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A PROBLEM IN PPAS OF ELECTRICITY SUPPLY CONTRACTS, INDEXATION

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Abstract. This research work shows a line of action for the solution of a calculation procedure within the power purchase contract for the supply of an Electric Distributor in Guatemala. The difficulty of working with an uncertain indexing is explained, which causes various interpretations, leading to a problem of decision by the parties, because the correct procedure to take is not explicit, since what exists in writing is ambiguous. The Economic Theory of Contracts is analyzed along with the most relevant aspects are: analyzing the international context of long-term contracts and the difficulties that arise in the form of application of indexation. Contrast them with the events presented in the Guatemalan practice and the problems that have been generated. Show a resolution method that avoids extending the differences between the parties. The Methodology used is that of content analysis, which is one of the methodologies of legal research, due to the fact that a qualitative investigation is carried out since a bibliographical investigation is carried out which reviews documentation concerning the subject. The expected results are: to obtain a basis to demonstrate that the indexing calculation procedure complies with what is written in the power purchase contracts between the power distributor and the power provider. This will provide the mechanism to follow to resolve future conflicts that may arise in the presence of a calculation interpretation.

Keywords: Energy Contract, Energy Supplier, Economic Theory of Contracts, PPA, Indexation.

UN PROBLEMA EN LOS PPA DE CONTRATOS D.E SUMINISTRO DE ENERGÍA ELÉCTRICA, LA INDEXACIÓN

Resumen. El presente trabajo de investigación muestra una línea de acción para la solución de un procedimiento de cálculo dentro del contrato de compra de energía para el suministro de una Distribuidora Eléctrica en Guatemala. Se explica la dificultad de trabajar con una indexación incierta, la cual provoca diversas interpretaciones, acarreando un problema de decisión por las partes, debido a que no está explicito el procedimiento correcto a tomar, dado que lo que existe por escrito es ambiguo. Se analiza la Teoría Económica de los Contratos junto con los aspectos más relevantes son: analizar el contexto internacional de los contratos de largo plazo y las dificultades que se presentan en la forma de aplicación de la indexación. Contrastarlos con los acontecimientos presentados en la práctica guatemalteca y la problemática que se ha generado. Mostrar un método de resolución que evite a extender las diferencias entre las partes. La Metodología utilizada es la de análisis de contenido, la cual es una de las metodologías de la investigación jurídica, debido a que se realiza una investigación cualitativa dado que se realiza una investigación bibliográfica la cual revisa documentación concerniente al tema. Los resultados esperados son: obtener un fundamento para demostrar que el procedimiento de cálculo de indexación se ajusta a lo escrito en los contratos de compra de energía entre la distribuidora de energía y el proveedor de energía. Con esto se tendrá el mecanismo a seguir para resolver futuros conflictos que se puedan dar ante la presencia de una interpretación de cálculo.

Palabras clave: *Contrato de Energía, Proveedor de Energía, Teoría Económica de los Contratos, PPA, Indexación*.

Introduction

Economic theory is a set of principles and concepts used to analyze how individuals, groups and institutions make economic decisions and how those decisions affect the overall economy. Some of the fundamental principles of economic theory include supply and demand, elasticity, economic efficiency, production costs, economic growth, the business cycle and international trade.

Economic theory is also divided into different schools of thought, such as Keynesianism, monetarism, classical liberalism. Each school has its own interpretation of how the economy works and how economic problems should be addressed.

Economic theory is also used to analyze issues such as wealth and income distribution, fiscal and monetary policy, international trade, the labor market, the public sector, environmental policy and the global economy.

The economic theory of contracts is a branch of economic theory that deals with the study of contracts and how they are used to solve problems of information asymmetry and to promote cooperation between the parties involved in an economic transaction.

Contracts are legal agreements that establish the obligations and rights of the parties involved in a transaction. Contracts are commonly used in many areas of economic life, including employment, the sale and purchase of goods and services, investment and financing.

The economic theory of contracts focuses on how contracts are designed and used to solve problems of information asymmetry, which occur when one of the parties involved in a transaction has more information than the other. For example, when a buyer purchases a good from a seller, the buyer may not have sufficient information about the quality of the good, while the seller does. Contracts can be used to convey information between parties and promote cooperation, which can help reduce the risk of fraud or non-compliance.

In addition, the economic theory of contracts is also concerned with the role of incentives and penalties in the effectiveness of contracts. For example, contracts may establish financial penalties for non-compliance with the obligations set out in the agreement, which may incentivize the parties to fulfill their obligations in a timely and complete manner.

In summary, the economic theory of contracts is an important branch of economic theory that focuses on the use of contracts as a means of solving problems of information asymmetry and promoting cooperation between the parties involved in an economic transaction.

Now, within the economic theory of contracts we have what has recently been called the economic theory of incomplete contracts, which refers to how individuals and companies can make agreements despite not having complete information about the future. Instead of having a contract that covers all possible future circumstances, incomplete contracts use incentives and penalties to encourage desired behavior. This theory has been used to understand how firms, employment contracts and other economic relationships work.

An example of an incomplete contract is the employment contract. An employer hires an employee to perform a job, but cannot predict with certainty how the employee will perform in the future. Instead of having a contract that covers all possible future circumstances, the employer can use incentives and penalties, such as a bonus for good performance or termination for poor performance, to incentivize desired employee behavior.

Another example of an incomplete contract is a lease. A tenant rents property from a landlord, but they cannot predict with certainty how the tenant will perform in the future in terms of maintenance and care of the property. Instead of having a lease that covers all possible future circumstances, the landlord can use incentives and penalties, such as a security deposit that is returned at the end of the lease if the property is in good condition, to incentivize desired tenant behavior.

The economic theory of incomplete contracts is important because it helps to understand how agreements can be made despite the uncertainty of the future. This is especially relevant in an ever-changing economy, as it enables companies and individuals to adapt and cope with change effectively.

The foregoing shows one of the problems that arise in electricity supply contracts, especially in long-term contracts, and which are faced by electricity distribution companies. These contracts are called PPA (Power Purchase Agreement), in which the Distribution Company and the Energy Supplier participate. The problem is the correct way to calculate the energy price indexation, i.e., there is a formula for its calculation, but the wording of the calculation methodology is ambiguous, creating questions about what is really meant to be understood and, given that the contract is incomplete, there are contractual gaps, which create a problem of how to correctly interpret what is written, in a situation that is not widely described in the contract. But there is also doubt about the economic and mathematical veracity of the calculation procedure presented by the CNEE (Comisión Nacional de Energía Eléctrica), who is the regulatory authority in Guatemala and therefore the authority over the Distributors, who are the ones who draw up these contracts, under the authorization of CNEE.

A solution procedure is proposed to demonstrate that the Indexation calculation is mathematically consistent over time and that it complies with the principle of annual variation.

For this purpose, an analysis is made of all the literature that can be accessed and a conclusion is reached as to whether there is any way, based on the Economic Theory that supports the proposed calculation, which provides legal certainty to the solution mechanism, at the time of indexing, without what is written in the contract, can provide more clarity. The objective is to specify the calculation procedure and to maintain mathematical and legal consistency when reading the text of the contract and to add a description that allows the calculation to be carried out without any surprises in time, since it is a simple process.

Starting from the origin, in this case the article by (Hülsmann, 1999)points out that the Austrian School of Economics is based on the principle that the value of goods and services is determined by the utility of consumers. This theory is used to explain how contracts allow parties to satisfy their preferences. Contracts enable parties to satisfy their preferences by allowing them to exchange resources and align their incentives. This is essential for market efficiency. Contracts also allow the parties to ensure that expenditures are allocated efficiently and that incentives are aligned to achieve the desired objective. This is also essential for market efficiency. Therefore, the Austrian School of Economics considers that contracts are an essential part of the market and that their use can improve the functioning of the market.

The assumptions of the theory of incomplete contracts presented by (Hart, 2016), argues that many contracts are incomplete in the sense that they do not specify all the circumstances that may occur during the term of the contract. This incompleteness can generate uncertainty and conflicts between the parties. To resolve these conflicts, it is necessary to take into account the incentives of the parties and how they incentivize the parties to act efficiently in the contract. Therefore, the theory of incomplete contracts emphasizes the importance of considering both the specific terms of the contract and the implicit expectations of the parties.

The aim is to eliminate the uncertainty of the indexation process based on current economic theories and to make it the basis for future energy contracts.

An example of what the theory indicates, is the case of a sanitary service concession contract to evaluate the quality of the service provided, as indicated in (Pacheco R., 2019:55), the following criteria can be applied: Identify the implicit expectations of the parties: It is important to understand what each party expects from the contract. For example, the concessionaire can expect the service to be of high quality, while the contractor can expect a reasonable cost.

Evaluate the incentives of the parties: It is necessary to consider how the incentives of the parties influence the quality of the service. For example, the concessionaire may be more motivated to improve service quality if it receives higher compensation for doing so.

Now, how the service of the medical personnel is evaluated, the care provided, this is something that is not possible to set with specific standards, which means that it is considered indeterminable, therefore, uncertainty and causes that it cannot be predetermined, resulting in an incomplete contract.

The relationship between the economic and legal aspects of contracts has been discussed. Contract law regulates the content and formation of contracts, as well as their effects and consequences. This regulation is important to protect the rights of the parties and to ensure that contracts are performed in a fair and equitable manner. Contracts are an economic tool used to coordinate the actions of the parties to achieve a desired result. The economic theory of contracts focuses on how contracts influence the behavior of the parties and the ultimate economic outcome. Therefore, a contract can be optimal if there is a balance between the incentives of the contracting parties.

Contract theory basically deals with the resolution of conflicts of interest between the parties involved, since some of the issues addressed by the theory include the interpretation of contracts, dispute resolution, efficiency and fairness in the application of contracts.

Here I highlight the issue of good faith, which is a manifestation of behavior in positive terms. Good faith leads to an effective behavior in the contractual relationship, developing an economically optimal contract.

Of course, there is also the possibility of requesting the revision of the contract under certain circumstances, since there may be contractual gaps within the framework of the theory of incomplete contracts, but it must be taken into account that changes in the economy, such as the one experienced internationally since 2022 with the invasion of Ukraine added to the fact that we were coming out of the Covid Pandemic, generate another type of problem, which is addressed in the Theory of Unforeseeability. This theory refers to the idea that an unforeseen and significant change in economic or legal circumstances may cause a contract to become unbalanced and unfair to one of the parties. In such cases, the affected party may request a revision or modification of the contract to restore the original balance. The theory of unforeseeability is often applied in long-term contracts.

As pointed out by (Urrejola, 2003:117), the theory of unforeseeability assumes that one of the benefits stipulated in the contract, as a consequence of an extraordinary and unforeseeable event, becomes excessively onerous. Applying this to the energy price formula becomes onerous if there is no correct calculation method over time and that varies "predictably" over the long term of the contract. In (CIJUL, 2007:2) it is stated that the theory of unforeseeability has been developed with the purpose of finding a remedy for contracts in which, being of continuous, periodic execution, one of the parties is subjected to an excessive or abnormal onerousness by virtue of the fact that the general conditions taken into account when contracting, are modified at the time of their execution. This will result in a revision or modification to the contract.

That is to say, an unforeseen event results in an imbalance, an economic imbalance within the contract for the contracting parties, since one of them takes advantage over the other by not being able to act in accordance with the missing or incomplete clauses or, in this case,

an unforeseen interpretation results in a more onerous amount for the price of the energy than the contractually agreed upon. As a consequence, the contract ceases to be efficient if a social part is involved, as is the case in Guatemala, since energy supply contracts are based on the Social Tariff Law, which provides an economic contribution to a certain portion of the customers of the country's distributors.

The lack of information in a contract, or what is known as contractual gaps, is of great importance in the life of the contract. Here the detail lies in the fact that we are dealing with an incomplete contract, which also introduces a problem of unforeseeability. For example, energy supply contracts are incomplete because there is no clause explaining indexation, the contract merely presents the formula and some definitions, but there is also a lack of foresight in not explaining the exact calculation methodology that is capable of adjusting to changes due to inflation over time.

For example, in the case of Guatemala, having to work under the non-efficient condition would directly affect the price of the social tariff, which is paid by all of the Distributor's customers, which, in turn, leads to working in a suboptimal manner. Therefore, it is easy to understand, under the scheme of working with incomplete contracts, the importance of having a precise procedure, thus avoiding cost overruns in the price of energy and increasing the direct costs to the population that pays for an energy tariff, since the costs must necessarily be passed on.

For example, in several Latin American countries, the concept was applied that during the state contracting process, the possible risks that could arise during the execution of the contract should be identified and, in turn, resolution mechanisms should be provided for, which can be interpreted as economic equilibrium.

Any long-term contract is incomplete, because of its long duration and has a relationship of exchange of collaboration and cooperation on the common interest.

As indicated above, the parties incorporate a clause if the cost of drafting it is lower than the expected benefits. If there is no optimal response to the contingency, then there is renegotiation, and if this point is reached, someone has an advantage over the other and will seek to maximize his or her profitable position.

Method

A qualitative analysis is carried out by collecting data from the literature on the topic in question. It is for this reason that the exploratory methodology of law is used.

The main procedure for data collection will be the review of published texts and documents, if possible from recent years.

This is then linked to the analysis of long-term contracts on the subject of energy price indexation. For the present topic, there is sufficient bibliography, although little is published. There will also be access to academic lectures on the research topic. Each of the bibliographic references was reviewed in depth in order to evaluate whether what was presented in them would allow for a common thread of the research topic and contribute something new to the subject.

For this purpose, a content analysis of the information obtained was carried out, selecting the necessary sources to build the structure of the solution mechanism within the contract, in order to correctly work out the indexation calculation methodology. By reviewing the minutes of contracts from other countries regarding indexation, the common aspects will be studied, and through rigorous examination, reference tables will be obtained, which can be used as a mechanism to visualize the differences that exist today.

Results

Price indexation in electricity supply contracts refers to the use of a price index, such as the consumer price index (CPI), which is the one commonly used to measure inflation; as a way of adjusting the price of electricity over time, so the generator does not lose value in the future for the price set within the contract. Instead of having a fixed price for the entire duration of the contract, the price is periodically adjusted according to the price index.

There are several types of indexes to be used, the most appropriate for the electricity sector would be the "Wholesale Price Index" type. This index measures the wholesale prices of a range of goods and services and can be used to adjust the price of electric power for changes in the cost of production.

The Producer Price Index (PPI) is an index of wholesale market prices. The PPI measures the prices that producers receive for the sale of their products and is used to see average price changes and is used in economics to measure the level of inflation. It is calculated from the prices of a basket of goods and services sold at wholesale in the market and is used as a measure of the change in wholesale prices over time.

The PPI is often used as a way to adjust the price of electricity in supply contracts over time. If wholesale prices increase, the price of electricity will also increase. If wholesale prices decrease, the price of electricity will also decrease. This can help protect the power generating company from losses due to a sudden decrease in wholesale prices and consumers from sudden increases in the price of electricity.

This indexation is often used in long-term power supply contracts because power prices often vary due to external factors, such as the cost of fuel used to generate electricity and inflation. By using a price index as a way to adjust the price of electricity, power companies and consumers can be protected from sudden changes in prices.

There are several ways of indexing, reviewing the formulation literature from other countries we have the following:

- Contracts in the Latin American region were analyzed; in general, the indexation procedure is very similar, so the contracts of three Latin American countries were taken for study: Colombia, El Salvador and Guatemala.
- These indexation procedures have in common the fact of fixing the year of the beginning of supply as the base year, but this incurs in an error of unpredictability if the 12-month period necessary to make the calculation is not specified and there is a crisis in the economy that triggers inflationary values and, therefore, the indexation value, then when speaking of annuity as certain energy supply contracts do, the inaccuracy of not calculating the annuity correctly falls into the trap of not correctly calculating the annuity.
- Another error in the wording is to define the PPI as an annual value, when it is used for contracts in which the value of a given month is to be used.
- In fact, most contracts take the starting month and analyze it with respect to another month "x", but always in the initial year, which breaks with what is expected of an annuity, namely a 12-month period. This can be worked out since the publication is done on a monthly basis and at the end of the year an annual average value is published.
- Each country varies the type of Indexer to be used, it can be the CPI, Consumer Price Index, or it can be the country's own PPI. In our analysis we will use the PPI of the United States.

As an example of the PPI description, the general and basic energy price formula is shown, which incorporates indexation into the formula for calculating the energy price:

$$PEO_j = PEO_k \times \frac{PPI_i}{PPI_0} \quad (1)$$

Where:
PPI is the Producer Price Index -IPP- for Industrial goods without
Fuels of the United States of America, published by the "U.S. Department of Labor, Bureau of Labor Statistics".
PEOj is the price of energy in year j.
PEOk is the price of energy at which the contract starts.

Currently in some of the contracts the indexation or rather indexation process is described as "indexation factor". After reading the economic theory of incomplete contracts and the theory of unforeseeability, it is observed that the problem of calculating the indexation is caused by the wording of the contract, since it indicates Annual indexation and declaring annual already generates a mathematical imprecision since then the text of the contract continues indicating the following: "This component will be adjusted every x date of the month xx, with the last published annual value of the index, for the year prior to the year of calculation". This generates a double problem. The first problem, depending on the country being analyzed, is that a value belonging to a month must be calculated with respect to an annual value, or an annual value, but with respect to another annual value that is fixed, which is usually the indexation value of the year of the beginning of supply, thus breaking the concept of interannuality.

Based on the theory of unpredictability, when experiencing sustained inflation over time, what is indicated in the contracts distorts the real calculation of the indexation and the calculation of the energy price is not accurate, Equation 1. Certain contracts go further and state the following: "...to establish the PPIi/PPIo factor will have a maximum year-on-year variation of X percent (X%) and a minimum of X percent (X%).

Then we define the PPIi component the Producer Price Index PPI whose value corresponds to month "x", and PPIo is the PPI value for day (x) of month xx of the year of the start of supply. This breaks the concept of annuity, as indicated above, since only the period of x months is analyzed. The second problem under the economic theory of incomplete contracts is that there is a contractual loophole, since there is no methodology that explains the correct calculation formula, without anyone getting confused and calculating erroneously.

As a measure to solve these problems, the following methodology is proposed in order to have mathematical precision and to overcome the possible contractual obstacles that may arise from working with incomplete contracts and that the lack of foresight does not affect the spirit of the drafter and the business between the parties.

In order to work consistently over time, it must first be established that the time will be a period of 12 months, so that an annual calculation is obtained, and then it is possible to speak with propriety about interannual calculations; next, it must be demonstrated that the form of calculation is mathematically correct, given that, due to contractual loopholes, the calculation methodology was not placed.

Methodology for indexing operations

The procedure to correctly calculate the quotient of Annual Producer Price Indexes PPI, will be based on the following mathematical expression:

$$\frac{\boldsymbol{PPI_n}}{\boldsymbol{PPI_0}} = \frac{\boldsymbol{PPI_i}}{\boldsymbol{PPI_0}} \tag{2}$$

Where n is the year of calculation, PPIn takes the value of each PPIi of the years prior to the year of calculation; PPIi takes the last annual value of the previous year of calculation, PPIo is the value of the PPI of the year of start of supply.

The procedure will be as follows: "The PPIi/PPIo quotient will be formed by the contribution of each annual quotient, by multiplying each one of them, until reaching the last year of calculation. In other words, a kind of productoria is used,

Producer:

$$\prod_{i=1}^{Año\ n} PPIi(n)/PPIo(n-1,2\ldots) \tag{3}$$

A Produceria is a series of successive multiplications that vary according to a specific condition. In this case it is the year "n" which varies according to the term of the contract.

Each year, an analysis will be made to ensure that the interannuality is between the upper and lower limits. With this, a reasonable accumulation effect is maintained over time, until the indexer in a given year takes a lower value, and decumulates in a certain economic sense, but always limited by the minimum percentage.

To exemplify the development of the mathematical demonstration of the proposal, the upper limit is set at 2.248% and the lower limit at 0%, these are the percentages that will limit the value of the indexation obtained by calculating the indexation quotients, as shown in Figure 1.

Figure 1

Formula for finding the value of the indexer for the year of analysis

$$\frac{PPIn}{PPIo} = \left(\frac{PPIn}{PPIn\text{-}1}\right)_{\lim 0\%}^{\lim 2.248\%} * \left(\frac{PPIn\text{-}1}{PPIn\text{-}2}\right)_{\lim 0\%}^{\lim 2.248\%} * \ldots \left(\frac{PPI1}{PPIo}\right)_{\lim 0\%}^{\lim 2.248\%}$$

The quotient of PPI will use the property of "Neutral Element of Multiplication of Fractions".

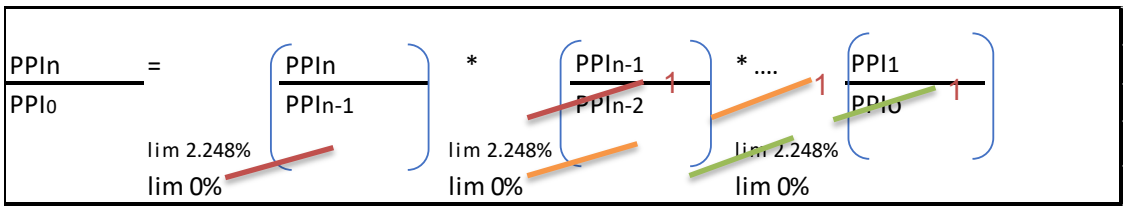
Properties of Multiplication of Fractions

Neutral element. - In the multiplication and division of rational numbers, there is a neutral element which is the number one, whose product or quotient with another rational number will result in the same number.

The principle of application is the elimination of elements of each fraction by means of the neutral property of the number 1, as illustrated in Figure 2. Therefore, we will present a way of expressing the PPI quotient as an equivalent expression, which is mathematically correct.

Figure 2

Exercise to find the value of the indexer for the year of analysis



The value to be calculated for the year of analysis was again obtained.

$$\frac{\boldsymbol{PPI_i}}{\boldsymbol{PPI_0}} = \frac{\boldsymbol{PPI_n}}{\boldsymbol{PPI_0}} \tag{2}$$

As can be seen we obtain Equation (2) again, i.e. we obtained a mathematical equality. It could even be considered that this equation is an Identity, but this will depend on the number of decimals with which we work, so it is not possible to make such a statement.

The proposed formula takes the value of the annual Producer Price Index PPI, as we have shown that it is a mathematical identity, which gives certainty and proves that the calculation procedure is accurate and consistent with the contractual clauses.

With this calculation methodology, the new proposed formula does not alter the indexation, it is only an application based on the correct concept of interannuality.

This formula takes the contribution for each year. That is, the quotient of each year is multiplied; from the quotient of year n (current year of calculation), year n-1 reaching year 1, ..., until reaching the starting year of the calculation, in order to obtain the quotient of the year being calculated, which is the result of the product of the annual quotients.

The values taken by PPI are those indicated by the contract at each moment of calculation. The important thing is to determine the value of the PPIi/PPIo ratio for each calculation period, respecting the established conditions, i.e., the year-on-year variation cannot exceed a maximum of (2.248%) or be less than (0%).

It is clarified that the value 1.02248 is a percentage of interannual variation, which is equivalent to saying that it is an upper limit, which is indicated in the proposed formula. The percentage value can be as high as 0, which is equivalent to saying that it is a lower limit. In other words, 2.248% is mathematically equivalent to the value of 1.02248.

That is, Equation (2) will work under the following mathematical notation:

$$\int_{\lim\inf\ 0\%}^{\lim\sup\ 2.248\%} \frac{\boldsymbol{PPI_i}}{\boldsymbol{PPI_0}} \tag{4}$$

It is pertinent to clarify that this notation does not mean that an integration calculation will be made to the indexing quotient, it only takes advantage of the fact that when writing

mathematical integrals it is possible to write down the limits in which the value of the quotient obtained in year n will be accepted. This is a summarized way of writing down the limits, another way already developed can be seen in Figures 1 and 2.

Example of calculations for year 5 of Indexing Calculation

For illustrative purposes, the calculation operation for the fifth year of

indexing.

A plant of an energy supplier that started supply in the year 2015 is taken as a basis.

The proposed modification is to take the annual value of the year of start of supply as a measure to correct the problem of incomplete contract, i.e., not to take a month "x" or a base year and leave it fixed in the calculations, but to analyze the individual contribution of year n, and that, by multiplying quotient by quotient, a value can be determined for the period of analysis.

The energy price for the start of supply will be Peok = 10.5 $/MWh. Table 1 shows the annual PPI values, as published by the U.S. Department of Labor, Bureau of Labor Statistics.

Table 1

Range of years of calculation

YEAR	Annual Value PPI
2015	194.2
2016	193.5
2017	199.5
2018	206.5
2019	207.2

To calculate the fifth indexation in the year 2020, we work with the Produceria (3)

Figure 3

Mathematical verification to find the value of the indexer for the year of analysis

$$PPIi = \frac{PPI_{2019}}{PPI_0} * \frac{PPI_{2018}}{PPI_{2018}} * \frac{PPI_{2017}}{PPI_{2017}} * \frac{PPI_{2016}}{PPI_{2016}} * \frac{PPI_{2015}}{PPI_{2015}} \frac{}{PPI_{0\ 2015}}$$

By doing this, the interannuality of each year is determined, from 2015 to 2019, so the contractually established is calculated and the products give the contribution of the period.

PPIi calculation for Year 5

PPI_o = 194.2 $PPIi_{2019=}$ 207.2 $PPI_{i2018=}$ 206.5 $PPI_{i2017=}$ 199.5

$PPI_{i2016=}$ 193.5 $PPI_{i2015=}$ 194.2

At this point Equation (2), which is an identity, is taken and Productivity (3) is developed.

$$PPIn/PPIo = \frac{207.2}{206.5} * \frac{206.5}{199.5} * \frac{199.5}{193.5} * \frac{193.5}{194.2} * \frac{194.2}{194.2}$$

PPIn/PPIo = 1.00339 * 1.03509 * 1.03101 * 0.99639 * 1

PPIn/PPIo = dentro del rango * > límite superior * > límite superior * < lower limit * 1

PPIn/PPIo = 1.00339 * 1.02248 * 1.02248 * 1 * 1 = 1.04901 **Applying limits (4)**

Then, the result is substituted into Equation (1)

Peoj = 10.5 * 1.04901 = 11.0146 **Rounding to 2 decimal places**

Peoj = 11.01 $/MWh

Methodological verification

$$PPIi/PPIo = \frac{207.2}{194.2} = 1.066941$$

Now the result of multiplying the contribution of 1.00339 * 1.03509 * 1.03101 * 0.99639 * 1 = 1.066940; which is practically the same value obtained from the check quotient.

At this point, when analyzing both the lower and upper limit we observe that none of the previously expressed values (2016-2018) fit the interannual limit value, so at this point the values are replaced by the limits, only the 2015 and 2019 values fit the range; which yields the following multiplication 1.00339 * 1.02248 * 1.02248 * 1 * 1 * 1. Therefore, the value of the indexer will be 1.04901 for this year and therefore an increase of approximately 51 cents per MWh, with respect to the original energy price of $10.50/MWh.

It is worth mentioning that this method allows, if necessary, to work with a negative minimum limit, i.e. there would be years in which the price of energy would fall, depending on the behavior of the world economy, but with emphasis on that of the United States, given that the indexation value depends on the macroeconomic results of that country.

Discussion and conclusions

It is recommended that this line of research be continued and adapted to the contractual conditions of each country in the region.

The main conclusions on the subject are described below:

Contract theory basically deals with the resolution of conflicts of interest. Therefore, a contract can be optimal if it seeks a balance between the incentives of the contracting parties. In a long-term contract, the fact that the contract is incomplete must be taken into account when

drafting the provisions of the different clauses, especially the economic clauses, so that they can behave efficiently, as in the case of the indexation of the price of energy

From the economic point of view, the principle of free negotiability of risks between the contracting parties is the most efficient. Also within contracts, the effects of the Theory of Unforeseeability may arise, which, if no thought is given to the possible effects it may cause, may result in onerous economic distortions for one of the contracting parties.

The methodology presented solves the two problems initially presented, incompleteness and contractual unpredictability, since the new methodology, once demonstrated, it is no longer necessary to include the entire development of the same in each contract, but to focus on the wording and above all to place the 12-month time frame for the calculation of the indexation factor and the same symbology with which it is normally drafted can be used. The new procedure solves the problem of economic unpredictability in the face of crises by ensuring a clear way to continue calculating the indexation without reaching extreme values. This will allow the energy prices of the energy supply purchase contracts to remain relatively stable and, above all, the price paid by the end customer, especially those customers who are within the consumption range established by the Social Tariff Law of each Distributor, will be kept away from sudden increases.

The important thing is that the values of a month "x" can be used, as long as care is taken to ensure that the value of the quotient is a value of a 12-month period, so that we really speak in terms of annuity, as is the spirit of the wording, especially in cases where we speak in terms of annuity or interannuality. This will avoid a certain degree of uncertainty.

The Distributors work with power purchase contracts, therefore, they have control over the method of indexing the price of energy, which being consistent with the terms described in the contract document and having the endorsement of the regulatory body, being the case for Guatemala the CNEE, the Distributors are empowered to apply the calculation in the manner proposed, by way of additional explanation, to resolve any concerns that may be raised by the energy supplier.

It is recommended to use this method in order to be able to incorporate it in future power supply purchase contracts, both nationally and internationally.

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