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Research note

An index decomposition analysis of tourism demand change

Mauro Mussini

Department of Economics, Management and Statistics, University of Milan Bicocca, Piazza dell'Ateneo Nuovo 1, 20126 Milano, Italy

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Introduction

The change in tourism demand in a destination is usually examined by monitoring changes in some key indicators, such as overnight stays, tourist arrivals and average length-of-stay. Even though the number of overnight stays depends on the number of tourist arrivals and average length-of-stay, a change in overnight stays may conceal different dynamics in tourist arrivals, average length-of-stay and mix of tourist segments. Table 1 shows a numerical example on this issue. The table reports overnight stays, average length-of-stay and tourist arrivals by origin in a destination in two different years, namely 0 and *t*. There are two foreign tourists and four domestic tourists in year 0. The proportion of foreign arrivals is 0.33 and that of domestic arrivals is 0.67. The average length-of-stay of foreign tourists is 4 and that of domestic tourists equals 1. The overall number of overnight stays is 12. Three alternative scenarios (A, B and C) in year *t* are considered. In case A, both foreign and domestic tourist arrivals increase while tourist-mix and average length-of-stay for both foreign and domestic tourists are unchanged. The number of overnight stays becomes 18 for the increase in tourist arrivals. In case B, tourist-mix changes whereas tourist arrivals and average length-of-stay are equal to those in year 0. Also in this case the number of overnight stays grows to 18, but because of the change in tourist-mix. In case C, there are increases in average length-of-stay for both foreign and domestic tourists whereas tourist-mix and tourist arrivals are unchanged. Overnight stays become 18 for the increases in average length-of-stay.

In each of the above cases, overnight stays grow to 18 but the source of such an increase is different. Tracking the change in overnight stays is more informative if this change is linked to changes in arrivals, tourist-mix and average length-of-stay. In addition, implications for destination management differ depending on the source of changes in overnight stays. If, for instance, a growth in tourist arrivals plays a major role in increasing overnight stays in a destination, such a destination has to face challenges due to a greater influx of tourists (e.g. a greater transport demand).

The change in overnight stays can be broken down into the contributions of changes in tourist arrivals, tourist-mix and average length-of-stay by using the log mean Divisia index decomposition (Ang et al., 1998). This statistical technique is widely used for decomposing the change in energy consumption into components (Ang, 2005), but it can also be used in other fields. Generally speaking, the decomposition is suitable to break down the change in every positive variable which can be written as a product of some factors. This is the case of the change in overnight stays, which is broken down into three components. One component quantifies the contribution of the change in tourist arrivals. A second component measures the change in overnight stays due to changes in the mix of tourist segments classified by a segmentation variable (e.g. tourist origin, age). A third component measures the

E-mail address: mauro.mussini1@unimib.it.

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Table 1
Sources of the change in overnight stays.

Year		Tourist arrivals		Tourist-mix		Average length-of-stay		Overnight stays
		Foreign	domestic	Foreign	domestic	Foreign	Domestic	
0		2	4	0.33	0.67	4	1	12
t	Case A	3	6	0.33	0.67	4	1	18
	Case B	4	2	0.67	0.33	4	1	18
	Case C	2	4	0.33	0.67	5	2	18

effect of changes in average length-of-stay.

The decomposition is used to examine the change in overnight stays in the provinces of Sardinia, one of the most tourism-oriented regions in Italy, over the 2011–2016 period.

Decomposing changes in overnight stays

Consider n destinations and two years, namely 0 and 1. Let D_{it} be the number of overnight stays in destination i in year t and A_{it} be the number of tourist arrivals. Assume that both D_{it} and A_{it} can be disaggregated into k segments by a segmentation variable (e.g. tourist origin). D_{ijt} and A_{ijt} being respectively overnight stays and tourist arrivals in segment j in destination i in year t, the aggregate number of overnight stays is $D_{it} = \sum_{j=1}^{k} D_{ijt}$ while the total number of arrivals is $A_{it} = \sum_{j=1}^{k} A_{ijt}$

The number of overnight stays in segment j can be factored as follows:

$$D_{ijt} = A_{it}\frac{A_{ijt}}{A_{it}}\frac{D_{ijt}}{A_{ijt}} = A_{it}M_{ijt}L_{ijt}, \tag{1}$$

where M_{ijt} is the proportion of arrivals in segment j to total arrivals and L_{ijt} is the average length-of-stay for segment j. In Eq. (1), M_{ijt} indicates the relative importance of segment j in terms of tourist arrivals in destination i in year t. The average length-of-stay, L_{ijt}, is an important indicator for tourism management since it influences service provisions and visitor expenditure (Gössling et al., 2018).

From Eq. (1), the number of overnight stays in destination i in year t becomes

$$D_{it} = \sum_{j=1}^{k} A_{it}M_{ijt}L_{ijt} \tag{2}$$

and the change in overnight stays from year 0 to 1 is

$$\Delta D_i = D_{i1} - D_{i0} = \sum_{j=1}^{k} A_{i1}M_{ij1}L_{ij1} - \sum_{j=1}^{k} A_{i0}M_{ij0}L_{ij0}. \tag{3}$$

ΔD_i can be broken down into three components by using the log mean Divisia index method, which was originally introduced to separate the contributions of different factors to the change in energy consumption (Ang, 2004; Ang et al., 1998). This method, in principle, is suitable to decompose the change in every positive variable that can be factored into the product of other variables. Since the number of overnight stays can be written in a factored form, as shown in Eq. (1), the log mean Divisia index decomposition of the change in overnight stays can be developed. Since this decomposition is a descriptive statistical tool, its validity does not depend on specific statistical assumptions underlying data (e.g. normality). The number of components corresponds to the number of factors appearing in the factorization of overnight stays, i.e. three components are obtained as there are three factors (tourist arrivals, tourist-mix, average length-of-stay).

A preliminary step to obtain the decomposition of ΔD_i is the calculation of the logarithmic mean of D_{ij1} and D_{ij0}, where D_{ij1} and D_{ij0} are positive numbers:

$$W_{ij} = \begin{cases} \dfrac{D_{ij1} - D_{ij0}}{\ln D_{ij1} - \ln D_{ij0}} & \text{if} \quad D_{ij1} \neq D_{ij0} \\ D_{ij1} & \text{if} \quad D_{ij1} = D_{ij0} \end{cases}. \tag{4}$$

W_{ij} is the weight of segment j in terms of overnight stays. W_{ij} is a weight function we use to decompose the change in overnight stays.

From Eqs. (1)–(4), ΔD_i can be broken down as follows:

$$\begin{aligned} \Delta D_i &= \sum_{j=1}^{k} W_{ij}\ln\left(\frac{D_{ij1}}{D_{ij0}}\right) \\ &= \sum_{j=1}^{k} W_{ij}\ln\left(\frac{A_{i1}M_{ij1}L_{ij1}}{A_{i0}M_{ij0}L_{ij0}}\right) \\ &= \sum_{j=1}^{k} W_{ij}\ln\left(\frac{A_{i1}}{A_{i0}}\right) + \sum_{j=1}^{k} W_{ij}\ln\left(\frac{M_{ij1}}{M_{ij0}}\right) + \sum_{j=1}^{k} W_{ij}\ln\left(\frac{L_{ij1}}{L_{ij0}}\right) \\ &= \Delta D_i^A + \Delta D_i^M + \Delta D_i^L \end{aligned} \tag{5}$$

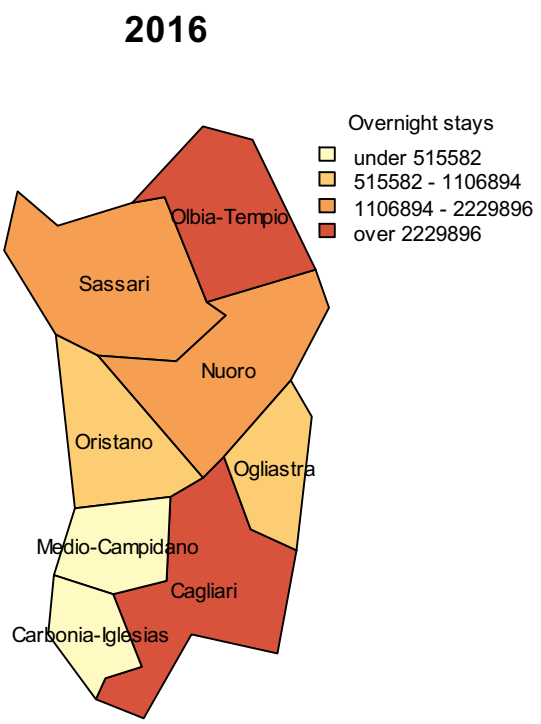

Fig. 1. Provinces of Sardinia by overnight stays (quartiles) in 2016.

ΔD_i^A is the tourist-flow component measuring the change in overnight stays due to a variation in tourist arrivals. The tourist-flow component is positive (negative) when total arrivals increased (decreased) over time.

ΔD_i^M is the tourist-mix component measuring the variation in overnight stays related to changes in the relative distribution of tourist arrivals among the k segments. The tourist-mix component embodies two effects: one is related to the weights of the k segments in terms of overnight stays, as measured by W_{i1}, …, W_{ik}; the second effect is connected to changes in the relative distribution of tourist arrivals among the segments. The more the segments with the largest weights augment (decrease) their proportions of arrivals, the greater (smaller) the tourist-mix component.

ΔD_i^L is the length-of-stay component quantifying the contribution of changes in average length-of-stay in the various segments. The interpretation of this component is straightforward: (*i*) ΔD_i^L is positive if average length-of-stay increased in each segment; (*ii*) ΔD_i^L is negative if average length-of-stay decreased in each segment; (*iii*) when average length-of-stay increased in some segments while decreasing in others, ΔD_i^L is positive (negative) if gains in average length-of-stay, weighted by the respective W_{ij}, are greater (less) than losses weighted by the corresponding W_{ij}.

Changes in overnight stays in Sardinia

The decomposition is used to analyze the change in overnight stays in the provinces of Sardinia from 2011 to 2016. Annual data on overnight stays, tourist arrivals and tourist origin come from the regional database of the Sardinia Region (Regione Autonoma di Sardegna, 2019). Data on overnight stays and tourist arrivals are disaggregated into two segments by tourist origin: domestic and foreign. Fig. 1 shows the map of the provinces of Sardinia by overnight stays (quartiles) in 2016. Olbia-Tempio and Cagliari had the highest numbers of overnight stays, whereas Carbonia-Iglesias and Medio-Campidano recorded the lowest levels.

Panels A and B in Fig. 2: show the time series of overnight stays in the eight provinces from 2011 to 2016. The number of overnight stays increased in most provinces of Sardinia, although with different trends. Overnight stays slightly decreased in Ogliastra. Fig. 3 (panels A and B) shows the decomposition of changes in overnight stays in the provinces of Sardinia from 2011 to 2016. The tourist-flow component is positive in each province, indicating that an overall increase in tourist arrivals contributed to growing overnight stays. The tourist-flow component plays a major role in increasing overnight stays in Cagliari, Nuoro, Olbia-Tempio and Oristano.

The length-of-stay component is negative in all provinces except Sassari. In most provinces, a negative length-of-stay component is more than offset by a positive tourist-flow component. Ogliastra is the only province where a negative length-of-stay component exceeds, in absolute value, a positive tourist-flow component, resulting in a decrease in overnight stays as the tourist-mix component is positive but almost negligible in magnitude.

The tourist-mix component is less important than the other two components. This indicates that changes in the mix of domestic

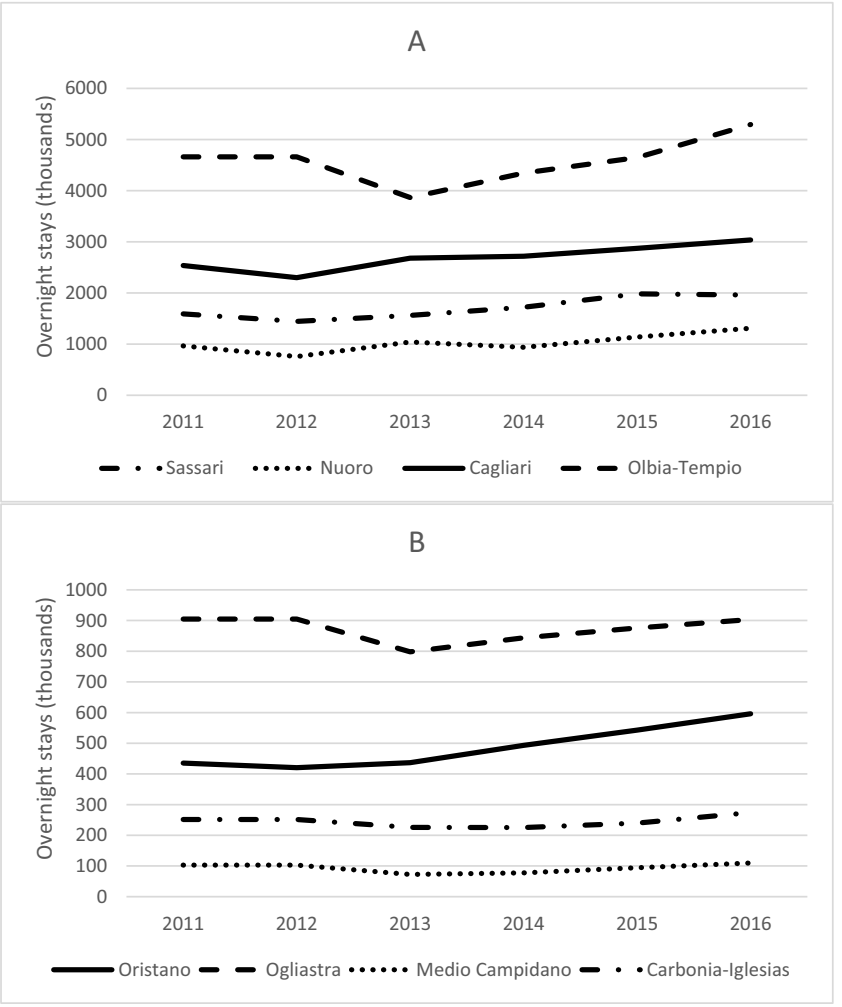

Fig. 2. Time series of overnight stays in the provinces of Sardinia. Annual data, 2011–2016.

and foreign tourists did not alter the number of overnight stays substantially.

Our findings indicate that overnight stays increased in most provinces because of the growth in tourist arrivals. Such provinces have to face challenges connected to a growth of arrivals. A greater number of arrivals requires additional transport infrastructures and airport capacity (Gössling et al., 2018), especially in the peak summer season.

The negative contribution of the length-of-stay component is relevant for tourism management. Shorter-stay tourists tend to spend less money than longer-stay ones, with a reduction of tourism expenditure. In addition, shorter-stay tourists are less willing to visit peripheral destinations (Barros & Machado, 2010), contributing to economic inequality between central and peripheral destinations of the region.

Conclusion

This study uses the log mean Divisia index method to decompose the change in the number of overnight stays into the contributions of changes in tourist arrivals, tourist-mix and average length-of-stay.

The decomposition of changes in overnight stays in the provinces of Sardinia shows that the tourist-flow component is positive in each province. Nevertheless, in some provinces the length-of-stay component is negative and large enough to offset the tourist-flow component, resulting in small changes in overnight stays. These findings suggest that a small change in overnight stays does not necessarily mean that tourism demand is almost steady, as this change may be the outcome of effects that tend to offset each other.

Future research directions include the development of a multiplicative version of the decomposition, which breaks down the relative change in overnight stays instead of the absolute change.

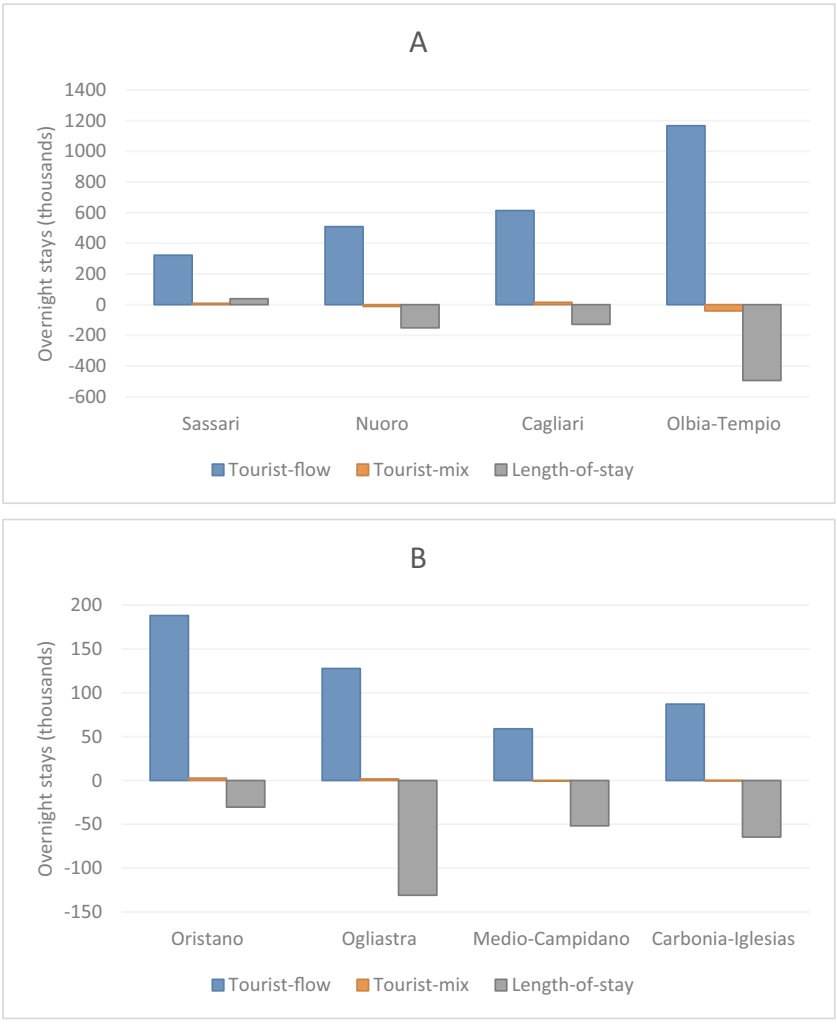

Fig. 3. Decomposition of changes in overnight stays in the provinces of Sardinia, 2011–2016.

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References

Ang, B. W. (2004). Decomposition analysis for policymaking in energy: Which is the preferred method? *Energy Policy, 32*, 1131–1139.
Ang, B. W. (2005). The LMDI approach to decomposition analysis: A practical guide. *Energy Policy, 33*, 867–871.
Ang, B. W., Zhang, F. Q., & Choi, K. H. (1998). Factorizing changes in energy and environmental indicators through decomposition. *Energy, 23*, 489–495.
Barros, C. P., & Machado, L. P. (2010). The length of stay in tourism. *Annals of Tourism Research, 37*, 692–706.
Gössling, S., Scott, D., & Hall, C. M. (2018). Global trends in length of stay: Implications for destination management and climate change. *Journal of Sustainable Tourism, 26*, 2087–2101.
Regione Autonoma della Sardegna (2019). Data on Tourist Movements in Sardinia (in Italian). Retrieved from http://www.sardegnastatistiche.it/argomenti/turismo/.