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Impact of daylight saving time on the Chilean residential consumption

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HIGHLIGHTS

- The impact of the application of DST is analyzed in Chilean distribution networks.
- The results indicate that there is indeed a marginally small reduction in residential electricity consumption.
- A total energy reduction is estimated based on the proposed methodology.

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ABSTRACT

Since 1970 Chile has had a Daylight Saving Time (DST) policy in order to reduce residential electricity consumption in the country. The time change was set for the first time by executive decree in 1970, and since that date it was applied every year without great changes until 2010. Since then, and to date, decrees have been set in order to increase the duration of the DST, arguing that there are reasons associated with energy savings that justify the extension of the measure that has been adopted by the authority in recent years. In the present study the impact of the application of DST in terms of decreased household electricity consumption is analyzed using two complementary methods, one based on a heuristic approach and the other using an econometric model. The results indicate that there is indeed a marginally small reduction in residential electricity consumption, although these results are not homogeneous throughout the country.

1. Introduction

The time changing policy in the summer and winter periods, known as Daylight Saving Time (DST), has as its main objective the aim to reduce electricity consumption at the residential level. This is achieved by decreasing the use of artificial light by adjusting the time in such a way that sunlight is used more efficiently, since the change in luminosity at peak demand times in the morning and evening are the events that would produce the largest effect in the use of electricity (Joseph Basconi, 2015; Hill et al., 2010).

Last year the main purpose of the DST policy has been questioned in Chile as well as in international experience, mainly due to several factors of variable and diverse nature, such as weather changes, energy efficiency policies aimed at reducing the consumption of electricity for artificial lighting in homes and companies, the use of air conditioning in summer and heating in winter, geography and morning demand peak. In particular, international experience has shown that the effect of applying DST is at least questionable, because some studies show that the effect is practically nil (Krarti and Hajiah, 2011; Momani et al., 2009; Kellogg and Wolff, 2008). Cases have also been reported in which the effect has been negative, i.e., applying the DST has increased the consumption of electricity instead of reducing it, which is its purpose (Kotchen and Grant (2011)). Considering these arguments, it is reasonable to question whether the application of this policy is still a valid alternative with the purpose of reducing the consumption of electricity.

Most of the studies concerning the impact of the time change in the countries do it from an energy approach, however, it is important to consider that the effects of applying such measures are not only limited to the purely energy, but also to the social live, psychological, financial and environmental effects.

The structure of the paper is the following: Section 2 describes the methodology used to evaluate the impact of the Daylight Saving Time policy, following an heuristic approach and a

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econometric model (Differences in Differences); Section 3 refers to the kinds of data used in the evaluation of the DST; Section 4 gives the results obtained by applying the proposed methodology to four regions of Chile; and Section 5 shows the Conclusion and Policy Implications of the study.

2. Methodology

For the development of the present study residential feeders representative of four cities of Chile: Arica, Santiago, Concepción and Punta Arenas, were analyzed. The regions considered for the analysis were defined by the Ministry of Energy of Chile, which also provided the consumption data associated with each of the feeders.

The information on residential consumption for carrying out the study was selected based on the dates on which the corresponding time changes took place in summer (ST) and winter (WT) (see Fig. 1); the green bands indicate 10 workdays in both directions with respect of the time change, and the red line 23 workdays under the same conditions.

This information in a long range of time is not precise at all, since the systems of Supervisory Control And Data Acquisition (SCADA), responsible to get observations about residential consumption, fail in the most of time in their communications.

In 2013 WT started on April 27 and ST on September 7, while in 2014 WT started on April 26 and ended on September 6.

Since in the literature there is no empirical research on the application of the DST policy in Chile, in a large part of this study methodological strategies gathered from the observation of international experience were applied, with slight variations and shades in accordance with the Chilean context. Following this logic, the method described to select the data tries to be as impartial as possible, so that it can approach what is known as simple random sampling (Gujarati and Porter, 2011). The aim underlying the selection of the two time strips mentioned in Fig. 1 is due to the fact that in Chile the DST policy is applied uniformly to the whole territory at two times in the year, on the dates mentioned, and to the physical restrictions for access to information belonging to the country.

In agreement with what was reported in U.D. of Energy (2008), it was decided to analyze two time strips around the two times of the year on which the time change took place, with data for two years when the four changes took place on different dates. The above is associated with the fact that the windows analyzed every year would not be exactly the same, i.e., they would contain different days and dates. We would therefore have two crossing sections merged in time. This allows analyzing the effect of DST considering weather factors (temperature) or intrinsic to each time window (days, months, etc.), which may have an effect on

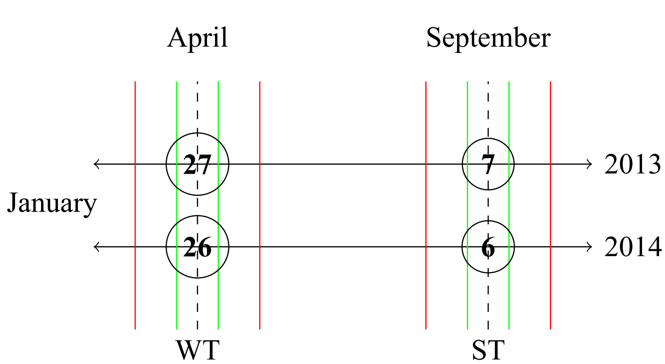

Fig. 1. Selected time intervals. (For interpretation of the references to color in this figure caption, the reader is referred to the web version of this paper.)

consumption after every time change. In this way we have a wider perspective that takes into account a greater range of determining elements at the time of giving an explanation of the performance of consumption. This would allow having a more detailed description than that which can be obtained from the traditional statistical-descriptive methods. The following section details the general methodology applied to the city of Santiago, which will then be extended to the cities involved in the evaluation.

2.1. *Heuristic method in Santiago*

The heuristic method was used as a way of approaching the saving in electric energy after the application of the DST, which is done by comparing the electric demand between two periods of time in which the time change is applied, without using a formal mathematical modelling. The approach is heuristic in the sense that through observation over a given range of days around the time change of the average electricity demand profiles observed in the days preceding and following the time change, a comparison is made trying to approach theoretically the gross effect of the policy (U.D. of Energy, 2008).

The methodology for the application of the heuristic method considers the following process:

1. First, the geographical area where the impact of DST is studied must be selected.
2. Then, the information of hourly electric power demand from a distribution company present in the region should be obtained.
3. The exact moment when the time change occurs is determined. Following that, two time periods are chosen, one of them prior to the date where the time change occurs and another where the change has already been applied. For example, in Chile, during the 2014, two moments were set in which the time change was applied, associated with four analysis periods.
   (a) *End of Summer Time*: April 26, 2014. Since that day, a period corresponding to the summer time (ST) and one after the change (winter time, WT) was established.
   (b) *Start of Summer Time*: September 6, 2014. On this day, a period prior to the time change was established (during WT) and one after the ST was also chosen.
4. It is necessary that the chosen periods are similar in number of days, such that the sample or data window is calculated with the same number of observations for each period, thereby avoiding biases in the trends. For this purpose, it should be noted that:
   (a) Only weekdays are considered for the Heuristic model, because the behaviour of electric consumption on Saturday and Sunday are considerably different from weekdays.
   (b) Similarly, the holidays are omitted from the analysis.
5. Once the hourly electrical demand curves for each day of the periods previously established were obtained, an equivalent curve was obtained for each analyzed time interval. This was achieved by averaging the value of the electrical demand, independently for each daylight hours. This allowed us to obtain an average demand curve per hour for each period, both before and after the time change. As an example, in each one of the curves provided in Fig. 2, the methodology explained above is applied.
6. After both equivalent curves of electricity demand (associated with each time change) were obtained, the time intervals considered as treated hours were determined, that is, to determine the time interval where the demand for electrical power changes due to the application of the policy of time change; that can be seen in a graphical way looking for the variations in the curve. For example, in Fig. 2, the time interval corresponds to the hours between 5:00 and 9:00 am and 17:00 and 23:00 in the evening.