.S. tax code includes Sections 1253(a) and 1221(a).
[26] See Rosen (2005), p. 367. A regulatory lock-in phenomenon has occurred with so-called "designated entities," who are prohibited from reselling spectrum licenses for a period of time.

the gratis approach interacts with the capital gains tax to impose a tax-like distortion in the secondary market for spectrum rights.

Figure 5. Tax-like effects of gratis spectrum on aggregate spectrum supply curve



Yet another way to look at the lock-in effect is through the lens of standard production theory. In competitive input markets, all firms must equate their marginal rates of technical substitution (MRTS) across factors of production with the corresponding ratios of factor prices.[27] The problem with gratis spectrum is that the capital gains tax means that firms with different spectrum cost bases face different effective factor prices. This leads to different equilibrium MRTS's for different firms, resulting in an inefficient allocation of input resources. Firms that received free spectrum would use "too much" spectrum, and competitors would not use "enough."

Admittedly when secondary transactions are already greatly limited by regulation, the lock-in effect is somewhat moot. However, the economic efficiency gains from more flexible rights and more liquid secondary markets will be limited to the extent that gratis spectrum rights produce significant capital gains lock-in. The inefficiency of inflexible rights is likely to outweigh any distortions the tax system may create in a secondary market, but as the spectrum rights system becomes more efficient, we may see that the tax treatment of spectrum rights becomes a relatively more important source of distortion.

- **Mitigating the lock-in effect**

At least three policy approaches could mitigate the lock-in effect. First, as discussed above, the government could auction the spectrum, so spectrum rights would carry a cost basis equal to the full market value at the time of the auction. This would not completely eliminate the lock-in effect because subse-

[27] Pindyck and Rubinfeld, p. 576.

quent to the auctions firms may accrue capital gains on their spectrum assets, but the it would mitigate the lock-in effect to the capital gain in market value just might occur with other kinds of assets.

Alternatively, the government could tax firms on the full market value of the spectrum rights at the time they are granted gratis, essentially requiring firms to treat gratis spectrum rights as income. It would also grant a cost basis of that market value. This approach would be contrary to traditional tax law that does not treat unrealized income as taxable, plus it could require fairly speculative estimation of a market value. To the extent that market values can be reasonably estimated, however, this approach would reduce the distortion on secondary market sales.

Finally, the government could by regulatory fiat set a cost basis other than zero for gratis spectrum or waive the capital gains tax entirely. The federal government has done this in several (sometimes controversial) instances, for example when the FCC issued tax certificates in relation to licenses acquired by minority-owned firms.

For two reasons, the gratis allocation/tax certificate approach would be worse for government coffers than an auction approach. First and most obviously, the government collects no revenue from the gratis allocation. Second, when a recipient of gratis spectrum sells it to a firm that deducts its purchase expenses against current income, the federal treasury is made worse off by up to 35% of the spectrum value, depending on the marginal income tax rate of the firm that buys the spectrum in the secondary market. Recall that in the resale example, the capital gains tax revenue is balanced by the deduction the purchaser takes from its income taxes. This balance would be disrupted if gratis spectrum recipients were granted a cost basis greater than zero.

- **A note on investment**

Potential recipients of gratis spectrum may argue that they will invest more in physical capital if given such rights. However true this may be, that is not an argument that such a policy would be cost effective. First, we have seen how the lock-in effect can result in spectrum resources being deployed by relatively less productive firms. Second, competitive markets for capital have the very purpose of identifying the most efficient kind and level of investment. If capital markets do not look favorably upon certain investments in physical capital, then it can be a tough case to prove why taxpayers should.

6. Transactions cost, political economy, and distributional considerations

Many observers agree that auctions are the most efficient means to allocate licensed spectrum rights, especially relative to comparative hearings and spectrum lotteries. However, some argue that important exceptions apply when the allocation method affects the timing of important policy reforms or when significant administrative costs apply. They contend, for example, that where existing incumbents hold limited rights (such as the right to broadcast television signals but not to provide any other services using the same spectrum), the most efficient approach would be to grant incumbents additional flexibilities free, so as to quickly devolve a set of exhaustive, exclusive, flexible, and marketable rights.[28]

At least two economic arguments support gratis rights in certain instances. First, transitioning to exhaustive flexible rights would create vastly more consumer and producer surplus than the existing system, and any delay towards that flexibility represents a substantial opportunity cost. Incumbent users may want flexibility in their licenses but would oppose any such flexibility unless it was granted to them at no cost. They may also believe that additional flexibility as part of a broader would dilute their profits, so that some compensation is justified.[29] Without such a beneficial transfer, affected parties may have the incentive to tie up reform in costly court proceedings.

To the extent that incumbents or anyone else has an incentive to oppose and delay new flexibilities (and can do so) unless they receive rights gratis or other compensation, some level of forgone auction revenue would be cost-effective in return for a faster move to a vastly more efficient and productive regime. The problem is that the level of compensation necessary to buy cooperation is uncertain and difficult for policymakers to obtain, but it may be possible to estimate. For example, Bovenberg et al. (2004) examine the efficiency costs of avoiding adverse industry-distributional effects under imposition of a pollution permit system, arguing that a politically realistic approach to environmental policy requires consideration of distributional impacts. They find that under wide range of parameter values, their numerical model shows that profits can be maintained by freely allocating less than 50% of pollution permits and auctioning the rest. The lesson of this work for spectrum policy is that it may be possible to "keep firms whole" without allocating all new spectrum rights gratis. Either a subset of rights or a share of auction proceeds may be sufficient compensation to counteract delay of broadly beneficial policy reforms without forgoing more efficiency-enhancing revenue than necessary.

The second argument for distributing some rights gratis is transactions and administrative costs. For example, the government may have to retract existing rights of incumbents so as to bundle them with new flexibilities to form a meaningful set of rights for auction. In some instances, these transactions costs may

[28] Hazlett and Muñoz (2004).
[29] For more on wireless license values and flexibility, see Hazlett (2004).

dominate any efficiencies gained by conducting the auction. This is especially likely when the revenue is not likely to be significant compared to the administrative costs of running the auction, although assuming the revenue is likely to be low should be done with some care. In appropriate cases it could be most cost effective to just give the new flexibilities to the incumbents (or others) and allow secondary markets to refine the allocative efficiency.

The distinction between equity and efficiency

The public debate about spectrum allocation (and most other policies) is often less about economic efficiency and more about who wins and who loses, especially incumbents and potential new claimants. The economic efficiency and the distributional effects of the tax system are importantly distinct. A Pareto efficient tax system minimizes overall excess burden, but does not guarantee that the resulting allocation is fair or equitable. In fact, the most economically efficient tax system (a fixed lump sum tax on each person) is assuredly unfair as it would require no more of the rich than the poor. The conflicts between equity and efficiency underlie much debate about appropriate tax policy.

Likewise, the economic efficiency and the distributional effects of the spectrum allocation system are importantly distinct. Some may view spectrum policy as unfair, for example, if it does not give sufficient deference to incumbents' interests or small businesses. Who wins and loses from spectrum allocation and tax policy is politically and socially important, but achieving distributional goals often comes with a loss in efficiency, a real economic cost that should be balanced by an identifiable social gain.

Given this important distinction, the presumed unfairness of spectrum "windfalls" or "giveaways" tells us nothing about their economic efficiency.[30] Spectrum rights are valuable and may confer (possibly enormous) wealth on anyone who gets them for free, but that alone does not make a gratis allocation system economically inefficient. Likewise, the government can introduce fully flexible, exhaustive spectrum rights and in doing so dissipate the monopoly rents of incumbent firms. This measure would greatly improve the efficiency of the licensed rights regime, but incumbent firms that had benefited from monopoly rents would clearly be made worse off. From an *efficiency* perspective this loss does not imply that those firms should be compensated with free rights. Assuming the license flexibility policy is implemented, the share of new rights that go to incumbents is largely a distributional (and therefore also political) consideration. Distributional factors are very important to understanding the views of incumbent firms and the political realities of policy debates. They do not affect, however, which allocation approaches are most economically efficient.

[30] For illustrative debate regarding spectrum "windfalls," see Ornstein and Calabrese (2003) and Hazlett (2004).

The arguments from proponents of greater unlicensed regimes sometimes convolve efficiency and equity, but they can be clarified into two distinct strands. The first strand emphasizes economic efficiency; it points to the explosion in innovative wireless devices as a societal benefit that accrues from common access policies. Proponents conclude that because the benefit of existing unlicensed bands has been so great, the benefit of additional unlicensed bands is likely to be as well. The second strand is largely distributional. It voices concern over *who* obtains the significant scarcity rents when spectrum rights are allocated, and emphasizes social benefits that derive from more widespread access. In unlicensed environments, all comers can gain, at least up until the point where noise pollution eases out the more sensitive users. In licensed environments, the distribution of economic rents depends greatly on the allocative mechanism, in particular whether the licenses auctioned or given out free and what happens to any auction proceeds. Unlicensed advocates may argue that the benefits to the general public are greater if the public can access scarce spectrum directly rather than gain indirectly through licensed allocations and revenue recycling.

Exclusive flexible rights advocates argue that if spectrum was allocated more efficiently (including flexibility), scarcity rents would be a fraction of their value today; thus we are arguing over a distortedly large pie. As argued above, an efficient spectrum rights management system could increase the effective supply of spectrum and lower the equilibrium price. However, even within such an improved system an important distributional choice remains intrinsic to the initial spectrum allocation system. Many billions could accrue directly to incumbents, other commercial interests, or the taxpayers depending on how licenses and their flexibilities are distributed.

Past policies have led to different distributional effects even among incumbents. Those with virtually perpetual property rights may not have paid at all for those rights, whereas competitors for the limited auctions of temporary rights may have paid quite a bit. Only comprehensive reform could make distributional effects across industries and firms more consistent.

7. Conclusion

This paper examines the economic efficiency of spectrum auctions relative to other spectrum allocation approaches in the context of the existing fiscal system. The paper reviewed the myriad sub-policies that must be optimized in order of optimize spectrum policy in the context of existing distortions in the tax system. It argued that the overall economic efficiency of the spectrum policy system depends on (among

other things) whether and how much it raises revenue for the government, but also importantly on the quantity and quality of the rights that are allocated and what happens to the revenue. Raising revenue by itself does not guarantee economic efficiency, but with appropriate revenue recycling a revenue-raising approach is likely to be more efficient than gratis allocations. On the other hand, an approach that maximizes revenue by restricting spectrum supply is virtually guaranteed to be inefficient.

The design of the spectrum rights system raises issues of economic efficiency that are substantially different than those of the subsequent allocation system for those rights, although both must be efficient to achieve overall efficiency. In particular, this paper concludes there is no compelling theoretical case or empirical evidence that auctions are distortionary, although an incomplete devolvement of spectrum rights assuredly is. This paper shows that important tax and tax-like issues abound in spectrum policy, including dead weight loss and tax-interaction effects from excess scarcity rents, capital gains lock-in from gratis spectrum allocations, and a tax-like burden on new entrants and technologies in the absence of robust secondary markets.

Finally, this paper notes that optimal spectrum policy may require recognition of distributional concerns that can prevent or delay efficiency-enhancing reforms. The presumed unfairness of spectrum "windfalls" or "giveaways" tells us nothing about whether such an allocation is economically inefficient. In some cases, with due care, some level (perhaps less than 100%) of forgone revenue may be an appropriate tradeoff to achieve a vast more productive spectrum policy outcome.

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Appendix A

A numerical example of the capital gains taxes lock-in effect on gratis spectrum

Suppose Firm A (the recipient) receives $100 worth of spectrum rights gratis from the government.

Option One: Recipient firm sells gratis spectrum in secondary market and reinvests proceeds

- Suppose Firm A sells the spectrum rights to Firm B for $100. Firm A must pay $35 in federal capital gains tax (plus any state corporate income taxes that apply) because it had a cost basis of zero on its spectrum asset. After tax, Firm A holds $65.
- Then suppose Firm A invests the $65 for a gross return of 12% for one year, or $7.80. But the returns from that new investment are taxable at the same marginal tax rate as capital gains (35%), so the firm's after tax return is (.65)($7.80), or $5.07 over one year. It pays income taxes of $2.73.
- The stock value of Firm A goes up by an amount dependent on the value of the spectrum. These capital gains are taxed when shareholders sell their stock, but the tax rate is a relatively low individual rate.
- Firm B (the competitor) pays Firm A $100 for the spectrum, its fair market value. Firm B can deduct (or depreciate) the expense against current income or deduct interest payments on any debt it incurs to pay for the spectrum. Either way, the after-tax opportunity cost of capital is incorporated into Firm B's willingness to pay for the spectrum.[31]
- Suppose Firm B earns a gross rate of return 12% on its spectrum, or $12. Its after-tax returns are 65% of $12, or $7.80 each year. Firm B's stockholders also pay income tax (at a reduced rate) on any dividend income or realized capital gains.

Under **Option One**, the federal government receives $35 from the capital gains tax, but loses $35 in income tax revenue from Firm B's depreciation of the assets. Thus in this example the capital gains revenue is really a wash for the government. (Of course this assumes the two firms have the same marginal tax rate. It won't be a wash if the tax rates are different.) The government receives an income tax payment of $2.73 from Firm A's alternative investment, and $4.20 from the annual income tax on Firm B's profits from using the spectrum. It also receives revenue when Firm A's stockholders realize their capital gains.

[31] If firm B chooses to finance its purchase with retained earnings, the situation is a little more complicated.

Option One	Capital gains Taxes paid (rec'd)	Expense against current income	Income taxes paid	After tax rate of return
Firm A	35		$2.73	5.07%
Firm B		(35)	$4.20	7.8%
Total Net Government Revenue $6.93				
+ capital gains tax on any stockholders' realizations and income taxes on any dividend payouts by Firm B.				

Option Two: Recipient firm keeps gratis spectrum

- Suppose Firm A keeps the spectrum rights and uses them as a factor of production. It must pay a 35% marginal federal income tax on its profits. As long as Firm A can make a gross rate of return that is more than 6.5% of the market value of the spectrum, it is better off keeping the spectrum than reselling it. Suppose Firm A makes a 10% gross return (whereas Firm B would have made a 12% gross return). Firm A nets $6.50 after taxes. The government gets $3.50 per year in corporate tax revenue.
- The stock value of Firm A goes up by an amount dependent on the value of the spectrum. These capital gains are taxed when shareholders sell their stock, but the tax rate is a relatively low individual rate.

Option Two	Capital gains Taxes paid (rec'd)	Expense against current income	Income taxes paid	After tax rate of return on spectrum asset
Firm A	0	0	3.50	6.50
Total Net Government Revenue			$3.50	

Conclusion:

Firm B can make better use of the spectrum than Firm A both in gross returns ($12 vs. $10) and in after-tax returns ($7.80 vs. $6.50), but Firm A's best deal after taxes is to keep the spectrum rather than resell it ($6.50 vs. $5.07). Firm B won't get the chance to produce using that spectrum, even though it would be more productive. This is the classic "lock-in effect," only worse than usual. Because the cost basis of the asset is zero, instead of applying only to increases in asset value the lock-in effect applies instantly to the entire market value of the asset.

Government revenue is also lower when Firm A keeps the spectrum ($3.40 vs. $6.93) because overall economic activity is lower (abstracting from what B does in the Option Two scenario). If government spending is fixed, then the lock-in effect could result in a marginally higher tax rate on capital or labor income, compounding its distortionary effects.

In addition to the two options presented above, Firm A could resell the spectrum and disperse its revenues as dividends to stockholders. Such dividends are taxable income for individuals, but the tax rate varies according to holding period and other factors. In 2003, U.S. tax law changed to lower the top rate for individuals on dividend income and capital gains to 15%. In this case, government revenue would probably be lower than it would be if Firm A kept the proceeds and invested the retained revenue. More work is necessary to properly assess all the effects.