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An Introduction to Financial and Economic Modeling for Utility Regulators

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1. Introduction

This paper provides an introduction to the design and use of financial and economic models that transparently quantify the impact of regulatory decisions. It draws on lessons from international experience in developed and developing countries in ordinary or extraordinary revisions and in the context of contract renegotiations.[1] The sample of experiences to draw from is still modest and growing slowly. During the 1990s, over 200 regulatory agencies have been created in developing countries as part of infrastructure restructuring. Many are yet to adopt transparent regulatory processes. Many more fail to rely on analytical frameworks capable of addressing the most common concerns included in regulators' mandates.

The most effective regulators in developing countries are following remarkably similar approaches. They essentially rely on "UK-type" regulatory processes adapted to local constraints and concerns. The main common element across "best practice" countries is the use of relatively simple quantitative models of operators' behavior and constraints to measure the impact of regulatory decisions on some key financial and economic indicators of concern to the operators, the users and the government.

Simplifying somewhat, these models force regulators to recognize that, in the long run, private operators need to at least cover their opportunity cost of capital, including the various types of risks specific to the country, the sector, or the projects with which they are involved. Because these variables change over time, scheduled revisions are needed to allow for adjustments in the key determinants of the rate of return of the operator. These revisions are a recognition of the fact that all these determinants--tariffs, subsidies, quality, investments and other service obligations--are interrelated and jointly determine the rate of return. At every revision, the rules of the game for the regulator are exactly the same: to figure out the changes in the cost of capital and to adjust the variables driving the rate of return to ensure that it continues to be consistent with the cost of capital.

These models have to be based on sound data collection processes for each of the key decision indicators. The most effective of these models draw on the information collected as part of the asset valuation process undertaken in the context of the "privatization" of a service.[2] This is the ideal base line. In practice, during the 1990s, few privatization commissions took these into account. In many cases, the consultants used to prepare the privatization did not even leave copies of the financial models they developed for the governments. This means that in many cases, regulators have had to start data collection efforts from scratch as part of tariff or contract revisions.

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[1] It also draws on the lessons from the development of macroeconomic accounting systems. It has always seemed strange to us that governments would consider normal the allocation of resources to generate macroeconomic accounts while doubting the value of generating similar accounts for the monitoring of public enterprises or for the regulation of privatized public services monopolies.

[2] Throughout the book the concept of privatization reflects a wide definition which covers actual sales of assets as well as concessions or licenses of services in which there is no initial transfer of property from the government to the operators.

If they can draw on reasonable data, these models do everything any financial model would do for the day-to-day management of a company but take a longer term view and include an explicit identification of the key regulatory instruments. They can monitor the consistency between cash flow generated by the business on the one hand and debt service and operational expense needs on the other to address the main concerns of the operators. They can also account for a large number of key policy factors including access and affordability concerns for various types of consumers. They generally account for the sensitivity of operators and users to various regulatory design options.

The rest of the paper is organized as follows. Section 2 offers a definition of regulatory models. Section 3 discusses the demand for regulation. Section 4 focuses on the need to match regulatory objectives and instruments. Section 5 reviews the main aspects of an operator's finances that the regulators are expected to understand and internalize in their monitoring of the effectiveness of the various instruments that address regulatory objectives. Section 6 concludes.

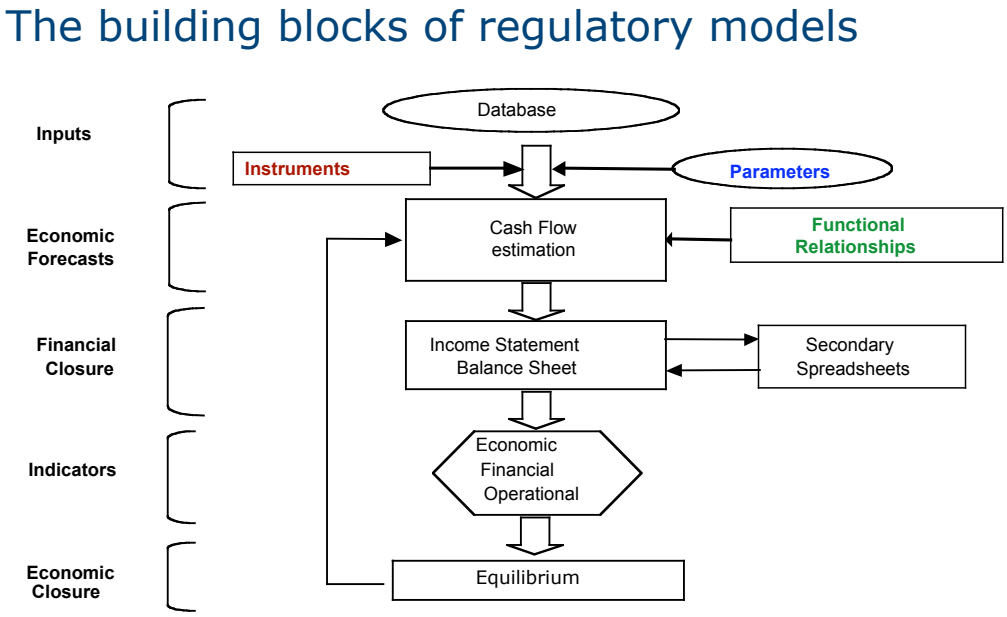
2. What Are Regulatory Models?

Regulatory models are essentially "improved" or "expanded" financial models designed to provide a rigorous analytical tool allowing regulators to address their most predictable concerns in a consistent way. They calculate the internal rate of return (just like a financial model would) accounting for all contractual constraints imposed on the operators. In particular, they allow the regulator to account for social concerns and for the behavior of the various agents. Unlike a typical financial mode, they also allow the simulation of the consequences of any policy or behavioral change on the various actors (users, operators and government).

However detailed these regulatory models are, they all follow a very similar structure across regulators, as summarized in Figure 1. Figure 1 shows that these models are built on an initial data base (summarizing the physical and financial performance of the company, including most of the accounting information regularly collected by the operator), an identification of the main regulatory instruments (e.g. tariff structure, quality options, investment speed and timing,..) and some economic parameters (e.g. demographic characteristics of the area of operation, macroeconomic indicators driving demand, efficiency levels, the sensitivity of users to changes in income and prices ....).

Next, they rely on explicit assessments of the expected impact on cash flows of the main actors' reaction (users and operators) to the regulatory instruments. This is done through an explicit modeling of the functional relations between consumption levels and instruments. The assessment of these reactions drives the financial equilibrium for the operator and can be done at a fairly detailed level for the main categories of costs and revenue.

Figure 1



Once the regulator has a good assessment of the operator's situation based on a larger set of performance indicators and the specific regulatory regime selected (price cap, profit sharing or rate of return), it can then assess the revenue it is going to allow the operator to collect through its tariff. The equilibrium tariff is the one that generates a net present value of 0 for the investment or the operation, which is equivalent to say that the internal rate of return (IRR) is equal to the firm's cost of capital (CoC). This assessment is driven by the cash flow forecast and builds it into the forecasted income statement of the operator through a complex set of modules. These sheets are use to generate the main monitoring indicators upon which a regulator needs to focus. Once these indicators are acceptable, the final average tariff is known. Agreement between operators and regulators usually requires multiple rounds of discussion but in each round, until convergence or until the regulator decides to stop the "negotiation", the process is exactly the same. The result is a continuous series of equilibria (between tariffs, investment, timing, aand al other contractual obligations). The regulator then has to decide which level maximizes the joint welfare of the primary stakeholders (users, government and firm).

This generic definition can be complemented by a brief summary of their contributions to the implementation of regulatory policies. They offer four main such contributions:

- **Quantitative rigor in regulatory assessments:** The models allow the regulators to avoid subjective or impressionistic assessments of the impact of their decisions. **"**What should be the impact of devaluation on a tariff?" is a question that requires an understanding of the financial structure of the company (how much foreign debt does it include) and which can only be usefully answered quantitatively. "What is the impact on the tariff of a change in the country risk premium in between two tariff revision periods?" is a no less demanding question in terms of numbers and is probably one of the most common questions regulators in developing countries need to be able to quantify. Without the rigor imposed by the kinds of models presented here, the responses to these questions are at best unreliable and are likely to be held in suspicion by both user and the regulated firm. The rigor of the results will be limited by the quality of data and robustness of the assumptions included in the model. But even with weak data and strong assumptions these models can give a good guide as to the sensitivity of the equilibrium to the use of different instruments as well as changes in the parameters. As such, the model also serves as a guide to where the main efforts have to be in terms of data collection and functional relations estimations.

- **Distinction between economic and financial concerns**: They allow the regulators to account for the financial and accounting concerns of the operators without having to give up on monitoring the wider concerns of society. The operator's investment decisions and the consumption decisions are endogenous. The models recognize that regulators may have to account for social concerns. They are designed to assess the trade-offs between various types of resource allocation problems and can also provide useful inputs into the fiscal budgetary process when subsidies are needed. All of these features make them more appropriate for the regulator's concerns than traditional financial models. We label them "quasi-economic" models because they still fall short of what economic models do for policymakers. For instance, they rely on market prices rather than shadow prices, ignore externalities such as the environment effects of operations and any other distortion on the factor or product markets. The reason for this is that there usually are no data available to quantify these economic effects, and in general, these impacts would be out of the scope of the regulator's responsibility. Nonetheless these models are flexible so if for any reason one would want to introduce any particular effect, it can be perfectly modeled.

- **Consistency in accounting for multiple concerns**: They force *consistent* quantifications of the financial and (quasi-)economic viewpoints of regulatory decisions. From a financial perspective, the regulator is asked to focus on synthetic indicators such as the cost of capital and the internal rate of return, or equivalent concepts and to understand the trade-offs of various regulatory or policy instrument combinations in terms of their impacts on these indicators. "How will a government's request to revise a contract in terms of investment levels or speed influence the profitability of the business and how should tariff levels be adjusted to restore the original profitability?" This is the kind of question that can only be answered by a model that recognizes all the interactions between the various decision variables. From an economic perspective, the main concerns of the regulator are to ensure the

continuity of the service, to achieve various types of efficiency (optimal resources allocation and costs minimization while ensuring that prices are consistent with costs) and to meet the political mandates in terms of social and redistributive concerns, if any. "Has the operator returned any of the benefits accrued from reducing operating costs to the consumers?" is an example of an efficiency concern that a regulator must grapple with. "How consistent with the poorest users' ability to pay are tariff adjustments to compensate for unexpected changes in the macroeconomic conditions?" is the sort of social concern that regulators must be able to address. The multiplicity of variables to be simultaneously taken into account is a major challenge which has not always been met by regulators. In many of these failures, the main victim is the one least capable of arguing its case. In practice, these are often the poorest users and it is not uncommon to see social concerns left out of the regulatory decision making process.

- **Transparency and accountability**: These models are also crucial in allowing better transparency in monitoring the behavior not only of the operators but also the regulators. They reduce the scope for corruption, collusion and capture or the appearance of those conflicts. At the very least, they significantly increase their costs. They ease the job of watchdogs to ensure that there are no abuses and that the expected gains from reform are indeed achieved and shared with the users. By increasing the transparency of the factors driving the allowed rate of return of the operator, ensuring that it covers the expected cost of capital of the company until the next tariff revision and by increasing the transparency of the factors that increase the operators' cost of doing business, the models provide a regulatory tool around which consultation processes can be organized. This is not to say that there will be no discussion. In fact, public hearings should facilitate the discussion of the main elements to be addressed by the model and give an opportunity for all actors to intervene. Ultimately, however, the regulator will usually have to decide on objective technical elements rather than subjective political grounds. This is what will make regulation fairer, more efficient and less subject to political interference and/or corruption and will eventually reduce the up to now high regulatory risks assessed by investors in public services in developing countries with the excessive opportunities for political interference. In this way, the model becomes an essential tool for explaining tariff increases or decreases, the rebalancing of rate structures or other sensitive decisions such as postponed investment targets.

Note that even the best regulatory models are by necessity simplifications of the interactions they are supposed to represent. The quality of the model depends on the strength of the assumptions of income and consumption profiles of the users or the ability of the operator to improve its efficiency. How robust these assumptions are, in turn, depends on the quality of the data available. Regulators should never forget that the data they need must match the goals of the model. The regulator must always arbitrate between the costs (imposed on the operator and the users) of generating more information and the benefits of doing so. In many countries, the preliminary information available is so limited that the initial assumptions used in the model have to be strong. As time goes by, the information asymmetry between regulators and operators shrinks and the importance of the

assumptions decreases likewise. The focus turns to medium to long run concerns and hence their data requirements are likely to be lower.

3. The Demand for Analytical Regulatory Processes

To assess more specifically what variables these models must account for, it is useful to understand the needs emerging from the demand side of regulation. The demand for regulation in industries operated by monopolies as expressed by the public at large generally tends to focus on a combination of current tariff and current service quality levels because these are the two main concerns of most users of public services. But there is more to it. Tariffs are an economic signal not only for users to decide on their levels of consumption but also for operators to decide how much and how fast to invest and for creditors to decide how much to lend to these operators. Tariffs also have a political dimension, which is one of the main constraints to many restructuring processes and is at the core of many conflicts during ordinary or extraordinary regulatory reviews. Tariff changes generally make the headlines of all the major media sources, not always fairly, in particular when no effort is made to provide analytically sound comparisons.

Many casual observers fail to see the linkages between today's tariffs, on the one hand and cost, quality, investment, social service obligations and tomorrow's tariff on the other. The type of models discussed here allow recognition of the linkages between these variables and, in fact, all other variables of importance to operators, users and government. Each of these is subject to implicit or explicit negotiations built into the regulatory process. The more analytical the interactions, the fairer the process.

To see this, it may be useful to think of the regulation of privatized infrastructure monopolies as a "game" among the service providers, the users and the government. The regulator is the referee and tries to enforce the rules of that game. In a nutshell, the rules of the game require that:

- the monopoly minimizes its costs, delivers on its service provision responsibilities and pays its liabilities to the government,
- all users (commercial, industrial, agricultural, and residential, as well as public sector users) see their demand met and pay their bills, and
- the government delivers on its commitments, whether financial (e.g. subsidies) or other (e.g. expropriations, contract enforcement, and non-interference in operations or regulatory decision making)

In addition, the regulator is expected to ensure that the gains from privatization are distributed fairly among operators, consumers and government. The stakes of this game are generally quite high. In Argentina's utilities privatization, the extra-income generated by the economy when the infrastructure sector is well regulated was assessed to at least 0.3% of GDP.[3] How fair the distribution of these kinds of gains is depends on the fine print in the regulator's rule book, meaning the specific design of the regulatory regime, the degree

[3] See Chisari, Estache and Romero (1999): "Winners and Losers of Argentina's Utilities Privatizations", World Bank Economic Review, vol. 2.

of independence from political interference with regulatory decisions or the degree of capture of the regulators by the operators, among other things.

In addition to the constraints imposed by this fine print, the regulator faces a very practical major problem: it has always less information than the private service providers on their performance, making any assessment of gains quite a challenge. Indeed, there is generally very little relevant historical data available from public enterprises from a regulatory perspective. In particular, detailed information about customers (e.g., consumption habits, ability and willingness to pay given tariff levels and even income levels of communities or households), detailed asset registries, or reliable depreciated asset values are often missing. Most of these data have to be generated during the design of the privatization and regulatory processes. The design of the "privatization" process should therefore ideally address the future information requirements of effective regulation of the new private monopoly. The regulatory processes should have been designed with the future information flows between regulators and operators specified as part of the contractual arrangements.

When this has not been done, information concerns appear as regulators prepare for their first tariff revision or in the context of a renegotiation. Formal information exchanges must be organized on processes, data and the timing of the interactions. These exchanges of information have to be built around the "analytical" framework used by regulators to make their decisions. It is designed to check for the internal consistency between all of the demands made by the government in the specification of the contract, the allowed tariff levels and structure and the financing requirements of the operators. What the model essentially does is ensure that the internal rate of return, or an equivalent concept, at least covers a reasonable assessment of the cost of capital of the operator.

While collecting information about the existing fixed assets, the likely demand of different categories of consumers at various tariff levels, and current and potential operating costs, the privatization team will build a model to estimate tariffs and test their ability to provide a fair return for operator given corresponding investment needs. The model should ideally be built by the privatization team at the outset of the reform and should then be passed on to the regulator, who is expected to maintain and update it. In these cases, the financial modeling of the initial transaction generates a useful baseline in terms of the base value of the assets owned by the monopolies at the beginning of the contract and sets up the future flows of incremental information (on investment, productivity gains, quality improvements, etc.) between the regulator and the concessionaires. This base value of the assets is critical in assisting future regulators to set price controls at periodic intervals throughout the concession period.[4] But it is clearly not enough and additional sources of information have to be built into the concessioning process.

The various ways in which information can and should be generated for the sake of transparency is emerging as one of the key outstanding concerns of regulators. The transparency of regulatory processes and educating the public at large, particularly the

[4] Of course, the larger the number of bidders, the better the information generated.

media, of its importance may be one of the major failures of the reforms implemented in the 1990s. Users forget how bad the services were before privatization, they forget rationing and they forget past prices. Unless there are constant reminders of the evolution of quality and prices and analytically sound indicators that track the evolution and show trade-offs, the regulatory process is subject to political manipulation of information. The models allow regulators to help the accountability of not only the players but also of the public. The regulators cannot forget, however, that some variables will always attract a greater attention and current tariff levels are often the main focus for very different reasons.

Indeed, if there is one thing that the 1990s experience with infrastructure reform teaches *politicians and casual observers* is that success is often perceived to be related to what happens to tariff levels. The need to cut costs, and hence tariffs, by increasing the productive efficiency of public services may have been one of the main reasons for the "privatization" and restructuring of the sector in the UK. The need to bring tariffs in line with costs to allow the financing of these services' operations and their expansion to a larger share of the population may have been one of the main goals of the reforms in Argentina, Chile, Bolivia and Peru. In some sectors, the cut in costs resulting from new management techniques or technology introduced by the private operators was sufficient to allow a tariff decline, even compared to the controlled tariff of the public enterprises that used to provide the services (as was the case for Argentina's gas and electricity sectors). In others cases, costs were cut but the initial controlled tariff levels were so far from even the lowest costs, that prices eventually had to be increased (as was the case for power in Peru or water in Bolivia). In the latter cases, the desirability of the reform was, and continues to be questioned by opponents, irrespective of the effective success achieved in terms of increased coverage, employment or quality.

What history also teaches *regulators* is that they cannot afford not to educate all parties on the mechanics of regulation. It is crucial for everyone involved to understand what drives tariffs, particularly that tariffs, including subsidies, must be in line with the cost imposed on the operators through various contractual obligations. When there is misalignment between the tariff and costs, it means one of two things: either the contract is too demanding or the government needs to co-finance the contractual obligations. From the regulator's viewpoint, this means is that the tariff regime defines the degree of government commitment to simultaneously address productive efficiency (cost minimization), allocative efficiency (the extent to which tariffs reflect costs), distributional concerns and fiscal concerns. In addition, its publicity/transparency and clarity reveals the government's commitment to regulatory accountability. [5]

Regulators should also learn from history that it is important for the media and the public at large to understand that tariffs are part of a larger picture. It is an important variable because of its immediate political visibility, but it is only one variable. It is important for all to see that just as the users' ability to pay is limited by their income, operators have an ability to produce that is limited by their ability to generate cash to

[5] We define the tariff regime as the set of rules that spells out the pricing rules (levels and structure) and all the additional norms that explain how the tariff levels and structures are set and can be changed.

service their debt and provide a reasonable return to equity holders. The main difference between the two is that operators and their creditors have alternatives whereas governments that have not managed to generate enough resources to finance the large investment needs of the public service sectors or have been unable to operate those services efficiently, will have to partner with the private sector. Regardless of the operator, average tariffs will have to cover all non-subsidized costs and generate a reasonable return. This means that social concerns cannot be addressed through direct control of average tariffs. They have to be tackled instead through the design of a tariff regime which includes tariff levels and structures to ensure that the operators of services with declining average costs can avoid losing money in their businesses as well as with specific rules for cost inputs, efficiency levels or access prices to common facilities.[6]

This analytical vision of the regulatory process begs for a matching analytical tool. All of the main concerns must be accounted for by the model if it is to help the regulator in ensuring that the trade-offs can be seen and understood by all. This is how the tools make all parties, regulators, users and operators, accountable. But before getting to the modeling, it may be useful to review the trade-offs.

4. Matching Regulatory Objectives and Instruments

Most regulatory regimes try to meet multiple objectives, the result of the multiple concerns government try to address simultaneously. It is not uncommon to find governments want to minimize simultaneously the fiscal costs of public services whole ensuring full coverage the population as quickly as possible at prices as low as possible. The ranking of these goals varies across countries and in many instances trade-offs are unavoidable. The regulatory challenge then becomes the need to consider various instrument combinations as a way of simultaneously meeting primary and secondary objectives or at least minimizing the need to face socially and politically difficult trade-offs.

4.1. Regulatory objectives

The main objectives regulators will generally have to focus on are:

- the *financial viability* of the operator: ultimately, if tariffs (including subsidies) do not cover costs, private operators will not be able to meet their service and investment obligations and potential entrants are unlikely to be interested. Most companies are

[6] We will not deal with all of these in this document. Efficiency levels and various concepts of cost benchmarking are discussed in Coelli, Estache, Perelman and Trujillo (2002) and access prices are discussed in Valetti and Estache (1998). This is a particularly important problem in the electricity sector. Indeed, generators, distributors and suppliers all need to rely on the distribution lines to supply electricity. In some countries, for instance, generators need them to deliver on contracts signed directly with large users. Similar problems arise in the telecommunications sector where long distance and portable service providers both need to access the local loops. Since competition in these services is impossible without access to the monopolistic facility, the problem of access prices and rules is vital to ensuring that the benefits of competition eventually reach the final users. This goes beyond the scope of matters we cover here.

willing to be in the red for the first few years after they take over the business, but for the short run only. The related indicators are the IRR, and returns over assets, equity and investments, debt coverage ratios and profitability...

- *productive efficiency*: this goal reflects the concern to push operators to minimize costs for a given level of production or to maximize production for a given level of inputs. One of the problems with rate of return regulation is that the regime itself does not promote cost minimization while price or revenue caps regimes are specifically designed to improve productive efficiency. Since they build in an incentive for the operator to avoid price cuts by hiding efficiency gains, information gathering becomes even more critical in these regimes. Related indicators are production or coverage levels for given input expenditure levels.
- *allocative efficiency:* this goal reflects the need to ensure that tariffs reflect marginal costs. There are, however, many distortions in the factor markets, limited credit markets, rigid labor markets and complex tax systems, all of which are completely beyond the control of the regulator. Related indicators reflect changes in the input or output mixes as a result of changes in input or output prices.
- *dynamic efficiency*: this is a more subtle goal in that it tries to ensure that the operator has an incentive to think of future users and invest accordingly. This reinforces the importance of ensuring that tariffs cover costs, including the cost of investments needed for future users. Related indicators establish a linkage between demand forecast and current investment levels.
- *distributional fairness*. This implies that tariff structures for each user type are consistent with the users' ability to pay. When the government cannot credibly commit to subsidies, regulators often rely on cross-subsidies aimed at helping the poorest users. Providing these users with service through cheaper technology or more modest quality standards may achieve the goal of fairness. Related indicators reflect the average service bill spend for each user type, classified per income group.

Box 1 shows how Argentina has clearly specified these economic goals in the legislation supporting the electricity distribution tariff, thereby clearly spelling out the mandate for regulators. It also illustrates the importance of trade-offs between all these objectives. For instance, Section d) of Article 40 aims at productive efficiency under a sustainability constraint. This is one of the many trade-offs that are likely to emerge.

Box I: Defining the Regulatory Objectives in the Legislation: The Case of Argentina's Electricity Distribution Tariffs

Law 24065 defining the Regulatory Framework for the Electricity Sector spells out a number of clear objectives the regulator will have to meet.

The sustainability goal is defined in sections a) and d) of article 40 of chapter 10 as follows:

> *The tariffs will provide the transmission and distribution companies behaving in an economic and prudent way with the opportunity to obtain enough revenue to cover reasonable operational costs related to the service, taxes, depreciation and a rate of return determined through processes in agreement with article 41 of this law.*

The allocative efficiency goal (that tariffs reflect costs) is spelled out in section b) of article 40 and says that tariffs:

> *Must take into account reasonable differences in costs between the various types of services, accounting for the form of service delivery, geographic location and any other characteristic the regulator may consider relevant.*

Finally, section d) of article 40 covers the productive efficiency goal (minimize costs) under a sustainability constraint (compatible with supply reliability):

> *Subject to compliance with the requirements specified in the previous sections ,the regulator must ensure a reasonable minimum cost to the users, consistent with the reliability of supply*

Fairness, from the viewpoint of non-discrimination, is reflected in article 44::

> *No transmission or distribution company will be allowed to differentiate its tariffs, charges, services or any other concept except when they are due to differences in location, service type or any other equivalent reason approved by the regulator.*

The social objectives, even if they are not included explicitly in the tariff sections of the law are addressed through the creation of the National Energy Fund (article 70) whose main objective is to transparently subsidize the access and use of electricity in the country.

In general, the primary trade-offs are found in the consideration of the following objectives:

- *Sustainability and efficiency,*
- *Efficiency and fairness,*
- *Sustainability and fairness*

*Sustainability and efficiency. Ma*rginal cost pricing is no longer the exclusive concern when asking the private sector to finance investment, due to the frequent changes in the financing costs of the operator. At every tariff revision, the regulator will have to ensure that the prices are consistent with the need to recognize the consequences for the financial viability of the operator of fluctuations in global financial markets. This is particularly important in countries where the long term borrowing capacity is limited because of weak credit markets. Most borrowing is short term and therefore short term fluctuations have immediate impacts on the financial state of the operator. This needs to impact the average level just as much as the concern for efficiency revealed by the usual emphasis on long run marginal cost pricing.

Efficiency and fairness. There are two main types of trade-offs related to efficiency and fairness. The first is due to the well-known efficiency consequences of the use of price discrimination in favor of the poor to achieve equity concerns. Cross subsidies have long been criticized for this specific reason. Many governments adopt it when their ability to finance direct subsidies is limited. In that context, cross-subsidies may indeed be unavoidable. What governments often forget is that each design will have different efficiency effects. The second trade-off is consistency in the allocation of efficiency gains between users and operators, where the incentive of the operator is to maximize these efficiency gains. The strength of the incentive for firms to cut costs is related to the share of the savings it is allowed to appropriate. If all gains must immediately be passed on to the users, there is no incentive for firms to cut costs, since cost-cutting frequently has a high initial costly expense (staff, equipment, investments). At the other extreme, allowing the firm to keep all efficiency gains achieved in the delivery of a monopolistic public service is both socially and politically untenable and defeats the purpose of public utility regulation. Efficiency gains will eventually have to be shared with the users through a combination of lower tariffs and better service quality.

Sustainability and fairness: Historic subsidy levels may not be consistent with the desire to guarantee the operator's financial viability. The transition from public to private provision of infrastructure services often implies a review of many of the historic subsidy levels and designs tolerated under soft budget constraints for public enterprises. Once a private operator takes over, the cost of subsidies becomes a much more serious issue and the concern for its financial sustainability forces the regulators to rethink subsidy levels and structures. The "privatization" process may force decisions about politically sensitive trade-offs.

The existence of these trade-offs and the related political sensitivities imply that regulatory regimes must fit into more formal processes to ensure their political acceptance and long run sustainability. Typically, these concerns center around processes and accountability. Regulatory regimes must be simple, justifiable and publicly justified, transparent, non-conflictive (they enjoy wide acceptance by the majority of actors), and fair in the allocation of total costs. They must also avoid both unjustified price discrimination and excessively fluctuating price levels. It is too often forgotten that models such as those described here are not only instruments to check the quantitative consistency

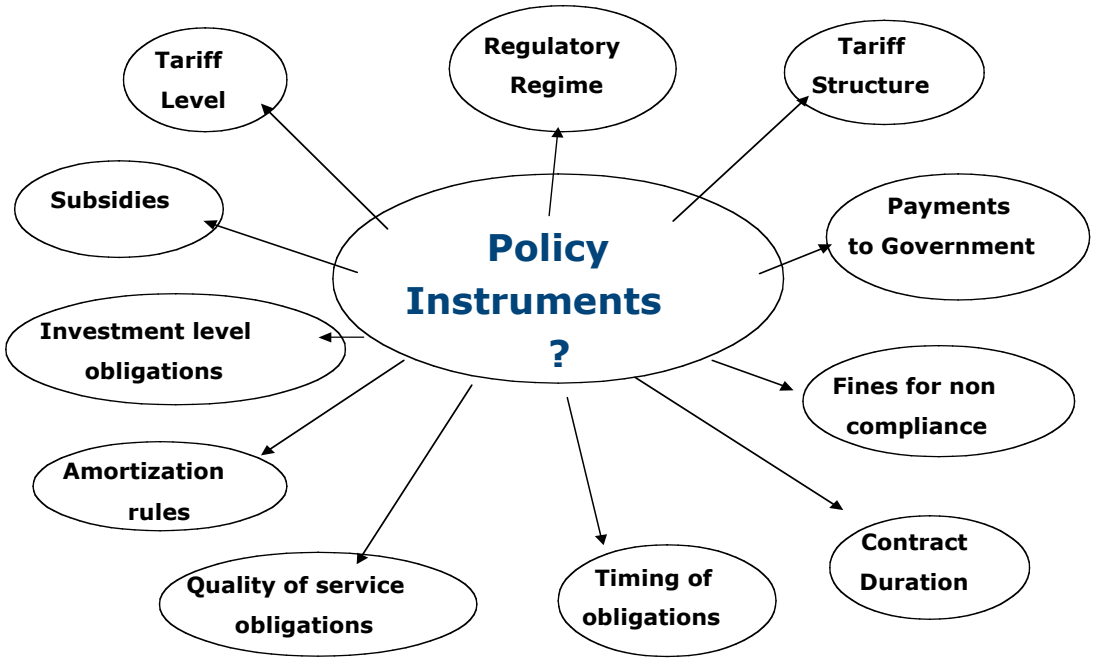
but also the key to accountable and acceptable processes that ensure the long run viability of reforms. The transparency contribution of the use of models is particularly important when trade-offs between objectives have highly-differentiated consequences for each interest group.

4.2. Regulatory Instruments

To achieve any combination of regulatory objectives, the regulator can pick from a wide set of specific instruments. Figure 2 provides a visual description of this diversity. The instruments listed in this figure can be aggregated into three broad categories:

- Regulatory regime
- Contractual obligations
- Tariff level and design

Figure 2: The main policy instruments for regulators



While these instruments are interrelated through their financial impact on the firm, they can initially be analyzed into these three above mentioned categories.

4.2.1. Regulation

There are three main types of regulation:

- Cost of service or Rate of Return,
- Price or revenue caps, and
- Hybrids.

Cost of service or rate of return. This essentially consists of fixing an upper limit on the mark-up allowed on costs, or equivalently, on the rate of return on the regulated firm's assets, accounting for the financial sustainability objective of the firm. The main responsibilities of the regulator are: to assess the various components of the total cost of providing the regulated service, to match these with the various categories of users and to then assess the tariff for each user group, accounting for their unique demand characteristics. This implies that the regulator has a good grasp of cost drivers and the demand side.

Tariff revisions are implicitly endogenous. If the actual rate of return grows significantly apart from the authorized rate of return due to changes in costs, a revision will be needed. This implies that the operator faces little risk to the extent that it knows that any shock to its costs will quickly be passed on to users through tariff adjustments. The main drawback of this approach is that it gives little incentive to the operator to cut costs. In fact, to the contrary, it may give an incentive to overinvest, including in quality, since costs will be reimbursed.

Price or revenue cap. This essentially consists of setting an upper limit to the average tariff for a service or the revenue that can be generated by that service. This is essentially done as follows. At the beginning of period *"t",* each operator sets its average tariff based on the expected inflation and on the expected efficiency gain set by the regulator. The main idea is to provide an incentive to the firm to cut costs and improve productive efficiency above the levels set by the regulator when calculating the cap. The larger the wedge between the cap and the realized cost, the larger the profit rate. The payoff from an increase in that wedge is what drives the operator's incentive to cut costs. The regulator generally sets minimum cost reduction targets expressed in terms of expected efficiency gains built in the specification of the price cap—this is the X in the generic RPI-X formula, where RPI is a retail or wholesale price index to ensure that the cap stays constant in real terms. The implementation of the formula tends to vary across countries and sectors. For instance, in its original design, in the UK, the adjustment applied to a basket of goods and services, while in Latin America, the cap tends to be set for each good and service.

Whatever the specific form adopted, the cap setting follows very similar models around the world. In the short run, the regulator can set caps based on best international benchmarks—(accounting for any relevant local cost or demand characteristics), in the medium run, the regulator needs to know how far off the operator's costs are from the best benchmarks and how fast the operator can catch up. This is why both the operator's cost

and the international cost benchmarks must be monitored by the regulator. In a sense, this behavior allows the regulator to mimic competition in the market. It is not an easy task. Setting the cap too high may allow the operator to enjoy rents equivalent to those achieved by monopolies well beyond what is necessary to provide the stimulus to cut costs. The challenge is to set a tariff that ensures cash flows that are consistent with a reasonable rate of return on assets, and compensate for prudent and efficient operational and financial expenditures.

Tariff revisions in which new caps are set are scheduled to take place every 4-5 years. They are largely exogenous to the behavior of the firm. They are designed to redistribute some or all of the realized cost savings/efficiency gains to the users. This is a data intensive process that takes about two years to prepare. There are two noteworthy problems with this type of regime. The first is that it is important for the regulator to monitor quality since one easy way of cutting costs is to cut investment in quality. More generally, this stems from an incentive to game investment strategies with a view to cut costs or to misclassify maintenance cost as investments to meet the contractual obligation without delivering on the investment. The second problem with this form of regulation is that it places all of the business risk on the operators. This means that in countries which are inherently risky, this form of regulation can become an impediment to investment simply because it adds to the overall risk level.

Hybrid regimes. In between these two regimes, there is a large number of intermediary solutions used in practice that add some guaranteed reimbursement to incentive-based regimes or that add incentives to some cost-based regimes. The most common is a price cap with automatic pass-through of some costs to users. Under this regime, some of the costs which are not under the control of the operator are excluded from the cap formula. Any increase in these costs is automatically passed on to the users through a tariff increase. In electricity or gas distribution for instance, the variability of generation prices and the inability of the distribution companies to do much about it (if they are not vertically integrated) explains why pass-through are efficient.

The general formula for this kind of regime is:

$$T_t = \alpha C^* + (1 - \alpha)\hat{C}$$

where Tt tariff for the service,

α share of cost subject to caps; it varies from 0 to 1; if α=0, the regime is a price cap regime; if α=1, it is cost-plus regime,

$\hat{C}$ costs subject to a cap, and

C^* costs that can be shifted to users

The adoption of a hybrid regime (with $0 < \alpha < 1$) is generally justified by the existence of costs that the operators cannot control combined with the need to introduce incentives. The more volatile or unpredictable these uncontrolled costs, the more important

it is to adopt a regime that reduces the operator's risks. Each specific hybrid regime design decides how much of this uncertainty can be passed on to users. An alternative is to rely on guarantees or subsidies, in which case the taxpayer ends up taking on part of the risk. Choosing between one approach or the other depends on the users' ability to pay or the government's willingness to shift service investment obligations from consumers to taxpayers.

Up to now the discussion has somewhat ignored the existence of inflation. In practice, of course, a major variable is the indexation rule adopted. The main purpose is to ensure that income and costs are recognized in real terms so that tariffs can be also predicted in real terms and inflation does not have efficiency, equity or sustainability effects. The measurement of inflation, the base year, and its periodicity are crucial in this context.

4.2.2. Contractual Obligations

The contractual obligations of the operator can be aggregated into three main types:

- Investment levels and timing,
- Quality levels, and
- Contract duration and termination rules

Investment levels and timing. Since in many countries the main purpose of looking for private partners in the delivery of public services is the need to gain access to their ability to finance investments, a major concern for regulators is to ensure that any investment commitment related to the partnership is enforced. In many contracts, the privatization teams prefer to set output targets such as connection rates rather an investment target. Whether directly or indirectly, investment levels are viewed as an instrument to achieve coverage goals. The related amortization rules are one of the most complex matters in the practice of regulation and are often a major source of conflict. Its definition and design have major effects on the incentive to invest and on the investment timing.

In many cases also, the timing of the investment is seen by politicians as a very effective instrument to be coordinated with election cycles. What most of them forget is that the timing of investments matters to cash flows and hence to the tariff levels needed to ensure the financial viability of the firm and the users' ability to pay. The rule of thumb to remember is that the faster the investment, the higher the tariff levels—although there is generally not a perfect correlation since faster investments may also lead to new revenue sources or more efficient operations.

Quality. As mentioned earlier, the regulatory regime has an impact on optimal quality levels. Cost-plus regimes lead to over-investment in quality, price caps to under-investment. One way for the regulator to offset the perverse incentives built in the regulatory regime is to set caps or floors on quality, as appropriate. It is important however to recognize the various dimensions of quality. Technical standards are the best known form of quality. Service quality is as important and can be used by operators to cut costs

just as effectively. Both deserve the full attention of the regulator and can be seen as regulatory instruments. A related instrument is the level of fines associated with quality violations. The correct use of these instruments requires an appropriate modeling of the relationship between quality and costs (investments, O&M,..). This is important when analyzing the consistency between authorized tariffs and quality requirements and the way in which fines maintain the incentive of the operator to respect this consistency.

Contract duration and termination rules. In view of the long construction periods and the long life and specificity of the assets in the sectors covered here, contract duration and termination rules are quite important to model. The operators need to have enough time to recover their investments and be clear about amortization rules and the rules for transferring or selling non-amortized investments at the end of the contract duration. Unclear or unfavorable rules may suppress any incentive to invest too close to the end of the contract period. Good rules are built into the costs and cash flows are monitored for the computation of tariffs.

4.2.3. Tariff level and structure

Tariff issues emerge in two dimensions: levels and structure. Ultimately, all of the main regulatory concerns will have to be reflected in the average tariff level. This level is computed as the tariff that allows the operator to break even under an allowed rate of return. In addition to this reasonable rate of return, it accounts for the invested capital assessed at reasonable values and for reasonable expected efficiency gains all of which are the responsibility of the regulator. The preparation of this information must rely on a clear accounting separation of regulated and unregulated activities and on a good understanding of the client basis. Regulators must be able to answer related questions such as “do the operators have captive users?, do they know the ability of the poorest users to pay?.

This design of the tariff structure is a complex and often an-underestimated matter. It can be left to the operator to decide on its implementation. Alternatively, it can based on guidelines provided by the regulator. The structure may be differentiated in many ways: across clients, regions, between fixed and variable costs, or according to the consumption level. This is why the type and degree of cross-subsidies a regulator may be willing to consider and endorse in its efforts to accommodate both fiscal and distributional as the cost of some inefficiencies is a particularly important problem worth discussing in the context of the modeling exercise presented here.

The social concerns guidelines are often adopted because a regulator or an operator focusing only on setting efficient tariff levels (following a structure close to the one that would emerge from Ramsey pricing) may hurt those with the least elastic demand, which turns out to be the poor or large users with alternative sources of service.[7] Allowing the regulator to simulate various types of tariff structures to account for various social concerns is one of the most important uses of the regulatory model. This implies that the

[7] These may include auto-generation in power or direct purchasing from generating companies in unbundled systems. For water, large users may also self-provide through their own wells, pumps, treatment equipment or desalination plants.

model must be based on a fairly disaggregated tariff structure and a good modeling of user groups and characteristics, including demand.

4.3. Matching Instruments with Objectives

There is a reasonably close relation between various goals and instruments, which can be summarized as follows:

- Sustainability ⇔ tariff levels, subsidies and regulatory regime;
- Allocative efficiency ⇔ the tariff structure;
- Productive efficiency ⇔ the regulatory regime;
- Fairness ⇔ tariff structure and various contractual obligations, including investment levels, speed and quality, as well as the regulatory regime.

It should be clear by now that the financial sustainability of the operator is driven mainly by the average tariff level. This tariff level should allow an efficient firm to cover its costs and achieve a reasonable rate of return. If the tariff level does not cover costs, subsidies will be a complementary option. However, their design may have an impact on allocative efficiency since they may change the relative price between regulated and unregulated activities. In highly unpredictable markets, the relationship between the level of risk and tariff levels is driven by the regulatory regime. Price caps in highly volatile environments combined by excessively spaced tariff revisions may result in financial unsustainability for the operator.

Within regulated activities, allocative efficiency is essentially influenced by the tariff structure. Unless the structure is closely (negatively) related to the demand elasticity of the various users, allocative efficiency is distorted. There are many ways of creating this distortion, as discussed earlier. Many of the structural designs, however, may reflect social concerns, revealing a major trade-off between these two regulatory objectives.

Next, the tariff level allowed for sustainability has to be consistent with the desire to achieve productive efficiency (the recovery of efficient costs). The incentive to minimize costs is essentially determined by the design of the regulatory regime, as seen earlier. Price caps are more likely to achieve productive efficiency.

Finally, fairness is clearly associated with the design of the tariff structure since, in addition to subsidies, it is the main mechanism used to match prices with ability to pay. The regulatory regime also matters however in a more subtle way since it drives the relationship between the level of risk and tariff levels. Cost-plus regimes in highly volatile environments combined with excessively spaced tariff revisions may result in frequent price increases which may not be consistent with some of the users' ability to pay.

5. What regulators need to know about the operator's finance

Ultimately, what the regulator does is identify a tariff level that will generate a cash flow consistent with the valuation of the firm, which in turn must be consistent with the firm's opportunity cost of capital. In other words, the regulator needs to focus on two main groups of indicators: (i) the cost of capital, which is a hurdle rate to decide if a tariff level is reasonable or not; and, (ii) the cash flows of the firm, which are used to assess the firm's internal rate of return. The ideal regulatory situation is one in which the tariff is set so that a project/concession's internal rate of return is equal to the cost of capital. For the project to be attractive to a private operator, the internal rate of return of the project must be at least equal to this cost of capital. When the cost of capital is larger than the internal rate of return, the net present value of the project is negative. We next analyze these concepts in some detail.

5.1. The WACC or cost of capital (CoC)

From an economic viewpoint, the WACC represents the fair rate of return to a company. Its determination is one of the main concerns of a regulator when preparing for a tariff setting or revision.

The discussion of its computation is adapted to LDC's concerns and constraints. The general formula is:

$$r_c = r_e \frac{E}{E+D} + r_d(1 - t_c)\frac{D}{E+D}$$

where r_c is the cost of capital for the assets of the regulated operator, r_e is the opportunity cost of equity, r_d is the nominal cost of debt, t_c is the corporate income tax rate, E is the degree of capitalization of the firm or its equity level, D is the market value of its net debt and $E+D$ is the value of the firm's assets.

The estimation of the cost of equity is usually based on an adaptation of the Capital Asset Pricing Model (CAPM) to reflect some of the realities of developed economies. Simplifying somewhat, it is the sum of three components: the first two are the same as in developed countries (the rate of return on a risk-free asset and the risk premium specific to the firm or the sector, reflecting the quality of the restructuring or regulation), and the third is a country-specific risk (CR):

$$r_e = r_f + \beta_e(r_m - r_f) + CR$$

where r_f represents the return on a risk-free asset, r_m is the return on a diversified portfolio in a developed country, and the difference $(r_m - r_f)$ constitutes the systematic

market risk or the undiversifiable risk and ρ_e represents the correlation between the firm's risk and the market risk and is influenced by the regulatory regime

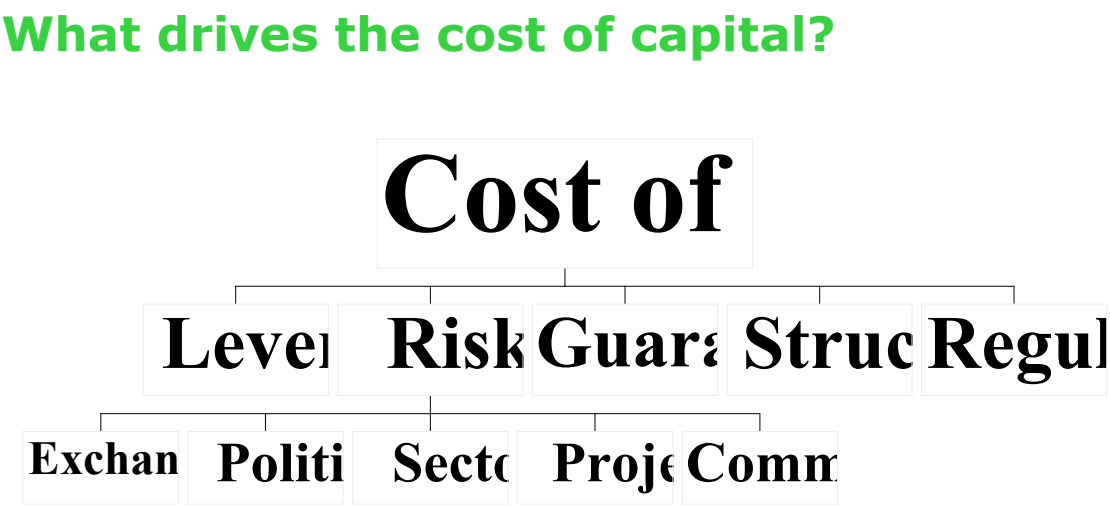
Similarly, the cost of debt now needs to reflect CR as well:

$$r_d = r_f + CR$$

Typically, assuming that large public utilities have good credit rating, the cost of debt can be approximated by the return on public bonds in the country.

Figure 3 shows the main factors driving the cost of capital. It provides a more complex picture than the simplified analytical framework presented here with respect to risk. Indeed, country risk is driven by many factors, including exchange rate and political risks, among others for instance. Analysts often consider those in isolated ways when assessing the risk premia to be assigned to a country.

Figure 3:



5.2. The internal rate of return (IRR)

To be able to assess the internal rate of return, the regulator must know what drives the value of the assets used by the firm, which implies that it must be able to forecast cash flows. We review here the various ways in which cash flows can be assessed:

- *equity cash flow,*
- *capital cash flow, and*
- *free cash flow*.

All concepts start from an assessment of operational cash flows:

Operational Revenue - Operational Costs - Provision for unrecoverable [8]

= Earnings before interests, taxes, depreciation and amortization (EBITDA)

also,

EBITDA *– Investments - Changes in working capital*

= Operational Cash Flow (OCF)

This formula shows that the OCF represents the net flow of funds collected by the firm in each period. It is clear that the regulated tariff is a key determinant of this cash flow as well as any regulatory measure influencing costs. All other cash flow concepts build on this one accounting for various aspects of the financing structure of the firm.

5.2.1. Equity cash flow

Equity cash flow focuses on the cash flow available to the shareholders in each period, once the firm has met all of its commitments to its creditors. This measure is used to assess the profitability of the firm's stocks:

Operational Cash Flow (OCF) - Cash Flow for debt service = Equity ***Cash Flow***

5.2.2. Capital cash flow

Capital cash flow focuses on the cash flow available to both shareholders and creditors. It provides an overview of the value of the firm. It is measured as follows:

[8] This provision is somewhat included in the operational costs.

Operational Cash Flow – Taxes

*[where Taxes = (tc * earnings before taxes or EBT)]*

= Capital Cash Flow

Taxes are calculated by applying the tax rate *tc* on the earning before taxes. In this method, tax savings due to interest payments are deducted from taxable income.

5.2.3. Free cash flow

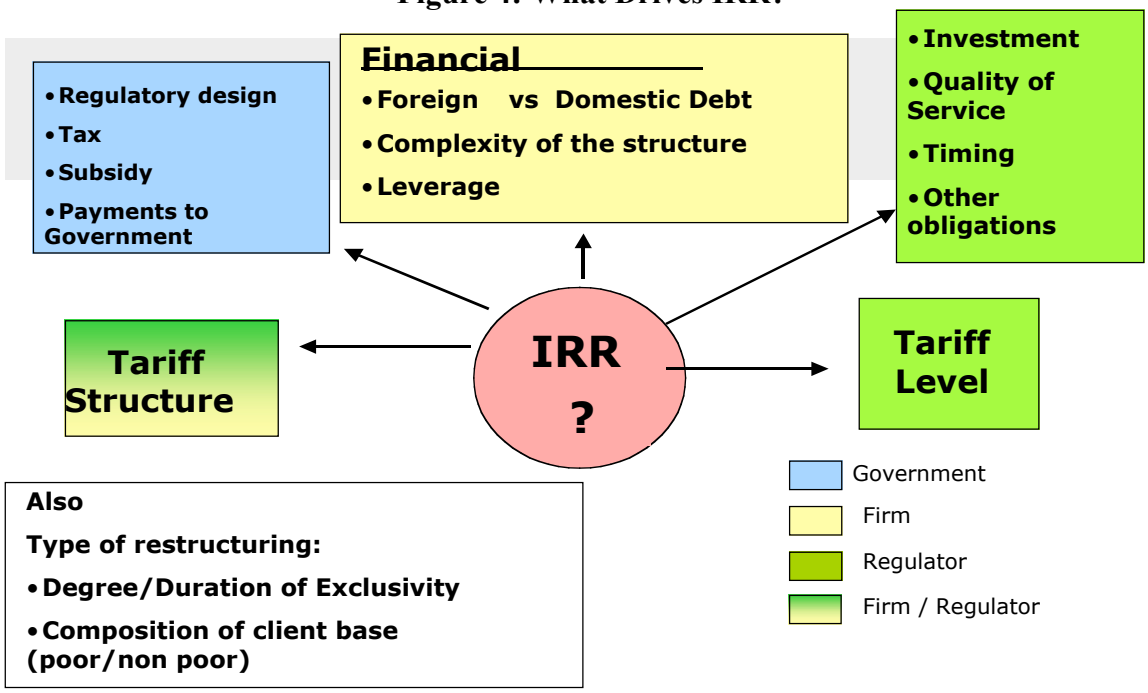
Among regulated firms, the most common approach to valuation is Free Cash Flow. Similar to the capital cash flow, the focus is on the cash flows available to both shareholders and creditors. The main difference is that the tax savings from interest payments are included in the discount rate rather than in the effective tax liabilities of the firm. This is done as follows:

*Operational Cash Flow – Taxes where Taxes = [tc * (EBT + Interests)]*

= Free cash flow

Figure 4 provides a visual representation of the key factors driving cash flows and hence IRR. The figure also illustrates the fact that not all sources of cash flow fluctuations are driven by the operator or the regulator. They share the responsibility of influencing the IRR.

Figure 4: What Drives IRR?



5.3. The relationship between IRR and the CoC

At the beginning of the process, the discount rate used to calculate the net present value of the cash flow is the weighted average cost of capital (WACC) discussed earlier. The appropriate average tariff is the one that ensures a net present value of zero at that discount rate. Any change in the operational conditions or to the cost of capital will result in an imbalance between the internal rate of return and the cost of capital. If this is a structural change, the scheduled, and sometimes unscheduled, tariff revisions will be designed to restore the equilibrium.

5.4. Accounting for inflation.

A first decision to take in developing an economic and financial model is to decide whether forecasts will be made in nominal or real terms. Since much of the exercise consists of forecasting expenditures and revenue that combine both volume and prices, when working in nominal terms, it is important to also forecast inflation. This forecast can then be included in all cash flows and the discount rate. The relationship between real and nominal cash flow is then represented as follows:

$$RealCashFlow_t = \frac{Nominal\ Cash\ Flow_t}{(1+\square)^t}$$

As for the discount rate, the adjustment is done as follows:

$$(1 + r_r) = \frac{(1 + r_n)}{(1 + \pi)}$$

where r_r represents the discount rate in real terms and r_n in nominal terms.

In the model presented here, the estimation of the cash flow is done in real terms at the initial price level. This is the easiest solution to not have to deal with possible differentiated forecasts for costs and revenue. The only variables initially estimated in nominal terms and then deflated are the financial variables, since financial markets work in nominal terms. The main difficulties arise in addressing those variables for which inflation is not neutral. Tax liabilities are a common example. The way most countries handle inflation in the tax code implies that regulators are likely to overestimate cash flows and hence the value of the firm. Another problem with this approach is that the financial statements reflect historical costs rather than replacement costs. This may also lead to distortions in asset valuation.

5.5 Accounting for the effects of the exchange rate

An important issue to consider when developing this kind of models is related to the exchange rate and the effects of its variations on the economic forecasts and, consequently, on the firm's cash flow. Several effects can take place, among others: from an operational point of view, costs and investments in regulated industries usually have imported components. On the other hand, from a financial point of view, these firms usually take debt in foreign currency. Additionally, fluctuations of the exchange rate affect the domestic inflation and, therefore, the cash flow. It is important to be able to assess the effects of a devaluation through different assumptions about: the proportion of costs and investment components affected by the exchange rate, the effects of the exchange rate on inflation, the share of asset base acknowledged in foreign currency and the firm's proportion of foreign debt, among others.

5.6. Accounting for other idiosyncrasies.

There are a number of additional considerations worth mentioning. The first is that obviously not all countries have the same accounting practices. This means that the regulators must be quite careful when learning from each other's experiences. Related to this is the fact that tax systems are also country-specific and international comparisons are rendered difficult as a result. A third major concern is that every sector has its own idiosyncrasies. The modelers must know very well the sectors they are working on. This means both on the engineering side to model the cost structure and on the economic side to model the demand. The demand is particularly important when modeling the tariff structure.

6. Conclusions

In the processes of utilities privatization, ordinary and extraordinary tariff revisions or contract renegotiations, the Regulator always arbitrates between the interests of the various actors –such as users, operators and government- who participate directly in the service and has to achieve certain goals using the available regulatory instruments. The multiplicity of variables and interests that simultaneously take part in such processes require that they are performed within an integral, consistent and transparent analytical framework capable of quantifying the impact of regulatory decisions.

The integrity of the process implies that the Regulator carries out the analysis through indicators which account for the economic, financial and operating performance of the firm and, for this purpose then, the Regulator needs to consider all the variables affecting the economic equation, the minimum needs of finance and the operator's operating conditions at the same time.

The transparency of a regulatory process is reflected when all the relevant factors affecting the economic and financial variables of service provision are accounted for and participants have access to such information.

The consistency of the analysis requires that all the variables affecting the indicators which show the operator's performance are combined in such a way that properly represents the behavior of market participants as well as sector, (quasi)economic and financial relations and constrains. This guarantees that the implementation of regulatory instruments has a quantitative effect which reflects the actual situation of the concession under study.

For the regulatory process to meet these characteristics, it may be performed through the implementation of a regulatory model which combines the variables describing the initial condition of the service, the objectives and the regulatory instruments. Thus, the model represents the tool allowing the Regulator to simulate, analyze the sensitivity and set new scenarios in relation to the future evolution of service provision under a scheme of rigorous quantification that, also, prevents the introduction of factors which would turn the results subjective. The model presented here can perform all the functions that any financial model of a firm would perform but it is designed with a longer term view and includes an explicit identification of the key regulatory instruments. Thus, one of the elements to be taken into account by the Regulator is that service provision requires that the firm get enough revenues to cover operating costs, investments on fixed assets and working capital and to obtain a return equivalent to the opportunity cost of capital. For this purpose, the model forecasts the net cash flow and the IRR of the business which is then compared to the cost of capital to get the value that the regulatory instruments should take in order to meet sustainability of service provision. Moreover, the model also includes in the forecasted financial statements, the key indicators to analyze the financial viability of the business, which is also to be considered in the regulatory process.

Although a regulatory model represents a tool allowing the development of an appropriate regulatory process, it also poses, at least, two important challenges to regulators. The first is that it is necessary to use uniform quantifications of (quasi)economic and financial perspectives of regulatory decisions. Then, the regulator is asked to focus on the analysis of a group of variables such as the cost of capital and the internal rate of return as well as to fully understand the economic and financial concepts generating the trade-offs of various regulatory and policy instrument combinations in terms of their impacts on these indicators. The other challenge arising out of the implementation of a regulatory model lies on the fact that the quality of the results will depend, basically, on the quality of the data used. This requires the regulator to generate a set of data including quantification of the capital asset, information on the service supply and demand and financial information. Said data should have a structure consistent with the model requirements.

Finally, from a practical point of view, it is important to bear in mind that the analysis that can be performed with a regulatory model has certain limitations. The most important limitation arises from the imposition of using spreadsheets, although the development of software programs has remarkably broadened the spectrum of the analysis to be carried out with them. On the other hand, it should be remembered that the implementation of a model appears as a way to represent the reality under analysis in a simplified manner. Therefore, the simplicity in operating the model, on the one hand, and the degree of disaggregation of the variables representing the real world, on the other, will depend on the simplifying assumptions.