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Tradable Universal Service Obligations

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Abstract

This paper proposes a novel policy to motivate private-sector operators of basic infrastructure to expand infrastructure into previously unserved regions. It is particularly useful when resources are transferred to the private sector, as occurs during the privatization of a state-owned telecommunications carrier, the introduction of competition, the release of spectrum, or the allocation of cash subsidies for this purpose. Firms receive tradable universal service obligations in the form of *milestones* that must be met, and *commitments* to meet specific deadlines. By exchanging its commitments, a firm can increase or decrease the rate at which it must expand infrastructure. By exchanging milestones, a firm can change where it must expand infrastructure. Making milestones and commitments independent and fully tradable allows each firm to develop the most cost effective business strategy possible, and to adapt that strategy as technology and demand evolve over time. The exchange of milestones and commitments does not diminish the obligations that must be met by industry as a whole, insuring the timely expansion of infrastructure. This paper focuses on telecommunications, but the approach is also applicable to other forms of infrastructure, such as electric power.

Section 1: Introduction

A critical objective in any national telecommunications policy is advancing *universal service*: making telecommunications services available and affordable to a greater fraction of the population. This is easy when telecommunications services are provided by a government monopoly. Government can decide where to build and what to charge customers irrespective of actual costs, provided that total revenues (plus any government subsidies) are sufficient to cover total costs. However, in country after country, experience has shown that competing profit-seeking carriers are more willing than government ministries to minimize costs, expand the infrastructure and customer base, lower prices, and improve quality of service. But will they advance universal service? The problem is particularly acute in developing countries, where there are often large regions with little or no basic telephone infrastructure. Many nations face similar issues with other services they wish to expand, like Internet or paging. This paper proposes a novel universal service policy for countries (1) with entire regions that lack adequate infrastructure for the desired service, and (2) where multiple private-sector firms can provide this service. The policy is invoked when dispensing cash, licenses, or resources to the private sector. This occurs during privatization, the introduction of competition, the release of spectrum, or the allocation of significant cash subsidies for universal service. While telecommunications is the focus of this work, the concept also applies to other forms of infrastructure, such as electric power or broadcast radio.

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Some argue that competition and the expansion of telecommunications infrastructure are incompatible. The concern is based on a genuine problem. Unregulated profit-seeking companies will not serve individuals who cannot pay the costs of providing a service, and they will not serve entire regions when collective demand is insufficient to cover regional costs. Due to economies of scale, serving a small number of users in a region is prohibitively expensive. Thus, regions with low population densities, many low-income households, or difficult terrain can be unprofitable. Explicit policies are needed that motivate commercial carriers to serve these regions.

At least in the case of basic telephone service, effective universal service policies in wealthier nations do not address this issue, and are therefore a poor model to emulate. The wealthier nations did not introduce competition until infrastructure was sufficiently wide-spread that service was available to almost everyone, although it is not affordable to everyone. Thus, the monthly charges to individuals with low incomes or who live in costly regions must be partially subsidized (implicitly or explicitly). These policies may also be of use when availability is not pervasive, but they are not sufficient. Effective universal service policies must also spur significant capital investments in infrastructure expansion, not just reduce prices for monthly service where needed.

This paper proposes a policy of *tradable universal service obligations* to foster the expansion of telecommunications infrastructure into unserved regions. Although the policy can be employed at any time, privatization, the introduction of competition, and the release of large spectrum blocks often mark the beginning of a transitional phase conducive to infrastructure expansion. This policy is designed to maximize (useful) expansion and minimize cost during this phase by giving private-sector providers the appropriate incentives. The policy remains consistent with the principles of open competition. Monthly subsidies to targeted low-income individuals could be provided by other complementary universal service policies. (See [TYLE95] for a description of some of the policies that have been used.)

Section 2 defines more specifically the objectives of a good universal service policy. The principal models used in developing countries today are described in Section 3. Section 4 describes the proposed policy. The paper is summarized in Section 5.

Section 2: Universal Service Policy Objectives

This section describes the three primary objectives of a transitional universal service policy to expand infrastructure, plus a fourth which applies in some nations due to political constraints.

- Expand telecommunications access such that social benefits are maximized.

  The universal service policy should cause infrastructure to be deployed in those regions of greatest social value. This may mean all areas that are currently unserved, or areas may be targeted specifically because they contain health care facilities, manufacturing plants, universities, or other important institutions. Infrastructure must also be expanded into targeted regions at a reasonable rate, as demarcated by appropriate intermediate milestones.

- Minimize costs and minimize subsidies.

  An efficient policy will minimize the costs of infrastructure expansion. Governments also wish to minimize subsidies. (These are closely related, but occasionally in conflict, since companies seek to increase subsidy minus costs.) We adopt four tenants of an efficient policy.

  First, wherever possible, infrastructure expansion should be the responsibility of competing commercial entities, or at least regulated commercial monopolies, rather than a government agency. Commercial entities have every incentive to maximize efficiency.

  Second, policies should influence results, but not technical means. There is an extraordinary variety of technical approaches to expanding infrastructure. Should the medium be a fiberoptic backbone, a wireless local loop, or a satellite link? Should it employ circuit switching (as in traditional telephone networks), IP (internet protocol), or ATM (asynchronous transfer mode)? Should there be separate telephone, Internet, and television networks, or should there be integrated-services networks carrying diverse traffic types? The best answer will vary from region to region, and year to year. An efficient policy must be technology-neutral.

  Third, the regions served by any given entity should be selected to exploit economies of scope and scale. There may be economies due to geographic proximity. For example, for cellular service, efficiency might be maximized when all of the areas surrounding a particular hill are served by one entity. With the break-up of AT&T in the Untied States, some of these economies were lost when one company gained the right to provide cellular service in New York City, and another gained the right to provide service for the New York City suburbs in the neighboring State of New Jersey. Economies are not limited to geographic proximity. For example, a satellite service is most efficient (relative to terrestrial) at reaching remote users, even when those users are far apart.

  It is equally important that the services offered by a carrier benefit from economies of scope [PEHA98a]. In some cases, there are great efficiency gains in combining two kinds of traffic on a single packet-switched network, such as high-definition television and email. In other cases, such combinations actually reduce efficiency. Traffic mix profoundly influences prices [PEHA98a,WANG97a].

  Fourth, the costs associated with administering a universal service policy should be minimized by reducing government involvement and oversight where possible.

- Logical transition to steady-state universal service policies.

  This universal service policy addresses a transitional phase of infrastructure expansion, but it coexists with other policies that will continue thereafter. The policy should remain coherent at all phases, and should not require drastic regulatory shifts.

- Use no general funds.

  In some nations, it is not possible to mix universal service funds with general funds. The primary reasons are political. After a long history of implicitly using telecommunications revenues to subsidize universal service, it may not be politically acceptable to use general funds for this purpose. Moreover, when funds supposedly

for universal service flow from telecommunications providers and users into general coffers, they are often diverted to other national needs, effectively becoming just another tax on telecommunications.

Section 3: Typical Universal Service Policies

This section describes the three primary policies that are currently used to motivate infrastructure expansion into unserved areas: build-out requirements, universal service funds, and targeted implicit subsidy obligations. In each case, a success story is described. Although quantitative assessment is notoriously difficult, we will qualitatively discuss the advantages and disadvantages of each approach.

Section 3.1: Build-Out Requirements

The most common approach is to require a newly privatized telecommunications carrier, or a newly licensed competitor, to meet specific requirements with respect to infrastructure expansion. These *build-out requirements* are bundled with one or more items of value: the infrastructure of the government carrier, permission to operate (a license), access to spectrum, and freedom from regulation for some fixed period. Attaching obligations to these assets reduces what buyers will pay for the asset. In effect, subsidies are provided to meet universal service obligations without the problems and inefficiencies of actually collecting and distributing those subsidies. Governments need only monitor progress, and impose sanctions when requirements are not met (as occurred in Argentina, Mexico, Peru, and elsewhere).

For example, Ghana's 1996 National Communications Authority Act called for the privatization of the state's monopoly, and the introduction of competition. A license was later sold that would allow a new company to provide a competing telephone service nationwide. The new license-holder would be required to serve 50,000 new customers. The private company that purchased a managing (30%) interest in the state telecommunications monopoly would face similar obligations. Thus, the government could be certain of some infrastructure expansion. At present rate, the number of new subscribers for both providers will increase dramatically as a result of this policy, greatly exceeding expectations.

In the case of Ghana, carriers were allowed to serve those new subscribers anywhere, so there is little motivation to expand access outside the triangle formed by Ghana's three largest cities, where profits are greatest. This will not help rural Northern Ghana, which before the new policy was accepted had 40% of Ghana's population and only 7.8% of its phone lines [GHAN94]. In general, build-out requirements may be more specific with respect to geography, technology, and type of service (such as fixed telephone, mobile telephone, Internet, paging, or payphones).

There are disadvantages to the build-out-requirement approach. As the Ghanaian example above demonstrates, commercial companies may not expand infrastructure into unserved areas unless the build-out requirements specifically require it. But how can the government determine what specific build-out requirements can be implemented efficiently? Ghana could have required the incumbent monopoly to extend access to a specific set of regions, and the new competitor to extend access to another set. As described in Section 2, it is important to do this in a manner that would allow each carrier to exploit economies of scale and scope. To do this effectively, the government would need detailed knowledge of the technology each company would use, and their deployment strategy, before the companies

were ever selected. Even if a government could somehow gather this information before privatization, demand and technology can change considerably in the years before those build-out requirements must be met. Thus, there are inherent inefficiencies in this approach.

Ghana also has a power company with significant telecommunications capacity, and three cellular providers, who could possibly expand the telecommunications infrastructure in a cost effective manner. They were not affected by this universal service policy. If the government were to try, the inherent inefficiencies of central planning grow when build-out requirements must be divided among an even greater number of firms.

Section 3.2: Universal Service Funds for Explicit Subsidies

A number of countries have created a government-managed universal service fund. These funds are to be spent in the manner that best advances universal service objectives. Because subsidies are explicit, it is easier to determine whether the benefits justify the costs.

Funds can come from annual taxes on the telecommunications sector (as in Peru, Ghana, and the United States) or from general tax funds (as in El Salvador and Chile). Universal service funds can also come from the one-time sale of resources, as occurs when a carrier is privatized. For example, Guatemala auctions spectrum licenses, which can be renewed indefinitely without cost. Proceeds of this one-time auction go into a universal service fund.

Universal service funds can be used to subsidize a commercial provider's expansion into unserved areas. In 1994, Chile established a temporary fund (through 1998) to extend access to rural and low-income regions through a series of auctions. Regulators select a set of regions for which the ratio of estimated social value to estimated cost is greatest for the next auction. For each selected region, regulators specify a number of localities where public payphones should be placed, a maximum price for phone calls, and a maximum subsidy deemed commensurate with costs. Firms then bid on the smallest subsidy (below the stated maximum) that they will accept to serve a given region. Winners must offer reliable payphone service for ten years. Because of economies of scale, once those first phone lines have been installed, the firm is likely to provide more.

This approach effectively harnesses the private sector to expand infrastructure, targets subsidies to high-value regions, and is technology neutral - all important advantages. Proponents also argue that competitive bidding always minimizes subsidies, minimizes infrastructure costs, and maximizes social benefits, as the auction will continue until bids to serve targeted regions approach actual costs. This is not the case, for a variety of reasons. Among them, when the value of two auctioned items is not simply the sum of their individual values, then auctions do not necessarily lead to the most efficient result [MILG97]. As described in Section 2, there may be economies of scope when serving multiple regions.

Under the Chilean approach, one might expect that every region would receive a subsidy greater than 0 and less than the listed maximum. Chile's first auction brought service to 1100 new localities. 46 regions were auctioned simultaneously, with an average of 28 localities per region. There was little competitive bidding. 9% of the regions received no bids. 35% went for the maximum allowable subsidy. Perhaps most surprisingly, 39% went of for no subsidy whatsoever, even though the bidders had not been willing to serve

these regions in the past without a subsidy. Economies of scope are a reasonable explanation [WELL97].

With such economies, simultaneous auctions do not maximize efficiency, i.e. assign those obligations being auctioned to the firms that can meet them at minimum cost, nor do the auctions minimize subsidies to meet the selected obligations. Consider the following simple example of the problem. Regions 1, 2, and 3 may be subsidized. The maximum subsidy for any region is 100. Any firm would require a subsidy of 120 to serve any one region. However, serving both regions 1 and 2, or both regions 2 and 3, would require a subsidy of only 140 for firms A and B, because they use a wireless technology that yields an economy of scope. Firm A bids 100 each for regions 1 and 2. If successful, Firm A would receive a subsidy of 200 when 140 would suffice. Firm B bids 100 for region 3 and 95 for region 2. This too would be highly profitable if successful, but now firm A stands to receive a subsidy of 100 where 120 is needed. The only way for firm A to avoid loss is to bid again on region 2, causing firm B to lose money. If the bidding war continues, both firms will lose money, possibly leading to bankruptcies rather than infrastructure expansion. On the other hand, cautious firms that are aware of this danger may be unwilling to accept a subsidy of less than 120 when subsidies are set through such an auction. This caution can prevent the firm that can develop the infrastructure at minimum cost from ever bidding, thereby increasing infrastructure costs. This also increases the subsidies the government must pay. It has been argued that this phenomenon undermined the 1998 Personal Communications Services (PCS) spectrum auctions in the Netherlands [MILG98].

Another serious problem with this approach is in the selection of obligations for the next auction. The cost of serving a given area and the potential revenues change over time, so correctly timing the imposition of a particular obligation can dramatically affect both the deployment cost and the subsidy required. This makes it difficult for a government to determine the auction in which a given service obligation should be auctioned.

The problem is considerably more complex (and severe) since entire sets of obligations are selected for auction, some of which may have economies of scope. For example, consider the case where there are 10 regions. Each region i: $1 \leq i \leq 10$ requires a subsidy of 120 to serve alone, but a subsidy of 20 is sufficient if the same firm has already deployed infrastructure in region i-1 or i+1. All 10 regions could be served for 210, but if only even-numbered regions are auctioned, it would require a subsidy of 600 to serve just 5 regions. This is a disadvantage of distributing obligations through a series of auctions.

Section 3.3: Targeted Implicit Subsidy Obligations

Another approach is to emulate the implicit subsidies typically used by monopoly carriers. In the context of a competitive industry structure, a license to offer a profitable service like cellular telephony or international toll service is coupled with the obligation to serve an unprofitable region. This approach has been adopted by the Philippines. In 1993, two executive orders in the Philippines mandated interconnection among all carriers and declared universal service provisions. These were reinforced by the Telecommunications Policy Act of 1995 which paved the way for privatization. Thanks to these reforms and a growing economy, the number of telephone lines increased remarkably from 1.2 per 100 people in 1993 [CABA98] to 9.1 per 100 people in 1998.

As with the other approaches, these implicit subsidies succeed in motivating commercial carriers to meet the needs of unserved areas, and the obligations are technology neutral. However, the system depends on the regulator's ability to match profitable and unprofitable

regions in an optimal way, much like the build-out requirement approach described in Section 3.1. Worse yet, even if optimal decisions are made when licenses are granted, circumstances change. Regions can become more or less profitable over time, possibly driving some firms to bankruptcy and giving others a tremendous competitive advantage. If the policy remains fixed, this is a risky proposition for potential bidders. There is no obvious way for the policy to evolve to steady-state policies without major disruptions.

A similar proposal was planned for India. Regions were categorized as having high, intermediate, or low market potential. Firms serving the former must also serve the latter. The approach was abandoned after strong protests from potential bidders, provoking concerns that few would bid [PETR96,SINH96]. The final policy was less restrictive, requiring firms to deploy 10% of their lines in rural areas.

Section 4: Proposed Policy

Section 4.1: Overview

Section 3 shows technology-neutral policies that induce commercial carriers to expand infrastructure. Each policy has advantages, but there is a recurrent theme in the disadvantages: a lack of flexibility. To minimizes costs, the right firms must be given the right set of universal service obligations to be fulfilled at the right time, and advance central planning by a government regulator is unlikely to produce that result. The solution is for government to set overall requirements, and give private firms greater flexibility to determine dynamically how to meet those requirements. This can be achieved through *tradable universal service obligations*.

An analogous approach has been used to limit air pollution in the United States and elsewhere. A permit allows a company to emit a given amount of pollutants into the atmosphere. By controlling the number of permits in circulation, the government can limit the total annual pollution rate. Permits can be sold and traded. Thus, a factory that can reduce its pollution levels inexpensively will sell its permits to a factory that cannot, thereby minimizing the costs of pollution reduction. In this section, we describe a universal service policy that builds upon this simple concept.

There are two aspects of the proposed universal service policy that make matters more complicated than the emissions policy described above. First, firms are trading obligations rather than permits. Second, because the objective of the proposed policy is to motivate the initial deployment of infrastructure, the universal service obligations are transient, and optimal timing is an important issue. Both these differences must be addressed.

Section 4.2: Flexible Obligations

There are two components to an obligation: what must be done, and when it must be completed. Thus, a universal service obligation consists of two components: a *milestone* to achieve, and a *commitment* to meet a specific deadline.

Beginning with the former, milestones may take many forms. All of these forms should refer to the availability of services, and thereby remain technology neutral. As described in Section 3.2, a successful infrastructure expansion in Chile may be the installation of payphones in selected localities of importance within a region. India would like to see at least one phone in every village of a given size. Ghana seeks to increase the number of subscribers to reach a specific teledensity. In the Untied States, a more likely definition of

successful infrastructure expansion is that *anyone* in a region willing to pay the given rate for a specified service should be able to get it. A milestone might even be so flexible that it does not specify whether the firm has to make phone service or Internet service available (at least in nations like Guinea and Haiti where those are offered though separate infrastructure [PEHA99]). Whatever the form, a set of N_r clear milestones ($N_r \geq 1$) must be defined for each region r. The N_r'th milestone meets the objective for expansion in region r. There are a total of $\sum_{\forall r} N_r$ milestones to achieve.

A typical build-out requirement might mandate that milestone i in every region must be competed by time T_i, but greater flexibility would improve efficiency. Investment could take place more quickly in some regions than others to maximize economies of scope and scale. Furthermore, there is strong financial incentive to time an infrastructure upgrade appropriately when equipment costs and demand are changing, and it is difficult for a regulator to motivate efficient timing with typical regulatory tools like price regulation [WANG97b]. The national interest is served as long as telecommunications carriers are making progress towards their assigned objectives at a reasonable rate. Thus, we might require that industry meet a specific number of milestones each year, without specifying which ones will be met. There should therefore be up to $\sum_{\forall r} N_r$ *commitments* outstanding, where a commitment requires that *some* milestone be met by the associated deadline. This deadline may differ from one commitment to another. If the number of outstanding milestones exceeds the number of outstanding commitments, then the government is implicitly allowing industry to achieve the milestones that cost the least.

Consider a firm with seven milestones, and five commitments. The firm is free to match each commitment with a milestone in any way that the firm chooses, corresponding to its strategy for infrastructure expansion. When a commitment is due, if the firm has not successfully met the requirements of any milestone that it currently holds, then that firm will be fined. Commitments are therefore liabilities, as they obligate a firm to either pay fines or invest capital to avoid those fines. Milestones are assets, as one needs a milestone in order to avoid paying a fine.

Firms are free to buy, sell, and trade milestones and commitments, alone or in combination. Thus, a firm that cannot meet the deadline associated with a given commitment may pay another firm to take that commitment. This exchange could bring capital to another firm that has a more aggressive expansion plan. For example, a low earth orbit (LEO) satellite provider that is still several years from operation might seek out later commitments, while firms that are expanding aggressively accept the earlier commitments, for a price. Firms would also be free to exchange milestones, allowing each to put together a portfolio of obligations that can be met efficiently. Where there is an economy of scope, a firm will seek to either obtain or divest of all complementary obligations.

If industry is free to select which milestones to meet at a given commitment deadline, the milestones should be of comparable social benefit. If this is not the case, a weight w(r,i) might reflect the estimated social value of the i'th milestone in region r. Commitments would also have weights, indicating how much must be accomplished by the given deadline. The sum of the weights of all milestones should equal or exceed the sum of the weights of all commitments.

What if the regional boundaries are not conducive to minimizing cost? With regulator approval, a firm might divide a milestone into two pieces such that the sum of the weights equals that of the original milestone. The regulator will insure that the relative weights assigned to each piece are reasonable. Commitments can also be divided, although regulator scrutiny is unnecessary in that case, provided that total weight does not change.

Section 4.3: Efficiency of Tradable Obligations

Tradable obligations allow industry to come close to minimizing the long-term costs of meeting commitments. Let k_c be the cost of meeting commitment c's deadline for the milestone associated under the current configuration of obligations, where cost is the net present value of infrastructure deployment and operating expenses minus revenues. $K = \sum_{\forall c} k_c$ is the total cost under current obligation assignments, and K' is the minimum cost of meeting current commitments under an optimal assignment. T is the maximum transaction costs of a trade, which includes identifying and negotiating a profitable trade. If $K > K' + T$, then there exists a trade that would reduce costs and benefit all parties involved. As long as transaction cost T is small, this approach is efficient.

In some markets, transaction cost T can be fairly large, especially when the number of firms grows large. However, in this case, T is probably small, for several reasons. First, the number of firms in a developing country is generally small. Second, firms can typically easily identify obligations that complement their own. Third, the government can require the registry of who possesses which milestone or commitment to be public, making it easy to find useful trading partners. Fourth, because each firm knows the obligations held by its trading partners, it has some idea which obligations others might value and how much.

Section 4.4: Who Can Accept Obligations?

Because firms are trading obligations (liabilities) rather than permits (assets), there is a danger that a firm with many outstanding obligations could go bankrupt. Indeed, in the absence of some protection, this is a tempting strategy for borrowing money; a pharmaceutical company could raise money by accepting many universal service commitments, with no intention of building telecommunications infrastructure. The company would later either "repay" the money by paying a telecommunications carrier to accept the commitments, or it would simply declare bankruptcy. A simple requirement that a firm must have at least as many milestones as commitments might curb the most flagrant abuses.

One way to further reduce the likelihood of this is to regulate who can accept universal service obligations. A firm need not have any telecommunications expertise, any more than a stock broker who sells agricultural futures must own a farm. However, a firm must have the financial resources to be held accountable if obligations are not met. Firms that wish to own commitments could first prove their solvency to a regulator, and perhaps declare collateral.

The other approach is to require that when a firm goes bankrupt, its commitments for universal service revert back to the previous owner. The regulator could then auction the milestones of a bankrupt carrier to those firms who were forced to take back its commitments, or the milestones could be auctioned to all interested bidders. This approach will discourage firms from giving universal service commitments to unstable companies. In effect, small companies and cooperatives can accept universal service obligations, while the larger firms that have demonstrated solvency to the state provide bankruptcy insurance.

Section 4.5: The First Years after Deployment

It is not sufficient to simply lay cable in a costly region; firms must provide services for a specified period of years to avoid fines. That period can begin once the commitment has officially been met.

Achieving the commitment may trigger other regulatory responses as well. Normally, if a telecommunications monopoly emerges in a given region, that monopoly should be price regulated. However, limiting a company's profits right after it makes a large capital investment is not the best way to encourage expansion. The regulator can grant a predefined period of relative freedom from price regulation that begins when the commitment is met, or if a company fails to meet its commitments, when the fines begin.

Section 4.6: Initial Distribution of Obligations

Previous sections discuss how universal service obligations can be met, or traded. Before any of this can happen, they must somehow be distributed. Since the trading phase will tend to minimize costs, the principal objective in the distribution of obligations is to minimize subsidies. This can be achieved in an open and competitive environment through use of an auction.

Designing an auction to minimize subsidies when there are potential economies of scope is nontrivial. With a small number of items to auction N, one possibility is to ask firms to bid on each of the 2^N-1 possible combinations of these items, as in a generalized Vickrey auction [CLAR71,GROV75,VICK61]. However, N would generally be too large to use this approach for universal service obligations. (Recall that Chile covered 46 regions and over 1300 localities in their first auction alone.) This is an open and active research area [KELL98].

A great deal can be achieved with a simple ascending simultaneous auction in which firms bid on each individual item until there are no more bids on any item, and the firm with the largest bid for a given item gets it. Combining sets of obligations into appropriate packages is the key to reducing subsidies. Obviously, if two obligations complement each other, i.e. the value of the combination exceeds the sum of their individual values, they should be bundled together.

Even when there are no such economies of scope, bundling helps considerably [CAME97,MILG97,PALF83]. For example, Firm A can serve region 1 for a subsidy of 50, and region 2 for 100. Conversely, Firm B can serve region 1 for 100, and region 2 for 50. When regions are auctioned separately, Firm A will get region 1 the first time it bids 100 or less. The same occurs for Firm B with region 2, so the total subsidy is roughly 200. If the regions were bundled, bidding would continue until one firm accepted a subsidy ≤ 150. (The winner would then promptly trade away one of the regions. This again demonstrates the value of tradable obligations; they make tolerable the inevitable tradeoff in auction design [MILG97] between minimizing subsidies and minimizing infrastructure expansion costs.) Bundling often reduces subsidies, especially when there are only a handful of bidders. Indeed, when there are only two interested bidders and minimum bid increments are small, bundling always reduces subsidies.[2]

When a package of universal service obligations (both commitments and milestones) is auctioned alone, the auction determines the government's cash subsidy, similar to the

[2] When regions are auctioned, the firm offering to accept the smaller subsidy wins, but the winner's subsidy is roughly what the other firm would accept. X_r and Y_r are the subsidies firms A and B will accept for region r, respectively. When regions are auctioned separately, the total subsidy is $\sum_{\forall r} \max(X_r, Y_r)$. When both regions are auctioned as a package, the total subsidy is $\max(\sum_{\forall r} X_r, \sum_{\forall r} Y_r)$, which is $\leq \sum_{\forall r} \max(X_r, Y_r)$.

Chilean approach described in Section 3.2. It is also possible to bundle these obligations with a resource of value, as with build-out requirements. Universal service obligations may be bundled with a state-owned carrier that is being privatized, with a spectrum license, or simply a license to operate. Licenses can be exclusive or non-exclusive, and may or may not leave the license-holder subject to regulation in the initial years. When bundling obligations and resources, there is no administrative overhead and no risk that money will be sidetracked, as opposed to cases where revenues are collected during privatization and then disseminated through auctions. Note that the valuable resources should also be tradable. In the case of spectrum, rules must be established on the flexibility that license-holders have to use spectrum for applications other than telecommunications, which influence both the value and the economies of scope; there are many tradeoffs in this decision [PEHA98b].

The bidding itself can take different forms, depending on the national objectives. At one extreme, the assets, milestones, and commitments are fixed, and are given to whoever will pay the most for them. At the other extreme, the price might be fixed, where the winner is the one that will accept the most or earliest commitments. Intermediate forms are also possible.

Section 5: Summary

This paper has presented a highly flexible policy of tradable obligations to advance universal service in the context of competing private-sector carriers. Firms receive tradable universal service obligations in the form of milestones that must be met, and commitments to meet deadlines.

Tradable obligations motivate private firms to bring given services to areas where these services have not been available. The approach could be used to improve the availability of telephone lines, Internet points of presence, broadcast radio stations, electric power, or even toll roads. Developing countries may adopt the approach to expand basic telephone infrastructure, especially when privatizing or introducing competition. At these times, obligations can be distributed along with the incumbent's assets or permission to compete. Obligations could also be distributed with other resources, such as spectrum (as in Guatemala) or cash subsidies (as in Chile).

Tradable obligations are technology neutral. Like build-out requirements, this approach allows private sector firms to accept obligations at subsidies that are determined through a market mechanism (an auction) without requiring the government to collect and distribute funds. Like the Chilean universal service fund approach, tradable obligations allow a government to prioritize needs and target subsidies based on cost-benefit ratios.

A tradable-obligations policy is the only approach that allows each carrier to determine which set of milestones and which deadlines it can meet most cost-effectively, while still insuring continual progress towards the desired final state. Exchange of milestones and commitments does not diminish the obligations that must be met by industry as a whole, insuring the timely expansion of infrastructure in a manner that meets social objectives. By exchanging its commitments, a firm can increase or decrease the rate at which it must expand infrastructure. By exchanging milestones, a firm can change where it must expand infrastructure. Making milestones and commitments independent and fully tradable allows each firm to develop the most cost effective business plan possible. Indeed, tradable obligations allow firms to change their strategies dynamically as technology and demand evolve. This is impossible with build-out requirements, where the regulator acts as central

planner, determining every thing in advance. With the universal service fund approach, obligations are determined via auction. This also yields less cost effective results when there are economies of scope among the items being auctioned.

Unlike a system of targeted implicit subsidies, a policy of tradable universal service obligations will transition easily to a regulatory environment in which areas with monopolies are regulated, areas with competition are not regulated, and no (uncompensated) accident of history will leave one player with a greater universal service burden than another.

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