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Research note

A note on estimating visitor spending on a per-day/night basis

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Abstract

There are two approaches to calculate a per-night spending average when visitor expenditures are gathered on a per-trip basis. The first and correct approach is to individually compute averages for trip spending and length of stay from the sample and then divide the two figures. The second approach, although more convenient and instinct-driven, is to compute per-night spending on a case-by-case basis and then compute the average of the per-night figures across all samples. This calculation procedure will generally produce an inflated per-night spending average, as per-day spending tends to decline with length of stay, and a biased variance.

Keywords: Calculation formula; Visitor spending averages; Ratio estimation

1. Introduction

Measuring total visitor spending associated with a short-term event/festival or year-round recreation activity is a frequent and important focus area for tourism agencies and academia researchers. While few studies have measured spending directly on a per-night basis[1] (Blazey, 1988; Stynes & Mahoney, 1989; Yuan, 2001), most spending surveys measure expenditure for the entire trip. Trip spending is then converted to a per-day or per-night basis by dividing by the length of stay. This seems like a simple and routine calculation, but it is one that is sometimes done incorrectly. This note points out the problem and how to avoid it.

The paper first presents the calculation procedures for computing per-night expenditures. A simple example is used to illustrate the flaw in the naïve approach and demonstrate the correct procedure. Empirical data are then presented to illustrate the magnitude and direction of bias with the naïve approach. Discussion to compute variances for the estimator will also be provided, followed by the conclusion.

2. Calculation procedure

When trip spending and length of stay are measured, the first approach to obtain a per-night expenditure is to individually compute averages for trip spending and length of stay in the sample and then divide the two figures. This procedure is also known as ratio estimation. The ratio estimation is recommended when both the denominator and numerator are likely to change if a different sample is taken (Lohr, 1999). The formula to calculate the ratio estimator is presented below (Lohr, 1999):

$$\hat{B} = \frac{\sum_{i=1}^{n} y_i}{\sum_{i=1}^{n} x_i} = \frac{\overline{Y}_i}{\overline{X}_i}, \quad (1)$$

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[1] In this approach, respondents are asked to report all expenses within the previous 24 h or one-day of expenditure for a pre-selected day during the trip.

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where $\hat{B}$ is the ratio estimator, y_i and x_i are two quantities measured on each sample unit, and n is the sample size.

Following this formula, the average daily expenses of a travel party should be calculated as shown in Eq. (2). This approach is also recommended by the World Tourism Organization in computing the daily expenditure (Canadian Tourism Commission, Instituto de Estudios, Swedish Tourist Authority, & Araldi firm, 2003, p. 81).

$$\text{Per-night spending} = \frac{\sum_{i=1}^{n}\text{Trip spending}}{\sum_{i=1}^{n}\text{Length of stay}} = \frac{\text{Average trip spending}}{\text{Average length of stay}}. \tag{2}$$

The second and naïve approach is first to compute per-night spending on a case-by-case basis and then compute the average of the per-night figures in the sample (Eq. (3)). This could be done easily within a statistical package such as Statistical Package for the Social Sciences (SPSS) or Statistical Analysis System (SAS) by computing a per-night spending variable and then requesting an average of the computed variable.

$$\text{Per-night spending} = \frac{\sum_{i=1}^{n}\frac{\text{Trip spending}}{\text{Length of stay}}}{n} = \frac{\sum_{i=1}^{n}\text{Per-night spending}}{n}. \tag{3}$$

We first use a simple example to demonstrate that Eq. (2) is the correct procedure to calculate the per-night spending. Assume a population of four trips with values of length of stay and spending as shown in Table 1. The average stay is three nights and the average spending per trip is \$100. Dividing these two figures yields a per-night spending average of \$33.33. If one computes per-night spending on a case-by-case basis for each trip and then averages these figures, the estimate is \$35. The four trips in the example involve a total of \$400 in spending. The \$33.33 average multiplied by 12 nights gives the correct total, while the \$35 average multiplied by 12 nights gives an incorrect total spending of \$420, a 5% overestimation.

The problem arises from changing the unit of analysis from trips to nights if the spending is measured on a trip basis. Eq. (2) weighs the per-night spending of each case (trip) by the number of nights it represents (length of stay) while Eq. (3) gives the same weight to each per-night average. In this example, there are really 12 nights represented by the observations, with trip A representing one night, trip B two nights, trip C five nights, and trip D four nights. The correct average of the per-night spending column is obtained by taking a weighted average with each case weighted by the number of nights it represents, i.e., $\$33.33 = (1 \times \$50 + 2 \times \$20 + 5 \times \$30 + 4 \times \$40)/12$. This example demonstrates that the correct formula to use in computing per-night expenditure is the ratio estimator (Eq. (2)).

3. Empirical results

Table 2 shows per-night spending averages calculated by two formulas for overnight visitor segments using data from several spending surveys that authors have conducted over the past few years. The direction (overestimation or underestimation) and the magnitude of differences (percent of error) between two computed results depend on the relationship of visitors' daily expenditures and their lengths of stay. The naïve procedure (Eq. (3)) inflates the averages when per-night spending declines with visitors' length of stay because Eq. (3) over-weights cases with shorter lengths of stay, which entail higher per-night spending. Conversely, if per-night spending increases with length of stay, the naïve procedure underestimates the spending averages. In most cases, per-night spending declines with increasing lengths of stay, and hence the naïve estimation procedure produces inflated estimates (Table 2).

4. Variance

Variance for the ratio estimator of per-night expenditure (Eq. (2)) and the naïve approach (Eq. (3)) under a

Table 1
A sample of four trips

Case	Length of stay (nights)	Spending per trip	Spending per night
Trip A	1	\$50	\$50
Trip B	2	\$40	\$20
Trip C	5	\$150	\$30
Trip D	4	\$160	\$40
Total	12	\$400	\$140
Average	3	\$100	\$35
Per-night spending average		$\$100/3 = \$33.33$	\$35
Estimated total spending		$\$33.33 \times 12 = \$400$	$\$35 \times 12 = \$420$

Table 2
Comparison of per-night spending for the overnight visitors from selected studies

Projects		Overnight segments			
Michigan Museum Study[a] (Stynes, Stoep, & Sun, 2003)		Visitor staying at hotel	Camper	Other overnight visitor	
	Party trip spending	$581.2	$365.0	$368.6	
	Length of stay	2.4	3.3	3.4	
	Correct party day spending[c]	$244.1	$111.6	$108.1	
	Incorrect party day spending[d]	$259.8	$130.4	$133.9	
	Percent of error[e]	6%	17%	24%	
	Correct std. error of mean[f]	12.47	11.75	10.69	
	Incorrect std. error of mean[g]	10.08	14.23	13.60	
Taiwan Inbound Traveler Consumption and Trends Survey[b] (Taiwan Tourism Bureau, 2001-02)		Visitor staying at hotel	VFR[h]	Other overnight visitor	
	Person trip spending	$883.9	$475.8	$913.9	
	Length of stay	4.5	8.8	12.8	
	Correct person day spending	$198.4	$54.1	$71.6	
	Incorrect person day spending	$257.5	$90.8	$115.7	
	Percent of error	30%	68%	62%	
	Correct std. error of mean	3.53	3.48	7.28	
	Incorrect std. error of mean	3.91	5.91	7.87	
Crater Lake National Park Economic Impact Study[a] (Stynes & Sun, 2002)		Visitor staying at inside park hotel	Inside park camper	Visitor staying at outside park hotel	Outside park camper
	Party trip spending	$517.4	$114.5	$371.7	$194.1
	Length of stay	2.0	1.8	1.9	3.0
	Correct party day spending	$258.7	$63.0	$199.8	$65.1
	Incorrect party day spending	$273.3	$63.0	$197.5	$63.1
	Percent of error	6%	0%	−1%	−3%
	Correct std. error of mean	50.3	7.0	11.9	6.3
	Incorrect std. error of mean	30.8	6.5	9.3	6.8
Olympic National Park Economic Impact Study[a] (Stynes, Propst, & Sun, 2001)		Visitor staying at inside park hotel	Inside park camper	Visitor staying at outside park hotel	Outside park camper
	Party trip spending	$688.4	$135.4	$516.2	$292.5
	Length of stay	2.4	2.4	2.4	3.3
	Correct party day spending	$283.9	$56.2	$211.3	$87.7
	Incorrect party day spending	$289.3	$61.6	$215.4	$88.2
	Percent of error	2%	10%	2%	1%
	Correct std. error of mean	25.7	4.7	14.3	20.9
	Incorrect std. error of mean	22.0	6.3	10.9	18.6

Note.
[a]Cases with party sizes larger than 8, length of stay longer than 7 days or per-night spending exceeding $1000 were excluded along with cases skipping the expenditure or length of stay questions.
[b]Cases with party sizes larger than 10, length of stay longer than 60 days or with missing expenditure or length of stay data were excluded.
[c]Using ratio estimator (Eq. (2)).
[d]Using the naïve estimator (Eq. (3)).
[e]Percent error = (incorrect daily spending–correct daily spending)/correct daily spending.
[f]Calculation formula = the square root of Eq. (4).
[g]Calculation formula = the square root of Eq. (5).
[h]VFR: Visitors who stay with friends and relatives or stay at seasonal homes.

simple random sampling design are presented in Eqs. (4) and (5), respectively (Lohr, 1999):

$$\hat{V}[\hat{B}] = \left(1 - \frac{n}{N}\right)\frac{1}{n}\frac{\sum_{i\in s}(y_i - \hat{B}x_i)^2}{(n-1)\bar{x}^2}, \quad (4)$$

$$\hat{V}[\bar{z}] = \left(1 - \frac{n}{N}\right)\frac{1}{n}\frac{\sum_{i\in s}(z_i - \bar{z})^2}{(n-1)}, \quad (5)$$

where $\hat{B}$ is the ratio estimator for the per-night spending, z represents the daily expenditure calculated by dividing the trip expenses by length of stay for each sample unit ($z_i = y_i/x_i$), n is the sample size and N is the population size.

The direction of errors (overestimation or underestimation) and the magnitude of differences between two computed variances depend on the characteristics of the data. The differences of the two estimators will be small if the deviations from the regression line, $y = Bx$, are small. In other words, if y (trip spending) and x (length of stay) are perfectly correlated, the computed variances from these two formulas will be equivalent. Similar to the calculation for per-night spending (Eqs. (2) and (3)), Eq. (4) weighs per-night spending of each case in relation to their length of stay when calculating variance, while Eq. (5) computes variance by assigning each case an equal weight. Therefore, if cases with longer stays have greater variation on spending than cases with shorter stays, Eq. (4) will produce a larger variance than Eq. (5) because these long-stay cases are given more weight in computing deviations from the ratio estimator ($\hat{B}$). Based on empirical data, it is more common to observe greater variation in trip expenditures and per-night expenditures for cases of longer duration. Hence, the naïve procedure will usually yield smaller variances than the ratio estimator (Table 2).

5. Conclusion

The correct procedure to estimate a per-night spending average from a sample of trips is to divide the average trip spending by the average length of stay (the ratio estimator). Calculating the per-night spending on a case-by-case basis and then averaging the computed variable (the naïve approach) yields an incorrect per-night spending average. Differences between the naïve and ratio estimators arise because trip spending and length of stay are not perfectly correlated. In general, spending per night declines with length of stay (Stynes & Mahoney, 1989). In this case, the naïve procedure yields an inflated average and an incorrect variance. The bias can be especially high with samples of trips involving widely varying lengths of stay and decreasing per-night costs. For example, the naïve estimates of per-night spending in the Taiwan inbound visitor survey were biased upward by as much as 68% for individual visitor segment (Table 2), due to economies associated with some fairly long stays. In this case, applying the naïve average to the population of trips will significantly overestimate total visitor spending.

We have examined all studies reporting visitor expenditures in the Journal of Travel Research from 1994 to 2004. Agarwal and Yochum (1999) appear to have used the naïve approach, thereby overestimating per-night spending averages by 6%. Many published studies that have estimated a per-night spending average do not report both length of stay and trip spending averages in order to detect the error.

For those who prefer to do calculations within a statistical package, the ratio estimator may be computed directly from a sample of trips by first computing a per-night spending variable (divide the trip spending variable by the length of stay variable), weighing each case by the length of stay and then calculating the weighted average of the per-night spending variable. SPSS Version 12.0 also has a special set of ratio estimation procedures[2] that will compute ratio estimators directly from the original variables.

The ratio estimator is also applicable for estimating spending on a per-person basis from a sample measuring spending by travel parties. The per-person spending average should be computed by dividing the per-party spending average by the average party size. Spending per-person will generally decline with party size, yielding a similar upward bias if the naïve estimator is used.

References

Agarwal, V. B., & Yochum, G. R. (1999). Tourist spending and race of visitors. *Journal of Travel Research*, *38*(2), 173–176.

Blazey, M. A. (1988). The Washington resident travel study: Differences between in-state and out-of-state vacationers. *Journal of Travel Research*, *26*(4), 21–28.

Canadian Tourism Commission, Instituto de Estudios, Swedish Tourist Authority, & Araldi firm. (2003). *Measuring visitor expenditure for inbound tourism*. Madrid, Spain: World Tourism Organization.

Lohr, S. L. (1999). *Sampling: Design and analysis*. Pacific Grove, CA: Brooks/Cole Publishing Company.

Stynes, D. J., & Mahoney, E. M. (1989). *Measurement and analysis of recreational and travel spending*. Paper presented at the 1989 symposium on leisure research, National Recreation and Park Association, Alexandria, VA.

Stynes, D. J., Propst, D. B., & Sun, Y.-Y. (2001). *Economic impact of visitors to Olympic National Park, 2000*. East Lansing, MI:

[2]In SPSS Version 12, Choose Analyze, Descriptive Statistics, Ratio. Select the trip-spending variable as the numerator and length of stay as the denominator. Check the weighted mean option within the statistics tab.

Department of Park, Recreation and Tourism Resources, Michigan State University.

Stynes, D. J., Stoep, G. A. V., & Sun, Y.-Y. (2003). *Economic impacts of Michigan museums*. East Lansing, MI: Department of Park, Recreation and Tourism Resources, Michigan State University.

Stynes, D. J., & Sun, Y.-Y. (2002). *Impacts of visitor spending on the local economy: Crater Lake National Park, 2001*. East Lansing, MI: Department of Park, Recreation and Tourism Resources, Michigan State University.

Taiwan Tourism Bureau. (2001–02). *Survey report on inbound traveler expenditures and trends*. Taipei, Taiwan: Tourism Bureau, Ministry of Transportation and Communications, R.O.C.

Yuan, M. (2001). Reoperationalizing economic data collection. *Annuals of Tourism Research*, *28*(3), 727–737.