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**THE MOMENTUM FOR NETWORK SEPARATION: A GUIDE
FOR REGULATORS**

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The momentum for network separation: a guide for regulators

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ABSTRACT

NGAs (Next Generation Access Networks) are a challenge to regulators and operators insofar as they require large investments, there is significant uncertainty about the ability to recover costs, and the choice of the appropriate regulatory regime is far from consensual. Regulatory authorities might want to seize the moment and reconsider the mandatory vertical separation of telecommunication firms, without jeopardizing incentives to innovation, investment and welfare.

We provide a provocative but simple test for the adequacy of network separation as a regulatory remedy. We propose a decision tree procedure with four steps in order to assess whether network separation is an adequate regulatory response: [1] “Is there significant market power in the market for the provision of access services under NGAs?”; [2] “Are there few vertical complementarities between services along the supply chain?”; [3] “Is functional separation a better regulatory tool than any other alternative?”; and [4] “Is structural separation superior to functional separation?”. A positive answer to the first three questions implies that the regulator should consider functional network separation, whilst the fourth is needed for the structural alternative.

JEL Classification: L51, L96.

Keywords: Telecommunications networks, Functional separation, Structural separation.

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1. INTRODUCTION

The concept of network separation in the telecommunications sector has been regarded as a taboo by the industry at large. Over the recent years, although many other sectors implemented network separation – electricity, railways, gas –, the telecommunications sector did not follow that trend. Naturally, many arguments were used to justify the difference. The most important one is that the telecommunications sector is different from the others because there is a larger degree of vertical coordination between services along the supply chain. In other words, there are clear cost synergies to be realized if services are provided to the final consumer by a vertically integrated operator.

Recently, the European Commission (2007) has disrupted the sector: not only did it discuss the possibility of network separation, but it also proposes that network separation (albeit in the “lighter” functional separation solution) can be imposed on dominant operators. Naturally, these proposals come at a time when Next Generation Access Networks (NGAs) are gradually (and in some cases quickly) making their appearance¹.

A NGA departs from the current copper-based access network by making use of other technologies, such as fibre. From the perspective of traditional telecommunications companies, there is a consensus that a new architecture is needed to implement a new range of services, such as triple play and quadruple play. NGA deployment will make way for traditionally separated businesses – such as cable TV, media and entertainment, telephone and broadband services– to be offered using a unique infrastructure.

NGAs are a challenge to incumbents and entrants in the telecommunications business, as they require large investment sums, and there is significant uncertainty about the ability to recover costs. The regulatory authorities might want to seize the moment to redesign the regulatory framework aiming at a more competitive environment drawing on the past experience. The most sought debate is the mandatory vertical separation of telecommunication firms in such a way to maximize consumers’ welfare, without jeopardizing incentives to innovation and investment.

This paper does not intend to discuss whether network separation is generally a correct regulatory tool or even whether it is likely to work. Our view is that the answer to the first question is highly subjective and the answer to the second depends on many different factors, including the nitty-gritty details of how such separation is implemented. Instead, we provide a simple test for the adequacy of network separation as a regulatory remedy. We believe the following four questions must be answered affirmatively in order to consider network separation as an adequate regulatory remedy, particularly under the emergence of NGAs:

- is there significant market power in the market for the provision of access services under NGAs?
- are there few vertical complementarities between services along the supply chain?
- is functional separation a better regulatory tool than any other alternative?
- is structural separation superior to functional separation?

Our proposal is simultaneously provocative and practical: is it provocative insofar as we are suggesting regulators how to think and make their decisions; it is practical because we believe these

¹ Gonçalves and Nascimento (2009) provide a detailed discussion of NGAs and the regulatory challenges they present.

four questions adequately address the problem at hand, namely whether or not, in a given country, the regulator should consider network separation.

We discuss each of the four questions in sections 3, 4, 5 and 6. Section 7 concludes.

2. IS THERE SIGNIFICANT MARKET POWER UNDER NGAs?

The access network connects the subscriber to the local exchange using copper wire connections (also known as the local loop). With recent technological developments, such copper wire connections proved to be capable of providing additional services (besides telephone services) such as broadband connections. xDSL connections, of which ADSL is by far the most popular, face a trade-off between maximum download speeds and local loop length: the longer is the loop length, the lower are the maximum download speeds. In particular, it is necessary for a subscriber to have a broadband connection of around 25Mbps to carry simultaneous multiple HDTV³ channels, broadband internet and voice services (OFCOM (2007)).

The deployment of NGAs is seen as the solution to this problem, as it entails laying fibre deeper into the access network (i.e. closer to the subscriber). The two most commonly referred to alternatives are Fibre to the Cabinet (FTTCab) or Fibre to the Home (FTTH)⁴. FTTCab allows subscribers to continue using their copper loops up to the street cabinet, but fibre replaces the existing copper connection from the cabinet to the local exchange. By contrast, FTTH entails the complete replacement of the copper-based local loop with fibre.

From a purely competitive perspective, such innovation has implications on firms' strategic behaviour regarding the telecommunications value chain, and on the development of alternative networks to provide competing services – such as cable networks. In practice we observe a high degree of convergence in the infrastructure components of the two main telecommunications networks – PSTN and cable. In practice, a cable network is very similar to a FTTCab deployment of a NGA. The fiber links the whole network at the street cabinet level, where consumers are connected using a coaxial cable. Where the cable network has a large penetration, consumers will be allowed to choose alternative solutions to access the service, and there seems to be a possibility for competition.

The boundaries of a NGA operator are not clear yet and the debate goes on about how the industry will look like in the future. The NGA value chain can be broken down horizontally and vertically. Horizontally, there are essentially three elements: customer equipment, network equipment, and interconnection with other networks. Vertically, there are two layers: the transport layer and the service/content layer, encompassing communication and media services that can be offered on such an infrastructure. Critically, this technological change allows the separation of the service layers from the infrastructure layers, which is likely to impact on definition of markets for regulatory purposes. In particular, the transport layer is no longer coupled with the service provided. Thus, it is possible that users, using the same infrastructure, have access simultaneously to a wide range of services from different service providers. Therefore, the current division of the transport layer into access and core is likely to be challenged as the services provided do not impose the same constraints as under the PSTN architecture. Moreover, NGAs allow regulation to be more service-neutral.

³ High-definition television (HDTV) is a digital television broadcasting system with a greater screen resolution than traditional systems.

⁴ There are other possibilities, such as Fibre to the Building (FTTB); the key difference in all variants is the end-point of the fibre (cabinet, building, home).

Gonçalves e Nascimento (2009) point out several interesting discussions, whose answer is likely to influence NGA deployment decisions. Firstly, NGAs are costly and are likely to be deployed in densely populated areas or for new build premises, as the incremental cost is relatively small. Secondly, roll-out is more likely in countries or regions where cable exerts a higher competitive pressure. Thirdly, wholesale revenues are likely to see their importance increased for vertically integrated operators. Fourthly, countries will adopt different NGA infrastructures depending on the current network. Fifthly, incumbents' strategies might be materially different from entrants' strategies (incumbents may prefer to choose FTTCab whereas entrants choose FTTH architectures). Sixthly, new players might choose to enter the "last mile" of the value chain, buying capacity from vertically integrated operators or independent network owners.

In this context, new market definitions are likely to emerge as NGAs are progressively deployed. New boundaries have to be designed so as to identify areas where players might have significant market power, which in turn prevents competition. The ability to address the problem is the challenge regulators are facing in the current environment. Though competition is considered to deliver the most efficient resource allocation, regulators must first check if conditions are met for competition to develop endogenously. Barriers to entry, or building a dominant position on given market segments might be considered important and require regulators' attention, an example of which local loop unbundling (LLU) regulation which allows new entrants to access the assets of existing players.

For analytical purposes, one might follow the route proposed by Cave and Doyle (2007) and Cave (2006) to breakup the telecommunications value chain in three components – retail, non-access, and access network. For practical purposes, a further disaggregation of each component might be needed to redefine potential markets. From the point of view of industrial organization theory, the degree of competitiveness of each market has to be assessed individually, in order to identify whether they are candidates for regulation.

Market power can be found where there are bottlenecks – or, equivalently, essential facilities –, but we argue that the existence of a bottleneck may not be sufficient to conclude that there is market power. If this input is essential to provide services to end-users and it cannot be economically replicated, typically because of sunk costs, there is a case for regulation. Regulators should make extensive use of past experience, such as the LLU regulation, where, contrary to expectations, the framework was thus far unable to deliver effective competition. Also, they must pay attention to the current and expected structure of the telecommunications industry. Countries with extensive coverage of competing networks – such as PSTN or cable – have different competition concerns as compared to countries where they are just complements. The same can be said about other social and economic variables, such as population, purchasing power, regional asymmetries, etc.

Bijl (2005) argues that structural separation is only an appropriate regulatory tool if there is a persistent bottleneck in the supply chain. We do not completely agree with this suggestion, because even though the NGA may constitute a persistent bottleneck, the truth is that cable-based networks may be viable alternatives for service provision. Therefore, whilst the NGA or the cable network may each individually be seen as a persistent economic bottleneck, in so far as it is not economically viable to duplicate either of them, our view is that the fact that they coexist and compete with each other should matter in the evaluation of network separation as a possible regulatory instrument. In fact, to the extent

that network separation solves the competitive problem, it would not only foster intra-network competition (competition between service providers using a given network – say, a NGA), as well as inter-network competition (competition between service providers using different networks – say, NGA-based service providers and cable-based service providers).

The need for regulation in a vertical structure arises because a vertically integrated firm can practice price and non-price discrimination in the activity where it is dominant, to weaken or eliminate rivals in the product market. This market power is transmitted vertically, either upstream or downstream producing a deadweight loss to the economy. This is likely to happen in the telecommunications industry, and if significant market power is found in a way that it might distort the competitive outcome, regulators should undertake further steps to design the regulatory action. If needed, the specific regulatory action should be to allow entrants to have access to specific assets (e.g., the infrastructure, or parts of it) and provide services to final consumers. Should no competition concern be found, the regulatory assessment might end here.

3. ARE THERE FEW VERTICAL COMPLEMENTARITIES BETWEEN SERVICES?

Increasingly, telecommunications networks are carriers of multiple services, all of which are (or will soon become) IP-based (Kirsch and von Hirschhausen (2008)). Under the traditional PSTN architecture, the transmission infrastructure was tightly coupled with telephone service provision, whereas a NGA is by definition a flexible multi-service platform. Naturally, as also suggested by Gonçalves and Nascimento (2009), the more clear cut separation between the transmission infrastructure and the services which are offered through that infrastructure must entail a significant reduction in the economies of scope. For example, with NGAs it is less necessary to have coordination between the infrastructure and service providers: by definition, NGAs will entail significantly higher bandwidths than those available today, which allows multiple service provision. Simultaneously, if such services are all IP-based, then nothing precludes each service from being provided by a different service provider.⁷

This brings us to what is, in our opinion, a critical factor in the evaluation of functional separation: in the provision of a specific service, does a vertically integrated operator have higher costs than the sum of the costs of the infrastructure operator and the service provider? In other words, are there few vertical complementarities between the two? If the answer to this question is affirmative, then functional or structural separation is likely to lead to a significant reduction in overall costs of service provision. On the other hand, our view is that if the answer is negative, functional (or structural) separation should not be considered a viable regulatory tool.

Let us look into this issue in more detail. Economic theory tells us that one of the main justifications for vertical integration is precisely the existence of such vertical complementarities. In that context, even if firms operate independently from each other for some time, they will quickly realise that cost reductions can be obtained through vertical integration, which assuming all else constant leads to a (overall) profit increase⁸. Baumol (1977) suggested that a multiproduct firm would be a natural monopoly

⁷ By contrast, Gomez-Ibanez (2003) suggests that in railways, vertical coordination is necessary because train operators cannot offer a reliable high-speed service unless the track is available as scheduled and in good condition.

⁸ The other main justification for vertical integration is known as the double marginalisation problem, whereby if both independent firms have some market power, they will set prices above their marginal costs in order to reap positive profits. However, this behaviour applied to a vertical relationship along the supply chain leads the upstream firm to charge a price to the downstream firm which is already higher than the underlying costs and which will then translate into a final consumer price which is considerably higher than the sum of costs along the supply chain (thus reducing final demand). Vertical integration prevents this

if its cost function was subadditive. Broadly speaking, subadditivity means that the costs of providing all products by a single firm are lower than the costs of having the same products provided by different firms, and this must be true for all output levels. It is important to note that, although relevant, the existence of economies of scale in the provision of either product is neither necessary nor sufficient for a cost function to be subadditive. Critically, subadditivity is also related to the existence of complementarities between those two products, i.e. the existence of economies of scope.

For the railways sector, Ivaldi and McCullough (2008) provide a practical test for subadditivity of the cost function. Notably, they find that significant complementarities exist between the infrastructure and service provision: a vertically integrated operator would have significantly (20%-40%) lower costs than two independent operators. This could well constitute an example of a sector which should not have been vertically disintegrated, as suggested by Pittman (2005).

As we will see below, vertical separation entails other costs, known as transaction costs, which are also seen as a common justification for vertical integration (Williamson (1979)). However, these would in all likelihood exist (although arguably less significantly) under vertical integration. Hence, in practice such transaction costs would be muddled with the economies of scope and disentangling the two would not be an easy task.

Therefore, we believe the critical question regulators must analyse at this stage is the subadditivity of operators' cost function, because subadditive costs imply the existence of significant complementarities between services which would be lost under vertical separation.

4. IS FUNCTIONAL SEPARATION A BETTER REGULATORY TOOL?

If one accepts that regulation is needed in telecommunications markets, one must recognize its limitations. Economic theory shows that for a number of reasons regulators are unable to replace the market to produce a first-best solution to the problem. For example, regulators are not perfectly informed about the incumbents' cost structure, which is essential for setting optimal regulated prices and access levels. Also, regulation is complex and time consuming, without any guarantee that the regulatory outcomes are optimal. As such, it might be better if regulation aims directly at incumbents' incentives, rather than trying to control their actions.

Thus far, competition in the telecommunications product market has been addressed through regulation on access to the incumbents' infrastructure, allowing entrants to buy capacity from incumbents. Practical experience shows that incumbents do not have incentives to act cooperatively. They make the unbundling process of key inputs costly and difficult, and exercise market power to weaken competition.

The industry has been long subject to the idea that separation⁹ of the infrastructure is needed to promote competition, but resisted it for very long time based on the argument that important cost synergies from vertical integration and coordination benefits might be lost if assets are broken up.¹⁰ The deployment of NGA brings back the vertical separation issue, where the regulated firm may be broken up into the monopoly part and the competitive part.

problem. However, in regulated sectors it is unlikely that a regulator would allow this "double margin" to be passed through to the final consumer, i.e. the regulator would act as a substitute of the market forces.

⁹ This policy tool has been used differently across various industries: railways, electricity are just a few examples.

¹⁰ One can also think of horizontal separation, such as the separation of cable and PSTN networks, which has occurred in many countries and follows the underlying trend of network convergence – the ability to offer the same services under alternative platforms. In Portugal, the Competition Authority and Anacom have just recognized the existence of two independent players in the telecommunications markets using alternative platforms to compete in the product market, following the horizontal separation that has taken place very recently.

The idea of vertical separation is such that the incumbent's retail operation is put in a position similar to that of entrants who do not have a local access network. The independent entity has neither the incentive nor the possibility to discriminate downstream entrants against the incumbent. Therefore, it is not possible to raise the costs of rivals or reduce the quality of service under the same infrastructure. Compared to a vertically integrated firm, the expected reduction in anticompetitive practices mitigates inefficiencies, and there are no incentives for cross-subsidization.¹¹

There are many definitions of vertical separation, ranging from setting-up Chinese walls between monopoly parts and competitive parts (i.e., accounting separation) to physically breaking-up the company into separate entities without ties between them (i.e., full ownership separation). The opinions diverge about which route to take to vertically separate the telecommunications firm. Cave (2006) suggests a detailed analysis balancing costs and benefits of various alternatives is required. He identifies six degrees of separation lying between (and excluding) accounting separation and ownership separation.¹²

Separation raises some important concerns regarding the difficulties in designing the boundaries of which components should be included in the separate entity. It is not clear where exactly the separation shall be made and the effects upon competition are uncertain, as there is no previous regulatory experience. There is a cost-benefit tradeoff for each alternative, as there are implications for players' strategic behaviour. For example, the simple accounting separation has virtually no operational costs for the vertically integrated firm¹⁴, but it opens the possibility for the incumbent to discriminate – both price and non-price – against the entrant. It also imposes high transaction costs to the regulator, who is responsible to enforce the contract.¹⁵ In an extreme situation, the complete ownership separation of the assets which are considered essential for competing in the product market reduces regulatory costs to a minimum, but raises important concerns about productive efficiency. Incumbents are forced to incur costs associated with redesigning their operations, and contracting in the market may be more costly than in-house contracting. A further argument is the negative impact upon the incentives to invest and innovate.

A usual form of functional separation involves segregation of particular assets into a new unit which has to handle both internal and external customers on the same level playing field. Separation is not fully achieved as the same owners might persist and management might respond strategically to incumbent's own interests. However, it is possible to have corporate governance arrangements that result in incentives to achieve non discriminatory treatment of both internal and external customers.

The balance between benefits and costs is a grey area, and as such further research is needed. Using evidence from other network industries, Cave and Doyle (2007) argue that benefits from structural separation outweigh the costs, and that the estimated costs due to lack of coordination and the disincentive to invest and innovate are largely exaggerated. In analysing this issue, one must keep in mind that the boundaries of the firm have thus far been discussed mainly within the context of competitive industries, where specific assets are the cause of vertical integration and determine

¹¹ The idea, says Bijl (2005, p. 6) is that "regulation in the non-bottleneck parts of the value-chain becomes simpler, more effective, and less costly. [...] Another argument of favour of separation is that it allows coordination of investments between all service providers and the network operator, rather than only between the incumbent's network and its retail activities."

¹² Cave (2006, p. 64).

¹⁴ It raises difficulties in identifying the cost components of the separated accounting division, but the vertically integrated incumbent does not need to change its operations to meet the regulatory obligations.

¹⁵ Cave (2006) proposes variations of this such as virtual separation, which does not encompass any change in the underlying operational process.

endogenously the market structure. The issues associated with mandatory separation are quite different, as we have to assess the degree of market power that is transmitted upwards or downwards the value chain. If a regulator imposes a mandatory separation – whatever alternative it has in mind – the motive is most likely to be eliminating discrimination and preventing foreclosure.

If vertical separation is devised as a regulatory alternative, it must be incentive compatible so as to encourage strategic action on market participants. In order to analyse the impact upon suppliers' behaviour, it is useful to look at the alternative options they have available to enter the market, which might have been discussed in a previous stage, when defining markets boundaries. Put it simply, one can think of two alternative entry strategies that are equally likely under NGA: [1] entrants rollout their own networks; [2] entrants do not rollout the network and buy capacity from existing firms.¹⁶

If all companies choose to enter rolling their own network, one might expect "infrastructure competition" and vertical separation is not an issue. The vertical separation might become important when there are companies whose entry strategy is using others' infrastructure, and the regulator is interested in allowing this option, envisaging benefits from static and, possibly, dynamic competition.¹⁷ The challenge is to redesign business processes to ensure equal treatment to both incumbent and entrant – i.e., internal and external purchasers of the same service – while preserving incentives to investment and innovation, without leading the industry into a costly coordination scheme as to avoid a market failure.

If mandatory separation is ruled by the regulators, the boundaries between markets where there is market power and competitive markets must be monitored continuously, which implies that the appropriate division depends upon current and predictable market developments. There is enormous scope for choosing different points of separation, not least because the number of activities is very large. Cave and Doyle (2007: 12), say that "separation should occur on the boundary between markets where the incumbent exercises persistent market power and markets which are potentially competitive. This will vary with the size of the economy which the telecommunications sector is serving: in a small country the scope for competition is probably smaller." Up until now the approach to vertical separation is traditionally made on two segments – access network (where the bottleneck is located), and the rest of the business activities – but some more complex separation forms are envisaged. For example, the New Zealand Government has proposed a bill for vertical separation in three segments – access network services; wholesale and retail business units – for the sake of competition.

The existence of a bottleneck or the risks of significant market power are not per se a reason for structural separation. The cost burden that is imposed on society due from vertical separation might be too high and the regulator might want to re-address the problem within the current regulatory framework. Only when the current regulatory framework cannot be improved shall the vertical separation be used as an option. It is not difficult to conclude that market characteristics play an important role in the decision, as costs and investments do not exist in vacuum. Costs and investments are higher in areas where population is scarce and scattered. Also, technological innovation might eliminate bottlenecks. The evolving characteristics of demand might widen the scope of the product market insofar the same infrastructure can be used to provide a range of services, thus decreasing the average cost or

¹⁶ In between these two extremes there are multiple alternatives, such as it is possible to have a firm rolling part of the network infrastructure while buying the remaining capacity it needs from rivals.

¹⁷ Even if in the long run firms' strategies converge to option 1, there must be a case for vertical separation. Under NGA, the rollout of the network takes time and the benefits from platform competition do not accrue to consumers immediately. Regulators might be called to step in to promote service competition in the meantime, while operators climb up the investment ladder.

increasing the average revenue per user. Finally, the institutional and legal regimes play an important role in firms' incentives to invest. The risk of being expropriated of its own assets, such as the mandatory access to the network at unrealistic low charges might discourage investors to expand the network and the product into some regional markets. All these arguments have to be balanced carefully, and if vertical separation is still the best solution, the boundary must be drawn where the efficiency gains of increased competition outweigh the benefits of integration.

Further, regulators can make strategic use of their mandatory power so as to induce firm behavior in a way that is compatible with welfare maximization. For example, the threat of structural vertical separation can be used to incentivise incumbents to behave competitively and allow non discriminated access to the bottleneck to entrants.¹⁸ Instead of imposing a costly vertical integration solution, the regulator might decide for an alternative regulatory framework, allowing the incumbent to grant access voluntarily to the specific assets that rivals need to compete in the product market, while threatening to vertically separate the integrated firm if it fails to deliver the desired outcome.

At present, as the deployment of NGA gathers momentum, regulators must try to strike the balance between costs and benefits, while considering the strategic action of all market players – regulators, firms and consumers.

5. IS STRUCTURAL SEPARATION NECESSARY?

As we have already discussed, functional separation is already a rather extreme regulatory instrument. Obviously, structural separation is an even more extreme solution, and therefore it should be analysed with even greater care.

In order to justify it, regulators must show that structural separation is superior to functional separation, i.e. either that it entails lower overall costs or greater overall benefits (or both simultaneously). Naturally, such costs and benefits must account not only for the direct effect on the operator whose network will be separated, but also on other network operators, regulator and consumers. Bijl (2005) also suggests that this type of cost-benefit analysis is necessary to decide whether structural separation is an adequate regulatory tool.

For instance, whilst functional separation is a regulatory tool which may require a closer regulatory oversight, structural separation is a more permanent solution, and hence should place a lower cost burden on regulators over time. Similarly, structural separation may be a more appropriate solution to the competition problems raised by vertical integration which we have already discussed. In that respect, it may bring a greater benefit to consumers. For example, Doyle (2008) suggests that in IP-based networks, service diversity is a crucial strategic element and integrated operators should voluntarily consider the separation of wholesale and retail services. Moreover, consumers value service diversity, and whilst economic theory¹⁹ tells us that from a welfare perspective we must balance the gains associated with greater service diversity with the costs of providing such services, we believe an increase in service competition would bring about an overall increase in welfare, i.e. the existing service variety is arguably too low.

However, it is not completely clear what the effect of network separation on investment incentives is. To the extent that such investment incentives would be reduced, and in particular to the extent that vertical coordination is necessary for such investments to be successful, structural separation would

¹⁸ Bijl (2005) points out that Ofcom used this threat to adjust BT's competitive stance in the wholesale market.
¹⁹ Spence (1976) and Dixit and Stiglitz (1977).

sacrifice dynamic efficiency. In addition, structural separation could lead to costs in the form of foregone economies of scope, as suggested by Crandall and Sydak (2002). However, to the extent that regulators have answered affirmatively to the three previous questions of our suggested test, it must be true that either such costs are relatively low or that they are offset by other benefits associated with network separation. In particular, Cave and Doyle (2007) suggest that investment incentives are not too different under functional and structural separation; therefore, with respect to investment incentives, the key question is not so much how they would differ between functional and structural separation, but mainly whether vertical coordination along the supply chain is necessary (the second question of our test).

Naturally, the problem of what to separate is an important one, as mentioned earlier. But assuming that it is relatively straightforward to define the boundaries of a NGA, it would in all likelihood constitute a good candidate for separation. Cave (2006), although thinking about existing networks, agrees that a separation between access and non-access parts of the network is a main candidate. The key question then is what benefits should we expect from structural separation. Bijl (2005) argues that infrastructure-based competition is superior to services-based competition, and concludes that structural separation is not necessary if there is (or will be) network competition. This line of thought confirms that the questions contained in our test make sense: if there is (or will be) network competition, then it is likely that the existing operators are not (or will not be) dominant in the relevant markets, in which case extreme regulatory instruments such as functional or structural separation may not be necessary.

In summary, our last question is related to the incremental costs and benefits that structural separation would entail when compared to functional separation. The former is a more permanent regulatory solution, but also a more radical one. In this cost-benefit analysis, the final question of our test, care should be taken to establish the difference between these two forms of network separation, and we should not forget that by reaching this stage we are already accepting that some form of network separation is necessary.

6. CONCLUSION

This paper provides a simple test for the adequacy of network separation as a regulatory remedy. A decision tree procedure, with 4 steps, is used to illustrate the economic reasoning that should be used by regulators when assessing whether network separation is an adequate regulatory response. It is not intended to provide a detailed analysis and its practical implementation deserves further research. In particular, our view is that market characteristics will be a critical factor in this assessment, and as such it is likely that different countries or regions might require different solutions.

REFERENCES

- Baumol, W. J. (1977), "On the Proper Cost Tests for Natural Monopoly in a Multiproduct Industry", *American Economic Review*, 67, 43-57.
- Bijl, Paul (2005), "Structural separation and access in telecommunications markets", *Journal of Network Industries*, 6(2), 95-114.
- Cave, M. (2006), "Six Degrees of Separation Operational Separation as a Remedy in European Telecommunications Regulation", *Communications & Strategies*, 64 (4th quarter), 89-103.
- Cave, M. and Doyle, C. (2007), "Network separation and investment incentives in telecommunications", Paper for eircom.

Crandall, R.W. and Sidak, J.G. (2002), "Is Structural Separation of Incumbent Exchange Carriers Necessary for Competition?", *Yale Journal on Regulation*, 19, 335-411.

Dixit, A. K. and Stiglitz, J. E. (1977), "Monopolistic competition and optimum product diversity", *American Economic Review*, 67, 297-308.

Doyle, C. (2008), "Structural separation and investment in the National Broadband Network environment", Report for Optus.

European Commission (2007), "Proposal for a directive of the European Parliament and of the Council amending Directives 2002/21/EC, 2002/19/EC, and 2002/20/EC", 13th November.

Gomez-Ibanez, J. (2003), *Regulating Infrastructure: monopoly, contracts and discretion*, HUP.

Gonçalves, Ricardo and Nascimento, Álvaro (2009), "Next Generation Access Networks and their Regulatory Implications", in Lee, In (ed.), *Handbook of Research on Telecommunications Planning and Management for Business*, IGI Global. (forthcoming)

Ivaldi, Marc and McCullough, Gerard (2008), "Subadditivity Tests for Network Separation with an Application to U.S. Railroads", *Review of Network Economics*, 7(1), 159-171.

Kirsch, Fabian and Von Hirschhausen, Christian (2008), "Regulation of NGN: Structural Separation, Access Regulation, or No Regulation at All?", *Communications & Strategies*, 69, 63-83.

OFCOM (2007), "Future broadband policy approach to next generation access", Public consultation, 26th September.

Pittman, R. (2003), "Vertical Restructuring (or Not) of the Infrastructure Sectors of Transition Economies", *Journal of Industry, Competition and Trade* 3, p. 5-26.

Pittman, R. (2005), "Structural Separation to Create Competition? The Case of Freight Railways", *Review of Network Economics*, 4(3), 181-196.

Spence, A. M. (1976), "Product selection, fixed costs and monopolistic competition", *Review of Economic Studies*, 43, 217-236.

Williamson, O. (1979), "Transaction-Cost Economics: The Governance of Contractual Relations", *Journal of Law and Economics*, 22 (2), 233-261.