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Pricing and Costing Practices in Telecommunications: the Brazilian Experience and Challenges

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Abstract

In this paper we provide an overview of the Brazilian regulatory framework for telecommunications, emphasizing the policies and models adopted for setting interconnection and access prices. In particular, we show how the regulations on interconnection and access services have evolved over time since the liberalization of the telecommunications sector (from July 1997 to December 2012), describe the two costing methodologies adopted, and formulate alternative approaches to address the regulatory challenges associated with the pricing/costing mechanism used, the target balance between service-based and facilities-based competition, and the impact of real options on the cost-based prices of regulated telecommunications services.

Keywords: Telecommunications, Pricing, Costing, Interconnection and access, Regulation.

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1 Introduction

The opening of the fixed, mobile, and data communications markets to competition, together with the subsequent reduction and elimination of entry barriers, has allowed new telecommunications operators to launch and develop their operations. In the effort to promote service-based competition in telecommunications while also allowing for long term infrastructure competition, regulators in different parts of the world have adopted cost-based prices for network interconnection and access services.

This paper extends the work of Franklin and Diallo (2010) in three aspects: (i) it shows how the regulations on interconnection and access services have evolved over time since the liberalization of the Brazilian telecommunications sector; (ii) it details the costing methodologies adopted for pricing interconnection and access services; (iii) it formulates alternative approaches to address the regulatory challenges associated with the pricing/costing mechanism used, the target balance between service-based and facilities-based competition, and the value of the option to delay network investment decisions and its impact on the cost-based prices of regulated telecommunications services.

The remaining of this paper is organized as follows. Section 2 brings an overview of the Brazilian regulatory environment in telecommunications. Sections 3 and 4 are respectively devoted to the pricing and costing practices in the Brazilian telecommunications sector. Section 5 discusses the choice between service-based and infrastructure-based competition. Section 6 addresses the need to consider the value of the delay option that is extinguished at the time of investment when calculating cost-based access prices. The paper ends with a conclusion and some research perspectives.

2 An overview of the regulatory environment

The liberalization process of the Brazilian telecommunications sector started in July 1997 with the approval by Congress of the General Telecommunications Law (National Congress, 1997) and was followed by the privatization of the Telebras System and the opening of the fixed and mobile phone and data communications markets to competition. (The Telebras System is the group of state-owned monopoly providers of telecommunications services in Brazil prior to the privatization of the telecommunications sector: *Sistema Brasileiro de Telecomunicações S.A.* – in Portuguese.) A regulatory framework aimed at ensuring the gradual and permanent transition from a monopolistic system to a competitive one guided the process of liberalization. The state relinquished its role as service provider and instead concentrated exclusively on regulating services and stimulating market forces.

The development of this new institutional model was based on a set of goals that can be summarized in two main ideas: competition in the provision of telecommunications services and universal access to basic services. The introduction of competition required the establishment of an independent regulatory agency (ANATEL: *Agência Nacional de Telecomunicações* – in Portuguese), charged with the mission of promoting fair competition, safeguarding the interests and rights of end-users, and attracting private investment. The regulatory agency proved to be a key element in securing investor confidence with regard to the stability of the rules established for the sector.

Much of what exists today in terms of regulation in telecommunications deals with responses to market power and therefore ties the possession of market power to regulatory obligations, in the interest of restricting potential and actual abuses of market power and of promoting effective com-

petition. Considering that the former state monopoly providers (incumbent carriers) possessed significant market power, ANATEL imposed one set of obligations on incumbent carriers and another on new entrants in order to give the latter the opportunity to launch their operations and develop. (Asymmetric regulation has been adopted by regulators in many parts of the world as a mechanism to control market power in natural monopoly markets.)

Among the rules and obligations that were imposed on all providers of telecommunications services of collective interest (*i.e.*, telecommunications services provided to the public in general), the following deserve mention:

- Mandatory interconnection under non-discriminatory terms and conditions for all networks used to provide telecommunications services of collective interest.
- Satisfaction of reasonable requests for access to network facilities, such as cables, fibers, ducts, poles and towers, among others, under fair and non-discriminatory conditions.
- Non-discriminatory rights-of-way under fair and reasonable prices and conditions.
- Quality goals specific to each telecommunications service.

Among the rules and obligations that were imposed exclusively on the incumbent carriers, the following deserve mention:

- Retail price control: intended to prevent abusive increases in retail prices charged to end-users.
- Wholesale price control: intended to prevent abusive tariffs for access and interconnection services.
- Universal service obligations: requirement for the incumbent carriers to meet a set of obligations related to the provision of universal service, as defined by the regulatory agency.
- Customer assistance: the incumbent carriers must ensure the continued expansion of their networks, within a reasonable timeframe, so as to provide services to anyone who requests them and is willing to pay commercial tariffs that cover the pertinent capital and operational costs.
- Service continuity: the incumbent carriers cannot interrupt the provision of fixed telephone service, except in well-justified cases.

Providers of public telecommunications services have to formulate and make publicly available a Reference Interconnection Offer (RIO) (ANATEL, 2005a) describing the terms and conditions for interconnection, along with all information needed to establish the interconnection. There are regulatory provisions aimed at preventing anticompetitive practices of cross-subsidization, price discrimination, improper use of information about competitors, delaying tactics, discriminatory use or withholding of information, quality discrimination, and undue requirements for the establishment of the interconnection agreement.

Table 1 shows some market statistics on how the telecommunications sector has evolved since its liberalization in 1997 until 2010 and 2011 (ANATEL, 2012c).

3 Interconnection and access pricing

Access problems arise whenever the provision of a complete service to end-users requires the combination of two or more inputs, one of which is non-competitive (Armstrong, 2002; Laffont and Tirole, 2001; Valletti and Estache, 1999; Noam, 2002). The services to which access is mandated in the Brazilian regulatory framework are:

- Fixed call origination/termination service (local fixed interconnection);

Table 1: Telecommunications statistics and market indicators

MEASURES	UNITS	1997	2010	2011
INDUSTRY GROWTH				
Total number of telephones (fixed and mobile)	Million	21.5	245.0	285.2
Total density (fixed and mobile)	Number of telephones (fixed and mobile) per 100 inhabitants	13.4	126.4	145.9
FIXED TELEPHONE SERVICE				
Fixed access installed	Million	18.8	62.0	64.7
Fixed access in service	Million	17.0	42.1	43.0
Density of fixed telephony	Number of fixed telephones in service per 100 inhabitants	10.6	21.7	22.0
Rate of network digitalization	%	67.8%	99.9%	99.9%
Number of public payphones	Million	0.5	1.1	1.0
Public payphone density	Number of public payphones per 1000 inhabitants	3.2	5.7	5.2
PERSONAL MOBILE SERVICE				
Mobile subscribers	Million	4.6	202.9	242.2
Density of mobile telephony	Number of mobile subscribers per 100 inhabitants	2.8	104.7	123.9
PAY TV				
Pay TV subscribers	Million	2.5	9.8	12.8
Density of pay TV service	Number of pay TV subscribers per 100 residences	6.0	16.6	21.2

- Transit service (long-distance fixed interconnection);
- Mobile call origination/termination service (mobile interconnection);
- Wholesale leased lines;
- Local loop unbundling.

3.1 Fixed call origination/termination and transit services

Long-distance carriers need access to call origination and termination services (at both ends of the call) for the purpose of completing end-to-end long-distance calls. Also, fixed operators need access to call termination services of other fixed operators in order to complete off-net local fixed calls, and mobile operators need access to call termination services of fixed operators to complete mobile-fixed local calls. In all these situations, the telecommunications operator that provides the retail service needs to pay the operator that originates and/or terminates the call the local fixed interconnection tariff, TU-RL. (TU-RL is the acronym for the tariff of use of the local network: *tarifa de uso de rede local* – in Portuguese.) Long-distance carriers may also need access to the transport network that brings the call from the point of interconnection to the local exchange that terminates the call. In that case, they also need to pay the long-distance interconnection tariff, TU-RIU. (TU-RIU is the acronym for the tariff of use of the inter-city network: *tarifa de uso de rede interurbana* – in Portuguese.)

After the privatization of the telecommunications sector, TU-RL and TU-RIU were regulated by separate price-cap regimes that were not based on costs. In 2003, two Brazilian long-distance carriers accused three vertically-integrated incumbent carriers of engaging in anticompetitive practices of price discrimination and cross-subsidization, squeezing the long-distance carriers' margins. The Secretariat of Economic Oversight of the Finance Ministry (SEAE: *Secretaria de Acompanhamento Econômico do Ministério da Fazenda* – in Portuguese) found that for several combinations of time of day, day of week, and distance between parties the vertically-integrated carriers actually set their long-distance retail prices at levels below or slightly above the local fixed interconnection tariff, leveraging their market power in the access service to the long-distance service market (Bragança, 2005). This case was forwarded to the Administrative Council for Economic Defense (CADE), which shelved it in

2005 due to insufficient evidence. (For details, see http://www.cade.gov.br/.)

Since the introduction of the new concession contracts in January 2006, the incumbents' TU-RL and TU-RIU (now split into two different tariffs: TU-RIU1 when the call is made between two locations with the same numbering plan area code: and TU-RIU2 when the call is made between two locations with different numbering plan area codes) have been set according to a *retail-minus* approach, where the *minus* is a percentage of the retail price of the fixed telephone service. Although this approach can prevent incumbent carriers from exposing new entrants to margin squeeze, it does not necessarily provide the right incentives for efficient investment in infrastructure. Starting in 2014, the fixed operators will cease paying other fixed operators for local calls made between networks (ANATEL, 2012a) – a mechanism also used in other countries and known internationally as *bill and keep*.

In February 2007, ANATEL determined that the maximum values of TU-RL, TU-RIU1 and TU-RIU2 charged by incumbent carriers and fixed operators with significant market power (SMP) in the market of fixed interconnection services will be based on a LRIC model that will reconcile the results of the top-down LRIC-CCA model developed by the incumbent and SMP fixed operators and the bottom-up LRIC-CCA model developed by the regulator (ANATEL, 2007, 2012a). (LRIC is the acronym for the long run incremental cost model/methodology, and CCA is the acronym for the current cost accounting cost base. For details, see the section on costing methodologies.)

3.2 Mobile call origination/termination services

Long-distance carriers need access to call origination and termination services (at both ends of the call) for the purpose of completing end-to-end long-distance calls. Also, mobile operators need access to call termination services of other mobile operators to complete off-net local mobile calls, and fixed operators need access to call termination services of mobile operators to complete fixed-mobile local calls. In all these situations, the telecommunications operator that provides the retail service needs to pay the operator that originates and/or terminates the call the mobile interconnection tariff, VU-M. (VU-M is the acronym for the value of use of the mobile network: *valor de uso de rede móvel* – in Portuguese.)

After the privatization of the telecommunications sector, the incumbents' mobile interconnection tariffs were regulated according to a price-cap regime (above-cost). Since 2001, after the third and fourth mobile operators entered the market, the value of the VU-M has been subject to commercial negotiation between service providers. In practice, however, the free negotiation regime did not work out, and ANATEL has often been asked to arbitrate the values of the mobile interconnection tariffs. Mobile operators have used the above-cost mobile interconnection tariff to subsidize handsets to their customers, greatly increasing the penetration of mobile services and the percentage of mobile users with pre-paid services.

In July 2006, ANATEL determined that the reference values of VU-M charged by the mobile operators with significant market power (SMP) in the market of mobile interconnection services will be based on a FAC model that will take into account the results of the FAC-HCA model developed by the SMP mobile operators and the FAC-CCA model developed by the regulator (Anatel, 2006). (FAC is the acronym for the fully allocated cost model/methodology; HCA is the acronym for the historical cost accounting cost base; and CCA is the acronym for the current cost accounting cost base. For details, see the section on costing methodologies.)

3.3 Wholesale leased lines

Retail and wholesale markets for dedicated capacity or leased lines are broadly parallel: (i) dedicated capacity or leased lines can be required by corporate clients to construct private networks and to link locations; or (ii) they may also be required by other telecommunications service providers to build their own networks, which in turn provide telecommunications services to retail clients. The incumbent carriers possess capillary networks that reach almost all places in their concession areas and enjoy the benefits of significant economies of scale and scope. Competitive service providers, on the other hand, need access to certain wholesale leased lines (in particular, to leased lines that cannot be economically duplicated) in order to provide telecommunications services to retail clients. These wholesale leased lines are denoted as *standard* EILD. (EILD is the acronym for the industrial exploration of leased lines/wholesale: *exploração industrial de linhas dedicadas* – in Portuguese.)

After the privatization of the telecommunications sector, the incumbents' wholesale leased line were regulated according to a price-cap regime, where the price caps were set at the costs measured and reported by the telecommunications operators using the technology available at that time (1996). The incumbent carriers offered discounts that varied according to a number of variables, such as transmission rate, distance, locality, term/volume commitments and network topology. The lack of a robust access regulation and a true cost-based model for pricing wholesale leased lines allowed the incumbent carriers to engage in anticompetitive practices of price discrimination and cross-subsidization, as well as other non-price anticompetitive practices, forcing retail competitors to margin squeeze and raising rivals' costs. A number of cases were forwarded to the Administrative Council for Economic Defense (CADE) and ended with consent decrees (*termos de compromissos de cessação* – in Portuguese) between CADE and the accused companies. (For details, see http://www.cade.gov.br/.)

In order to improve transparency and prevent anticompetitive practices, ANATEL established new rules, terms and procedures with which telecommunications service providers with significant market power (SMP) in the market of wholesale leased lines must comply when providing *standard* EILD services (ANATEL, 2005b, 2012b). ANATEL also determined that the reference values charged for *standard* EILD services provided by telecommunications service providers with SMP will be based on an LRIC model that will reconcile the results of the top-down LRIC-CCA model developed by the SMP service providers and the bottom-up LRIC-CCA model developed by ANATEL. The telecommunications service providers without SMP have no obligation with respect to the provision of wholesale leased lines to other telecommunications service providers.

3.4 Local loop unbundling

Competitive service providers need access to physical local loop facilities to provide telecommunications services to end-users. Local loop unbundling happens when incumbent local carriers lease the local loop at wholesale prices to new entrants to enable the new entrants to provide a range of telecommunications services to retail clients. The General Telecommunications Act, approved in 1997, established that providers of public telecommunications services have to make their networks available for use by other public telecommunications service providers. However, at that time no regulation was established to determine the terms and conditions under which incumbent local carriers would have to provide unbundled access to local loops.

In May 2004, ANATEL determined that the incumbent local carriers have to offer two different forms of local loop unbundling: full unbundling (*i.e.*, unbundled access to the entire frequency spectrum of the local loop for the competitive provision of voice and data services by third parties); and line sharing (*i.e.*, unbundled access to the high frequency spectrum of the local loop for the competitive provision of DSL services by third parties). ANATEL created standard operational procedures for the provision of local loop unbundling, and established maximum reference values (price caps) for the shared use of the local loop based on cost information provided by the incumbent carriers. Since then, the incumbent local carriers have had to make available on the Internet reference offers for unbundled access to the local loop under the supervisory control of ANATEL. However, due to the asymmetry of information between regulator and regulated companies, the price caps were probably set too high (above cost), which can explain why competitive service providers have not contracted the provision of local loop unbundling from the incumbent carriers.

In June 2003, the Ministry of Communications established a set of public policies and directives determining (among other decisions) that the tariffs charged by incumbent carriers for fixed interconnection services and local loop unbundling will be based on a long run cost model that will take into account the universal service obligations imposed on these carriers (Presidency, 2003).

3.5 In summary

The access tariffs charged for the services to which access is mandated in Brazil will all be based on costs: either LRIC or FAC. The date after which they will be based on costs will be determined by further resolutions. Table 2 provides an overview of how the regulations on interconnection and access tariffs have evolved over time since the start of the liberalization process in 1997.

The implementation of such a pricing/costing mechanism requires an excessively high level of effort by the regulatory agency. Cost studies typically consist of a number of activities, such as defining the cost methodology and approach, gathering base input data, deriving needed cost study data, deriving network component costs and service costs, and validating these costs. In many telecommunications markets, the operators develop the cost studies, and the regulatory agency just evaluates and validates the study. In Brazil, ANATEL will evaluate/validate the top-down cost studies prepared by the telecommunications operators, develop the respective

Table 2: Evolution of access pricing models.

Access Tariffs	Access Pricing Model										
Year	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	Adopted, but not applied yet
Local fixed interconnection	Price cap									Retail-minus	Cost based LRIC-CCA (TD& BU)
Transit services	Price cap									Retail-minus	Cost based LRIC-CCA (TD& BU)
Mobile interconnection	Price cap										Cost based FAC (HCA&CCA)
Wholesale leased lines	Price cap								New price cap, terms and proc.		Cost based LRIC-CCA (TD & BU)
Local loop unbundling	No regulation								Price cap		Based on a long run-cost model

TD & BU: top-down and bottom-up reconciled.
HCA & CCA: HCA and CCA reconciled.

bottom-up models, and perform the top-down/bottom-up reconciliation. (It should be noted that in Brazil there are four incumbent local exchange carriers operating in demarcated areas, one long-distance incumbent carrier operating in the whole country, and eight mobile operators operating in overlapped areas, while in most of other countries there is only one incumbent fixed carrier and just a few mobile operators.)

In order to avoid unnecessary effort, cost study activities need to be carefully distributed between the regulatory authority and incumbent carriers. For example, the regulator may provide standard templates for the input cost study data, while the incumbent carriers gather all base data and derive the needed cost study data; and/or the regulator may develop the bottom-up cost models for just the main parts of the telecommunications network, where the bottom-up LRIC model is later used to investigate the top-down model and to compare outcomes and results.

4 Costing methodologies

In Brazil, two different costing methodologies are used to measure the costs of access services: long run incremental cost (LRIC) and fully allocated cost (FAC).

- FAC is an accounting-based approach that allocates total costs to services. It is usually based on audited costs of existing networks and considers actual installed capacities and actual costs of operation. The concept of fully allocated costs implies a top-down costing system where all costs incurred are attributed to services based on pure activity-based costing (ABC) rules.
- LRIC is an economic approach based on the forward-looking costs of a network that is assumed to be efficient. It has been widely recognized as the costing methodology that best mirrors the effect of efficient competition in the market, although it may undercompensate incumbents because of its use of forward-looking costs (Salinger, 1998; Crandall, 2005). LRIC can be calculated using two different approaches: top-down or bottom-up.

  - The top-down approach is based on the costs actually incurred by a telecommunications operator and the data appearing on its accounting system.
  - The bottom-up approach establishes a number of assumptions on how an efficient operator would be structured to meet a given level of demand and what kind of cost it would incur.

Both FAC and LRIC methodologies require the study of input data and allocation keys in order to apportion total operating and capital costs among the products/services provided by the carrier. Figure 1 provides an overview of a service cost study.

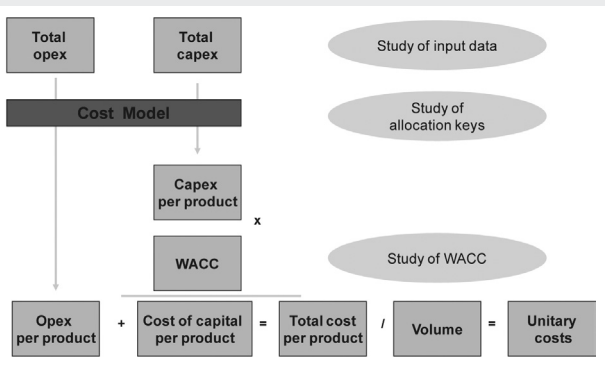

Figure 1: Cost study overview

A service cost study must identify the amount of network resources each service uses. When many products and services are provided over a common network platform, it may be difficult to isolate the investments and expenses used to support each service. Figure 2 shows a schematic representation

of public-switched telephone network (PSTN) resource consumption by different services.

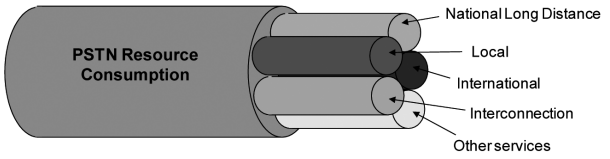

Figure 2: Schematic representation of PSTN resource consumption

4.1 The fully allocated cost (FAC) model

The FAC methodology requires that all costs incurred be attributed to products/services based on pure activity-based costing (ABC) tools and techniques (Cooper and Kaplan, 1991). Costs may be directly assigned to products/services or network elements (NEs), or can be allocated via activities (maintenance, customer service, etc.). The cost system should allocate costs, assets and liabilities to activities, network elements and products/services according to a transparent assignment/ distribution method based on the causality principle. This method uses as its basis the cause of costs (referred to here as cost drivers), allowing the tracing and allocation of costs through the activities performed.

Costs can be classified in different ways (ITU, 2009):

- Directly attributable costs are caused by and can be directly and unambiguously related to a service/product or network element. For example, access copper cables are directly attributable to the local loop element (and to the supply of the various access services), and an international gateway switch is directly attributable to the supply of international calls. Directly attributable costs can be fixed or can vary with service volumes.
- Indirectly attributable costs are shared by more than one service, but it is possible to allocate them across services on a non-arbitrary basis. An appropriate allocation method such as ABC can be used to spread indirectly attributable costs across products and services. For example, the costs of a cable repair team can be attributed to the copper cables and fiber cables they repair based on the time spent on each repair activity and then allocated to the access and core services that use the cables. Indirectly attributable costs can be fixed or can vary with service volumes.
- Fixed costs are costs that do not vary with the volume of a service. A billing system for some products may be considered a fixed cost – the computer and software is required for one or one million customers. This type of cost is a fixed cost but it may be directly attributable to the service for which it was bought.
- Variable costs are costs that vary with the volume of a service. For example, most media gateway costs (*i.e.*, costs of IP concentrators supporting voice and broadband services) vary according to the number of access lines, although there are some fixed costs as well.
- Common costs are those costs for which no direct or indirect method of apportionment can be identified. It is, therefore, impossible to allocate these costs to products and services in a direct way. Once direct and indirect costs have been allocated to individual services on the basis of causality (using ABC), the remaining costs should be allocated to products and services on some rational basis. Common costs include, for example, audit fees and the total costs of the office of the Chairman.

The cost/asset allocation process consists of a series of allocations to smaller and smaller groups (or *cost pools*) such that at the end all rev-

enues, costs, and capital employed are allocated to products/services. It typically includes intermediate stages of activities that enable a higher proportion of indirect costs to be allocated in an objective fashion to products/services. Figure 3 shows the cost centers and cost/asset allocation stages described in the Document for Separation and Allocation of Costs issued by ANATEL (ANATEL, 2005c).

- Products and Services: cost center composed of the set of products/services that are pooled into Product Lines and Business Areas.
- Primary Plant: cost center made up of elements that perform network functions that are vital for the provision of telecommunications services and the costs ascribable to it (*e.g.*, switches).
- Support Plant: cost center composed of infrastructure components that support the primary plant (*e.g.*, electric power plant).
- Support Functions: cost center composed of costs and assets related to functions that are not directly linked to the provision of telecommunications services, but that are required for the operation of the company (*e.g.*, maintenance).
- Common Costs: cost center made up of costs and assets related to functions that have no causality relation with the provision of products/services but are required for the operation of the company, with respect to which it was not possible to find a rule for allocating the cost to other cost centers.

Network elements form the building blocks of any network cost model. A key component of both the FAC and LRIC methodologies is the causal allocation of network element costs to services. The costs of the various network elements are allocated to the services according to the amount of network element resources each service

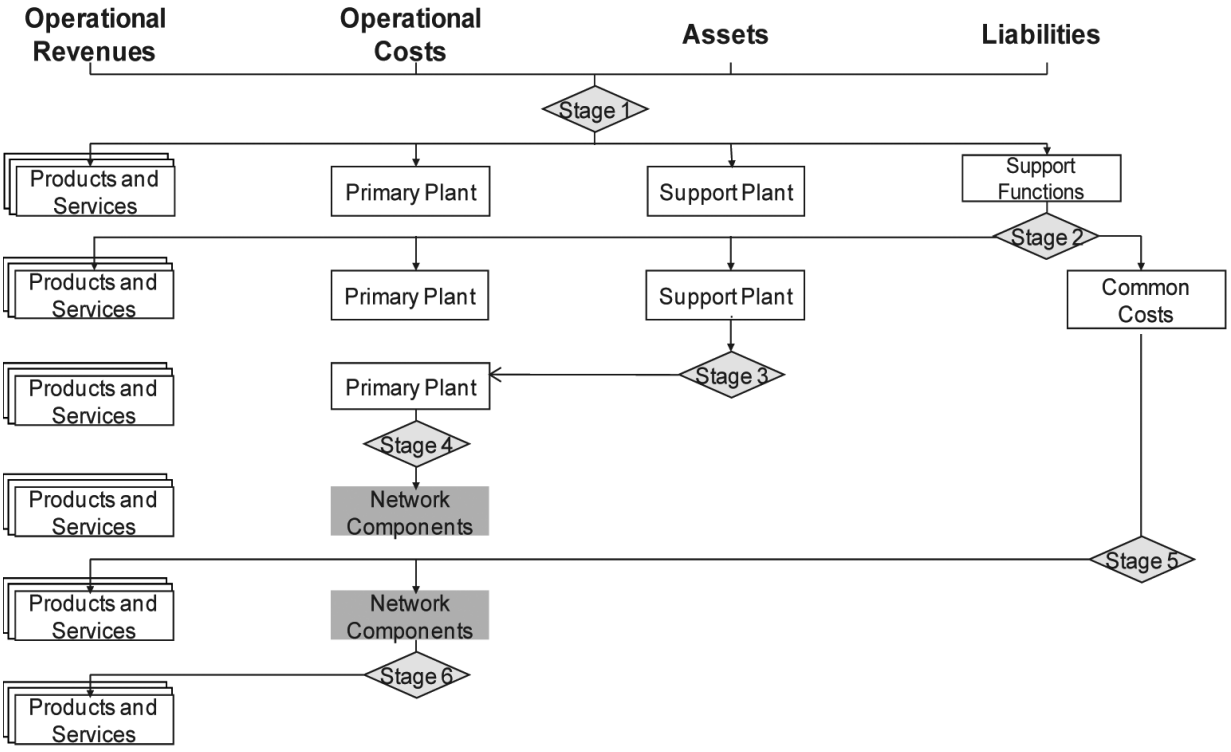

Figure 3. Cost allocation process used in the FAC model

uses. Routing factors are used to determine the extent to which each service causes the cost. For most network-driven costs, this is dependent upon two factors: (i) the relative capacity consumed by a unit of demand of each service; (ii) the path through the network that the demand takes.

The investment/costs associated with each network element (*i.e.*, total operating and capital costs) need to be unitized according to the demand cost driver (or, routing factor volume) associated with the network element. Each service has a routing (or usage) profile indicating how the service uses each network element. Routing factors specify, for each type of service, the average use made of each network element. If $RF_{i,\Delta}$ denotes the amount of NE_{Δ} resource consumption by $Service_i$, the routing factor volume of NE_{Δ} in a given year is measured by the routing factor weighted demand on that network element, that is

$$rv\Delta = \text{Routing Factor Volume of } NE_{\Delta} = \sum_{\text{all services (i)}} (\text{Demand for Service}_i) RF_{i,\Delta}. \quad (1)$$

In the end, a routing factor matrix is needed to allocate network costs to network services on the basis of the traffic that each service generates on each network element. The unitary cost of each network element is calculated by dividing the total operating and capital costs by the annual routing factor volume, and then all network costs are assigned to network services on the basis of how much each service uses each NE:

$$\text{Unitary Cost of } NE_{\Delta} = \$ \frac{\text{Total Operating and Capital Costs}}{\text{Routing Factor Volume of } NE_{\Delta}}, \quad (2)$$

$$\text{Unitary Cost of Service}_i = \sum_{\text{all NEs}(\Delta)} (RF_{i,\Delta})(\text{Unitary Cost of } NE_{\Delta}). \quad (3)$$

Joint and common costs are allocated to products/services and network elements on the basis of the EPMU (equiproportionate mark-up) method, *i.e.*, in proportion to the sum of the directly attributable costs plus the indirectly attributable costs that have been allocated to the product/service and network element. Although the Ramsey pricing rule would be a better way of marking up prices to cover common costs (from the perspective of efficiency maximization), difficulties in obtaining reliable estimates of the elasticities of demand have made most regulatory authorities around the world consider the EPMU method as the most appropriate approach.

4.2 The change of cost base from HCA to CCA

The current cost accounting (CCA) cost base considers the efficient utilization of resources, taking as basis the real network of the telecommunications operator. Excess capacity is excluded from the CCA valuation, where an asset is considered to have excess capacity if there is non-used capacity (above the acceptable safety margin) that is not expected to be used in a time horizon of three years.

The capital costs associated with a fixed asset is calculated by multiplying the asset's net current value by the company's weighted average cost of capital (WACC). The asset's net current value (*i.e.*, its net current replacement cost) is derived from the asset's gross replacement cost, which is equal to the cost of replacing the existing asset by another of similar performance characteristics based on modern equivalent technology – *i.e.*, a

modern equivalent asset (MEA) with the same service potential.

Depreciation expenses are adjusted to reflect the current value of the assets. The value of the depreciation expense under the CCA cost base is the difference between the net current value of the asset in the beginning of the period and the net current value of the asset at the end of the period. The economic asset lives used for the HCA and CCA cost bases are identical. The impact of MEA over operational costs, such as the maintenance, space, and energy costs, must be reflected in the CCA cost base.

4.3 The long run incremental cost (LRIC) model

The LRIC methodology combines a number of principles:

- Long run: In the long run, all capital inputs (and therefore all costs) vary due to a change in the volume or in the structure of production, in response to changes in demand. All investments are therefore considered as variable costs in the long-run perspective, since all will require replacement at some time.
- Incremental: The incremental cost is the increase in total costs following the introduction of an additional product or service *increment*. The product/service volume *increment* can take several forms. It may be defined as an additional unit of service, the entire output of a given service, a group of products/services, the total service, all services offered by the telecommunications operator, etc. With telecommunications services, it is often convenient to think of an *increment* as the entire output of a given service (such as total call volumes or total number of access lines).
- Forward-looking costs: Reflect the costs that a network service provider would incur were it to build a brand new network today, using modern equivalent assets (MEA). These costs are based on looking forward to anticipated levels of demand for network capacities and planning horizons for equipment installation necessary to run an efficient network. LRIC is estimated using forward-looking economic costs because they mimic the cost base expected in a competitive market. The concept of forward-looking costs requires that assets are valued using the cost of replacement with the MEA, since a competitive-market operator would use the MEA.
- Efficiently incurred costs: Inefficient costs should be excluded, since in a perfectly competitive market an operator would not be able to recover inefficiently-incurred costs. Practically, however, decisions made by the operator in the past cannot be judged against current standards of efficiency. In allowing only efficiently-incurred costs, therefore, the regulator usually demands reasonable efficiency.
  - This assumes that the topology of the network is fixed and that the equipment at each node is optimized (efficient). This approach is referred to as *scorched node* because the costing approach accepts the existing number (and locations) of switching nodes as given.
  - The alternative approach considers the costs of an idealistic network topology referred to as *scorched earth*. This scorched earth approach allows complete redesign of the network, without considering any past investment and existing node locations/number.

The method used to calculate the LRIC considers the costs that would be avoided in the long run by not producing one unit of *increment* (*e.g.*, a

product/service or a network element), given that costs can vary and some level of output already exists. With respect to the total cost of the company, the incremental cost of a given product/service is numerically equal to the savings that would be obtained had the product/service not been supplied. The total incremental cost of a product/service is the sum of the costs that would be avoided by not producing the product/service (the *pure* LRIC) and a mark-up in respect of joint/common costs. For details on the top-down LRIC convention, see for example BT Group (2011).

The LRIC model uses costs and asset values adjusted to the CCA basis and consolidated into cost and asset groups (or cost categories) of similar cost/asset types and identical cost drivers. The key component of the top-down LRIC analysis (and the main difference between FAC and LRIC methodologies) is the mapping and building of the cost-volume relationships (CVRs). The CVR is a curve that describes how the costs associated with a given cost category (*y-axis*) varies according to the volume of its associated cost driver (*x-axis*). The appropriate cost measure is the long-run cost, which includes all costs that are present in this cost category (capital costs, operating costs, etc.) stated on a long-run annualized cost basis.

The costs that would be avoided in the long run by not producing an *increment* are computed with reference to the CVR of each cost category by analyzing the impact of the product/service on the cost driver volume of each CVR. The processing sequence is determined by the CVR calculation hierarchy, which reflects the dependency between cost categories in such a way that independent categories are processed first, and thereafter the cost categories with first order dependency, second order dependency, and so on are processed. (Each cost category has a single cost driver, which may be linked to a factor that is either exogenous or endogenous.) The incremental cost of each individual product/service (*i.e.*, the *pure* LRIC) is derived by zeroing out the demand volumes associated with that product/service, identifying the reduction in the cost driver volume of each cost category, and reading out the *y-axis* of the CVR curve for the effect of these changes on the total costs of each cost category. Figure 4 shows the contribution of a cost category to the LRIC of an *increment*.

Joint costs are determined, for each cost category, by calculating the difference between the LRIC of a group of similar products/services (*e.g.*, access services, traffic services, etc.) and the sum of the *pure* LRIC of each individual product/service that belongs to that group. These costs are allocated proportionally based on the *pure* LRIC of each product/service forming the *distributed* LRIC of the product/service. Common costs are then allocated proportionally based on the *dis-*

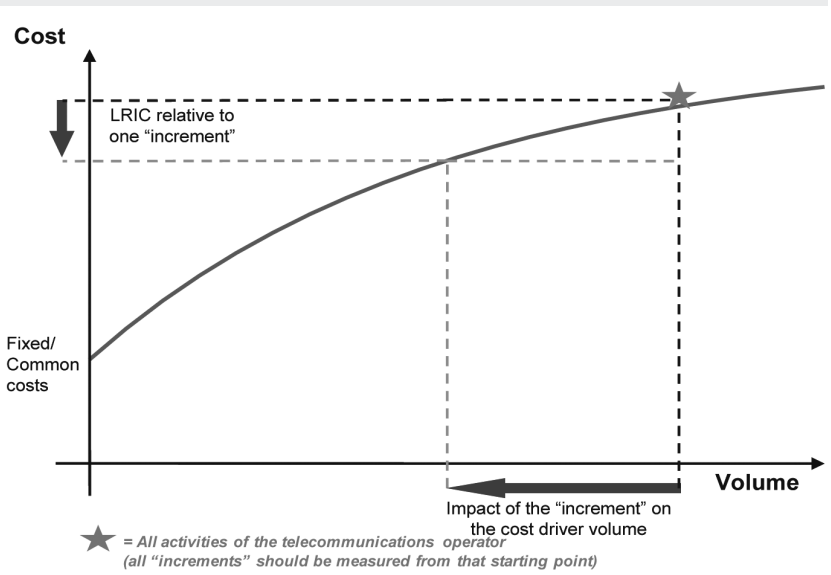

Figure 4: Contribution of a cost category to the LRIC of an *increment*.

tributed LRIC of each product/service, so that the total amount of costs allocated to products/services (*i.e.*, the *fully loaded* LRIC) is exactly equal to the total amount of fixed and variable cost of all cost categories.

5 Service-based vs Facilities-based competition

There has been a debate on whether regulatory regimes based on mandatory unbundling and the sharing of incumbents' facilities provide long-run welfare gains for consumers. Some studies show overall gains from mandatory unbundling (Clarke *et al.*, 2004; Ford and Pelcovits, 2002; Willig *et al.*, 2002), while others show reduced investment and welfare losses in the long run (Crandall *et al.*, 2004; Jorde *et al.*, 2000). Other studies estimate the consumer welfare benefits of entry into local markets (Economides *et al.*, 2008) and the impact of new entry on service prices (Knittel, 2004), as well as on variety of services (Greenstein and Mazzeo, 2003).

The purpose of ANATEL's recent regulations on cost-based access pricing is to promote service-based competition by ensuring new entrants' access to existing network facilities under conditions that enable them to compete with incumbent carriers. The key issue has been how to establish a pricing mechanism that ensures optimal competition and investment in network facilities (Prieger and Heil, 2009).

- Service-based entry has low investment requirements (as it relies on access to the incumbents' networks) and can help competitive service providers quickly build up a subscriber base and then move them over to their own facilities.
- Facilities-based entry, on the other hand, is more expensive for new entrants, but leads to more vigorous competition, because the competitors can provide their own innovative services (it only requires interconnection with incumbents).

To date, the competition in the Brazilian fixed telephone and broadband markets has been purely facilities-based. Through the end of the third quarter of 2012, the incumbent local carriers still had 68.9% of the fixed access lines in service, and 51.8% of the broadband accesses in service (Teleco, 2012). Competition is most visible, however, in the markets of mobile communications and long-distance calls. The question now is how interconnection and access costs should be computed so as to promote service-based (retail) competition without reducing incentives to build new networks and/or upgrade existing ones. Cave (2006) proposes what is called the *ladder of investment* approach (LOI), which entails providing entrants, successively, with different levels of access (the *rungs* of the *investment ladder*), while inducing them to climb the ladder by setting access charges that increase over time or by withdrawing access obligations after some predetermined date. New entrants can climb the *investment ladder* step by step, starting from resale, which requires the least investment, then moving to the different forms of unbundled access to the local loop (bitstream, line sharing and full unbundling), which requires additional levels of investment, and finally building their own network infrastructure, which costs the most.

Proponents of the LOI approach claim that such regulatory measures would make service-based entry and facility-based entry complements – instead of substitutes – in promoting competition. Critics, however, question the validity of key underlying assumptions and claim that the LOI approach still lacks some economic foundations (Bourreau *et al.*, 2009).

6 The option to delay network investment decisions

In telecommunications networks, capital investments tend to be high, so that a significant portion of the costs associated with products/services relates to capital costs. Such investments are in large part irreversible – they involve sunk costs. When investment is sunk and future demand or cost conditions are uncertain, investment expenditures involve the exercising, or *killing*, of an option – the option to productively invest at some time in the future. The incumbent carriers have been required by regulation to share the use of their network facilities/equipment with rivals (competitive carriers) at the option of the rivals, who are free to utilize the facilities/equipment they choose, when and as long as they wish.

There is a fair body of work on valuing the option that arises out of firms being able to defer irreversible investment. Dixit and Pindyck (1994) and Trigeorgis (1996) are the classic references on the topic. There are also a number of studies on the need to consider sunk costs in the regulation of tariffs and return on capital in regulated sectors, such as the works of Salinger (1998), Small and Ergas (1999), Alleman and Noam (1999), and Hausman (1999). More recent studies, such as those of Alleman (2002), Hausman and Myers (2002), Hori and Mizuno (2006), Pindyck (2005, 2007), Harmantzis and Tanguturi (2007), and Brandão and Gomes (2011) have proposed the use of the real options methodology in a variety of applications, including capital budgeting, decision analysis, strategic planning, economic regulation, and cost modeling.

In the decision analysis field of economic regulation, a number of studies have addressed the relation between regulation and the option to delay. Teisberg (1993) shows that the more uncertainty there is, the more regulation reduces the value of an investment project, so that regulation can lead a firm to delay its investment decisions. Hausman (1999) and Hausman and Myers (2002) show that incumbent providers have been forced to grant to new entrants a free option, where such option is the right but not the obligation to purchase the use of incumbent's network, and argue that a markup factor must be applied to the investment cost component of costing methods in order to compensate incumbents for this option value. Pindyck (2005) analyzes the impact of network sharing agreements in the telecommunications industry and proposes a method to adjust the cost of capital in the TELRIC access pricing formula to account for the option to delay value. (TELRIC is the acronym for the total element long run incremental cost methodology – a variant of the LRIC methodology.) Franklin and Diallo (2012, 2013) recognize that different network elements are subject to different demand and technological uncertainties, and calculate option value multiples for the decisions to invest in three main network elements, each representing a different part of the Brazilian fixed telecommunications network, subject to different demand and technological uncertainties.

There has been a great debate about which option value multiple (if any) should be applied to the investment cost component to account for the value of the delay option extinguished at the time of investment. Some authors say the real option value is negligible and should be ignored, as in Pelcovits (1999), while others calculate markup values that are quite significant, as in Hausman (1999) and Pindyck (2005). Franklin and Diallo (2012, 2013) show that the markup values may be negligible for some network elements and quite significant for others, and the impact of real options on the cost-based price of a regulated telecommunications service depends on the network elements used by that service and the option value multiple calculated for each network investment

decision – *i.e.*, the true unitary cost of a particular service ($Service_i$) is

$$\sum_{\text{all NEs}(\Delta)} (RF_{i,\Delta})(\text{Unitary Cost of } NE_{\Delta} \text{ "after markup"}). \quad (4)$$

Regulators to date have not incorporated into their price setting the value of the options that are extinguished at the time of investment. In order to provide the right incentives for efficient investment in infrastructure, the cost base used for calculating the cost-based prices of regulated telecommunications services should include not only the actual cost of investment, but also the value of the real options that are extinguished by committing capital and building the network.

7 Conclusion

The Brazilian telecommunications industry has been transformed by the introduction of competition. An industry which was once a protected utility is now a dynamic and innovative sector of the Brazilian economy. However, the process of introducing competition has not been easy, and many issues have arisen in the past few years related to interconnection and access – that is, issues related to which facilities should be made available by the incumbent carriers, and on what terms and conditions.

In this paper, we provide an overview of the Brazilian regulatory framework in telecommunications, emphasizing the policies and models adopted for setting interconnection and access prices, and show how the regulations on interconnection and access services have evolved since the liberalization of the telecommunications sector. We also describe the costing methodologies applied for pricing interconnection and access services, and formulate alternative approaches to address the regulatory challenges associated with the pricing/costing mechanism used, the target balance between service-based and facilities-based competition, and the impact of real options on the cost-based prices of regulated telecommunications services.

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