# Calibration as a tool to enhance accuracy and coherence in tourism statistics

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**Abstract**

*Calibration is a reweighting method widely used to improve the accuracy and coherence of official statistics. The Spanish Residents Travel Survey has as its main objective the measurement of the number of trips made by the resident population each month. Travelling is an activity performed by a small percentage of the population, making sampling highly inefficient. Besides, those making trips are more difficult to contact.*

*On the other hand, the Hotel Occupancy Survey also measures the trips and overnight stays of residents staying at hotels and similar establishments, based on the information provided by the hotels. Each survey provides different figures for very similar magnitudes, creating confusion in the measurement of the tourism sector.*

*This paper aims to describe i) the measures applied to improve the efficiency of the sample (substratification based on a logit model predicting the probability of travelling), ii) the calibration to sociodemographic variables to improve the accuracy of the estimates, and iii) its extension including the hotel overnight stays provided by the Occupancy Survey in the calibration enhancing the coherence of tourism statistics.*

*This paper assesses the differences in the survey estimates when comparing three scenarios: no calibration, calibration with sociodemographic variables, and calibration with all the variables, including overnight stays.*

*In this process, regions with fewer records have to be grouped together each month due to sample size limitations. To calibrate each region separately, a reference period of three months could be considered, thereby increasing their sample size. The paper also explores the results of calibrating the three months of each quarter altogether, comparing them with the monthly estimates.*

**Keywords:** Calibration, accuracy, coherence, tourism statistics

1. **Introduction**

The Spanish Residents Travel Survey (RTS) has as its main objective the measurement of the number of trips made by the resident population each month. The main characteristics of the trip are collected to obtain estimates according, for instance, the destination or the accommodation or the means of transport used during the trip. Travelling is an activity performed by a small percentage of the population, making sampling highly inefficient and leading to small samples of trips, even when a considerable amount of interviews are conducted every month.

On the other hand, the Hotel Occupancy Survey (HOS) also measures the trips and overnight stays of residents (and non-residents) staying at hotels and similar establishments, based on the information provided by the hotels. Both sources are complementary: HOS provides an accurate picture of the accommodation market at destination level while RTS gives the complete picture of the visitors received, taking into account non-market accommodation as well, but with lower level of geographical detail. But if no measures are taken, each survey can provide different figures for very similar magnitudes, creating some confusion in the measurement of the tourism sector, as shown in Table 1.

**Table 1. Overnight stays and coefficient of variation by month.**



Source: Residents Travel Survey and Hotel Occupancy Survey 2017.

Auxiliary information coming from the sampling frame of the RTS is used during the sampling stage to increase the efficiency of the sample. Besides, HOS estimates, with lower coefficients of variation (see Table 1), are used during the RTS weighting process to improve accuracy and to enhance the coherence of both sources.

1. **Residents travel survey**

The Residents Travel Survey is a household survey aiming to estimate the total number of tourism trips made by the population resident in Spain. Both trips within the national territory and abroad are studied, and also their main characteristics: nights spent and associated expenditure. Information on the main elements of the trip (e.g. origin, destination, length, main purpose, accommodation, means of transport, etc.) and the visitor is also available to analyse the travelling behaviour of the population.

This statistical operation follows the guidelines determined by Eurostat in the *Methodological Manual for Tourism Statistics,* developed under the Regulation 692/2011 concerning European statistics on tourism, and which are in line with the *International Recommendations for Tourism Statistics 2008* of the UNWTO.

Monthly and quarterly estimates are published on a quarterly basis. Around 8,200 interviews are conducted every month. Respondents give information on the trips they have finalized in the two previous months. Thus, estimates of the number of trips made in one month are based on a sample of around 16,400 questionnaires. After a process of editing and imputation, data are weighted to obtain the final figures. Calibration is part of the weighting process, and it is described in the next sections. A methodological reference of the survey is available online.

The main difficulty of this kind of surveys is the lack of efficiency of the samples: only a percentage of the population makes tourism trips, depending, among other variables, on the country (region) and the time of the year. Thus, to obtain a good sample of trips that allows a detailed analysis of the travelling habits of the population, much bigger samples of people are needed, with the subsequent costs. As an example, in 2017 in the Spanish survey, on average, just the 24% of the sample had made at least one trip during the period of reference of the questionnaire (the two previous months). Obviously, that percentage decreases when focusing on specific kind of trips such as trips abroad, trips using hotels as the main accommodation, etc. This leads to high sample errors, as shown in Table 2.

**Table 2. Trips by month and main accommodation. Coefficient of variation**

 Source: Residents Travel Survey, 2017.

To deal with this problem, the sample of the RTS is selected from the Continuous Household Survey, which provides additional information about the selected households and individuals. This information is used to assign to every household a propensity score to travel. This propensity is calculated through a logistic regression model based on the information collected in the survey in previous waves, and includes information on the members of the household (gender, age, marital status, educational level), the household itself (tenancy regime, number of members) and other characteristics of the neighbourhood (average income level, percentage of unemployed). Initial strata are substratified in two groups according the assigned propensity. Then, more prone to travel households are oversampled, increasing the trips sample and decreasing the estimation variance. Of course, the weighting factors are processed in order not to introduce bias in the estimations due to this procedure.

Figure 1 and Figure 2 show the visitors and trips per person in 2017 in the sample, and once the sample has been weighted. Oversampling in the group of households with higher propensity to travel is adjusted when the sample is weighted. Being August the month with the highest number of visitors and trips, effects of oversampling are not observed.

**Figure 1. Percentage of visitors (sample and weighted). Note: y axis origin is shifted**

Source: Residents Travel Survey, 2017.

**Figure 2. Trips per person (sample and weighted). Note: y axis origin is shifted**

Source: Residents Travel Survey, 2017.

1. **Calibration. Description**

Calibration is a method commonly used in official statistics to improve estimates obtained from sample surveys using auxiliary information from exogenous sources. The idea is to recalculate the initial sample weights to obtain from the sample the official population figures. Särndall and Deville (1992) proved that estimators obtained using this methods have good properties. In the RTS calibration is applied with two main goals: to improve the accuracy of the estimates and to enhance the coherence between different tourism surveys.

This is performed through the calibration to monthly sociodemographic variables which are extracted from the census and the Labour Force Survey. Thus, new raising factors are calculated, correcting sample biases and adjusting the sample structure to the population. The marginals (exogenous figures) used in this process are the following (at autonomous communities –NUTS 2- level):

* Population by nationality (Spanish or foreign)
* Population by gender and age (five-year groups)
* Population by educational level (primary, secondary and higher education)
* Population by provinces (NUTS 3 level)

This is a standard procedure in most household surveys at the Spanish National Statistics Institute. But, in the RTS, accuracy is also improved by enhancing the coherence with the Hotel Occupancy Survey (HOS), which provides estimates of residents staying at hotels or similar establishments based on the information provided by the establishments. In this case, we cannot directly use these estimates due to methodologic differences between both surveys, which must be solved before calibration. These differences are mainly two:

* The HOS considers the overnight stays spent in hotels on the reference month whereas the RTS assigns all the overnight stays linked to one trip to the month in which the trips ends. That means that, for a given month:

1. RTS considers some overnight stays of previous months and HOS doesn´t.

2. RTS doesn’t consider reference month overnight stays of trips ended in following months and HOS does.

* Systematic differences in the coverage as for example permanent residents in hotels, considered by the HOS but not by the RTS (because no trip was made).

This was solved in 2014, carrying out a transformation of the overnight stays provided by the HOS into RTS overnight stays, trying to remove the differences mentioned above. For the following years, the RTS is adjusted to the marginal obtained applying the HOS variation rate to these comparable overnights estimated for the first year. In addition, to estimate the monthly auxiliary variables, the RTS overnight stays are truncated to the maximum number of days of the reference month, to be coherent with the marginals used. It is noted that the RTS collects information of all the stages of the trip (destination and accommodation), allowing to estimate the hotel overnight stays spent in each autonomous community.

Six monthly variables are used to calibrate: hotel overnight stays in Madrid, Canary Islands, Andalusia, Catalonia, Valencian community and one which groups the others altogether. The reason to make this last group is that these communities don’t have enough sample size to be calibrated by its own, causing problems in the convergence of the CALMAR algorithm.

1. **Calibration. Results.**

In this section we analyse separately the RTS estimates when sociodemographic calibration is included in the survey process and its extension to calibrate the HOS hotel overnight stays.

* 1. *Calibration to sociodemographic variables*

To understand the effect of this calibration in the survey results, Table 3 shows how the population structure changes with this process, in relation to some of the variables calibrated (nationality, educational level and gender). Next chart shows these structures for December 2017:

**Table 3. Population distribution according nationality, educational level and sex**

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **VARIABLE** | **% (NON-CALIB)** | **% (CALIB SD)** | **DIFFERENCE** | **TRIPS/PERSON** |
| **Spanish** | 88,64 | 88,74 | 0,10 | 0,326 |
| **Foreigners** | 11,36 | 11,26 | -0,10 | 0,062 |
| **Primary education** | 16,20 | 21,94 | 5,74 | 0,105 |
| **Secondary education** | 53,02 | 49,55 | -3,47 | 0,268 |
| **High education** | 30,77 | 28,51 | -2,26 | 0,490 |
| **Men** | 49,39 | 48,67 | -0,72 | 0,346 |
| **Women** | 50,61 | 51,33 | 0,72 | 0,298 |

Source: Residents Travel Survey. December 2017.

In this case, it is noted a significant difference in the educational level structure whereas the nationality and gender structure also change, but to a lesser extent. If we analyse this for the whole year, the educational level structure changes in similar magnitudes every month, whereas the other two variables do not always present the same bias.

Focusing on the educational level, it is observed that primary education respondents are underrepresented in the sample whereas the secondary and higher education groups are overrepresented. Since the first group has always much lower trips per person rates than the others, adjustment of the population totals should mean a decrease in the survey trips estimates, just like it is observed in Figure 3:

**Figure 3. RTS trips estimates (non-calibrated and calibrated to sociodemographic variables). Note: y axis origin is shifted.**

Source: Residents Travel Survey. 2017.

The average decrease in 2017 is close to 450.000 trips what means a -3,25% variation respect to the non-calibrated estimates.

* 1. *Calibration to HOS hotel overnight stays (and sociodemographic)*

As it was stated in previous sections, this approach was considered to get more accurate results and to increase the coherence with the Hotel Occupancy Survey, not sending contradictory messages to the users when both surveys are analysed together.

Next graph shows the hotel overnight stays in the Canary Islands (one of the regions calibrated individually), comparing: the HOS estimates, the RTS estimates calibrated only to sociodemographic totals and the RTS estimates including also calibration to HOS figures.

**Figure 4. Canary Islands hotel overnight stays. HOS estimates and RTS estimates (calibrated to SD variables and calibrated to SD and HOS estimates):**

Source: Residents Travel Survey and Hotel Occupancy Survey. 2016-2017.

A significant enhancement in the coherence between both surveys is observed in the graph when calibration to HOS figures is included. It is also remarkable the smoothing in periods where the tourism has a higher seasonal component. Differences due to overnight stays of trips starting and finishing in different months remain but the impact of a few long trips on the final figures is minimised.

If we focus on the annual variation rates (Figure 5), it is also observed almost for every month a notable approach in the RTS variation rates to the HOS ones:

**Figure 5. Canary Islands hotel overnight stays variation rate. HOS estimates and RTS estimates (calibrated to SD variables and calibrated to SD and HOS estimates):**

Source: Residents Travel Survey and Hotel Occupancy Survey. 2016-2017.

1. **Extended calibration: combining monthly and quarterly totals.**

The previous approach only benefits the five regions treated individually. As shown in Figure 6, in the individual estimates of the autonomous communities calibrated altogether, the lack of coherence RTS-HOS still remains.

**Figure 6. Balearic Islands hotel overnight stays. HOS estimates and RTS estimates (calibrated to SD variables and calibrated to SD and HOS estimates):**

Source: Residents Travel Survey and Hotel Occupancy Survey. 2016-2017.

For these autonomous communities with a smaller sample size, a new possibility is being explored. Although the sample is designed to provide monthly estimates, pooling monthly files into a quarterly one allows to increase the number of trips to each region of destination. The new approach consists of adjusting in the same process the monthly auxiliary figures described in the previous section for each of the three months considered and one more quarterly variable for the overnight stays in each autonomous community not calibrated individually in the monthly process.

To ensure the coherence with the monthly aggregate for this group of regions, new quarterly marginals are computed sharing the monthly marginal among all the autonomous communities grouped together, using their weight in the HOS estimates.

The quarterly auxiliary variables are computed following the same procedure than the monthly ones: truncating to the maximum number of days of the reference month but for all the autonomous communities individually.

Figure 7 shows the quarterly series for the Balearic Islands hotel overnight stays when the quarterly individual total are taken into account.

**Figure 7. Balearic Islands hotel overnight stays. HOS estimates and RTS estimates (monthly and quarterly calibrated)**

Source: Residents Travel Survey and Hotel Occupancy Survey. 2016-2017.

In this case, it is noted how the fitting between the RTS and HOS improves as opposed to the monthly calibration where a more irregular behavior of the series is observed. Figure 8 focus on the variation rates:

**Figure 8. Balearic Islands hotel overnight stays variation rate. HOS estimates and RTS estimates (monthly and quarterly calibrated)**

Source: Residents Travel Survey and Hotel Occupancy Survey. 2016-2017.

Note how this calibration changes the size and occasionally the sign of the variation rates: although differences due to methodological reasons remain, this new figures give the users a coherent message. Besides, as we are fitting the estimates to the HOS survey results, with lower sampling errors and highly correlated with the RTS figures, the new results are more accurate.

1. **Conclusion**

This study shows how auxiliary information can be used to improve the information obtained from sample surveys. First of all, at the sampling stage, the use of a logit model to predict the respondent probability of travelling based on the available information of the individual is presented as a suitable option to increase the sample size without the need to add additional costs.

During the weighting process, calibration to HOS overnight stays allows to get more accurate hotel overnight stays estimates and to increase the coherence between both surveys making the analysis easier for users.

Regarding the quarterly calibration, the results are satisfactory and invite to include this procedure in the survey process, nevertheless more analyses must be performed to assess if this could cause a break in the series, making useless the comparison with already published information.

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