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Abstract

The ladder of investment is a regulatory approach that has been used by European National Regulatory Authorities (NRAs), in order to foster infrastructure competition among operators. The idea is to force incumbent operators to open several levels of access to their network in such a way that alternative operators may climb up the ladder, using more of his own infrastructure, and thus decreasing their reliance on the wholesale products of the incumbent operator.

In order to market their own services, the alternative operator has to complement the wholesale resources acquired from the incumbent operator in regulated conditions. In principle, these complementary resources should be acquired in commercial conditions, but this is not always the case. For example, the alternative operator may use some physical space in the incumbent's premises to deploy their equipment, or rely on capacity services delivered by the incumbent operator in regulated conditions in order to reach specific geographical points.

This suggests that analysing the degree of advance just in the "main" ladder of investment could suppose a gross underestimation of the real degree of alternative infrastructure deployment by alternative operators.

In this paper, we provide a theoretical explanation for this phenomenon with the help of the theory of the discovery market process and the theory of capital, as proposed by the Austrian School of Economics. The situation of the identified ladders of investment is assessed for the Spanish market, and some conclusions are drawn and applied in the form of policy recommendations for the NGN ladder of investment.

JEL codes: : B53; K23; L43; L51; L96
Keywords: Austrian School of Economics, discovery market process, complementarity, ladder of investment, capital structure, NGN

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1 Introduction

The “ladder of investment” is a regulatory approach that has been used by European National Regulatory Authorities (NRAs), in order to foster infrastructure competition among operators. The concept was originally proposed in (Cave, 2004). The idea is to force incumbent operators to open several levels of access to their network (the “rungs” of the ladder) in such a way that alternative operators may climb up the ladder, using more of his own infrastructure, and thus decreasing their reliance on the wholesale products of the incumbent operator. The final result would be the deployment of its own access network by the alternative operator, once it has captured the appropriate number of costumers to profit from the economies of scale of that investment.

The ladder of investment typically includes the following rungs or activities (Cave, 2006): resale of broadband services; indirect (national or regional) access to local loop; unbundled local loop, and own infrastructure. Thus, by reselling services, a new entrant may acquire a certain base of customers. These customers may provide a source of revenues and scale economies, so that investment to reach the next rung is viable.

In order to market their own services, the alternative operator has to complement the wholesale resources acquired from the incumbent operator in regulated conditions. For example, a reseller may buy wholesale broadband services from the regulated operator. But these, he needs to complement with other activities, like access to the World Wide Web or retailing functions, as billing, help-lines, marketing… In principle, these complementary products are not acquired in regulated conditions.

However, this is not the case in all the rungs. When unbundling local loops, the alternative operator needs to control some physical space to deploy their equipment. This space is currently provided by the incumbent operator in regulated conditions, due to co-location obligations.

Moreover, both in ULL and indirect access services, the alternative operator need to reach specific geographical points by means of its network. It may deploy its own infrastructure for this purpose, but operators may also rely on backhaul services

provided by the incumbent operator, again in regulated conditions. An example is the signal delivery service included in the Spanish Reference Unbundling Offer (RUO).

The Austrian School of Economics provides a possible theoretical explanation for these phenomena and its causes. The theory of the discovery market process (Hayek, 2002) (Kirzner, 1973) and the theory of capital (Lachmann, 1956) may be used for this purpose.

The first one explains competition as a process propelled by entrepreneurs. These agents locate undervalued resources and, if right in their valuation, they are able to sell them at a profit. This profit acts as "beacon" for other entrepreneurs, who imitate the activity of the pioneer, reducing and eventually competing away the extraordinary profit. The theory of capital explains the process by which investments are made and assets added to the production structure. Irreversibility and complementarity are the key to understand this economic concept.

In brief, alternative operators need to acquire complementary resources to the wholesale services provided by the incumbent. If more of these complementary resources are also provided in regulated conditions, then it seems that alternative operators have several ladders to climb, not only the one with the traditional rungs (resale, bitstream, ULL).

No study in which this insight is taken into account has been identified. So far, all research on the success of the ladder of investment exclusively focuses on what could be called the "main" ladder of investment. It is contended that this could be a gross underestimation of the real degree of advance to the goal of alternative infrastructure deployment. In order to analyse this, it is not enough to see if alternative operators are climbing the main ladder, but it is necessary to assess if they are also climbing the complementary ladders. Otherwise, there is just no possibility of becoming independent of the regulated services of the incumbent.

In this paper, such an analysis will be attempted using empirical evidence for the Spanish market. The result will be an assessment of the real degree of infrastructure deployment by alternative operators.

The rest of the paper will be organized as follows. In the second section, a more detailed description of the ladder of investment approach will be provided, together with the results of a survey on related empirical literature. In the third section, praxeology is briefly introduced, and an explanation of the economic phenomena involved is given from the perspective of the Austrian School of Economics. The fourth section assesses the situation of the Spanish market regarding the relevant complementary ladders of investment. Fifth section concludes and makes some policy recommendations with regard to the newly proposed ladder of investment for optical fibre.

2 The ladder of investment approach

2.1 Description

Provision of telecommunication services requires the deployment of a telecommunication network. This deployment, in turn, requires significant investments and long time periods. Specifically, this applies to the access network, the part of the network by means of which households and enterprises are reached, the so called “last mile”.

Because of these technical reasons the market was considered a natural monopoly, and governments decided that these services should be provided under a legal monopoly regime. Thus, it is under such privileged regime that most incumbent operators deployed their telecommunications network.

In 1998, the liberalisation of telecommunication services was completed in most member states of the European Union (EU). However, the former monopolists could arguably use its de-facto monopoly position to deter quite easily any to-be competitors. This challenge was tackled by imposing special obligations exclusively to those operators which were in this situation of significant market power.

These obligations mainly focus on granting third operators access to the incumbent network, so that they can use it in roughly the same conditions as the incumbent

operator[1]. As a consequence, alternative operators and competition had to rely on the incumbent facilities, at least at the beginning of the liberalisation.

Since that moment, the deployment of an alternative network to that of the former monopolist has possibly been the main concern of the European Commission and the NRAs. According to their logic, deregulation of the sector will only be possible when there is an important degree of facility-based competition and alternative operators do not have to rely anymore on the incumbent network.

The question is how alternative operators may be able to deploy their access network in an open market, because the duplication of the incumbent network is risky and involves high sunk costs, if made at one time. In this context, the "ladder of investment" or "stepping-stone" approach provides new entrants with a smooth path for investments, which allows them to progressively deploy their networks. Their risk lowered in this way, the probability of deployment is bigger.

The concept was originally proposed in (Cave, 2004). The idea is to force incumbent operators to open several levels of access to their network (the "rungs" of the ladder) in such a way that alternative operators may climb up the ladder, using more of his own infrastructure, and thus decreasing their reliance on the wholesale products of the incumbent operator. The final result would be the deployment of their own access network by the alternative operator, once he has captured the appropriate number of costumers to profit from the economies of scale of that investment.

For example, an operator may start providing broadband services by simply reselling those of the incumbents under its own brand. As it acquires costumers, it gets revenues that may allow it to further its investments up to the next access point or "rung", deploying its own infrastructure closer to the customer premises, which results in higher product differentiation and variety, and in less dependence on the incumbent's network. Supposedly, the process goes on, until a point comes where the operator finds attractive to deploy its own facilities, and to severe their dependence on the incumbent.

[1] These services, provided by the incumbent operator to other operators, are usually called wholesale services, to distinguish them from those provided to end users.

This gradual climb is only possible if NRAs regulate prices of the various access products in a consistent way, and if the right number of rungs is defined to allow for smooth transitions between each successive rung (Cave, 2006).

2.2 Results

Cambini & Jiang (2009) provide a comprehensive review of the economic literature dealing with the relation between broadband investment and regulation. Regarding the efficacy of the ladder of investment approach, no conclusion may be reached.

According to the authors, "*there is still a lack of convincing theoretical analysis to support (or not) the ladder-of-investment theory*" (Cambini & Jiang, 2009, p. 567). On this ground, they refer to papers by Avenali et al. (2008) and Bourreau & Dogan (2005).[2]

Referring to empirical research in this area, their conclusion is similar: "*The lack of micro-data at local exchange level does not permit empirical estimations on the evolution over time of the modes of entry (with unbundling or with own infrastructures) by competitive providers, that is, to test the sustainability of the ''ladder of investment'' theory*" (Cambini & Jiang, 2009, p. 569). The authors propose that these micro-data "*could be used to describe in a rigorous way the patterns of broadband investments, to analyze the complementarities among different access services (bitstream, share access, full LLU...) in a dynamic setting, and to evaluate the real impact of competition (both inter- and intra-platform) on investment.*"

López & Vives (2008) and Lopez (2009) provide such an analysis, even if not at local exchange level. The authors analyse the evolution of wholesale services between 2001 and 2008 in Spain, distinguishing between resale + bitstream, shared access and ULL. They analyse the data in relative terms, with the results shown in the Figure 1 below[3], which may be considered as the typical analysis of the success of the ladder of investment approach.

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[2] For another theoretical analysis on the feasibility of the ladder of investment approach, see Herrera-González & Castejón-Martín (2011).

[3] Source: "The ladder of investment in Spain – Slides- Ángel L.López", 17 March 2009. Available at www.nerec.es. Last accessed: 21 August 2009.

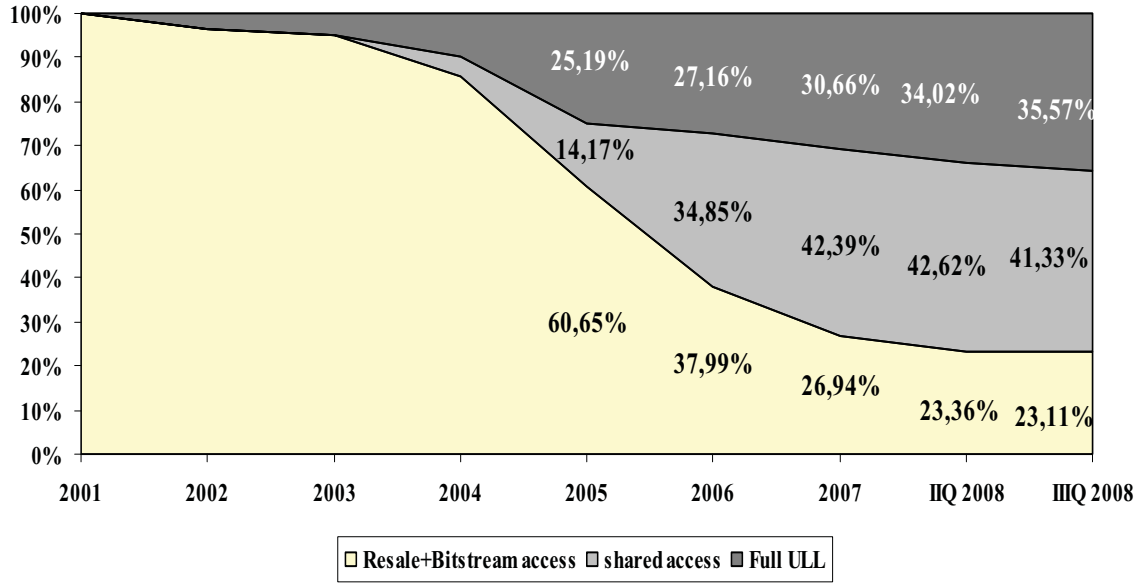

Figure 1: Evolution of wholesale accesses for broadband in Spain

From this data, conclusions such as these may be deduced:

"*In conclusion, it appears that the ladder of investment theory is confirmed for the Spanish case, at least up to the unbundled local loop point of presence*"[4] (López & Vives, 2008, p.10)

"*On one side, we have that the ladder of investment process up to the local loop has been accomplished in Spain*" [5] (López, 2009, p.3)

2.3 Outlook: the ladder of investment for NGNs

In spite of the doubts raised by economic research, the ladder of investment approach is also proposed by the EC to incentivise the deployment of Next Generation Networks (NGNs), specifically optical fibre.

Thus, the EC Recommendation on NGAs[6] proposes the following rungs for the ladder of investment on optical fibre:

[4] *" En conclusión, aparentemente parece confirmarse la teoría de la escalera de inversión en el sector español, al menos hasta el punto de presencia que se corresponde con la desagregación de bucles locales."* (Own translation)

[5] "*Por un lado tenemos que el proceso de la escalera de la inversión hasta el bucle local se ha cumplido en España*" (Own translation)

[6] EC, Commission Recommendation of 20 September 2010 on regulated access to Next Generation Access Networks (NGA)

- **Bitstream** (indirect access): it is similar to the homonymous service on copper. It allows the use of the regulated operator optical fibre by connecting to indirect point of access. In Spain this service is already defined and regulated, and will be available in 2012[7].

  EC recommends that the price should be regulated and cost oriented. SMP operator should make new wholesale broadband access products available at least 6 months before being allowed to market its own corresponding NGN retail services,
- **Unbundled access to the fibre loop:** The alternative operator directly exploits the optical fibre from the optical node. This obligation has to be complemented with co-location obligations at the optical node and backhaul services.

  In the case of FTTN (Fibre-to-the-Node), an obligation of unbundled access to the copper sub-loop should be imposed, and supplemented by measures such as backhaul and co-location (physical or virtual).
- **Access to the terminating segment (in the case of FTTH-Fibre-to-the-Home):** alternative operators may hire the last segment of the fibre, the one that reaches the customer premises from the first distribution point[8] (or last optical multiplex). Prices should be regulated and cost oriented, and the SMP operator should publish a reference offer.
- **Access to civil engineering infrastructure**: including ducts, manholes and poles, and any physical facilities hosting local loop cables. Prices should be regulated and cost oriented, and the SMP operator should publish a reference offer. In Spain, this offer is already in place and in operation.

If NRAs follow the Recommendation of EC, there will appear another ladder of investment, and thus there will be a ladder of investment for copper wire and a ladder of investment for optical fibre. The main difference between both ladders will be, of course, that the first one is built upon an existing infrastructure, which is not the case of the second one. The problems for operators of changing from the former ladder to the new one, and how regulators could incentivise this "jump", have been discussed by Cave (2010).

[7] CMT, Resolución sobre la propuesta de nuevo servicio de acceso mayorista de banda ancha, 11 November 2010

[8] Intermediary node in an NGA network from where one or several fibre cables coming from the the feeder segment are split and distributed to connect to end-users' premises.

2.4 Summary

The ladder of investment approach is implemented by opening several levels of access to the infrastructure of the incumbent or SMP operators. If these points are suitably defined, they allow alternative operators a gradual deployment of their own infrastructure.

Review of empirical evidence to analyse if this approach is working, focuses on numbers of accesses by alternative operators at each regulated level. This empirical analysis shows how operators evolve from the lower rungs of the ladder (bitstream) to the upper ones (unbundled loop).

3 Theoretical analysis

As illustrated above, when verifying if the ladder of investment approach is working, analysts focus on the evolution of the number of access provided to each alternative operator on each rung. The idea is, if the ladder of investment works, wholesale access should flow from the lower rung to the higher rung; thus, the more accesses there are on the higher rung, the better is the ladder of investment working, and the nearer to deploying its own infrastructure is the operator.

This view completely forgets about the need of complementary assets in any production structure. As will be explained, two or more products and services of higher order have to be acquired and combined to provide services of lower order. Wholesale regulated access is just one of the inputs needed to provide retail services. So, in order to assess if the ladder of investment is working, it seems necessary not only to study the evolution of accesses, but also of the complementary assets required.

In this section, a theoretical explanation of this insight is developed. First, the theory of the market discovery process is exposed, explaining competition according to the Austrian School of Economics. After that, the theory of capital is briefly described. Finally, we deal with the complementarity of assets in the context of the ladder of investment.

3.1 The market as a process

Austrian economists understand the market as a dynamic process of discovery generated by entrepreneurs (Hayek 2002), as opposed to the model of perfect competition that is used by *mainstream* economists. (Kirzner 1985) summarizes this view around four key concepts.

- Competition: understood as rivalrous activities of market players.
- Knowledge and discovery: the competitive process does not only mobilize existing knowledge, but also generate awareness of opportunities whose very existence was known to no one at all.
- Profit and incentives: Profits are not understood as the mere subtraction of known costs from known revenues, but as the incentives to locate gaps between costs and revenues. In other word, profits are a sign that resources are more valuable in other uses than in the current ones.
- Market prices: in each moment, they are the exchange ratios worked out between market participants; they provide information to entrepreneurs on the current valuation of commodities, and, thus, on the opportunities of profits.

The discovery market process is carried out by entrepreneurs. Entrepreneurs are constantly looking for new opportunities for profits, that is, of gaps between current prices of resources and expected prices for them; the identification is done by market calculation, by means of which they are able to make estimates that can guide their ex ante decisions. Thus, prices act as signs for entrepreneurial activity.

Detecting a profit opportunity is akin to detecting a more valuable use for a commodity. The entrepreneur that decides to act have to acquire the supposedly undervalued resource, mix it with other resources in the productive process and then be able to sell the product at a price that allows him to recover all investment, including the interest rate for the passing of time. If, after the process, there remains a profit, it means his anticipation was right and that the commodity is more valuable in the new use. On the contrary, a loss would signal a wrong use for the resource, and a clear warning that the commodity should be returned to its original use.

If there is a profit, more amount of the commodity should be used for the new use. This will be accomplished by entrepreneurs attracted by the profits. The process goes on up

to the moment in which the profit is exhausted, due to an increase in available stock for the commodity or to an increase in the prices of the resources, which will in turn act as a signal for profits at a downstream market.

As already said, profit opportunities depend on the gaps between current prices of resources and expected prices of them. Changing in prices may prompt profit opportunities: a raise in a price signals an increase in the relative scarcity of the commodity, be it due to an increase in its value for costumers (for example, because of a new use), or to a decrease in the available stock. A reduction in a price signals the opposite: an increase in the relative abundance of the commodities, due to dual reasons.

Entrepreneurs do not automatically act in answer to changes in prices: this information requires interpretation in order to be transformed into knowledge, upon which the entrepreneur may act.

Summing up, in the unhampered market, scarce resources are channeled to their more valuable uses by the interaction among entrepreneurs using prices and profits as guides, as depicted above. If an entrepreneur removes resources from more valued uses to less valued ones, he will incur in losses. He may sustain losses for a while, but eventually he will have to stop acquiring the resource due to lack of funds, and the resource will be channeled back to more valuable uses.

3.2 The theory of capital

Entrepreneurs, when taking investment decisions, are conditioned by the prevailing composition of the existing capital stock. In this subsection, the existence of capital stock in the economy is explained, according to theory proposed by the Austrian School of Economics.

Individuals satisfy their needs by consumption goods (goods of first order), those that men can directly use. The most part of natural resources are not directly usable, so they have to be modified in order to become consumption goods. This is done by production, consisting of the combination of two or more existing goods in order to attain a consumption good. All such goods, which need transformation before becoming serviceable, are the factors of production (goods of higher order).

Production is not instantaneous, it takes some time. Moreover, production is usually structured in stages, so that after each stage of production, the goods are more near of becoming consumption goods. Because of this, factors of production can be of second, third and higher order, depending on how many stages they need to become consumption goods.

In each stage of production, two or more factors of production are combined, following plans of different degrees of complexity. Only those production processes whose results are more valued than the used resources, including the passing of time, are sustainable. So, the more "long" is a process, the most productive can be expected to be; moreover, the most part of production processes allow the ellaboration of consumption goods that are not directly obtainable (all telecommunications services are of this kind).

Thus, in any given moment, there is definite structure of factors of production in their process to become final goods. There are some resources at the earlier stages of production, while others are nearly ready for consumption. This is the capital stock of the industry or of the economy. In brief, the existence of capital is explained by the use of complex production process to obtain consumption goods, processes that take some time to complete.

Both the copper that has just been extracted from the mine and is long way from becoming a consumption good (for example, as a phone call), and the refrigerated food about to get ready for lunch, are capital goods.

The structure of capital is formed by the goods of higher order, but it owes its form to the consumption goods. For Lachmann (1956), the capital structure can only be interpreted according to the individual plans from which it derives. If capital goods are seen as isolated (copper pair, switches, ducts, buildings...) they are simply factors of production. They only have value as part of a production plan. And it is according to this plan that the goods shaping the capital structure are complementary, even if the mode of complementarity may change from period to period (p. 42)

3.3 Relation between capital stock and entrepreneurial decision

In order to exploit the detected profit opportunity, the entrepreneur has to make an investment in the various resources required for accomplishing the product. This is an investment because, as we have seen, the transformation of resources (production process) consumes time, and so anticipated resources may only be recovered in the future.

In general, investments will tend to take such concrete forms as are complementary to the capital already in existence: the new investment must "fit" into the existing capital (Lachmann 1956, p.7-8).

As new capital goods are being used in combination with existing ones, the lower the price of existing capital goods, the greater the profitability of the newly invested goods. "*Just as the profitability of all capital goods in a combination depends inter alia on the wages of the co-operant labour, so the rate of profit on each capital good depends on the cost at which complementary capital goods can be secured. The expected profitability of new capital goods depends inter alia on the prices at which existing capital goods can be obtained in the market.*" (Lachmann, 1956, p. 48-50)

In fact, "*new investment depends on nothing so much as on the* ***availability of cheap complementary resources*** *of labour and capital. (...) The entrepreneur in making his decision will be guided by his expectations about what complementary capital resources will be created during his investment period, and what other already existing resources will then be available in a complementary capacity*" (Lachmann, 1956, p. 117, bold added).

Resource complementarity refers not only to the capital goods within the firm and its production plan, but also to the capital resources in the general economy (Lachmann 1956. p.117). For example, an entrepreneur trying to produce 3D movies for TV, have to consider its current assets, but also the existence (current or expected) of 3D TV devices and of telecommunication networks with enough capacity for its distribution.

3.4 Application to the ladder of investment approach

In summary, in order to profit from a detected opportunity, the entrepreneur relies heavily on the existence of cheap complementary resources. Such cheapness will tend to increase the expected profitability of his investment and thus the chances of making it.

As already stated, there are complementary resources not only within the firm but also external to it. All of them have to be considered before taking an investment decision.

The ladder of investment approach assumes that the main input for providing broadband services, in terms of required resources, is the access network. Thus, it proposes to oblige the owner of this network to open it at several points, on regulated conditions.

Being the main resource for the provision of broadband services, if its regulated price is perceived as cheap by the entrepreneurs, they will detect a business opportunity and make their market estimation in order to decide how to progress.

The market estimation involves the identification and valuation of the resources required to provide the end service or product, i.e., the identification of the required complementary resources according to his plan.

As an example, Cave (2006, p. 230) considers the following as complementary of the regulated access:

- ATM backhaul
- Access to an IP network
- Access to the WWW via transit or peering services
- Retailing functions, such as marketing, billing, helplines…

The set of complementary goods obviously depends on the concrete rung of the ladder of investment. In principle, as operators climb the ladder, they will need a larger amount of complementary resources.

For example, in the specific case of ULL services, goods such as DSLAMs, physical space (where the required equipment is deployed), backhaul, electric power (to feed the

equipment), security services, maintenance, and so on, are seen as complementary, whereas DSLAMs are not complementary for an operator using wholesale bitstream or resale services.

The entrepreneur will obtain these complementary resources from (in principle) unregulated markets, as opposed to the regulated conditions for the wholesale access service. Being that the case, the paid price will tend to reflect the value of the acquired good, and the relative scarcity of it.

Consider real state. Alternative operators need some physical space where their equipment is laid out. This space may be hired or acquired in the real state market, where the price per square meter will reflect its value for individuals (that is not say that the referred market is unregulated, nothing farther from truth). If the operator wishes to provide services in metropolitan areas, the needed space will command a more expensive price that if he does the same in suburban or rural areas. This reflects the relative scarcity of space in the former areas in comparison with the later ones.

But, of course, this makes the business case of the alternative operator less attractive. In fact, it may reduce its appeal to a level where no operator is interested in deploying its network, even in the presence of wholesale regulated access services. Recall that the profitability of investment largely depends on the availability of cheap complementary resources.

If that is the case, the ladder of investment approach will fail, unless the regulator is somehow able to also lower the prices for those complementary resources, so as to make the business case attractive.

In fact, an inspection of the RUO of the Spanish incumbent (Telefónica), will show that there are plenty of complementary goods to the wholesale access, whose price and conditions are also regulated. For example, the current version of the RUO includes the following services:

- Hiring of physical space (co-location)
- Conditioning of space
- Electric power provision

- Conditioning for backhaul services: deployment of ducts, boxes, optical fibre cables, racks…
- Conditioning for radio delivery: project design, deployment of connecting infrastructure, deployment of antennae
- Internal cable deployment (*TCI*)
- External cable deployment
- Backhaul services
- Provision of information about local lopp
- Expansion of circuit breakers ("*ampliación de disyuntores*")
- Connection of co-located equipment
- Maintenance services, with four modalities *premium*.
- Sync tests…

In summary, it seems that regulating prices for a concrete good (such as wholesale access) is not enough in order for this regulation to be effective. It is also necessary to regulate the conditions for some, even several, complementary goods. Which complementary goods need to be regulated is a process of discovery, in which some entrepreneurs will try to convince the regulator of the need of regulating more products, where others will argue on the contrary[9].

In any case, this empirical observation is supported by the theory of interventionism, of Ludwig von Mises (1977)[10]. This theory shows that any intervention that alters the function of the market will need further intervention in order to be sustained, and the process will unavoidably lead to the central planning of the economy.

3.5 How many ladders of investment

So, NRAs also need to regulate complementary resources to the wholesale access, if they want that the ladder of investment is effective. However, NRAs can only regulate conditions for Significant Market Power (SMP) operators. So, when an obligation is mandated of providing physical space, it just applies to the space owned by this operator, not for the rest of the market.

[9] Regarding the process of creation of regulation, see Stigler (1971).
[10] See also Herrera-González and Castejón-Martín (2009).

The use of these mandatory services increases, thus, the dependence of alternative operators on the incumbent one. Because of this, it runs against the main goal of the ladder of investment, which is that alternative operators become independent from the incumbent infrastructure, achieving in this way network competition.

Being that the case, consistence would demand from NRAs that they define a ladder of investment for the regulated complementary resources, providing a way out of the incumbent facilities for alternative operators. No such regulation seems to exist at this moment.

In fact, it seems almost impossible to enforce with the current set of sector rules. For example, in order to provide a ladder of investment for physical space, the NRA would need to impose regulation on the real state market, which seems out of the question. This is not so far-fetched as it would seem: recall that in one initial version of the newly approved EU framework, it was proposed to extend some kind of regulation to all ducts, not only those provided by telecommunication operators[11].

In any case, it is clear that, if an alternative operator is to deploy its own network by climbing the main ladder of investment, it shall have to climb the complementary ladders of investment too. The alternative access network is not only a matter of transmission media: it will need its own buildings, its own conditioning, its own maintenance, its own electric power and the rest of complementary resources not currently regulated. And it may well be the case that some of these complementary ladders of investment turn to be harder to climb than the main one.

4 Empirical analysis

In this section, we will show the empirical evidence about this phenomenon, that is available for the Spanish market. However, as this paper uses the approach of the Austrian School of Economics, some methodological remarks are in order.

[11] See discussions at the Europarliament around the article 12 of the Framework Directive.

The Austrian methodology does not rely on empirical or historical evidence for its conclusions, but on logical reasoning. According to the Austrian school, economics is a science in the same sense that mathematics and logic are sciences. Its claims are based on logical deduction from indisputable axioms, and may be illustrated historically, but never verified or falsified experimentally. In the same way, we do not ask for experimental verification that a straight line is the shortest distance between two points on a two-dimensional plane.

Thus, the conclusions achieved in the precedent section are true (provided there are no flaws in the logic reasoning), with independence of the results of the historical evidence analysis. Besides, historical phenomena are too complex to allow the isolation of a concrete cause for a given event. In brief, the historical analysis now proposed does not change in any direction the theoretical results already developed.

Our goal in this section is to complement (never better said) the perspective of the evolution of the "main" ladder of investment (as shown in Figure 1), with data regarding what could be the "complementary" ladders of investment.

If alternative operators are really climbing the "main" ladder of investment with the purpose of developing their own access network, this should be also apparent in the complementary ladders of investment, as explained.

Unfortunately, it is very difficult to find public data about these services. Because of it, this is more an illustrative exercise than a complete analysis, in the hope that, if this paper contention is correct, NRAs will start also looking to indicators such as those proposed in order evaluate the real success of the ladder of investment. If this is the case, then a more thorough analysis may be possible in the future.

The analysis will focus on two of the complementary resources identified above, namely co-location and backhaul services. The incumbent operator is obliged to provide both services on regulated conditions. Of those included in the list, these are likely the most important services for operators in order to use ULL services.

4.1 The ladder of investment for co-location

Co-location is required so that alternative operators may deploy their assets (mainly, DSLAMs) near the beginning of the copper loop, thus saving transmission costs. They could also use other nearby premises and connect from there to hired loop.

The first rung of this ladder of investment is the co-location, while the second one would be for the operator to have its own premises, different from those of the incumbent operator. These premises may be rented or owned, but that is of no concern for our purpose.

When operators climb this ladder of investment, the number of local switches with co-location would tend to reduce. The same would happen with the coverage of ULL services, as operators start using their own buildings and access network for the provision of services.

At the beginning of the process, the number of local switches with co-location should grow, as alternative operators climb to the ULL rung of the ladder and start deploying their network. But this should end in a plateau once these operators reach the desired coverage. In parallel, if operators are really climbing the ladder, this number should begin to decrease, as they leave the incumbent premises.

In the Figure 2, the evolution of both the number of co-located switches and the coverage of ULL is shown.

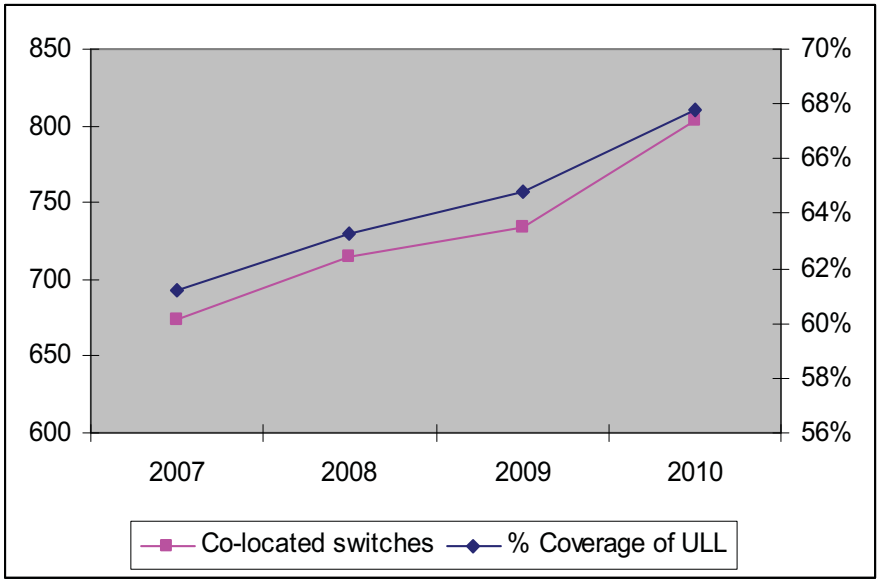

Figure 2: Evolution of co-location ladder of investment[12]

Of course, it is very difficult to draw definitive conclusions from such aggregate data; the micro-data asked by Cambini & Jiang (2009) could also be very helpful here. Data about alternative operators' premises would also be needed to see how they evolve, information that is not publicly available.

What is clear is that number of co-located switches has grown through all the analysed period, year over year; in 2010, the increase was near 10%. The same has happened with the coverage, with 3 p.p. just in the last year.

From these data, it would be easier to conclude that there is no progress in the ladder of investment for co-location, than arguing for the opposite. In any case, progress in the co-location ladder of investment seems to be strongly related to the climbing from the unbundled local loop rung to the own infrastructure one. As it is shown in the following tables, there seems not to be that kind of climbing in Spain:

[12] Source: CMT, Annual Report 2010 (p. 317)

	xDSL	CABLE-MÓDEM	LMDS	WIFI-WIMAX	FTTx	OTROS	TOTAL	% / TOTAL
Telefónica de España	5.559.981	-	-	-	49.200	-	5.609.181	52,7
Ono	78.913	1.442.115	-	-	-	-	1.521.028	14,3
Orange	1.121.238	-	-	-	-	-	1.121.238	10,5
Jazztel	854.854	-	-	-	255	-	855.109	8,0
Vodafone	742.173	-	-	-	-	-	742.173	7,0
Euskaltel	3.545	221.056	-	5.189	-	-	229.790	2,2
R	6.891	180.765	-	-	-	-	187.656	1,8
TeleCable	-	110.062	-	-	4.534	1.149	115.745	1,1
Iberbanda	4.801	-	-	55.979	-	143	60.923	0,6
Procono	-	25.910	-	-	-	-	25.910	0,2
Resto	44.185	76.518	2.060	48.708	5.992	212	177.675	1,7
Total	**8.416.581**	**2.056.426**	**2.060**	**109.876**	**59.981**	**1.504**	**10.646.428**	**100,0**

Source: Annual Report CMT, 2010 (p. 356)

	ADSL	CABLEMÓDEM	LMDS	OTROS	TOTAL	% / TOTAL
Telefónica de España	4.312.854				4.312.854	56,3%
Ono	49.172	1.227.388		145	1.276.705	16,7%
Orange	701.343				701.343	9,2%
Yacom	442.193				442.193	5,8%
Tele2	258.015				258.015	3,4%
Jazztel	239.500				239.500	3,1%
Euskaltel	5.404	158.929		3.985	168.318	2,2%
R Cable	2.372	114.117		36	116.525	1,5%
Telecable de Asturias		80.871			80.871	1,1%
Resto	33.762		28.251	1.358	63.371	0,8%
Total	6.044.615	1.581.305	28.251	5.524	7.659.695	100,0%

Source: Quarterly Reports CMT, Third quarter 2007

It is clear that no operator using ULL or other wholesale access services (operators which provide ADSL services, such as Orange, Vodafone-Tele2 o Jazztel) had own access network in 2010, the same that happened in 2007. That, in spite of the large increase in costumers these operators have achieved.

Summing up, the inspection of the ladder of investment for co-location services does not seem to add information to the evolution from ULL services to own access network.

4.2 The ladder of investment for backhaul services

Backhaul is the part of the network that transports the signal from the remote location (local switch) to the core network of the alternative operator. The backhaul network may be deployed by the alternative operator: we have seen that RUO includes regulated

conditioning services for both conventional and radio backhaul, so that alternative operators can access their co-located equipments with the infrastructure of their convenience.

In the same line, they could hire backhaul services from other operators. Finally, they have the option of hiring backhaul services on regulated conditions from the incumbent operator.

The climbing of this ladder of investment involves the substitution of hired backhaul segments by own infrastructure or other kind of assets that are not in the hands of the incumbent. So, the climbing in this ladder of investment should be reflected by an decrease in the wholesale leased lines provided by the incumbent.

The public available data aggregates the lines provided by all operators. However, as Telefónica has a market share of 82.5% in the market[13], it is not a bad proxy to the provision of lines by the incumbent.

In the Figure 3, we show the evolution of the number of high capacity digital leased lines, which include Ethernet, Fast Ethernet and Gigabit Ethernet, regulated by CMT in 2007 specifically to be used as backhaul services. Together with it, the evolution of "*Capacidad portadora*" services is shown; most of these services are provided in commercial conditions to mobile operators, so they may not be so relevant for our purpose. Take also into account that these data only accounts for the number of circuits, with no regard for its capacity.

[13] CMT, Annual Report 2010, see table 79 in page 337.

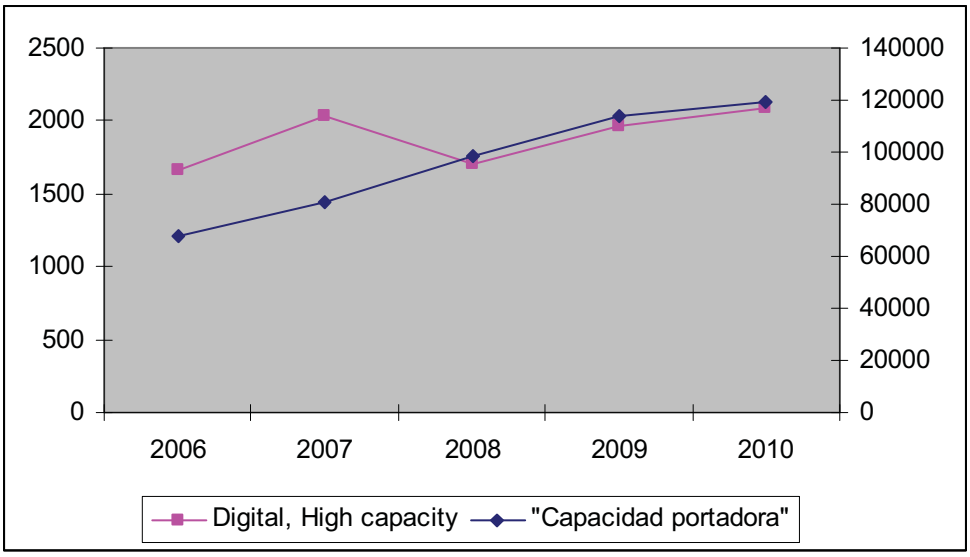

Figure 3: Evolution of backhaul ladder of investment[14]

This evolution would suggest, with all its limitations, that no climbing is happening on the backhaul ladder of investment, because the number of circuits keeps growing with good rhythm.

It should be noted that Telefónica began delivering Ethernet regulated circuits in November 2008. As these circuits in general provide larger capacities than the other high capacity circuits, this could explain the decrease in absolute number of this magnitude in 2008. This substitution seems to have also affected medium capacity circuits, as may be seen in the referenced table 78.

CMT reflects in its annual report the spectacular growth of regulated Ethernet services, which starting in November 2008 have grown to 1.500 by December 2010. In all, the compound growth from 2006 to 2010 reaches 25% for high capacity leased lines and 277% for "*capacidad portadora"* services. All these data shows, at an aggregated level, that the dependence of alternative operators on incumbent services is not decreasing, but on the contrary, that it keeps increasing, driving us farther from the objective of having alternative access networks, at least by means of the ladder of investment.

5 Conclusion and policy recommendations

In the unhampered market, entrepreneurs detect profit opportunities and evaluate them by means of market calculation, This process involves the identification of

[14] Source: CMT, Annual Report 2010, table 78 (p. 337)

complementary resources; complementarity of goods is not objective, but depends on the plans of each individual, who is the only one who knows which resources are complementary and why according to his specific plan., The existence of cheap complementary goods is key for the profitability of investment.

The provision of broadband services requires, as that of any other good, of several complementary resources. This is also truth when the operator uses the regulated wholesale access services imposed on the SMP operator. Moreover, any rung requires its specific set of complementary resources, even if some of them are common for two or more rungs.

Even if the price set for the regulated access is seen as cheap by entrepreneurs (meaning a relative abundance of network accesses), it could be the case that other complementary resources are not cheap enough for the investment to be profitable. If this is the case, the regulator will see the failure of its efforts, and may be tempted to regulate those complementary resources, if able. This is normally possible with the assets of the SMP operator, as has been shown for the case of the RUO in Spain. But it is not so easy outside the electronic communications market, where these assets belong; so, regulators do not usually provide a ladder of investment for the complementary good.

In any case, in order to deploy its own network, alternative operators need to climb, not only the main ladder of investment, but also the complementary ones, related to other regulated complementary services. It is just not possible to climb the main ladder of investment by itself in order to deploy an access network independent of the incumbent operator, which is the goal of the ladder of investment approach.

With the empirical analysis proposed, we have tried to show if this other climbing is happening in Spain. Unfortunately, public data for this analysis is lacking, and it is very difficult, if at all appropriate, to reach sound conclusions on the available data. What can be deduced is that it seems not to be happening, both at the co-location and at the backhaul ladder of investment; this result would be coherent with the lack of advance to the last rung of the main ladder of investment in Spain.

Based on the above analysis and conclusions, we would propose the following policy advice:

- Regulators should be aware that regulating complementary resources may be needed for their "main" regulation to be effective. If no ladder of investment for these resources is provided, alternative operators will be trapped in those, and no climbing will happen to the last rung (own infrastructure).

- Identification of complementary resources is subjective and depends on the plans of each individual. Identification, and subsequent regulation, of these resources by NRAs, may result in freezing the innovation at the market, as entrepreneurs would rather use the complementary regulated conditions than risking a different plan at market prices[15].

- The ladder of investment for optical fibre is specifically prone to this problem, as the results and possibilities in the market are already untested. So, it is not possible to determine at this moment which are the "right" complementary goods for each proposed rung in the ladder, much less to decide which ones to regulate.

- Finally, it should not be forgotten that complementarity refers to goods not only within the telecommunications industry, but also outside it. If the expensive complementary resources required by entrepreneurs to climb the ladder are outside the telecommunications industry, and thus NRAs are unable to regulate them, climbing will not happen, even if regulated prices on the rungs are driven to zero.

[15] In this regard, the following comment by Cave (2006, p. 232) is also of application for the NGN ladder of investment: "*Decide which of the value chain products are clearly non-replicable, recognising the danger that the regulator may be making a self-fulfilling prophecy in this regard"*.

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