Distribution Access Pricing: Application of the OFTEL Rule to a Yardstick Competition Scheme

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Abstract—The paper formulates an access-pricing model applied to electricity distribution, based on the Office of Telecommunications (OFTEL) model, originally structured to price telecommunications monopolistic-essential facilities. The aim is to achieve an optimal access price charge, in an environment where a distribution network monopoly serves both regulated and nonregulated customers. The nonregulated market faces competition, so that the competitors must use the network to reach their customers. A usage-based hybrid model is proposed to couple with a tariff scheme for regulated customers that uses yardstick competition. A way to set appropriated opportunity costs by the use of the OFTEL model is introduced. Finally, the paper focuses on properly recognizing both regulated distribution and competitive supply costs. The scheme is assessed within the Chilean regulatory scheme, proposing a way to establish marginal and fixed distribution costs for distribution companies.

Index Terms—Access pricing, distribution costs, distribution pricing, opportunity costs, power sector deregulation, supply costs.

I. INTRODUCTION

POWER SECTOR deregulation has led to competition in the generation market while preserving regulation in transmission and distribution, due to the presence of large economies of scale and scope in both kinds of networks. Recent deregulation models have introduced a new agent, the supplier or broker, as an independent company who purchases energy to generators in the pool or through bilateral contracts, and sells it to nonregulated customers or distribution companies, paying therefore access charges in transmission and distribution. While full retail price deregulation is advancing slowly, the current worldwide trend aims at increasing competition by lowering the size of consumers facing regulated prices. So, the implementation of an efficient and direct open access price model has won increasing importance in the last years. If the regulator sets an access price for distribution networks that is not economically optimal, it could lead to serious distortions in the whole electric market, like cross-subsidies between regulated and nonregulated customers, increasing market power of the monopoly, and creating barriers to entry to the supply activity [1]. All these market distortions could have a negative impact on the final charges paid by both regulated and nonregulated customers.

Nowadays, the major task faced by distribution regulation is to provide incentives for efficiency in the investment and operation of distribution networks, while ensuring that every company recovers its costs, plus a reasonable rate of return, according to the risks faced by each company [2]. The distribution regulatory schemes of several South American countries, led by Chile, pretend to reach these objectives through a yardstick competition scheme. The scheme compares the real companies with an efficient, fictitious model company, established in specific geographical areas, reflecting the differences introduced by economies of scope arising from population density and size of networks [2]. So, profits of the real distribution company depend directly on its relative performance respect to the model company.

Even though the yardstick competition scheme is useful for pricing distribution services for small consumers, the question arises on how to adequately price wire access charges, according to a strict separation of the two businesses: supply and distribution.

The English telecommunications regulator has adopted a usage-based model to set access charges to the local telephone operator, called the Office of Telecommunications (OFTEL) model [1]. This model sets the access price according to the opportunity cost faced by a monopoly as it allows a competitor to use its network. This goal is achieved by setting a markup over the marginal cost, which depends on the profits earned by the companies involved. By using the OFTEL model and costs arising from the yardstick distribution regulation, this paper proposes a new access charge scheme.

II. OPTIMAL ACCESS PRICING AND THE USE OF THE OFTEL RULE AS AN ALTERNATIVE SOLUTION

The base case is a monopolistic distribution company, located in a specific geographical area, supplying electricity to regulated customers. Moreover, there is a nonregulated customers market located in the same area, which is supplied in a competitive way either by supply companies or the same local distribution company. The network is fully owned by the distribution company, and each supplier must use this network to reach its customers. All entities supply the same commodity (electricity). There are no barriers to entry to the supply activity, and all suppliers are price takers respect to the access charge. Finally, the regulator has full information about the cost structures of all companies involved.

Given $q_1$, $q_2$, and $q_3$ as the amount of electric power (in kilowatts) transited by the distribution monopolist to its regulated and nonregulated customers, respectively, and given that $q_3$ is the amount of electric power (in kilowatts) transited by the sum of all suppliers, the total power served for customers is then $Q_t = q_1 + q_2 + q_3$. The amount of power transited by each...
entity through the network determines the investment required by the distribution company. As networks must be designed to transfer the peak demand of the distribution system, the transited power sets the capacity of the network. Energy (kilowatt hours) only determines the ohmic losses involved [3]. The cost functions $C_1$, $C_2$, and $C_3$ are then

\[ C_1 = c_1 Q_1 + K_0 \quad \text{(Monopoly for regulated customers)} \]
\[ C_2 = c_2 Q_2 \quad \text{(Monopoly for nonregulated customers)} \]
\[ C_3 = c_3 Q_3 \quad \text{(Suppliers for nonregulated customers)} \]  

(1)

where $c_1$ is the marginal cost of investment and operation of the distribution network, and $K_0$ is the fixed network cost. $c_2$ and $c_3$ are marginal supply costs, corresponding to costs incurred in the commercial attention of customers, like billing and staff needed for this purpose.

The marginal cost of the distribution network is composed by the required capital investment, which directly depends on the demanded peak power, and operational costs such as maintenance costs and special equipment to keep the quality of service of the network [4]. The nature of the distribution fixed cost ($K_0$) is diverse, as it includes operation and maintenance costs that do not depend on the power supplied, plus capital investment costs such as buildings, vehicles, laboratories, and computer equipment.

Taking $p_1$ as the per power unit regulated price of the monopoly, and $p_2$ and $p_3$ as the competitive per power unit prices of the monopoly and suppliers, respectively, the profit functions for both entities are

\[ \pi_M = p_1 q_1 + p_2 q_2 + s q_3 - C_1 - C_2 \]
\[ \pi_L = p_3 q_3 - s q_3 - C_3 \]  

(2)

where $\pi_M$ and $\pi_L$ are the profit functions of the monopoly (distribution company) and suppliers, respectively. Furthermore, $s$ is the per-power-unit access charge, which rewards the monopoly for the use of its network. In this situation, the profits of the monopoly are negative ($\pi_M < 0$), because it faces the complete cost of the network ($C_1$). Therefore, in theory, the regulator would have to subsidize the monopoly, so that its profit becomes nonnegative. The theoretical subsidy $T_M$ is assumed to make $\pi_M \geq 0$ [5]. Then

\[ \pi_M = T_M + s q_3 \]
\[ T_M > p_1 q_1 + p_2 q_2 - C_1 - C_2. \]  

(3)

The fact of transferring funds from the regulator to the monopoly would imply the existence of an opportunity cost of these funds, named $1 + \phi (\phi > 0)$. So, the regulator would incur in a loss, valued by

\[ \text{regulator’s loss} = (1 + \phi) (T_M + C_1 + C_2 - p_1 q_1 - p_2 q_2). \]  

(4)

The regulated customer values by $U_R(q_1)$ each unit of power consumed, and the nonregulated customer values by $U_F(q_2, q_3)$ each unit per power consumed; $U_R(q_1)$ and $U_F(q_2, q_3)$ are both consumer benefit functions. Then, the regulator maximizes the total social utility of the system (consumers utility plus companies’ profits), regarding that both monopolies’ and supplier’s profits are nonnegative

\[ \text{Maximize} \quad U_R(q_1) + U_F(q_2, q_3) - p_1 q_1 - p_2 q_2 - p_3 q_3 \]
\[ \text{subject to} \quad \pi_M = [T_M + s q_3] \geq 0 \]
\[ \pi_L = [p_3 q_3 - s q_3 - C_3] \geq 0. \]  

(5)

Equation (5) shows the regulator’s optimization problem. The first two lines of the objective function above show the consumer’s utility. The consumer’s utility is composed from benefit functions, minus payments to the companies $(p_1 q_1 - p_2 q_2 - p_3 q_3)$ and minus the regulator’s loss, valued in (4). The third line of the objective function shows the company’s profit functions: the monopoly’s profit $\pi_M$ and the supplier’s profit $\pi_L$. Optimization variables for this problem are competitive prices $(p_2, p_3)$, power amount transited $(q_1, q_2, q_3)$, and access price $s$.

If $U_R(q_1)$ and $U_F(q_2, q_3)$ are concave functions, and $C_1$ is convex, the solution of this maximization problem is given by the Ramsey–Boiteux equation (6). The numerical solution and a potential physical interpretation of this problem are mathematically very complex, and it is beyond the scope of this paper to develop them. However, the numerical solution of a similar problem is shown in [5]

\[ \frac{p_1 - c_1}{p_1} = \frac{\phi}{(1 + \phi) \eta_L} \]
\[ \frac{p_2 - c_2 - c_1}{p_2} = \frac{\phi}{(1 + \phi) \eta_2} \]
\[ \frac{p_3 - c_3 - c_4}{p_3} = \frac{\phi}{(1 + \phi) \eta_3} \]  

(6)

where $\eta_L$, $\eta_2$, and $\eta_3$ are, respectively, the price superelasticities of the demand functions involved. The superelasticity of a good is based on the traditional elasticity, but including cross elasticities arising from substitution and complementation of different goods [1].

An optimal access charge $s$ can be derived directly from the third Ramsey–Boiteux equation in (6). Considering perfect competition in the nonregulated customers market, then $\pi_L = 0$. This condition is reached when $s = p_3 - c_3$ [taking the second equation in (2) and using $C_3 = c_3 q_3$ from (1)]. Using $s = p_3 - c_3$ in the third equation in (6), the optimal access charge is given by

\[ s = c_1 + \frac{\phi}{(1 + \phi) \eta_3}. \]  

(7)

Due to the presence of the fixed cost $K_0$, the access price is higher than the marginal cost of investment, plus operation and maintenance of the distribution network ($\phi > 0, \eta_3 > 0$). So, optimal access pricing imposes a markup over the marginal cost of the network, which depends inversely on the elasticity of the demand functions and on the possibilities of substitution in the supply market.

Optimal access pricing theory does not depend on the model used to set regulated price $(p_1)$, which is calculated in an exogenous way [6]. Furthermore, the model works if regulated prices
are calculated within a price cap, like RPI-X, or with a yardstick competition scheme.

Even though optimal access pricing theory is exact respect to the strict assumptions presented, the practical usage of the model is extremely complicated, because of the estimation of demand elasticities. Moreover, electricity demand faces continuous distortions, which make estimation a very uncertain process. Therefore, considering the concepts arising from optimal access pricing model, as summarized in (7), the OFTEL scheme introduces a usage-based model that does not need any demand estimations.

Optimal access pricing (7) can be adapted to allow practical estimation of access price $s$, without using price elasticities. The term $\phi p_3/(1+\phi)q_3$ in (7) reflects the markup over the marginal investment, operation, and maintenance costs, due to the presence of fixed cost $K_0$. This markup can be expressed in practice by the use of variable profits, avoiding therefore the need to estimate elasticity demand. Taking $\pi_1^v, \pi_2^v$, and $\pi_3^v$ as the variable profits (without fixed costs) of the different companies and considering the same costs functions (1)

$$\pi_1^v = (p_1 - c_1)q_1$$
$$\pi_2^v = (p_2 - c_2 - c_1)q_2$$
$$\pi_3^v = (p_3 - c_3 - c_1)q_3.$$  

We replace the original markup with the portion of fixed cost assigned to the monopolist competitive activity, weighted through variable profits, i.e., taking the per-power-unit fixed cost assigned to the monopolist competitive activity ($K_0/q_2$) and prorating it among users of the network with variable profits. Then, the optimal access price formula (7) takes the following form, called the OFTEL Rule:

$$s = c_1 + \frac{K_0}{q_2} \left[ \frac{\pi_2^v}{\pi_1^v + \pi_2^v + \pi_3^v} \right].$$  

Equation (9) shows a usage-based cost function that is formed to value the access price and whose components are marginal and fixed costs needed by the monopolist to provide access. Variable profits, which can be evaluated using historical records, replace the shadow price $\phi/(1+\phi)$ and the superelasticity. As $s$ must set the marginal difference between commercialization’s price and costs (considering perfect competition and $\pi_L = 0$ as above), then $s = p_2 - c_3$. If the monopolist’s budget is balanced (profits cover fixed costs), then $\pi_1^v + \pi_2^v + \pi_3^v = K_0$, and the access price is set equal to $s = p_2 - c_2$. This means that the system is reaching the efficient component pricing rule (ECPR) [1].

The ECPR was proposed in [7] as a way to reflect proper opportunity costs when an independent regulator sets access monopolist charges. Basically, assuming strict market competition conditions, the ECPR rule establishes the access charge as the internal opportunity cost faced by the monopolist when using its own network [8]. This internal cost is valued as the difference between competition selling price and marginal costs, except the network ones, and is transferred directly to the network users as an access price $s = p_2 - c_2$.

In the OFTEL model, fixed costs are prorated among the different users of the system by the use of a profit estimation of the different segments involved. As the access charge $s$ depends directly on $\pi_2^v$, and $p_2 - c_2 = s$, it can be concluded that the access price in $t = 1$ depends on the access price in $t = 0$. Consequently, the OFTEL model must be introduced in a fixed-point process. Or, alternatively, the model can be established by using historical data or estimations about the profits, costs, and prices involved [1].

The practical application of the OFTEL model requires a strict accounting separation between distribution and commercialization activities from the monopolistic distribution company. Furthermore, this strict separation must focus on the costs incurred by the monopolist, whose interest goes on to the recognition of most costs as possible in the regulated sector, not facing therefore the risks imposed by competition activities. Moreover, the OFTEL model could reinforce a perverse behavior by the monopolist, who could internally raise the value of $\pi_2^v$, lowering exactly in the same amount the value of $\pi_1^v$. This internal cost transfer is not reflected in the monopolist’s profits, but it raises the value of the access charge (9). This behavior could set barriers to entry to the supply segment or may lead to the bankruptcy of the current supply companies. Therefore, when using the OFTEL model, the regulator must perform a strict auditing of the costs and profits presented by the monopoly and the competitive companies, preventing distorted policies arising from a bad regulation.

The distribution access charge model proposed in this work uses the OFTEL model to set a usage-based access charge that reflects the distribution company’s opportunity costs.

In the absence of suppliers, previous to introducing them as agents, it is impossible to estimate historical variable profits. Supposing, with no loss of generality, that in (9), $\pi_1^v + \pi_3^v = \pi_C^v$. This means all nonregulated customers are served by a unique supplier. Replacing in (9) we have

$$s = c_1 + \frac{K_0}{q_2} \left[ \frac{\pi_2^v}{\pi_1^v + \pi_2^v + \pi_3^v} \right].$$  

Then, to set access charge $s$, the objective is to estimate the profit ratio $[\pi_2^v/(\pi_2^v + \pi_C^v)]$, taking into account the absence of historical profit data. If the assumption is made that total marginal distribution costs are indifferent with respect to the type of client served (regulated or nonregulated), then profits, as a ratio, depend only on an income’s ratio. Then, taking $I_C$ and $I_1$ as regulated and nonregulated distribution historical incomes, respectively, then (10) becomes

$$s = c_1 + \frac{K_0}{q_2} \left[ \frac{I_1}{I_1 + I_C} \right].$$  

Equation (11) can then be used to set access charges using the OFTEL rule, considering no initial profit historical data and estimating costs markup as an income’s ratio. This model is used to set access charges in our case study, which is applied to the Chilean distribution tariff scheme.

III. DISTRIBUTION YARDSTICK COMPETITION SCHEME

Distribution-regulated tariffs based on a yardstick competition scheme consider a comparison between real companies and a model company, established by the regulator using typical distribution areas [2]. A model distribution company is set in each
typical area, determined by the optimization of a real company. The final costs arising from the model company, named *distribution added value*, are consolidated with regulated generation-transmission prices, conforming final tariffs for regulated customer. In this context, each distribution company’s profits are not assured, as they depend on its relative performance with respect to the model company. The regulator only assesses global performance of the distribution business, assuring some specific minimum return to the whole sector.

The main components of the distribution added value are [2]

1) fixed costs, which cover customer’s commercial attention costs and billing (they are independent from level of electricity consumption);
2) standard investment, operation; and maintenance costs;
3) distribution losses in power and energy.

Standard investment, operation, and maintenance (SIOM) costs are the most significant part of the distribution added value, and they are expressed per power unit ($ per kilowatt). The total model distribution company’s costs are divided by peak power demand, so that distribution added value emerges as an expression for medium costs, not marginal costs. In absence of particularly large economies of scale or scope, or extreme high consumption density, medium distribution costs are equal to marginal distribution costs [3]. Therefore, model companies are set in proper typical distribution areas, reflecting cost and consumption rate differences between real distribution companies.

The actual application of this scheme in South America considers assets valued through a new replacement value (NRV) method. Investment costs consider a 30-year duration and are annualized with a given discount rate. Asset valuation in the Chilean scheme considers NRV as the “cost to renew all assets, facilities, and physical goods, dedicated to provide the distribution service with the required quality” [2]. This concept involves a hybrid method, between substitution and replacement costs [3].

The Chilean yardstick competition tariff scheme appears as a hybrid method too, because it considers benchmarking of different companies, grouped in typical areas, but compared with a single model company per area. Therefore, regulation efforts are conducted to perform a horizontal benchmarking between heterogeneous companies, whose relative performance is compared with an integrated, efficient, model company.

**IV. MODEL APPLICATION: COST SEPARATION IN DISTRIBUTION AND SUPPLY**

This paper proposes a way to separate tariffs for regulated customers, assigning them to distribution (wire) and supply companies, depending on the usage nature of these costs. Only distribution wire costs conform the distribution access charge.

Fixed costs, as they reward commercial attention to customers, are completely allocated to supply companies. SIOM costs are prorated between both kinds of companies. These latter costs may be separated as follows.

1) *Distribution investment costs:* They are allocated entirely to the distribution business, as they reward present and future capital expenditure.

2) *Nondistribution investment costs:* They include buildings and equipment (e.g., offices and vehicles), some also used for commercial attention. Therefore, they are prorated among distribution and supply companies.

3) *Intangible costs and working capital:* These costs are calculated as a fixed percentage of investment costs.

4) *Operation and maintenance costs:* They are of a diverse nature, including both internal and external operation and maintenance costs (external costs arise from outsourcing activities). A model company must consider outsource activities only if they are the economical optimal solution. They are assigned to distribution companies, as they normally correspond to network costs.

5) *Distribution losses:* Technical losses are assigned to distribution companies, while losses arising from nonpaid bills are assigned to supply.

Fig. 1 illustrates the indicated cost separation scheme, with shared percentages reflecting the reality of the Chilean distribution business, determined after analyzing a sample of real companies. Intangibles and working capital are shared using the U.K. Office of Electricity and Gas Regulation’s (OFFER) numbers [4], assigning 90% of these costs to distribution companies.

**V. MODEL APPLICATION: MARGINAL AND FIXED COST ALLOCATION**

As described, the OFTEL model uses distribution marginal and fixed costs, and the proposed access charge model has to take medium distribution costs arising from the distribution added value and then split them into variable and fixed ones. Attention is focused to split SIOM costs, because the fixed costs of the distribution added value were already allocated in the supply activity, and distribution investment costs were allocated in the distribution activity. SIOM variable costs are those who directly depend on peak power transited, and the remaining costs are considered as fixed costs.

Table I illustrates the SIOM cost distribution for the Chilean distribution business, determined after analyzing a sample of real companies.
TABLE I

<table>
<thead>
<tr>
<th>Cost Item</th>
<th>Variable cost (%)</th>
<th>Fixed cost (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Distribution Investment</td>
<td>100</td>
<td>0</td>
</tr>
<tr>
<td>Nondistribution Investment</td>
<td>35.9</td>
<td>66.1</td>
</tr>
<tr>
<td>Working capital</td>
<td>50</td>
<td>50</td>
</tr>
<tr>
<td>Intangibles</td>
<td>0</td>
<td>100</td>
</tr>
<tr>
<td>Operation and maintenance</td>
<td>76.2</td>
<td>23.8</td>
</tr>
</tbody>
</table>

Nondistribution investment costs depending on power demand are 52% of communications equipment and laboratory equipment and 59% of computing equipment and storage costs. On the other side, vehicles, buildings, and ground costs are fully assigned as fixed costs.

Operation and maintenance costs, depending on demanded power, distribute 71% for own staff costs, 68% for outsourcing costs, and 61% for network equipment costs.

VI. CASE STUDY: APPLICATION OF THE OFTEL MODEL TO THE CHILEAN DISTRIBUTION BUSINESS

The distribution access charge model proposed in Section II uses the OFTEL model to set a usage-based access charge that reflects the distribution company’s opportunity costs. This model, reflected in (11), is applied to the Chilean case, using cost assumptions, therefore, described in Sections IV and V.

Variable SIOM costs described in last section are used as marginal access costs, while the remaining costs are used as fixed distribution costs. So, marginal and fixed access costs can be calculated from the distribution added value studies per typical area.

To apply (11) to the Chilean case, \( I_1/(I_1 + I_C) \) is defined as the income ratio. Furthermore, \( \eta = q_1/Q_T \) is defined as the power ratio. In Chile, \( Q_T \) is not often public information, even though the total amount of energy served usually configurers public information. So, taking \( E_T \) as the total annual amount of energy served per typical area, the load factor \( f_C \) is used to estimate \( Q_T \). Then, the OFTEL model expression used in this case study is

\[
s = c_1 + \frac{8700 \times f_C \cdot K_0}{E_T} \cdot \frac{1}{\eta} \left[ \frac{I_1}{I_1 + I_C} \right].
\]

(12)

Costs are calculated taking into account SIOM cost separation, per typical area. \( Q_T \) is the current peak power demand of the distribution company, which is estimated using \( E_T \) and \( f_C \). Power ratio \( \eta \) and income ratio \([I_1/(I_1 + I_C)]\) have to be estimated by analyzing data from real distribution companies.

Parameters are estimated by analyzing real Chilean distribution companies and five typical distribution areas used in the 2000 distribution pricing exercise (each area representing a different level of load density, dense urban, urban, urban-rural, rural). \( \eta \) is estimated by calculating the amount of power served to all customers with a connected power demand higher than 200 kW\(^2\). Income ratio is calculated by identifying, per distribution area, historical incomes of all customers with a connected power demand higher than 200 kW and under 200 kW. Table II shows income’s ratios and \( \eta \) for the five areas. The first distribution areas reflect industrialized highly populated urban zones, with important proportion of nonregulated customers. Distribution area 1 is Santiago, the capital and most industrialized sector in Chile.

Using the distribution added value costs, ratios from Table II, and (12), the resultant access prices for the Chilean distribution business are shown in Fig. 2 and are compared with the distribution added value regulated tariffs.

Every distribution area shows, under the OFTEL model, higher access prices than regulated distribution added values, in spite of minor costs involved\(^3\). This means that income ratios are greater than power ratios \( \eta \) for each area, as indicated in Table II.

The exercise shows that Chilean distribution companies access price could be higher than the regulated charge, because nonregulated customer profits reported to those companies are higher than regulated ones. Therefore, distribution networks have different opportunity costs, depending on the use of

\(^1\)Load factor is defined as \( Qm/QT \), where \( Qm \) is the average power supplied, which can be expressed as \( Qm = ET \cdot 8/7/60 \).

\(^2\)There are plans to only regulate final prices to customers under 200 kW; suppliers that must pay access charges will provide the rest.

\(^3\)The costs are minor because access costs include only 60% of nondistribution investment costs and 90% of intangibles and working capital costs.
them by distribution companies, who could earn higher profits supplying nonregulated customers. This assessment takes into account all estimations and assumptions made.

The obtained results are quite different among distribution areas, because of differences arising from historical data used. All optimal conditions taken by the model company and all density and costs characteristics of each area are reflected by the distribution added value costs. Additionally, this model reflects historical incomes and power served to each type of consumers. Therefore, important differences appear between distribution areas, depending on their own business characteristics, and those differences are directly transferred to supply companies, by charging an opportunity-cost-based access price.

VII. CASE STUDY: SENSITIVITY ANALYSIS

The proposed model is based upon several assumptions and estimations. Therefore, a sensitivity analysis is done to assess the effect in access charges to changes in parameters and cost components. The following values are reviewed:

1) Nondistribution investment costs (NDIC): Sixty percent was assigned to distribution activity (Fig. 1).
2) Investments discount rate, \( r \), was set to a fixed annual value of 10%. In Chile, it is set at 10% by the present regulation, but in other countries it is defined as a variable discount rate, depending on each company’s risk structure, using a capital asset pricing model.
3) Operation and maintenance (OM): One hundred percent was assigned to distribution activity (Fig. 1).
4) Operation and maintenance percentage assigned to distribution fixed costs was set to 23.8% (Table I).

Fig. 3 shows sensitivities of the access charge, for distribution area 1. Results are given as a percentage, with respect to the base case described in Section VI.

Access charges are not sensitive to nondistribution investments, with a 0.3% variation over the base case. However, changing the investment discount rate by 0.25% creates a 1% distortion in the access charge. Despite the important investment associated with distribution, its relative weight is diminished because of the long recovery period (30 years).

The access charges are very sensitive to OM annual costs. Access charges reduce 10% by assigning only 85% of the total OM costs to distribution activities. Moreover, as fixed costs \((K_0)\) are multiplied with income and power ratios, the variation in the percentage of OM assigned to fixed costs is amplified or diminished by those ratios. As an example, increasing OM costs allocated to fixed costs by 10% implies increasing by 5% the access charge. In distribution area 4, the same change implies a 12% variation of the access charge.

VIII. CASE STUDY: COHERENCY BETWEEN REGULATED TARIFFS AND ACCESS CHARGES

Access charges under the OFTEL model result in higher prices than for current regulated customers, as illustrated with the Chilean distribution areas. Therefore, to maintain a balanced budget for each distribution company, those higher access charges must lead to lower regulated prices. If this were not done, company profits would raise, and cross subsidies between different customers would arise.

To apply the proposed model to a distribution tariff yardstick scheme, access charges should necessarily be incorporated in the whole distribution added value process, resulting in an iterative calculation. The process should be as follows. Taking initial distribution added value costs and historical profit estimations, access charges are calculated using the OFTEL model, and regulated tariffs are set by the yardstick method. Then, total profits for distribution companies are estimated adding profits from both segments. Total profits are compared with an imposed offset profit \([2]\), set by the regulator, considering each company’s risk situation. Finally, if current profits do not fit into the offset profits, an iteration process begins by estimating new OFTEL formulas and profits. Fig. 4 shows the proposed iteration tariff model.

The OFTEL model has the disadvantage of expanding costs distortions cyclically over different regulation periods. If the regulator does not set correct distribution costs and profits in \( t = 0 \) (the first time the method is applied), incurred distortions are transferred, through OFTEL’s variable profits estimation, to the next regulation period in \( t = 1 \). Therefore, accurate cost and profit estimation is required when setting the first access charges, preventing market distortions that are transferred in the future time.

IX. CONCLUSION

Optimal distribution access pricing requests to allocate fixed costs among users of the distribution network, assigning therefore a markup over marginal distribution costs. However, difficulties in practical application of the optimal access price model leads to search for alternative models. This paper proposes a usage-based one, based on the OFTEL model.

Under yardstick competition distribution tariff schemes, access costs are incorporated in the final regulated charge, through the distribution added value process. A proposal is made to split the distribution added value costs, assigning them to distribution and supply companies, under strict accounting separation scenery. Most significant costs—distribution investment and operation and maintenance costs—are assigned...
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Fig. 4. Distribution tariff and access charge scheme.

completely to the distribution activity. Moreover, the distribution added value medium costs are assigned as variable and fixed costs, using the OFTEL model.

The OFTEL model is applied, as a case study, to the Chilean case using incomes and power ratios, which set the appropriate allocation of the fixed costs. Results, illustrated with simulations of the Chilean distribution business, lead to higher access charges than regulated ones, due to the higher opportunity cost of using distribution networks to supply nonregulated customers. Therefore, the value of the proposed model is mostly to set two efficiency signals: one provided by costs of the model company and another provided by the valuation of the real opportunity cost of using networks to supply different customers.

Sensitivity analysis reflects the significance of estimating precisely operation and maintenance variable and fixed costs, which are highly relevant for the final value of the access charge.

Finally, a proposal is made to include the OFTEL access charge model in the whole distribution tariff scheme, reaching therefore complete business efficiency.

It is important to state that the OFTEL model used in this paper is evaluated using a Yardstick competition scheme. Nevertheless, this approach can be also evaluated using any other regulated tariff scheme, like Price Cap. The use of the OFTEL model to set access charges is independent of the method used to set regulated charges, which is a clear advantage of the presented model.

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