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Supply-side measures for policy makers to promote mobile broadband coverage

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Supply-side measures for policy makers to promote mobile broadband coverage

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Abstract

Governments around the world recognise widespread broadband access as a facilitator of economic growth. As a result we observe that many countries have introduced National Broadband Policies which set ambitious targets for broadband coverage. Fixed network may not be commercially viable in more remote rural areas because the cost of roll out is too high. Therefore mobile networks are likely to play an important role in achieving these national targets. In particular, for rural and remote areas of a country where fixed networks are not viable, mobile will likely be the primary form of broadband access. Whilst Governments are interested in maintaining competitive markets there may be some rural areas of a country that are so uneconomic that even mobile network competition may not achieve coverage, either within the required timeframe or at all. It may, however, be desirable for such areas to be covered because of the wider economic benefits of widespread broadband availability. This paper presents and evaluates different forms of supply-side intervention that can be used to achieve mobile broadband coverage in rural areas.

Keywords: Competition Policy, Network Economics, Telecommunications Policy, Economics of Regulation

* The opinions expressed in this article are the authors' own and do not reflect the view of Frontier Economics Ltd. This is a preliminary version of the paper, please do not cite. This paper builds on a project that the authors carried out for the Groupe Speciale Mobile Association (GSMA).

1. Introduction

Governments around the world recognise widespread broadband access as a facilitator of economic growth. This is backed by empirical research by scholars such as Czernich et al. (2009) who analysed data from 25 OECD countries between 1996 and 2007, finding that a 10% increase in broadband penetration raises per-capita GDP growth by 0.9-1.5 percentage points. Similarly, Koutroumpis (2009) analysed 22 OECD countries between 2002 and 2007, finding that an increase in broadband penetration of 10% yields a 0.25% increase in GDP growth. Research on the impact of broadband on productivity has also identified positive effects. For example, Waverman et al. (2009) determined the economic effect of broadband on the GDP of 15 OECD nations for the period from 1980 to 2007. They estimated that for every 1% increase in broadband penetration in high and medium impact income countries, productivity grows by 0.13%. Crandall et al (2003) found a positive impact of broadband on job creation. They estimated the employment impact of broadband deployment aimed at increasing household adoption from 60% to 95% and requiring an investment of USD 63.6 billion. Their results showed the creation of 140,000 jobs per year over ten years and total jobs amounting to 1.2 million.

As a result we observe that many countries have introduced National Broadband Policies which set ambitious targets for broadband coverage. However, fixed network may not be commercially viable in more remote rural areas because the cost of roll out is too high. Therefore mobile networks are likely to play an important role in achieving these national targets. In particular, for rural and remote areas of a country where fixed networks are not viable, mobile will likely be the primary form of broadband access. There are also studies that have quantified the impact of the mobile sector on economic growth, particularly in developing countries. For instance, Lee et al. (2009) examined the effect of mobile phones on economic growth in Sub-Saharan Africa. The authors found that mobile availability is an important determinant of the economic growth rate, and that the marginal impact of mobile telecoms is greater in areas where fixed lines are rare. Waverman et al. (2005) concluded that 10 more mobile phones per 100 people would increase GDP per capita growth by up to 0.6 percentage points.

Governments are also interested in maintaining competitive markets. This is not surprising given the mobile network competition model, in which more than one vertically integrated mobile network operator (MNO) competes for retail customers, has delivered significant consumer benefits over the last three decades thereby becoming the predominant market form. Nevertheless, there are rural areas of countries that are uneconomic and hence are not covered.. It may, however, be desirable for such areas to be covered because of the wider economic benefits of widespread broadband availability. The question that arises and which this paper is aiming to answer is whether there are forms of Government intervention that can be used to achieve mobile broadband coverage in rural areas, and which at the same time are consistent with the maintenance of the benefits delivered by the network competition model.

The structure of this paper is as follows. First we summarise the theoretical and empirical literature on the link between network competition and consumer outcomes in Section 2 and discuss why some of the empirical findings might diverge from theoretical predictions in Section 3. Next, we present the framework that is used to evaluate different supply-side measures for promoting rural coverage that are available to policy makers in Section 4. We then apply the framework to a range of different supply-side measures in Section 5 and conclude in Section 6.

2. Literature review

In this section we provide a brief discussion of both the theoretical and empirical literature about the relationship between competition and consumer outcomes. There are a number of authors who analysed from a theoretical perspective how outcomes like penetration, coverage and prices are affected by the level of competition and measures that dampen price competition like uniform pricing. The empirical evidence on the link between competition and consumer welfare presented in this paper are limited to mobile telecommunications markets.

2.1. Theory

Götz (2013) examines the effect of the regulatory regime on both penetration and coverage of fixed broadband networks. One of the key findings is that as long as firms can price discriminate across regions, i.e. firms are unregulated, the monopoly scenario yields the same coverage as the scenario of facility-based competition. Using an approach similar to Valletti, Barros, and Hoernig (2002), the paper highlights the importance of population density for whether firms invest to provide internet access. The analysis reveals a trade-off between coverage and penetration under regulated uniform retail and wholesale access prices, i.e. when firms are regulated. Higher prices lead to wide coverage but low penetration – there is a trade-off between setting high prices which allow the monopoly to earn a high return and make it attractive to roll out in rural areas, and low prices which increase penetration across all regions.

For Valletti et al. and Gotz, the result of this trade-off is that price discrimination should lead to higher coverage both under a monopoly and facilities based competition, and that unregulated competition should not result in higher coverage. But overall penetration might be higher under facilities based competition than under a monopoly due to lower prices in regions where several firms are present. If firms are required to charge a single price across all markets/regions, then this will lower the degree of price competition in urban areas. This is because without uniform pricing firms could set low prices in competitive areas where local average costs are low due to high population density. But with uniform pricing the relevant cost for breaking even is the average cost across all the markets that a firm serves. So the incumbent, who by assumption is the one serving all high cost regions that have a regional monopoly, would not be able to sustain the competitive prices in urban areas. As a result the incumbent might find it preferable to leave some of the competitive urban areas in order to keep prices high in areas where it is the monopolist.

Adding to this, Gautier and Wauthy (2010) consider how an incumbent might be affected by the addition of a universal coverage requirement. They show that this has a destabilising effect on the incumbent's pricing strategy, as well as reducing the coverage and increasing the price of entrants. Incumbents are left with conflicting incentives: on one hand they can 'withdraw' to regions with limited competition and charge higher prices, ceding the more competitive regions to the entrants by maintaining a higher price; alternatively, they have the opportunity to undercut the relatively high prices of the entrants but at the expense of margins in areas they dominate.

Foros and Kind (2003) show that competition may not lead to increases in welfare if there is a uniform pricing requirement, instead finding that coverage and welfare improvements are far more likely under non-uniform pricing. Indeed, they show that regional price discrimination leads to a similar level of coverage compared to the coverage achieved under a social planner regardless of the level of competition. As such, the introduction of competition is focused on delivering higher welfare and penetration through lower prices.

Alternatively, Poudou and Roland (2013) suggest that uniform pricing can have a positive effect on welfare if implemented by the regulator alongside coverage requirements and requirements on the level of competition in each market. The authors discuss the implementation of 'license constraints', a minimum or maximum coverage restriction imposed on new entrants which allows policy makers to control the level of competition within markets, in addition to coverage requirements on incumbents and uniform pricing. The authors argue that, per Cramer et al. (1998), the main flaw of universal coverage and pricing when implemented independently (and without controls for the level of competition through license constraints) is that there is no guarantee MNOs will find alternative methods for avoiding providing coverage to high-cost consumers. For example, universal coverage without sufficient competition may still lead to excessive pricing, allowing providers to 'withdraw' from high-cost areas in the way suggested by Gautier and Wauthy. However, given a more holistic regulatory approach ensuring sufficient competition in areas with greater population density and guaranteeing coverage in rural areas, Poudou and Roland argue that a uniform pricing regime will then improve overall welfare.

2.2. Empirical findings

The GSMA (2014) assessed the case for Single Wholesale Networks (“SWNs”). Part of this study was a comparison between mobile telecommunication markets in which there was only one mobile network operator, with markets in which there was competition between several networks.

The analysis was based on a 2001 dataset covering 137 countries worldwide. The dataset consisted of population and area coverage estimates, GDP per capita, population and time since 2G was introduced from the GSMA intelligence data base, and population density data from the United Nations. Further explanatory variables used for sensitivity checks include urbanisation and political risk, the latter of which was calculated based on various indicators published by the World Bank related to accountability, political stability, quality of regulation, rule of law and control of corruption. The year 2001 was chosen, because there were considerably more countries with single networks at that date than at the time the study was conducted. Earlier years than 2001 were disregarded due to data limitations. As a sensitivity test the authors repeated the analysis for a later time period (2005).

First, the authors conducted an OLS estimation with robust standard errors and found that controlling for other factors, there was a statistically significant difference in coverage between countries with single networks in countries with network competition. In particular, the authors found that coverage in countries with single networks was about 12-15 percentage points lower on average. Secondly, the authors also assessed whether there are differences between different market structures in terms of the speed at which coverage has increased over time. For this the authors selected those countries that had a mobile coverage below the 2001 sample average and calculated by how much coverage increased by 2005. The authors found a statistically significant difference showing that coverage in countries with network competition increased more than two times faster than in countries without. While the overall results of GSMA (2014) are robust to various sensitivity tests the following caveat should be noted. To the extent that the analysis does not take into account the effect of any supply-side interventions that regulators used there may be an omitted variable bias in the estimated difference between single networks and network competition.

Other empirical findings include a paper by Shinohara, Morikawa and Tsuji (2013), in which the authors regress mobile broadband adoption on a number of factors including the Herfindahl-Hirschman Index over a panel dataset. They find that market concentration has a negative impact on mobile broadband diffusion. While the paper is limited in its analysis, the general result does suggest that the promotion of competition has a positive effect on the take up of mobile broadband. A similar result can also be found in Kongaut and Bohlin (2016). Conducting an analysis of the Swedish mobile broadband market, the authors focus primarily on demand-side factors that influence mobile broadband penetration. However, they do find that user-friendliness and quality of service are important drivers of mobile broadband penetration. These are factors related closely to inter-platform competition, with the greater user-friendliness experienced in areas where multiple platforms are competing both on price and service quality.

3. Reconciliation of empirics and theory

Regarding the benefits of network competition, the theoretical literature seems to partly support, and partly contradict empirical findings. Both the theoretical and the empirical literature agree that the most densely populated areas will receive coverage first. The straightforward reason for this is that higher population density implies higher profits (in the case of profit-maximizing firms) or social welfare (in the case of a benevolent social planner) given a fixed investment, because more consumers can be reached. Where population density is too low, firms would not be able to recover the fixed costs of roll out and would therefore not provide coverage. This general result holds for both monopolistic markets and markets with some degree of competition. Indeed, absent market interventions such as the ones described in Section 5, we observe that urban areas are usually the first areas to receive broadband coverage in any country.

Another theoretical finding that is in line with empirical observations is that as long as there are fixed costs, coverage is inefficiently low compared to the coverage achieved under a benevolent social planner. A benevolent social planner maximises total social welfare and would therefore serve every consumer for which the benefit of connection was higher than the marginal cost of connection. This would lead to coverage of every region where the total welfare summed across all consumers is larger than the fixed costs involved. A monopolist, or companies that are in competition, on the other hand maximize profits rather than social welfare. Absent price discrimination (which is a realistic assumption because operators are usually required to charge a uniform price to all consumers) the number of households served at the profit maximizing uniform price in any region would be lower than under a social planner. This means that there will be some regions that it would be efficient to serve but the monopolist, or companies in competition, find unprofitable and which are therefore left unserved. In reality we observe that governments (i.e. the closest proxy for a benevolent social planner) frequently develop national broadband policies that aim at bringing broadband coverage to rural areas. This is because broadband coverage has a social value that is greater than the private profits earned by firms. The empirical findings mentioned in the introduction provide some evidence of the benefits of broadband coverage on economic growth. To the extent that these positive externalities on the wider economy are not taken into account by profit-maximizing companies, this therefore supports the theoretical finding that coverage achieved by a profit-maximizing monopolist, or firms in competition, is inefficiently low compared to that achieved under a benevolent social planner.

The theoretical literature contradicts empirical evidence in that it finds that since a monopolist generates the highest industry profits, a duopoly (or higher degrees of competition) would only be possible in an even smaller set of regions, i.e. that coverage would be lower. The reason for this is twofold. First, with several firms operating, fixed costs would be replicated, thereby decreasing individual firms' profits. And second, when firms have to charge uniform prices, competition creates an incentive to serve fewer of the low density (high cost) areas and undercut competitors in the high density areas. This strategic effect drives down prices but also reduces the number of regions where competition is sustained. Hence the number of regions where it is possible to sustain competition is smaller than the set where a monopolist would choose to go. The empirical literature discussed in Section 2.2 on the other hand suggests that network competition leads to better consumer outcomes in terms of coverage, innovation and other factors.

This contradiction can potentially be explained by the following: First, the theoretical literature does not account for efficiency gains brought about by firms that are in competition compared to monopolists. It is possible that these efficiencies reduce the fixed costs involved in rolling out into a region. This could explain why coverage under network competition is higher than predicted in theory. Second, operators do not compete on the basis of price alone. Users on a network enjoy positive network externalities the more other users can potentially be reached. Coverage can therefore be a selling point and may induce competing firms to increase coverage beyond the level that a monopolist would provide. Third, the empirical studies discussed in Section 2.2 do not account for supply-side interventions like coverage obligations, which can increase the set of regions with competition. To the extent that such interventions are more prevalent in countries with network competition, this offers an explanation for the observed greater coverage in countries with network competition.

4. Framework for supply-side interventions to promote rural coverage

This chapter sets out the theoretical framework used to compare various supply-side measures to facilitate rural coverage. We focus on wireless (mobile) communication networks, as these are typically better suited to deliver coverage in less densely populated rural areas. Our conclusions can to a large extent be applied to fixed communication networks as well, but given the focus of our paper we refer to mobile networks in the remainder of this paper.

We consider the following four criteria for assessing supply-side measures to promote mobile network coverage in rural areas:

- The effectiveness of providing coverage in those areas of the country where it is desirable to do so (i.e. in areas in which total welfare of coverage exceeds the cost coverage);
- The cost/difficulty involved in implementing the measure, and whether there is international precedent;
- The potential for distortive effects on competition; and
- The potential to complement the measure with demand-side measures.

First, a framework should be able to assess whether an intervention would lead to coverage in areas which would be desirable to cover (in the sense that a benevolent social planner would roll out). To this end, we categorise any given area in a country as one of the following four types:

- Areas which will always be covered by network competition (i.e. with multiple network operators) – these are urban and suburban areas of high demand where operators would expect to compete and comfortably make a profit by covering them (Area 1 in Figure 1).
- Areas which can only be covered with some degree of network-sharing or a single network – these are areas that lack the demand to support multiple national operators each rolling out their own networks independently, such that in the event of multiple operators rolling out, at least one would make a loss. Therefore, in these areas, operators may lack a clear business case for deciding to roll out independently. In theory this area would be covered by one network. However the lack of certainty may result in no operators rolling out, and the area remaining uncovered. However, the level of demand may be sufficiently high to support at least one network without public funding. This means that by engaging in some form of network-sharing, operators could remove the risk and uncertainty of rolling out independently and jointly cover the area instead (Area 2 in Figure 1).
- Areas which can only be covered with some form of public funding – these are areas with relatively low levels of demand, such that even network-sharing is not a viable option for operators. Examples include sparsely-populated rural and remote areas. In these areas, some form of public funding would be required for operators to consider rolling out (Area 3 in Figure 1). It would be efficient to cover this area from the perspective of a social planner who is maximising social welfare rather than private profits.
- Areas best covered by other technologies – these are areas so remote that even a benevolent social planner would not roll out. The reason is that mobile technology is either not the most efficient way of providing broadband coverage (i.e. these areas might be more efficiently served by other technologies) or where the provision of broadband services does not make economic sense even with a public subsidy (Area 4 in Figure 1).

Supply-side interventions are not needed in area 1. And area 4 would not be efficiently covered by a benevolent social planner. We therefore evaluate any supply-side interventions according to how effective they are in achieving coverage in areas 2 and 3.

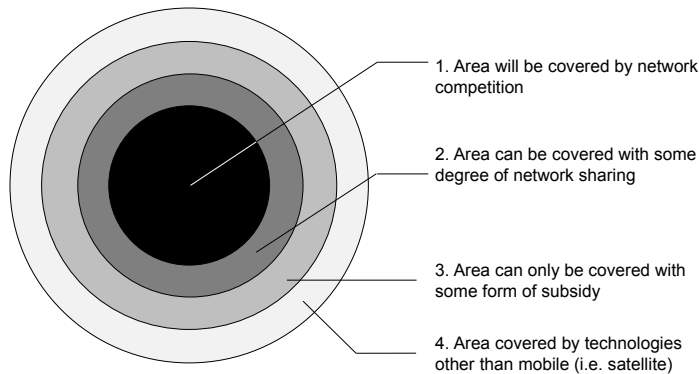


Fig. 1 Categorising areas by viability of mobile coverage

Second, apart from their effectiveness in achieving coverage, we evaluate interventions according to how costly and how difficult they are to implement, and whether there is successful international precedent. An intervention might be preferred over another, because it is less complex or risky and therefore less costly to implement. Being able to learn from successful interventions in other countries can reduce the cost of implementation substantially, and therefore lead to a larger net benefit to society, even if it is less effective at achieving coverage in rural areas. Third, given positive consumer outcomes in terms of coverage, prices and innovation associated with network competition, regulators may be concerned about the degree to which an intervention distorts competitive dynamics. In particular, it is conceivable that interventions could distort prices and unintentionally favour some operators over others, thereby reducing investment incentives. From the point of view of a regulator who decides which measure to use based on the net benefit it provides, it will therefore be important to take into account these additional costs associated with a loss in competition. And lastly, regulators may rely on a combination of different types of supply-side interventions, or even consider demand-side stimuli to promote rural coverage. The ease by which an intervention can be complemented with other measures can therefore be a decisive factor in choosing which measure to use.

The framework by which this paper is going to evaluate supply-side interventions is summarised in Table 1 below.

Table 1 Framework for evaluating different supply-side interventions

Criterion
Effectiveness in achieving coverage in area 2
Effectiveness in achieving coverage in area 3
Cost/ difficulty of implementation
Successfully implemented elsewhere
Risk of distortive effects (e.g. on prices/ investment)
Complementarity with other measures (e.g. demand side)

5. Evaluation of supply-side interventions

In this section, we suggest ways in which rural broadband coverage can be promoted, whilst at the same time the risks of distortion of competition in the mobile market are minimised. In particular, we present and

evaluate the following forms of supply-side intervention against the framework presented in the previous chapter:

- licensing of low frequency spectrum in combination with coverage obligations;
- promoting voluntary infrastructure sharing in rural areas; and
- using public finances to (co-)finance rollout in uneconomic rural areas.

5.1. Licensing of new, low frequency spectrum in combination with coverage obligations

The first form of public intervention we will focus on is coverage obligations, typically introduced as conditions in operating licences, which are commonly awarded through a competitive tendering process (spectrum auctions or beauty contests). Coverage obligations set out the scope of coverage and the timescales in which it is to be achieved. The focus of this section is on combining the tendering of spectrum with the tendering of coverage obligations in one single auction.

In setting coverage obligations, policymakers face a trade-off between coverage and the proceeds that might otherwise be generated by the auction of a licence without such a condition. This is because potential licensees will be willing to pay less for a licence with more extensive coverage obligations, as coverage obligations require licensees to cover areas in which no economic case for rollout can be made. The difference between what an operator is willing to pay for a licence without and a licence with an obligation can therefore be seen as lost revenue to the Government or the amount the Government is contributing to support the rollout of services in areas that would not be served, absent the obligation.

Taking into account that operators will bid less for licences that include a coverage obligation, Governments might be tempted to set reserve prices to guarantee a minimum return from the auction. While in principle this is a legitimate concern, regulators should take into account that reserve prices that are set too high might discourage bidders and make the auction less competitive. In an extreme case, spectrum blocks might be left unsold or unused as has occurred in India and Australia. Therefore, if stringent coverage obligations are imposed, this might need to be reflected in the level of the reserve price.

5.1.1. Specification of the coverage obligation

There are a number of variations regarding how a coverage obligation can be specified (for example, whether it focuses on population or geographic coverage, how the provision of a mobile data service within the coverage area is ensured, etc.). The exact drafting of a coverage obligation will need to vary between markets according to the demand and cost characteristics of the market concerned. We discuss some of the points to consider below.

5.1.1.1. Choice of spectrum band

Low frequency spectrum has certain characteristics that make it especially useful for extending coverage. This is due to the fact that as a result of its wavelength, it propagates better over long distances compared to high frequency spectrum. High frequencies are useful in cities because they can carry a large amount of data over short distances and are thus suitable for extending network capacity in densely populated urban areas. Low frequency spectrum is generally well suited for extending coverage in rural areas because it requires fewer cells for equivalent coverage. This means lower infrastructure investment and therefore the cost of rollout is lower for mobile operators. For these reasons, recent spectrum auctions in Europe and the US would typically attach more stringent coverage obligations to sub-1GHz spectrum (700, 800 and 900 MHz spectrum) compared to higher frequency bands.

Regulators might either require that operators use a specific spectrum band to fulfil the coverage obligation or to leave it to the operator to decide which frequency bands to use. The latter might be the preferred option as it gives the operator more room to find the most cost efficient solution.

5.1.1.2. Outdoor vs. indoor coverage

Coverage targets can either be defined in terms of outdoor or indoor coverage. Indoor coverage is difficult to measure as it is dependent on the characteristics of buildings, such as the thickness of walls. There are substantial practical challenges associated with testing indoor coverage in a way that takes account of the wide variety of building types for monitoring purposes. It might therefore be preferred to specify a level of outdoor coverage instead. This is the approach Ofcom has chosen in the last 4G auction. In particular they attached the requirement to reach 98% coverage outdoors and “at some indoor locations within the vast majority of residential buildings”. According to Ofcom, requiring 98% coverage outdoors would ensure that there is a sufficient level of indoor coverage.

5.1.1.3. Geographic / Population reach of coverage

Coverage obligations usually state what percentage of surface area or population of the country needs to be covered by the licensee. International experience indicates that coverage obligations are typically set on a population basis, rather than an area basis, to minimise the risks of inefficient network investment in areas where there is no demand for mobile services. Nevertheless, when setting coverage targets, the regulator might also consider setting certain minimum requirements for particular regions, as a complement to requirements on overall population coverage. In the UK, for example, Ofcom decided to impose a coverage obligation of 95% for England, Wales, Scotland and Northern Ireland (in addition to reaching 98% coverage in the UK as a whole). In Germany and the Czech Republic, the regulator identified a list of ‘underserved areas’ (in combination with overall population coverage obligations) where operators had to provide basic broadband coverage before they could start rolling out in profitable urban areas. In addition, regulators often also set targets for reaching area coverage by certain times, when a new technology is introduced.

In relation to what percentage of population/ area is to be covered through the obligation, the regulator may also need to specify a QoS (Quality of Service) target. This can for example be specified in terms of average speed in terms of Mbit/s. It seems advisable to set relatively conservative QoS targets in more rural areas at the outset. This will focus operators’ efforts on attaining basic coverage in these areas and give them more time to achieve faster broadband speeds over a period of time.

5.1.1.4. Absolute vs. relative reference

The reach of a coverage obligation can be defined with an absolute or relative reference. The former would specify coverage to where, for example, 98% of the population lives according to the latest census data. The latter might require coverage in, for example, at least 90% of areas where there is currently 2G coverage. In the UK, Ofcom has chosen to use absolute references in the latest 4G auction on the grounds that this is easier to define. It also enables prospective bidders to evaluate the cost of fulfilling the obligation with a higher level of confidence.

5.1.1.5. Number of operators

As mentioned above, an additional important question to consider is to whom any coverage obligation should apply. Here, there are two broad options to consider. First, the same coverage obligations could be imposed on all operators. This will lead to network competition throughout the served area but could lead to inefficient duplication, which network sharing or ‘first mover’ coverage would otherwise avoid. Thus, it will also impose higher costs on the sector than the second approach and, hence, also on the Government because of decreased revenues from the spectrum auction. Secondly, coverage obligations could be imposed only on a sub-set of operators or on a single operator (or there could be asymmetric coverage obligations, with one licence having more stringent obligations than the others). The licence with a coverage obligation may also include additional spectrum rights compared to those with no obligation, to support that licensee in meeting its obligations. Or there may be additional obligations imposed on the licence holder, for example the requirement to grant wholesale access to other operators.

Ofcom, for instance, considered in the last 4G auction whether to impose coverage obligations on several operators. In the end, Ofcom decided to apply obligations to only one licence and without wholesale access obligations. Firstly because it is not necessary to impose obligations on several operators as competition will encourage operators without the obligation to accelerate their rollouts anyway. And secondly, even if in rural areas there might only be one network present, it is unlikely that consumers in these areas are to suffer substantially higher prices due to a lack of competition. This is because operators usually charge uniform prices to consumers across the UK.

5.1.1.6. Additional rights and obligations attached to the licence

Given the particular market structure in question, the regulator might consider attaching further rights or obligations to certain licences. One example of this is the obligation to grant wholesale access in uneconomic areas. This applies mainly in the case where a coverage obligation is imposed on a single operator who might then be the only operator in rural areas. Nevertheless, the regulator considering imposing this additional obligation should carefully consider the costs and benefits of this measure.

Firstly, while the obligatory wholesale access allows others to use the network in a given area, and hence facilitating competition, it is not obvious that this would lead to significant benefits for consumers. In particular, if there is effective competition between multiple networks in urban areas and prices (and other terms of mobile service) are nationally averaged, then one would expect outcomes in rural areas covered by one network operator (that is subject to coverage obligation) to remain competitive, even in the absence of any wholesale access obligations. And secondly, wholesale access obligations could potentially decrease the value of spectrum for operators by limiting the revenue that the Government can raise from auctioning the spectrum with coverage obligations and increasing the risk that the spectrum might be left unsold.

For instance, in the 4G spectrum auction, Ofcom considered imposing such obligations. However it decided against this because of (i) difficulties in designing such an obligation in a way that does not undermine commercial incentives, (ii) difficulties in specifying details and in particular within which areas the obligation applies; and (iii) because consumer experience in roaming areas has been poorer.

Therefore, while there might be a rationale for imposing additional wholesale access obligations on the licence with a coverage obligation, the regulator needs to take into account potential risks and costs related to this additional obligation.

5.1.1.7. Timing issues

Despite the fact that network competition leads to rollout of new technologies substantially faster than other market structures, regulators in some countries envisaged the rollout of 3G to occur even faster. So, in 4G auctions, one of the reasons why coverage obligations are quite common is to speed up the rollout to rural areas. When setting the time frame in which rollout should occur, the regulator has to take into account the characteristics of the national mobile market. There is a trade-off between setting goals that are ambitious enough, but are at the same time realistically attainable by market participants. If the requirements are too tight, they might prevent some operators from bidding for these licences which would make the auction process less competitive. Regulators should also take into account the length of licences. Rollout in uneconomic areas involves large investments at the start whereas revenues might be relatively low due to low population densities. It might therefore take more time to earn a sufficient return to justify rollout in rural areas compared to urban areas. In order to increase the likelihood of operators earning a sufficient return on their investment, more extensive coverage obligations may require relatively longer licence periods.

5.1.1.8. Enforcement and other considerations

A proposed coverage obligation should be specified in detail. It is very important for bidders to understand the practical implications of accepting the coverage obligations in terms of cost and feasibility. It is also a relevant prerequisite for a meaningful discussion about the geographical extent of the coverage obligation. In

relation to this, the specification of the coverage obligation also needs to provide potential licensees with certainty about how achieving coverage targets will be enforced and non-achievement will be penalised. In particular, when making their bids, operators need to take into account what happens if coverage targets are not achieved due to force majeure events. One tested way of enforcing coverage obligations is the use of performance bonds. These are bonds issued by the holder of the coverage obligation at the start of the licence. The Government has the option to monetise the bond if the obligation is not met as specified. Regulators should consider if the obligation should be technology and band neutral. This would allow the licensee who has the coverage obligation to deliver the specified service in whichever way is most cost effective.

5.1.2. Evaluation

In terms of Figure 1, coverage obligations can be used to achieve rollout in Areas 2 and 3 (in Area 1, they are not needed as rollout will occur in any case). When setting the level of coverage, the regulator needs to have an idea about the relative sizes of Areas 2 and 3 (and how many licensees are subject to this obligation). Covering Area 2 is economically viable for at least one operator, so the coverage obligation is unlikely to impose a huge financial burden if it only applies to one licensee. Therefore the challenge for the operator who is subject to the obligation lies in achieving coverage subject to the specified time frame. However, Area 3 is so uneconomic that rolling out there is loss-making. So if the level of required coverage is set such that a large part of Area 3 needs to be covered, operators will factor this in during the bidding process. This may decrease the revenue generated during the auction, or in an extreme case, leave spectrum with coverage obligations unsold, in particular if reserve prices are set prohibitively high. In such a case, the direct use of public funds might be a preferred approach to coverage obligations in reaching Area 3.

For operators, coverage obligations score well in terms of simplicity of implementation, especially if they are combined with spectrum auctions in a single tender. This is because it is easier for operators to internalise the transfer from profit making areas to uneconomic areas and adjusting their bid value accordingly if the two tenders are combined into one auction. There may also be some efficiency gains from combining coverage obligations and frequency allocations. This is because operators likely need to adjust/reconfigure their network both to efficiently use newly allocated spectrum and to meet the coverage obligation at lowest possible costs. It might therefore be more cost efficient to do this reconfiguration only once. If coverage obligations are imposed separately (and with a time lag compared to the spectrum auction) operators would have to reconsider the configuration of their different spectrum bands twice.

For regulators, coverage obligations are easy to design, despite the numerous features they may entail. The more difficult aspect in the implementation of coverage obligations attached to spectrum licenses is the design of the auction itself. However, spectrum auctions with coverage obligations have been used in many countries and there is therefore a substantial amount of international precedent on how best to design such auctions (see Annex A.1. for examples).

If well designed, spectrum auctions will lead to prices paid for the obligation that correspond to their true value. On the one hand this means that regulators are not foregoing more auction proceeds than necessary. This can be achieved if the auction process is competitive, for example by ensuring that a sufficient number of interested parties are admitted to participate in the auction. On the other hand this also implies that operators have a lower risk of overpaying for the obligation. In this context it is important to note that the design of spectrum auctions can play a crucial role in the amount that operators pay for licenses. The 2013 spectrum auction in Austria for example is often seen as an auction design which allowed operators to increase the bid of other participants without any risk, resulting in. More generally, the closer the price at which a coverage obligation is auctioned is to its true value, the less distortion there is among competing operators.

Coverage obligations attached to spectrum licenses tend to be relatively easy to complement with other supply-side and demand-side measures. Examples of the former include access obligations which can be used

to foster retail competition by enabling new or existing MVNOs. And examples of the latter include stimuli such as state-funded basic access in rural areas which would make the roll out more attractive for operators. This could include residential customers, or could be limited to only public institutions such as schools, hospitals etc. Complementarity with such measures is high as the regulator has enough flexibility to introduce additional license conditions when auctioning the spectrum. The key risk that needs to be considered is that by adding more conditions and requirements the spectrum may become commercially less attractive for operators. In an extreme case this could lead to there being spectrum left unsold.

Table 2 Evaluation framework applied to coverage obligations

Criterion	Evaluation
Effectiveness in achieving coverage in area 2	High
Effectiveness in achieving coverage in area 3	Medium
Cost/ difficulty of implementation	Low
Successfully implemented elsewhere	Yes
Risk of distortive effects (e.g. on prices/ investment)	-Medium
Complementarity with other measures (e.g. demand side)	High

5.2. Promoting voluntary network sharing in rural areas

It may be the case that in rural areas, there is insufficient demand to support multiple operators rolling out independent networks. However, there may be enough demand to support one operator (or a combination of operators involved in network sharing) rolling out. Through network sharing, operators may be able to share infrastructure and save costs by avoiding duplication and removing the uncertainty that it is profitable to jointly roll out. In this section we briefly discuss the different types of network sharing (in increasing order of operational integration) and evaluate this option against our framework.

5.2.1. Types of network sharing

Network sharing can take several forms but always involves a certain part of a mobile network being used by more than one MNO. The options range from sharing only passive elements (like the site or masts) to sharing active elements such as antennas or the core network.

5.2.1.1. Site Sharing

This concerns the sharing of the compound on which masts and any backhaul equipment of a substation are installed. It is the most basic form of network sharing as operators only share acquisition and maintenance of the site but erect their own masts and backhaul equipment. However, this form of sharing can lead to cost savings of up to 10%² and make rollout in rural areas more viable. In urban areas there might sometimes be no other choice than to co-locate sites due to limited space. Most agreements include the sharing of sites, for

² Vodafone: Network Sharing in Vodafone (<http://www.gsma.com/mobilefordevelopment/wp-content/uploads/2012/06/Vodafone1.pdf>)

example in Australia, Cyprus, Germany and Pakistan.³ The degree to which sites are shared differs significantly across countries, but can reach up to 50%, as was the case in Austria in 2009.⁴

5.2.1.2. Mast / backhaul sharing

MNOs can take this a step further by sharing passive components, such as the masts on which antennas are located, but maintaining their own antennas and separate Node Bs/ BTS⁵ and RNC/ BSC.⁶ There are estimates of potential overall cost savings for an MNO of up to 15%.⁷ If backhaul equipment is shared, additional cost savings of up to another 15% are possible.⁸ We note that in some countries, such as India, there are third-party infrastructure providers (such as Tower Companies - see below) that specialise in the provision of shared infrastructure. These companies do not themselves operate mobile networks but lease shared infrastructure to MNOs. An increasing number of countries are permitting this approach, one of the most recent examples being Myanmar.

5.2.1.3. RAN sharing

This form of sharing includes active parts of the network such as antennas, Node Bs/ BTS and RNC/ BSCs in addition to the site and mast. This means that operators share their entire infrastructure up to the point where it connects to the core network. However, they maintain separate logical networks and their own separate spectrum. Sharing of the RAN (including passive and active elements of the network) can lead to potential total cost savings of up to 30%.⁹

5.2.1.4. Core Network sharing

This is the most involved form of infrastructure sharing as MNOs give each other access to network elements such as the core transmission ring or logical network elements such as VAS platforms or the OMC¹⁰ (operation and maintenance centres). Transmission ring sharing occurs if an operator has spare capacity on its lines and can be of great value for new entrants who have not yet rolled out their own infrastructure. Total cost savings achievable tend to be lower than those of RAN sharing, because the RAN usually accounts for a larger part of network costs than the core network.¹¹

5.2.1.5. National roaming

Roaming is distinct from other forms of network sharing as it doesn't involve shared investments in infrastructure. Instead, under roaming agreements, MNOs are allowed to route traffic on each other's networks. It is therefore not necessary for an MNO to operate its own access network across the country to

³ GSMA Mobile Infrastructure Sharing (<http://www.gsma.com/publicpolicy/wp-content/uploads/2012/09/Mobile-Infrastructure-sharing.pdf>)

⁴ BEREC-RSPG report on infrastructure and spectrum sharing in mobile/wireless networks (http://rspg-spectrum.eu/_documents/documents/meeting/rspg25/rspg11-374_final_joint_rspg_berec_report.pdf)

⁵ Node Bs include radio frequency transmitters and receivers used to communicate with mobile devices and are used in UMTS networks. Base transceiver stations are the GSM equivalent of Node Bs.

⁶ Radio network controller (RNC) and base station controller (BSC) control several Node Bs/ BTS (for example manages the handover between them) and acts as an aggregator.

⁷ GSMA Mobile Infrastructure Sharing (<http://www.gsma.com/publicpolicy/wp-content/uploads/2012/09/Mobile-Infrastructure-sharing.pdf>)

⁸ Coleago Consulting: Network Sharing business planning (http://www.coleago.co.uk/fileadmin/user_upload/Downloads/Network%20Sharing%20Overview%20Coleago.pdf)

⁹ BEREC-RSPG report on infrastructure and spectrum sharing in mobile/wireless networks (http://rspg-spectrum.eu/_documents/documents/meeting/rspg25/rspg11-374_final_joint_rspg_berec_report.pdf)

¹⁰ Coleago Consulting: Network Sharing business planning (http://www.coleago.co.uk/fileadmin/user_upload/Downloads/Network%20Sharing%20Overview%20Coleago.pdf)

¹¹ GSMA Mobile Infrastructure Sharing (<http://www.gsma.com/publicpolicy/wp-content/uploads/2012/09/Mobile-Infrastructure-sharing.pdf>)

achieve certain levels of coverage. We include it as a form of network sharing, because it has been proposed by MNOs and permitted by regulators as part of network sharing agreements in the past.

5.2.1.6. *Tower Cos*

Operators tend to either enter one of the above sharing arrangements or to opt for a different organisational form of network sharing. e.g. by creating a Tower Company (“Tower Co”). As with the other forms of network sharing mentioned above, the goal is to achieve cost efficiencies by removing duplication of infrastructure. In broad terms, there are two types of Tower Cos:

- Operator-owned Tower Cos - this category consists of companies created by transferring assets of telecoms companies into subsidiaries.
- Independent Telecom Tower Cos - this category consists of companies that are not owned or managed by telecom operators and build, own and lease towers to them.

5.2.2. *Evaluation*

Network sharing can lead to cost savings resulting in some low-demand areas becoming commercially viable for operators to cover. As such, promoting network sharing can be used to foster coverage in Area 2 – areas in which no more than one network would commercially roll out. It is however not suited to cover Area 3, which are areas in which a benevolent social planner would roll out, but which are so rural that no profit maximising operator could sustain a network.

There may be barriers to voluntary network sharing and these barriers effectively represent an additional cost which may result in some areas not being covered. This is particularly relevant for rural areas, where voluntary network sharing can have a positive impact on coverage increase. The cost of implementation may depend on the regulatory and administrative regime in any given country. There are for example administrative barriers such as having to apply for planning permission which may delay the implementation of network sharing arrangements. Ways to reduce these costs include simplifying bureaucratic procedures. For example, in the Netherlands no planning permission is required for deploying small antennas. Secondly, shared ownership may cause delays if one operator needs permission from another to make on-site changes. These delays and associated costs may be mitigated by obliging operators to include provisions in network sharing agreements that ensure all operators involved maintain planning independence.¹²

Network sharing agreements are successfully used in Europe and around the world (see Annex A.2. for some examples). As such there is a plethora of international precedent regulators can draw upon, thereby reducing any implementation risks to some extent.

Operators who engage in network sharing may experience lower OPEX and CAPEX compared to other operators. While this may in principle present a competitive advantage over other operators, network sharing can still satisfy the criterion of competitive neutrality. This is because network sharing arrangements are generally reviewed by competition authorities to ensure that they do not lead to a diminishing or distortion of competition. And if appropriate, competition authorities could in principle consider whether to impose measures to address competitive distortions. One potential problem from a competition perspective is that network sharing may facilitate collusion due to information exchange. If this is a concern, competition authorities and regulator have the opportunity to limit the degree of information sharing between operators.¹³

¹² See European Commission's 2003 decisions in the UK and Germany, both regarding network sharing agreement between O2 and T-Mobile (Case COMP/ 38.370 and Case COMP/38.369)

¹³ This was for example implemented by the German regulator RegTP in its 2001 general guidelines concerning network sharing.

As network sharing arrangements reflect commercial arrangements between mobile network operators, without any public funding or favourable treatment, they should in general be more consistent with the principle of competitive neutrality, compared to policies that involve a significant risk of a competitive distortion, such as the establishment of a national single wholesale network.

There are two further issues that regulators may take into account when considering Tower Cos as a means to fostering rural coverage:

- **Coordination** – this might be a potential concern to regulators in the case of operator-owned Tower Cos. Similar to network sharing agreements, if operators set up a joint Tower Co some information about network rollout will be shared in order to realise cost savings. Regulators might be concerned that this coordination extends beyond what is envisaged and that operators use their joint activities to tacitly collude. As mentioned in Exhibit 4 this risk can be mitigated by limiting the amount of information sharing that is allowed between operators.
- **Excessive pricing** – in the case of independent Tower Cos, there is the risk that excessive pricing prohibits rollout in uneconomic areas if there is a lack of competition. In an extreme case, where there is only one Tower Co providing access to sites and towers in a country, the profit-maximising price that the monopoly Tower Co sets might be too high in rural areas for operators to make use of this service.

There is some degree of complementarity with other measures mainly on the supply-side. These are in relation with specific interventions Governments can undertake to decrease the administrative barriers to infrastructure sharing and roll out such as lengthy procedures for obtaining planning permissions. Other examples include financial incentives that Governments can give to operators to promote network sharing in rural areas.

Table 3. Evaluation framework applied to network sharing

Criterion	Evaluation
Effectiveness in achieving coverage in area 2	High
Effectiveness in achieving coverage in area 3	n/a
Cost/ difficulty of implementation	Low – Medium
Successfully implemented elsewhere	Yes
Risk of distortive effects (e.g. on prices/ investment)	Low - Medium
Complementarity with other measures (e.g. demand side)	Medium

5.3. Using public finances to support rollout in uneconomic areas

Public intervention might be necessary to fund network rollout in order to reach the most uneconomic rural areas (Area 3 in Figure 1). There are a number of alternatives the Government can adopt in order to approach this issue, but all of them require its financial participation, either directly or indirectly, in covering at least some of the cost of rollout in these areas.

The focus of this section is on the following four interventions:

- targeted fiscal incentives to induce rollout;
- competitive tendering of public funds to directly co-finance network rollout in uneconomic areas;
- (co)-financing the construction of national links, bringing connectivity closer to the end user and decreasing cost of access network rollout in remote areas; and

- some form of network intervention in underserved rural areas. This involves the direct provision of public infrastructure in uneconomic areas to be shared by commercial operators.

The above options can be implemented in a way that is consistent with the principle of competitive neutrality. Indirect public funding, such as using fiscal incentives, for example, in the form of tax rebates will leave competitive neutrality unaffected as this is available to all operators. Also, a competitive tendering process, if designed appropriately, will be able to avoid providing any operator with any undue advantage. Thirdly, (co-)financing the construction of backhaul links will maintain competitive neutrality, provided that all operators have access to it with no undue discrimination, and that backhaul links are funded in the areas where such funding is necessary for their deployment. Lastly, as public network intervention occurs only in areas which are not served by commercial operators, it doesn't interfere with the competitive market. Giving all operators access to the shared public infrastructure without any undue discrimination should ensure that no one operator is favoured over another.

5.3.1. Targeted fiscal incentives

There are a number of channels through which fiscal measures can influence rollout decisions of operators. These include, for example, taxes in relation to the operation of tower sites or energy consumption and import tariffs on network equipment. What they have in common is that they impose an additional cost on operators which might be pivotal in some investment decisions and therefore lead to some rural areas not being covered because no economic case can be made.

Mobile operators often face additional tax burdens compared to many other sectors of the economy, which would be expected to reduce the economic case for expanding coverage – e.g. Bangladesh, Nigeria, Turkey, Algeria and Ghana¹⁴ as well as Latin American countries such as Argentina and Mexico.¹⁵ If Governments wish to promote coverage by using targeted fiscal measures they need to take into account the following:

- Targeting – there should be a direct link between the chosen measure and the desired outcome – wider coverage. In practice, this means that if, for example, a regulator chooses to use corporate income tax rebates to promote rural coverage, these should only apply to revenues generated in uneconomic areas rather than to the company as a whole. The more direct this link, the bigger the impact will be.
- Efficiency – designing and monitoring any such scheme might incur a significant cost if it is too complex. So while any fiscal incentives should be as closely linked to the ultimate policy goal as possible, regulators should pay attention to choose measures that can be administered easily such that the cost of the scheme doesn't outweigh its benefits.
- Transparency – if any tax rebate scheme is offered it should be well defined so it is clear to operators at the outset which geographic areas it will apply to and which taxable items it is targeting. This is essential to avoid any potential disputes.

Targeted fiscal incentives have been used in the past to foster rural coverage. See Annex A.3. for an example of an application in Malaysia.

¹⁴ In Bangladesh, mobile operators are subject to a special corporation tax rate 10% higher than all other sectors except for tobacco. Also, we understand from the GSMA there is a regulatory duty of 5% imposed on approximately a quarter of all imported network equipment. In Ghana and Nigeria, various fees on mobile operators raise the cost and administrative complexity of rolling out networks. In Nigeria, there are local business taxes of on average N 30,000 per site, town planning fees amounting to an average of N 650,000 per site and annual civil aviation taxes of N 50,000 per site. In Ghana, on the other hand, fees for fibre rollout in amount approximately to \$ 4,000/km.

¹⁵ <http://www.gsma.com/publicpolicy/wp-content/uploads/2012/12/GSMA-2012-Latin-America-Tax-ReportWEBv2.pdf>

5.3.2. Direct public funding

Another form of intervention to facilitate network rollout in rural areas is to directly support mobile operators to extend coverage, with public funds allocated on the basis of a public tender. One way of doing this is by, for example, using a Dutch auction. In this auction type the price is automatically lowered over time until someone is willing to bid (or the reserve price is met). In the case of public funding, this would mean that the amount of subsidy received is increased over time until an operator is willing to bid and commit to roll out a network in an underserved area.

There are different ways in which Governments can and have run such public tenders geographically: one option is to structure these tenders such that a single entity/operator rolls out in all uneconomic areas (and potentially provides wholesale access to other operators). Another option implies running several tenders to allocate funds for providing coverage in different predefined geographic areas. In this case, the Government could request that a national roaming offer is developed under which existing retail mobile operators can have access to these networks in uneconomic areas under a common, national contract. This means that operators would not have to negotiate with all the different operators of these wholesale networks, thereby facilitating the provision of retail services in uneconomic areas.

Although the option of direct public funding is attractive in principle, there are two practical implications that make it more of a risk:

- ensuring competitiveness of the auction; and
- ensuring transparency in the way funds are managed.

First, any tendering process needs to safeguard competition. If not properly designed, there might be limited room for multiple operators to compete. If the number of operators participating in the tender is limited, this could negatively affect the competitiveness and the bidding behaviour of the operators. This can be a way for the winning bidder to extract more money from the Government than what would be necessary to roll out efficiently in uneconomic areas. One of the reasons why in mature economies there might be an absence of bidders other than the fixed incumbent is that, in general, fixed incumbents provide (near) universal coverage. This means they can be at an advantage compared to other operators in relation to such tenders. In developing/emerging economies where fixed incumbents typically provide much less than universal coverage, they should necessarily be considered to have an advantage in relation to rural coverage as a result of the coverage of their fixed networks. They may, however, still enjoy some advantages as a result of being the legacy fixed telecommunications providers.

Second, directly awarding funds to operators is a similar but less transparent option than licensing low frequency spectrum in combination with coverage obligations.¹⁶ The lack of transparency can be an issue for this or other kinds of funds. For example, a recent GSMA study¹⁷ provides evidence for a range of issues in relation to Universal Service Funds (“USFs”) in African countries. Among the most prominent is the lack of transparency and poor administration which often leads to inactive or ineffective funds. Providing public funding indirectly through a single spectrum license award auction with coverage obligations could be, where feasible, a more efficient option to allocate public funds.

Direct public funding has been used in the past to foster rural coverage. See Annex A.4. for a summary of applications in various countries.

¹⁶ We show in **Section 5.1** the benefits of awarding coverage obligations and licences in the same auction.

¹⁷ http://www.gsma.com/publicpolicy/wp-content/uploads/2012/03/Sub-Saharan_Africa_USF-Full_Report-English.pdf

5.3.3. (Co-)financing backhaul links

The third option to use public finances to enable coverage of uneconomic areas is the (co-)financing of the backhaul links. The backhaul is defined as the portion of the telecoms network that connects the tower/BTS to the core/backbone network. It is also used to refer to any portion of the network that connects into the centre of the network.

In some local areas, there may be sufficient demand to support operators rolling out an access network. However, the difficulty may lie in providing backhaul connectivity from this access network to the core network in a cost-effective way. In remote areas, a lack of backhaul connectivity may therefore result in operators deciding not to roll out in areas that would otherwise be commercially viable.

The Government could decrease the cost of rollout in remote areas by supporting the extension of backhaul links to bring broadband connectivity closer to rural consumers. This could come in the form of either public funding (either paid to existing operators or used to finance a Government-led rollout) which provides fibre backhaul on an open access basis and on affordable terms, or through promoting backhaul network sharing. This would make it more cost effective for mobile operators to roll out their wireless access networks.

(Co-)financing backhaul links has been used in the past to foster rural coverage. See Annex A.5. for a summary of applications in various countries.

5.3.4. Public provision of network infrastructure in uneconomic areas only

Another possible way for the Government to subsidise rollout in uneconomic areas consists of directly providing public network infrastructure in underserved areas.

As set out in Section 4 of this paper, there will be some truly uneconomic areas of the country, typically remote rural areas where commercial operators are unable to roll out in the short- to medium-term, even taking into account potential cost savings associated with network-sharing. In these areas, it may be possible for the Government to justify an intervention in the form of publically funding network infrastructure. The key purpose of any network intervention will be to extend coverage to these uneconomic areas, while minimising market distortions and the public funding required to co-finance the network rollout and operation. We discuss in turn the two dimensions along which network intervention can be defined – geographic footprint and scope of the intervention.

- **Geographic footprint of intervention:** Any intervention involving public funds is necessary only in areas which are truly under-served (Area 3 in Figure 1). Intervention should not occur in any areas that are already covered (or will be covered in the short- to medium-run) either through the model of network competition (Area 1), or through some form of network-sharing agreement (Area 2). The main reason for this is that the Government should seek to minimise the public funding necessary to achieve its aims and to maximise the use of private capital invested by the existing operators. Public intervention in areas where some form of network competition is viable would likely distort market structure at the expense of end users. Therefore, the boundaries of intervention should be clearly defined to minimise the extent of such a distortion, which further amplifies the importance of the accurate mapping exercise / gap analysis. However, it should be noted that the boundaries between these different models or ‘areas’ (i.e. between (i) network competition and network-sharing; and (ii) network-sharing and the public intervention) are likely to be fluid and subject to change over time. For example, as equipment becomes cheaper over time and income-levels (and therefore demand) increase over time, areas that were once only profitable to cover using some form of network-sharing agreement may become sufficiently profitable for operators to roll out competing networks. This represents a move from 2 to 1.
- **Scope of network intervention:** It might not be desirable or even necessary to construct a full public network consisting of passive and active infrastructure and designated frequency bands. Governments have

to consider that the more involved its intervention, the more costly and complex the project will become. We therefore suggest that public consultations with the commercial operators are held prior to any intervention to find out what the operator's appetite is in terms of its own engagement in any such intervention. It might, for example, be the case that all that is required is public provision of passive infrastructure and that operators are willing to provide active network elements themselves.

5.3.5. Evaluation

The effectiveness in achieving rural coverage differs somewhat across the various options within public finances. Fiscal incentives for example are difficult to target compared to other measures. As a result they are likely to be less effective in achieving rural coverage. (Co-)financing backhaul links or an entire rural wholesale network on the other hand may be effective in achieving coverage in area 3, but should not be used to achieve coverage of area 2 if the objective is to protect network competition.

Similarly the measures discussed above vary in terms of their ease of implementation. Fiscal incentives such as tax breaks for example are relatively easy to implement compared to the construction and operation of a rural wholesale network. In addition, a rural wholesale network is the only measure discussed in this paper for which there is no international precedent to date making it the most risky measure. Another risk that most options of public finances have in common is that there may be distortive effects on competition and investments. This is particularly the case in countries in which the boundaries between areas 2 and 3 are rapidly changing. In these dynamic markets it is possible that the use public finances might impair network competition. In the case of fiscal incentives this might occur if such incentives are not targeted enough or adaptable such that certain operators or industries in the value chain receive an undue advantage over others. In the case of financing network infrastructure this might happen if the boundaries between economic and uneconomic areas are changing rapidly. This can lead to a situation in which MNOs find themselves competing against a state-backed network in certain areas of the country, thereby reducing their incentives to invest into their own infrastructure. In the case of direct public funding the risk of distortive effects might be somewhat lower depending on how the mechanism is designed. If for example public funds are allocated through a competitive tendering process (e.g. a Dutch auction), this option is similar to coverage obligations in the context of spectrum auctions.

To the degree that there can be distortive effects from using public finances to promote rural coverage, complementarity with other supply-side measures is limited. This is because distortive effects can make it more difficult to implement other supply-side measures such as network sharing incentives. For instance, it may be challenging to promote voluntary network sharing if operators know that if they do not roll out in a given rural area, the Government will eventually finance rollout through direct subsidies.

6. Concluding remarks

In this paper we presented three supply-side measures - coverage obligations, network sharing and the use of public finances - which policy makers can use to promote mobile broadband coverage in rural areas. Table 4 shows an overview of our evaluation of each of the options against a number of criteria. These include their effectiveness in achieving coverage, the cost/ difficulty of implementation and whether they have been successfully implemented elsewhere, the risk of any distortive effects arising from them and the ease by which they may be complemented with other measures.

As becomes apparent from Table 4, there is no single option that is clearly superior to others. Which supply-side measure to use depends to some degree on the objectives of the policy maker. The set of available measures is different when the goal is to accelerate rollout in areas which could profitably be covered by one network (Area 2), compared to when the goal is to promote coverage in areas which are uneconomic to cover

(Area 3). While there are some differences in the cost/difficulty associated with the implementation of each measure, most of the options have been successfully deployed elsewhere which offers policy makers guidance and may help reduce implementation cost. This is particularly the case in countries with similar regulatory regimes, or countries that are similar in some other respect (e.g. topography). Somewhat correlated with the cost/difficulty of implementation and the existence of precedent is the risk of distortive effects. These depend to a large extent on the complexity of the intervention and how it is implemented. For instance, the distortive effect of an intervention like a spectrum auction with coverage obligations may depend to a large extent on the auction design.

While this paper concludes that there is no one-size-fits-all approach to promoting mobile broadband coverage, it highlights the relative strengths and weaknesses of the different options. Further research in this area may be directed towards quantifying the performance of each option against each of the evaluation criteria, which would shed further light on the circumstances under which an approach may be preferred to others. More generally, this discussion may benefit from an empirical analysis of how well the measures presented in this paper perform in different regulatory environments and accounting for country-specific characteristics.

Table 4 Evaluation summary

Criterion	Coverage obligations	Network sharing	Public finances			
			Fiscal incentives	Direct public funding	(Co-)financing backhaul links	Provision of network infrastructure
Effectiveness in achieving coverage in area 2	High	High	Low	High	n/a	n/a
Effectiveness in achieving coverage in area 3	Medium	n/a	Low	High	High	High
Cost/ difficulty of implementation	Low	Low – Medium	Low	Low	Medium	High
Successfully implemented elsewhere	Yes	Yes	Yes	Yes	Yes	No
Risk of distortive effects (e.g. on prices/ investment)	Medium	Low - Medium	Medium	Low - Medium	Medium	High
Complementarity with other measures (e.g. demand side)	High	Medium	Medium	Medium - High	Medium	Medium

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Appendix A. International precedent

A.1. Examples of coverage obligations

Germany: In 2010, 800 MHz licences required that operators roll out to rural areas first, before rolling out to urban areas (which might already receive mobile broadband services over a 3G network in another frequency band). Within less than two years, all licensees had met their coverage obligations in specified districts and

were allowed to use the frequencies they purchased in the 800 MHz band in all federal states.¹⁸

Sweden: In 2011, an obligation was placed upon one licensee in the 800 MHz auction to provide service of at least 1 Mbps or better to a list of stated addresses (identified as being broadband ‘not spots’, lacking any other form of broadband connection). The obligation included a commitment from the winner to spend SEK300 million (EUR34.2 million) on covering homes and businesses in rural areas of the country.¹⁹

UK: The 4G auction only included a coverage obligation for one block of 800 MHz spectrum. O2 obtained 2x10 MHz of 800 MHz spectrum with a coverage obligation to "provide a mobile broadband service for indoor reception to at least 98% of the UK population (expected to cover at least 99% when outdoors) and at least 95% of the population of each of the UK nations - England, Northern Ireland, Scotland and Wales - by the end of 2017 at the latest". O2 expects to meet the national coverage obligation by 2015, two years earlier than required.²⁰

Chile: In 2013, in what was a mixture between an auction and a “beauty contest” (a ‘hybrid’ method), the terms of references indicate that bidders had to specify their coverage plans if they were awarded a spectrum block. There were also certain minimum requirements such as a commitment to cover 1,281 rural locations. To date, Chile has already successfully achieved 30% of the forecast. Taken together, the obligations are expected to lead to 4G coverage of 98% thereby ending the digital divide in Chile.²¹

Brazil: 3G services were launched in November 2007. 3G coverage obligations were imposed on winners of the auction, such as:

- Coverage of all the municipalities without any mobile technology within 2 years;
- Coverage of all the municipalities with populations above 100,000 inhabitants with 3G within 5 years;
- Coverage of 50% of the municipalities with populations between 30,000 and 100,000 inhabitants with 3G within 5 years; and
- Coverage of 15% the municipalities with populations below 30,000 inhabitants within 8 years.

We understand that after 5 years 100% of Brazilian municipalities already had mobile coverage.²²

A.2. Examples of network sharing agreements

¹⁸ AETHA (2011), “Case studies for the award of the 700MHz/800MHz band: Germany”. Available at: <http://www.gsma.com/spectrum/wp-content/uploads/2011/11/700MHz-800MHz-band-Germany.pdf>

¹⁹ Radio Spectrum Policy Group (2011), “RSPG Report on Improving Broadband Coverage”. Available at: http://rspg-spectrum.eu/_documents/documents/meeting/rspg26/rspg11_393_report_imp_broad_cov.pdf

²⁰ OFCOM (2014), “4G radio spectrum auction: lessons learned”. Available at: <http://www.nao.org.uk/wp-content/uploads/2015/03/4G-radio-spectrum-auction-lessons-learned.pdf>

OFCOM (2012), “The Office of Communications: Annual Report and Accounts”. Available at: http://www.ofcom.org.uk/files/2013/07/Ofcom_Annual-Report_AD600_ACC-2_English.pdf.

²¹ ITU (2014), “Post Connect Americas Summit Report”. Available at: [http://www.itu.int/en/ITU-D/Conferences/connect/Documents/Post%20Connect%20Americas%20Summit%20Report%20\(English\).pdf](http://www.itu.int/en/ITU-D/Conferences/connect/Documents/Post%20Connect%20Americas%20Summit%20Report%20(English).pdf).

²² ITU, “The Brazilian experience on spectrum pricing modeling: The 3G and 4G license”. Available at: https://www.itu.int/ITU-D/finance/work-cost-tariffs/events/tariff-seminars/Mexico-13/pdf/Sess5_Silva_spectrum-en.pdf

Malaysia - Malaysia has been on the forefront of network sharing in South-East Asia. Celcom and Digi have an infrastructure alliance based on site, mast and backhaul sharing. Celcom engaged in a domestic roaming agreement with U Mobile from as early as 2007. The deal helped U Mobile to achieve national coverage before rolling out its own 3G network and provided Celcom with a new stream of revenue. Celcom has been engaged in sharing of active elements (including spectrum) with Altel since 2013. Altel seeks to achieve national coverage until it has rolled out its own 4G network.²³ Maxis has been sharing infrastructure and spectrum with REDtone since in 2012 claiming that it will enable them to fast track their rollout of 4G services. Network sharing is a response to the Malaysian Government's call for mobile operators to avoid duplication of infrastructure and is expected to lead to reduced capital expenditures and more efficient use of spectrum.

India: The Indian telecoms regulator TRAI²⁴ published recommendations on network sharing in 2007. Amongst others, it cited the benefits such as greater coverage, cost reductions and faster rollout.²⁵ TRAI also approved the use of a universal service obligation fund (USOF) in support of the scheme. The fund was set up in such a way that (up to three) operators received subsidies if they decided to share passive infrastructure.²⁶ There were two rounds of public tenders during which 8,000 and an additional 11,000 masts were shared respectively. Tower sharing is very prominent in India today with over 80% of towers in the country owned and managed by operator-owned companies.²⁷ One of those companies is Indus Towers, a joint venture between Bharti, Vodafone and Aditya Birla Telecom. The main reasons for the creation of this joint venture were reduced capital and operational expenditures and the acceleration of the rollout of new technologies - particularly in rural areas.²⁸

Ghana: In 2010, the three operators – Tigo, MTN and Vodafone – have sold their transmission towers to other specialized business entities. In particular, American Tower Corporation (ATC) agreed to acquire a stake in almost 2,000 of MTN Ghana's transmission towers. They would create a joint venture company, TowerCo Ghana, with ATC responsible for managing the assets.²⁹ Ghana has a majority of its towers (around 63%) owned by independent telecom Tower Companies.³⁰

A.3. Examples of using public finances (fiscal incentives)

²³ <http://www.soyacincau.com/2014/04/23/altel-to-invest-rm1b-in-5-years-to-roll-out-lte-network/>

²⁴ Telecommunications Regulatory Authority of India

²⁵ <http://www.gsma.com/publicpolicy/wp-content/uploads/2012/09/Mobile-Infrastructure-sharing.pdf>

²⁶ <http://www.ictregulationtoolkit.org/en/toolkit/notes/practicenote/3157>

²⁷ http://www.icra.in/Files/ticker/Telecom%20_notel.pdf

²⁸ [http://www.coleago.co.uk/fileadmin/user_upload/Downloads/Network%20Sharing%20Overview%20Coleago.p](http://www.coleago.co.uk/fileadmin/user_upload/Downloads/Network%20Sharing%20Overview%20Coleago.pdf)

²⁹ Tower Exchange (2012), "Are three towercos in Ghana too many?"

³⁰ AT Kearney, "The Rise of the Tower Business";

ICRA Rating Feature (2011). "Indian Telecom Tower Industry: Consolidation Round the Corner"

A recent budget of the Malaysian Government³¹ included the following measures to incentivise investment in mobile broadband coverage:

- “Last Mile Broadband” network investment incentive. This provides a tax exemption for up to 70% of corporate income tax on qualifying (rural broadband) expenditure which has been used to deploy a faster access network.
- Exemption from import duty and sales tax for broadband equipment and consumer access devices for the provision of broadband services which are not produced locally.

A.4. Examples of using public finances (direct public funding)

France: In 2003, the French Government established a system of collaborative funding to improve mobile coverage in rural areas. 3,000 not-spots (areas that did not have 2G coverage from any one mobile network) were identified and a consultation process took place to help local communities to identify and nominate themselves for inclusion in the scheme. The three MNOs jointly contributed around 75% of the total cost, with the balance being provided by central and local public funds.³²

UK: In 2013, the UK Government introduced the Broadband Delivery UK (“BDUK”) scheme. Although this programme refers more generally to the broadband sector, the conditions operators have to satisfy in order to obtain the aid can also be adopted in the case of mobile networks. According to the BDUK scheme, each body which intends to rely on public intervention to deliver its broadband project has to follow three steps:

- identify the geographic areas where public intervention is needed;
- motivate why intervention is needed; and
- run a public consultation.

The public funds are awarded according to who makes the most economically advantageous offer. All local bodies are required to include a claw back provision in the contracts with suppliers to deliver local broadband projects. This ensures that the successful supplier does not receive excess funding in the target areas.³³

Ireland: In 2008, Hutchison Whampoa (“Three”) won a competitive tendering process to implement and operate the National Broadband Scheme (NBS). The objective of the NBS was to deliver basic, affordable broadband to certain target areas in Ireland in which broadband services were insufficient. According to the NBS contract, Three was required to provide services to all premises in the NBS coverage area who sought a service. In order to facilitate competition in the area, Three also had to provide wholesale access to any other authorised operator who wished to serve premises in the area covered by the NBS. The rollout of the

³¹ <http://www.mia.org.my/new/downloads/circularsandresources/budget/2014/B18.pdf>

³² PA Consulting Group (2010): “Not-spots research Impacts, causes and potential solutions for areas of poor coverage, not-spots”. Available at: http://stakeholders.ofcom.org.uk/binaries/research/telecoms-research/notspots/PA_Consulting_main_report.pdf

³³ European Commission (2012), “State aid SA.33671 (2012/N) – United Kingdom National Broadband scheme for the UK - Broadband Delivery UK”. Available at: http://ec.europa.eu/competition/state_aid/cases/243212/243212_1387832_172_1.pdf

provision of NBS services advanced incrementally over a 22 month period and was completed in October 2010. In line with the NBS contract, broadband services were made available to all premises within each of the 1,028 designated NBS Electoral Divisions across 25 counties. Direct funding as a form of intervention has also been adopted outside Europe. Examples of non-European countries where Governments have provided operators with subsidies awarded through a competitive tendering process are Chile and India.

Chile: To increase access to public telephones in rural and low-income urban areas, the Chilean government set up Fondo de Desarrollo de Telecomunicaciones (FDT) in 1994. The fund is financed by the national budget and administered by the regulatory authority, SUBTEL. The regulator decides on the annual programme of projects eligible for subsidy and awards these through competitive bidding, each project being awarded to the bidder asking for the lowest subsidy. These projects covered almost 1,300 localities throughout the country. The localities typically have fewer than 1,000 inhabitants and are located within roughly 50 kilometres of existing telecommunications facilities. The original goal for the Fund was to provide a public telephone service to about 6,000 unserved localities – a target that was met over the 5 year period between 1995 and 1999. After having achieved Chile’s social telephony objectives, the Fund was redefined to support tele-centre projects. The Fund aimed to launch a national tele-centres programme in 2002. An initial target was to set up tele-centres in about 90 municipal headquarter towns with over 8,000 rural inhabitants. By 2006, there were tele-centres in all 341 municipalities. The Fund still exists and receives an annual budget to carry out projects aiming at increasing coverage in uneconomic areas.³⁴

India: A number of initiatives have been undertaken by the Government to improve the telecom penetration in rural India. The Government’s Bharat Nirman programme was aimed at intensifying rural infrastructure development. The subsidy support for mobile towers in rural areas through the USF is another example of the Indian Government’s initiatives to promote rural telecommunications. Under the Bharat Nirman programme, 61,186 out of the remaining 62,302 villages have been covered as of December 31, 2009.³⁵

A.5. Examples of using public finances (backhaul links)

Hungary: Based on the 5 year Digital Renewal Action Plan (2010-2014), the Hungarian Ministry of National Development published a draft call for projects to finance broadband backhaul network developments. This project will help increase the usage of ICT skills in those areas where demand is not that high and make broadband Point of Presence available for those areas where optical connection is present.³⁶

New Zealand: New Zealand is another country implementing a series of major telecommunications policy initiatives, aimed at accelerating the deployment of ultra-fast broadband to its citizens and social services institutions. These initiatives include the Rural Broadband Initiative (RBI), a NZD 300-million government funding programme aiming at improving the availability of fibre backhaul links in less-urbanised parts of

³⁴ The World Bank Group (1997), “Extending Telecommunications Service to Rural Areas—The Chilean Experience”. Available at:

<http://siteresources.worldbank.org/EXTFINANCIALSECTOR/Resources/282884-1303327122200/105welle.pdf>

³⁵ RAD (2010), “Rural India holds the key to push the country’s broadband base”. Available at:

<http://www.rad.com/12/broadband-in-rural-India/22081/>

³⁶ <https://ec.europa.eu/digital-agenda/en/best-practice-%E2%80%93-broadband-backhaul-network-development-hungary>.

New Zealand, and providing the country's schools with reliable, ultra-fast connectivity. The current objective is to bring broadband of least 5 Mbps to 86% of rural customers by 2016.³⁷

³⁷ The Broadband Commission for Digital Development (2011), "Broadband: A platform for progress".