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ECONOMIC THEORY, APPLICATIONS AND ISSUES

Working Paper No. 76

**Financial Implications of Seasonal
Variability in Demand for Tourism
Services (A Draft)**

by

Clem Tisdell

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**Financial Implications of Seasonal Variability in
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¹ The draft of a proposed contribution to Chia-Lin Chang and Michael McAleer (eds) "Handbook of Tourism Finance: Connecting Tourism and Finance" to be published by World Scientific. Comments welcome.

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Financial Implications of Seasonal Variability in Demand for Tourism Services (A Draft)

ABSTRACT

Using Jensen's inequality (and its mathematical generalization), this contribution shows how increased seasonal (periodic) variability of demand for tourism services can increase the annual profit of a tourism enterprise and the producers' surplus of a corresponding competitive segment of the tourism industry experiencing this increased variability. It identifies conditions which result in these effects being magnified and takes account of the fact that a tourism business' supply of services is often subject to capacity utilization constraints. A novel feature is that allowance is made for the possibility that variations in the market demand for tourism services may alter the prices of factors of production.

Keywords: demand variability; Jensen's inequality, price instability in tourism; profitability in tourism and demand variability; producers' surplus and demand variability.

JEL Classifications: C02; D20; D41; L83.

Financial Implications of Seasonal Variability in Demand for Tourism Services (A Draft)

1. Introduction

The demand for many tourism services alters throughout the year mainly due to changing seasons and variations in the pattern of public holidays. As a result, the extent to which tourism services are utilized normally varies throughout the year and affects the annual profits of tourism enterprises. In the low season, they often find that they have considerable excess capacity whereas in the high season their capacity is fully utilized. An interesting question is: would the annual profits of a tourism business be increased by reducing the variability of demand for its services? It will be shown that this may actually reduce the firm's profits.

This is shown by adapting the findings of Walter Oi (1961) to this case and mathematically extending his results by making use of Jensen's inequality (Jensen, 1906; Anon, 2016) and its generalization presented by Hardy et al. (1934, theorem 90, p. 74). The generalization by Hardy et al. covers the extension of Jensen's inequality by Karamata (1932). A purely (perfectly) competitive economic model is assumed of the standard type first developed by Alfred Marshall (1890). Initially, a diagrammatic exposition (similar to that used by Oi) is employed to show how known seasonal variations in the demand for tourism services add to focal enterprises' annual profit and the producers' economic surplus in the corresponding segment of the tourism industry experiencing these fluctuations compared to a stationary level of demand throughout the year. Secondly, the mathematical generalization of this result follows. Subsequently, attention is given to how capacity considerations might influence the results. This is followed by a discussion of the findings, paying attention to qualifications and ways in which the analysis might be extended.

2. An Example of How Seasonal Variability in Demand for Tourism Services can Increase the Profitability of a Firm and the Economic Surplus of the Corresponding Segment of the Tourism Industry.

Suppose that the segment of the tourism industry under investigation is purely competitive. Businesses operating in this segment are consequently price-takers. Furthermore, for simplicity, imagine that for half of the year there is a high level of demand for the services of this segment of the tourism industry (for example, tourist accommodation) and for the other half, there is a low level of demand for these services. Consequently, in the case shown in Figure 1(b) (in which BS represents the supply schedule) this may result in market equilibrium in the relevant segment of the industry being established at E_1 during the low season and at E_2 , in the high season. Then the market price of services (for example, accommodation) is P_1 during the low season and is P_2 in the high season. Therefore, the average price of these services for the year is $\bar{P} = 0.5 (P_1 + P_2)$. Note that the demand schedules are not shown in Figure 1(b). They can take any form and they need not shift in a parallel fashion. The relevant question is: if demand can be stabilized at \bar{P} , would the producers' economic surplus in this segment of the tourism industry and the annual profit of enterprises operating in this segment be lower or higher than when seasonal variability of demand prevails?

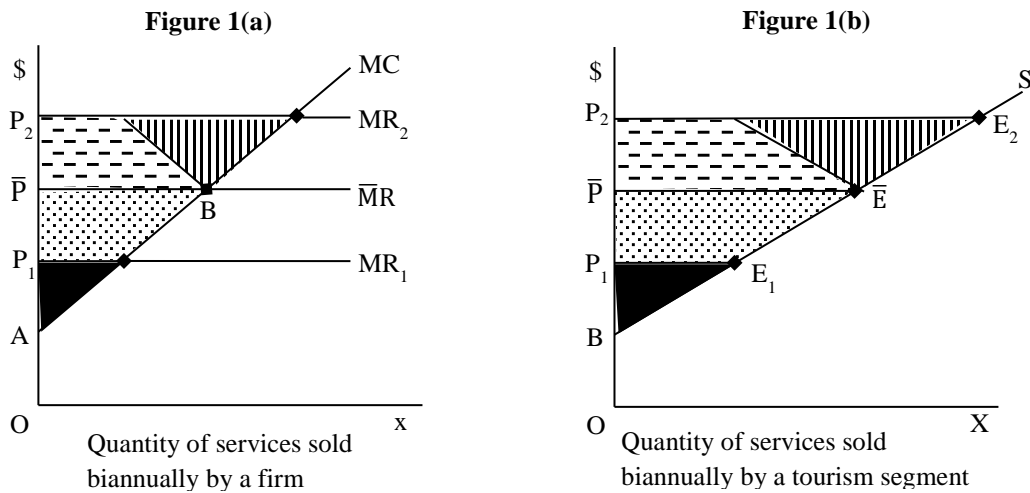


Figure 1: An illustration to show that an increase in the variability of demand for tourism services in a segment of the tourism industry raises the producers' economic surplus obtained in this segment and the profitability of firms operating in this segment. Note that the horizontal scale of Figure 1(b) is compressed compared to that of Figure 1(a).

Given the case illustrated in Figure 1, it can be shown that the annual profit of tourism operators rises with greater seasonal variability of demand and also producers' surplus in the corresponding segment of the tourism industry. When the price of tourism services is \bar{P} throughout the year, the annual operating profit of a representative firm is equal to twice the shaded plus the dotted area in Figure 1(a). In Figure 1(b), the annual producers' surplus is also equal to twice the shaded area plus the dotted area. The annual profit of the representative firm rises by an amount equivalent to the hatched triangular area shown in Figure 1(a) when the price of tourism services is P₁ for half the year and P₂ for the remainder. Producers' surplus also increases by an amount equivalent to the hatched triangular area shown in Figure 1(b). The proof is the same for both cases so that for the representative firm need only be presented.

In the low season (when price is P₁), the profit of the representative firm is below that when price is stabilized at \bar{P} by an amount equivalent to the dotted area in Figure 1(a).

On the other hand, when price is P_2 , profit in the high season exceeds that when price is stationary throughout the year by an amount equal to the sum of the flecked area **plus** the hatched area. The flecked area is the mirror image of the dotted area. Hence, the increase in annual profit of the firm as a result of seasonal variability in demand for its services is equivalent to the hatched area. Furthermore, as the difference in demand between seasons increases so too does the firm's annual profitability.

It can also be shown that seasonal variability of demand is more profitable to a firm the more responsive are its operating costs to altering demand conditions. This happens (other things being held constant) when the slope of the marginal cost curve as a function of output is reduced, that is the rate of change of the marginal cost curve declines (Tisdell, 1968, Ch. 6). In this case, the change in a firm's operating (variable) cost becomes more responsive to variations in the price of tourism services.

3. Mathematical Generalization

The results illustrated in Figure 1 can be mathematically generalized using Jensen's inequality and its most general form as set out by Hardy et al. (1934, theorem 90, p. 74). This is because if the marginal cost of a tourism business increases with its supply of tourism services, $C'(x) > 0$, for values greater than its average variable cost, its operating profit as a function of the price of these services (determined by their market equilibrium value) increases at an increasing rate for values of P in excess of the firm's minimum average variable cost of production. The firm's operating profit function (in this range) is therefore a strictly convex function of P . The mathematics of this is explained in Tisdell (1968, Appendix to Chapter 5). When price is less than its minimum average variable, it pays the business to close down for this period and its operating profit is then zero. Consequently, an operating loss is avoided for that period.

Let π represent the level of maximum profit of the firm when price is P and let P_0 correspond to the minimum of the average variable cost of the firm. Then the following relationship exists if the second derivative of its total variable costs as a function of its supply of tourism services (x) is positive.

$$\pi = f(P) \quad f' > 0, \quad f'' > 0 \text{ for } P \geq P_0 \quad (1)$$

$$= 0 \quad \text{for } P < P_0 \quad (2)$$

In the case illustrated in Figure 1(a) where the marginal cost schedule of the firm is linear, the function π consists of a portion of the positive branch of a quadratic function for $P > P_0$. P_0 is the intercept of the firm's marginal cost curve with the horizontal axis in Figure 1(a). P_0 is also the minimum of the firm's average variable cost in this case.

Given that the function $f(P)$ is strictly convex for P_0 , Jensen's inequality and its extensions apply. This inequality has been primarily applied to probability theory. A different novel application will be given here. However, first consider the implication of the theory for probability theory. If $f(P)$ is strictly convex and P is variable then,

$$E [f (P)] > f (E[P]) \quad (3)$$

where E represents the statistical expected values (first moments) of the relevant random variables involved. This expression indicates that the expected value of the function $f(P)$ is greater when P is variable than when P is constant at the average of its variable values. This result basically follows because the chord (secant) jointing any two different points on a strictly convex function lies above the function.

This is illustrated in Figure 2 for a biannual case. Note that relative frequencies rather than probabilities are relevant to this tourism application of Jensen's inequality. In Figure 2, the continuous portion of $f(P)$ is represented by the strictly convex curve ABCE and for $P < P_0$, it corresponds to point O, a zero operating profit. If for half the year, the price of tourism services is P_1 and for the other half it is P_2 , the average annual price of tourism services is $\bar{P} = 0.5 P_1 + 0.5 P_2$. If the demand curve stabilized so that \bar{P} prevailed throughout the year, annual profit of the firm amounts to twice $\bar{\pi}$. However, if price is seasonally variable, annual profit is equal to twice $\hat{\pi}$ which is greater than twice $\bar{\pi}$ because $\hat{\pi}$ lies on the center of the chord BE at point D which is above point C.

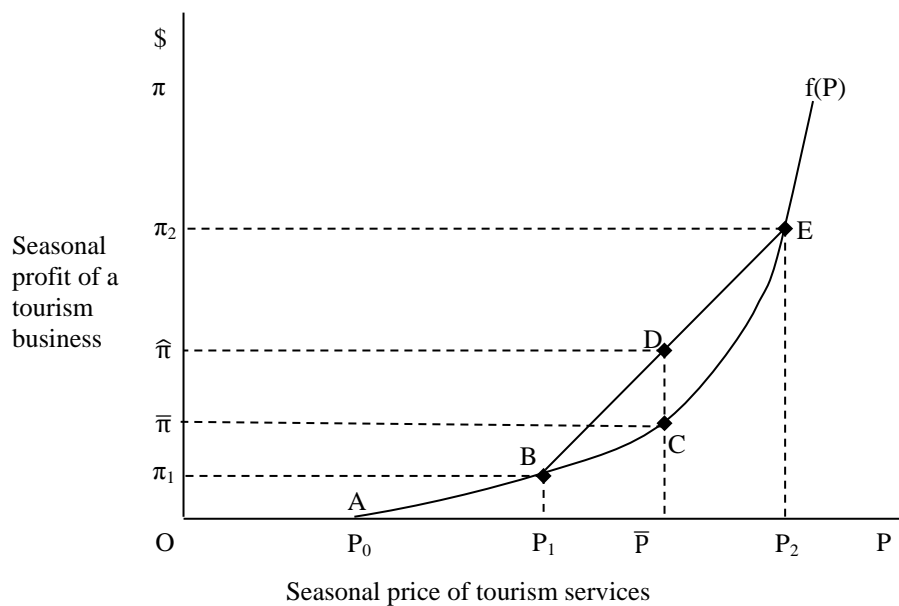


Figure 2: An illustration of Jensen's inequality which is re-interpreted so as to show the impact on the profitability of a firm of the seasonal variability of demand for tourism.

Given this mathematical representation, the annual profit of the tourism business is greater the more variable is the seasonal demand for its services, the level of average seasonal demand remaining constant. Other things equal, this effect is magnified the greater is the convexity of $f(P)$, that is the larger is f'' . In turn, f'' is larger, the smaller is the rate of change of the firm's marginal cost in relation to its supply of tourism services.

Given this neoclassical economic model of the firm, a firm's operating profit as a function of the market price of its product is discontinuous, because when this price is less than its average variable costs, it does not pay the firm to operate. Nevertheless, a chord joining the zero value of the profit function to a price level where it does pay to operate will be in a superior position to $f(P)$. While increased price variability for values less than the minimum of average variable cost will have no effect on annual profitability, other things held constant, increased price variability for prices in excess

of a firm's minimum average variable cost will elevate its annual profit even if it does not pay it to operate in some seasons.

Consider how the model outlined above can be made operational in the case of a tourism business experiencing seasonal (periodic) variation in the demand for its services. The seasons or periods considered need to be of equal lengths and the short run cost functions ought to be the same in each period. Obtaining seasons or periods of equal lengths for a year is not a serious constraint if the periods are based on weeks because 52 has several different possible divisions which yield whole numbers.

If the year is divided into n equal periods, if i indicates the i -th period, and if r_i is the relative (annual frequency) of period i , which numerically has a value of i/n (which can also be expressed as r^{-1}), then when the price of tourism services varies throughout the year,

$$\sum_{i=1}^n n^{-1} f(P_i) > f(\sum_{i=1}^n P_i/n) \quad (4)$$

assuming that all values of P are not less than P_0 . This inequality corresponds to inequality (3). The annual profit of the tourism business is equal to n times the expressions in inequality (4). Consequently, the annual profit of the tourism services is higher when the price (demand for its services) varies seasonally or periodically throughout the year compared to situations in which the demand for its services is stable at the average of the altering price. It is higher by an amount n times the L.H.S. of expression (4) less n times that on its R.H.S. There is even room for the stabilized price of tourism services to be somewhat higher than the average fluctuating price and for the annual profits of the firm to be higher with price variability than in its absence.

The same type of mathematical analysis as that used above can be employed to specify the effects of demand variability on the level of producers' economic surplus in a segment of the tourism industry. If the supply curve of this segment has a normal slope, producers' surplus as a function of the equilibrium prices of the tourism services supplied by this segment increases at an increasing rate. Therefore, producers' surplus as a function of the equilibrium price of tourism services is strictly convex. Hence the same mathematical analysis applies to this case.

4. Allowing for Capacity Constraints

The above analysis of the effect on the profits of a tourism enterprise of fluctuations in the demand for its services does not allow for capacity constraints. However, in the short-run, many tourism enterprises have capacity constraints, for example, the total number of hotel rooms, the available seats in buses, airplanes and so on. How does this affect the result outlined above? Perhaps surprisingly, the firm may still benefit from increased variability of demand for its services which results in its operating at full capacity for part of the year and at less than full capacity for the remainder of the year. This can be shown by modifying Figure 1, and is illustrated in Figure 3.

In Figure 3, the representative firm's biannual supply of tourism services reaches full capacity at $x = x_k$ and the line AB represents its marginal cost schedule. Let P_k be the price of tourism services that just makes it profitable for the firm to operate at full capacity. If the price of its services is P_k throughout the year, the firm's total annual profit will be equal to twice the shaded area plus the dotted area. Now suppose that the price of these services is P_1 in the low season and P_2 in the high season so that on average the price of these services is P_k . Annual profit will increase by an amount equal to the hatched area. The same type of argument is relevant as that applied in the case illustrated by Figure 1. Moreover, the greater is the disparity between P_1 and P_2 , the larger will be this hatched triangle. The firm benefits by not fully utilizing its capacity throughout the year in this case.

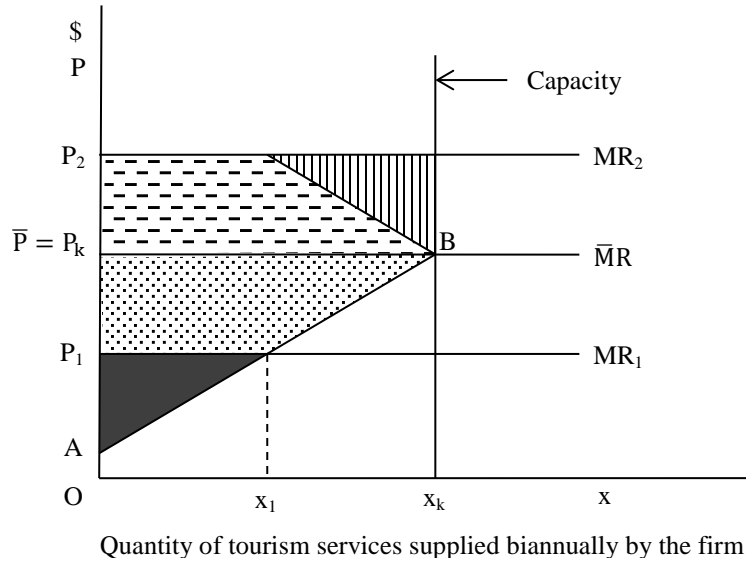


Figure 3: An illustration that the annual profit of a tourism enterprise can be increased by greater seasonal (periodic) variability in the demand for its services resulting in it transiting from a situation where its capacity is fully utilized throughout the year to one in which its capacity is underutilized for a part of the year.

It may come as a surprise to discover that having underutilized capacity in the tourism industry for part of the year can be profitable. Note that if prices are always such that the firm's capacity is fully utilized, its annual profit is not increased by greater price instability given that the average price level of tourism services remains constant. This is because its level of operating is a linear function of P in these circumstances.

Note that the firm's marginal cost curve need not be linear for the above results to follow. Also the previous modelling can be adjusted to fit this case. In this case, the firm's operating profit function $f(P)$ is zero for $P < \text{minimum average variable cost}$; strictly convex for $P_0 \leq P \leq P_k$ (where P_0 corresponds to the minimum of average variable cost) and linear for $P > P_k$.

5. Discussion and Concluding Comments

Although the above modelling is relatively general, it does have some limitations. It

supposes that the firm's cost function is the same for each period. The prime assumption needed is that its production efficiency remains the same in all periods. However, it is possible to allow for systematic periodic changes in factor prices both in constructing the focal supply schedule of the industry and the corresponding marginal cost schedule actually experienced by firms operating in that segment. This model can take account of a situation in which the level of production of a segment of the tourism industry increases the prices of variable inputs as the level of the segment's production rises. In this case, the adjusted supply curve of the focal segment of the industry becomes steeper when the rate of change in factor prices as a function of the level of production of this focal segment increases. Hence, increased annual producers' surplus as a result of magnified demand variability will be lower the more sensitive are resource prices to the level of production of this segment of the tourism industry. Furthermore, the adjusted marginal cost curves of firms (that is, adjusted to allow for variations in resource prices) will be steeper in these circumstances. Consequently, the economic benefit firms obtain from the increased variability of demand for their tourism services is reduced. However, these benefits would only be eliminated if this phenomenon caused their adjusted marginal cost curves to become perfectly inelastic, which is very unlikely. The same applies to producers' surplus: producers' surplus would only fail to increase in response to increased variability of demand if the adjusted supply curve happened to become perfectly inelastic. The propositions set out in this paragraph can be easily illustrated by modifying diagrams 1(a) and 1(b) in Figure 1. The adjusted market supply curve rotates in an anti-clockwise fashion on the fixed point \bar{E} and the marginal cost curve does likewise on the fixed point B.

The modelling does not allow for errors which may be made by firms in their production decisions because of possible uncertainty about the level of periodic (seasonal) demand for their services. The importance of seasonal price uncertainty is probably not as great in the tourism industry as in agriculture but is unlikely to be completely absent in all segments of the industry. Types of adjustment which can be made to allow for this uncertainty are set out in Tisdell (1968). If increased errors in production decisions occur as product variability rises, this reduces the economic benefit to a firm of price variability, and if these errors are extreme, product price variability can lower the profit of the business.

Another relevant issue is whether a business will in fact maximize its profit by closing down when the price of its product is below the minimum of its average variable cost of supplying tourism services. In some cases, it may pay the firm to hoard staff in periods of low demand because it may be difficult to re-hire qualified staff when demand recovers. Costs are therefore, not entirely reversible; an element of hysteresis may be present. In general, the extent to which it pays a tourism business to alter the flexibility of its operations to cope with product price variability and uncertainty is an additional aspect worthy of consideration. This is given some attention in Tisdell (1968, Ch. 6).

Further extension of the theory is desirable to take account of situations involving imperfect competition. This will not be attempted here. Nevertheless, there are circumstances in which the basic theory does extend to situations involving imperfect competition.

To conclude: it has been shown that increased seasonal (periodic) variability of demand for tourism services can increase the annual profit of tourism enterprises and also producers' surplus in those segments of the tourism industry experiencing increased variability of demand. Factors which influence the size of these effects have been identified and qualifications to the basic theory have been specified. The results obtained are not intuitively obvious. For example, it can be more profitable for a tourism business to have excess capacity for part of the year rather than have a stabilized demand situation in which its capacity is fully utilized throughout the year.

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