Argumenta Oeconomica
Year 2024, Vol. 53, No. 2
ISSN 2720-5088
journals.ue.wroc.pl/aoe

A dynamic programming model for hospitality performance in tourist cities

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Quote as: Sheng, L. (2024). A dynamic programming model for hospitality performance in tourist cities. *Argumenta Oeconomica*, 2(53), 144-158.

DOI: 10.15611/aoe.2024.2.10

JEL: R11

Abstract: The paper suggests the use of a dynamic programming model to describe how external shocks from tourism source markets are dispersed across visitor flows to a travel destination, with major effects on the destination's hospitality performance. One can determine the driving forces underlying local cycles by modelling this mechanism, which also provides a theoretical foundation for empirical research. Additionally, the study revealed that in an equilibrium tourism market, positive changes in the push and pull variables have a beneficial influence on the local economy, resulting in decreased prices and increases in the number of visitors and revenues. In contrast, a negative external shock can have a detrimental influence on these aspects of the local economy.

Keywords: dynamic programming, propagation mechanism, hospitality fluctuation, tourism flows, travel destinations

1. Introduction

The global tourism industry fluctuated considerably during the Covid-19 pandemic, raising the need to explore the path and logic of market dynamics impacting this sector. According to the World Travel and Tourism Council, after a devastating 50.4% decline in its GDP in 2020, the tourism sector recovered by 21.7% in 2021 (WTTC, 2022). Although many scholars have studied the volatility of tourism (Wong, 1997; Botha & Saayman, 2022), the subject literature still lacks a dynamic theory that explains local tourism cycles over time. To expand the theoretical foundations and enhance the regression specifications of tourism research, it was necessary to conduct additional research on the economic cycles of tourist destinations. Accordingly, using a dynamic programming model to describe the impact of external shocks from tourism source markets on the destination's hospitality performance, this study advances tourism and hospitality research by making theoretical contribution and extracting useful implications for managerial applications.

Increasingly, the literature is focused on the pull and push factors that influence decisions in tourism (Baloglu and Uysal, 1996; Lewis & D'Alessandro, 2019; Sheng, 2011). The pull factors indicate the holiday destination's desirability, whereas the push factors describe the travellers' personal motivations for visiting (Phau et al., 2013; Nikjoo & Ketabi, 2015). Additionally, both types of variables are frequently employed in international finance research to investigate the factors that influence cross-border capital flows (Fratzscher, 2012; Kang & Kim, 2019). As demand forces are the primary drivers of tourist flows, many empirical studies quantify tourism demand (Song et al., 2009; Bronner & de Hoog, 2017). However, theoretical research on the influence of those elements is far less fruitful than its empirical equivalent in the tourism literature, which contains no significant investigation of the effects of the tourism supply (i.e. the hospitality industry), presumably because this service sector appears minor compared with other sectors, leading to the assumption that its supply is infinitely elastic (Li et al., 2005, p. 88). It is commonly overlooked that supply can spur or even generate demand, e.g. the launch of a new resort casino may attract interested guests prompted by clever marketing tactics to spend more than they intended. Therefore, future research should focus on the supply side.

The tourism studies (such as the tourism economics literature and operations research applied to the hospitality literature) lack a dynamic theory that explains the economic cycles of tourist destinations over time. Dynamic considerations do appear in the tourism and hospitality research, but these are primarily in conceptual studies with a plethora of verbal descriptions (Pappas & Bregoli, 2016), occasionally in quantitative investigations with simulated system dynamics (Georgantzas, 2003; Beran & Ali, 2017), and sometimes in empirical works with regressions of multiple covariates (Garn-Munoza & Montero-Martn, 2007). As seen in Macao and Las Vegas, the two biggest casino resort markets in the world, the propagation mechanism leading to local economic cyclicality is a dynamic process that makes it possible for those factors to have either a substantial or moderate impact on local hospitality-based economic performance (Sheng & Wan, 2017). While previous studies have empirically considered the impact of external shocks caused by source market on cyclical fluctuations in visitor flows from a natural disaster perspective (Wang, 2009), from a travel restrictions perspective (Khalid, Okafor & Burzynska, 2021), or from an anti-corruption campaign perspective (Li & Sheng, 2018), the theoretical transmission mechanism of external shocks is still unclear. As suggested, there is room for a great deal of improvement in the literature.

To address the research gap mentioned above, the author suggested a truly dynamic model for theoretical economic analysis of the tourist and hospitality cycles. This study proposes a dynamic programming (DP) model of tourism demand to formulate the dynamics of visitors' income variations, which depend on source-market economic cycles (Smeral, 2012). The hospitality supply in a tourist location is the subject of another mathematical programming model; both models are designed to interact with each other through changing prices that are competitive. To sum up, this study makes three contributions to empirical research on tourism and hospitality economics. First, it updates and expands certain models of tourism economics (Song et al., 2012) to analyse cross-border interactions between a travel destination and its source markets. The goal of this expansion was to comprehensively examine both the supply and demand sides of the tourism industry. This paper may be the first theoretical effort to develop a dynamic pull-and-push model that can be used to link local hospitality cycles to outside tourism shocks. Second, it applies a true dynamic model that formulates a typical consumer's intertemporal decisions. The model's discount factors define temporal preferences and wealth accumulations, allowing both saving and dissaving to sustain spending over time in the wake of income shocks (Sargent, 1987). Third, since this study systematically examined the effect of external shocks on tourist destination, its theoretical and empirical results can yield certain distinct implications useful for policy making and business operation in different destinations. By taking two tourist cities as examples, the author's theoretical predictions confirmed by real-world observation can be used for policymaking and company management.

2. Literature review

A business cycle is defined by upswings and downswings in a variety of economic activities, with expansion or recession taking place under conditions that change over time in terms of their intensity and duration. The causes of swings in the business cycle are random, unforeseeable shocks (Orlando & Zimatore, 2020). The issue of whether such cycles can be attributed to supply-side or demand-side variables is a topic of discussion in mainstream economics. There is a scholarly controversy about Say's law, which is often implicated in the 'general glut' (supply vs. demand) debate (Aghion & Howitt, 1998; Romer, 2001). Neoclassical economists frequently hold that deviations from the market economy's harmonious operation are caused by exogenous factors, such as governmental restrictions, trade unions, monopolies in certain industries, technological shocks, and natural causes. Heterodox thinkers frequently hold that periodic ups and downs are an inherent feature of the market system, with the paradox of thrift proposed during the Keynesian revolution as an endogenous reason for economic cycles. The debate over the causes of the business cycle has significant policy consequences with respect to the question of whether to strengthen or weaken government regulation. The Great Recession (2007-2009) reignited the dispute between the Keynesians and the neo-classicists (Acemoglu, 2018, Sheng, 2016).

Ultimately, the business cycles in source markets have an impact on tourism flows as a form of cross-border economic activity. Inbound flows also have an immediate or delayed impact on a destination's local hospitality performance (Sheng & Gao 2018, Sheng & Zhao 2016). However, there is little research on hospitality cycles, considered unimportant in major economies (Croes & Ridderstaat, 2017). Prior to 2010, few studies examined the cyclicality of tourism (i.e. Wong, 1997; Gonzalez & Morales, 1996; Greenidge, 2001; Gouveia & Rodrigues, 2005). Even extensive academic reviews of tourism and hospitality virtually ignore the local economic cycles in travel locations (Song et al., 2012). Only more recent studies considered inbound travel as an exporting industry and analysed its cyclical patterns in relation to source-market business cycles (Guizzardi & Mazzocchi, 2010; Papatheodorou et al., 2010; Bronner & de Hoog, 2017; Hsu, 2017). These studies concentrated on the tourism demand for a travel destination, influenced by travellers' income, which in turn is affected by business cycles in the source markets (Mayers & Jackman, 2011; Sheng, Li & Gao, 2019; Smeral, 2012; Kozic, 2014). Even though many of these studies are empirical and helpful, their regression specifications must be theoretically supported by economic models, as in this paper.

The recent literature includes numerous studies on the effects of the external or macroeconomic environment and fluctuations in tourism and hospitality on local tourism performance, which have major ramifications for job creation in and the economies of travel destinations (Smeral, 2017, 2018, 2019; Sheng & Gao 2018). By providing a theoretical foundation for those studies, this paper makes an additional contribution investigating the underlying mechanisms by which international tourism flows spread to regional hospitality cycles. The author used non-linear models to investigate this propagation mechanism to explain the asymmetric features of the local hospitality cycles that follow global business cycles. The propagation instruments include both push factors, which operate as incentives to visit, and pull factors, which entice visitors to a particular location. Many sectors, including those involving economics, finance, management, and tourism, employ both push and pull factors (Fratzscher, 2012; Shu et al., 2018; Carstens & Freybote, 2019; Kang & Kim, 2019; Hudik, 2021). Although the literature in other fields contains theoretical discussions of both types of factors (Agenor, 1998), this paper fills the gap in relevant literature on tourism or hospitality (Phau et al., 2013; Nikjoo & Ketabi, 2015; Chan et al., 2018; Lewis & D'Alessandro, 2019; Su et al., 2020). The author used both push and pull forces in a dynamic study of travel demand to define the spread of exogenous impulses. Due to its adaptability, the proposed concept of market equilibrium can be applied to a variety of situations in which foreign tourist shocks can either amplify or dampen local hospitality cycles.

3. Analytic framework and hypotheses

In the extant literature, there seems to be no theory of tourism and hospitality economics applicable to incorporating the interaction of external economic shocks and local tourism fluctuations into dynamic programming. The proposed theoretical model is depicted in Figure 1 to show the direction for theoretical economic analysis of the tourist and hospitality cycles. The study systematically outlined the operations and movements of a casino tourist market using both operational research approaches and a theoretical framework, beginning by considering the dynamic budget-constrained utility maximisation of a typical visitor. This common problem incorporates not only important pull variables of tourist destinations but also a variety of push variables of tourism-generating regions, such as disposable income, asset accumulation, and economic growth. The solution to this problem is the demand for tourism as a function of pricing, push variables, and pull variables. The author then created a profit-maximisation model for local hospitality businesses (such as resort casino hotels) in tourist areas. Key draw elements, e.g. artificially created amenities and natural attractions, were addressed as fundamental characteristics of both the push and pull variables. After this issue was resolved, the hospitality supply was determined by the price and the pull variables. The market equilibrium price was then produced by balancing the demand and supply, substituted back into their corresponding functions, and also producing the market equilibrium quantity. Finally, the equilibrium pricing and quantity were used to examine how local hospitality performance was affected by tourist shocks and their variations, which might be either large or small depending on the propagation mechanisms at work.

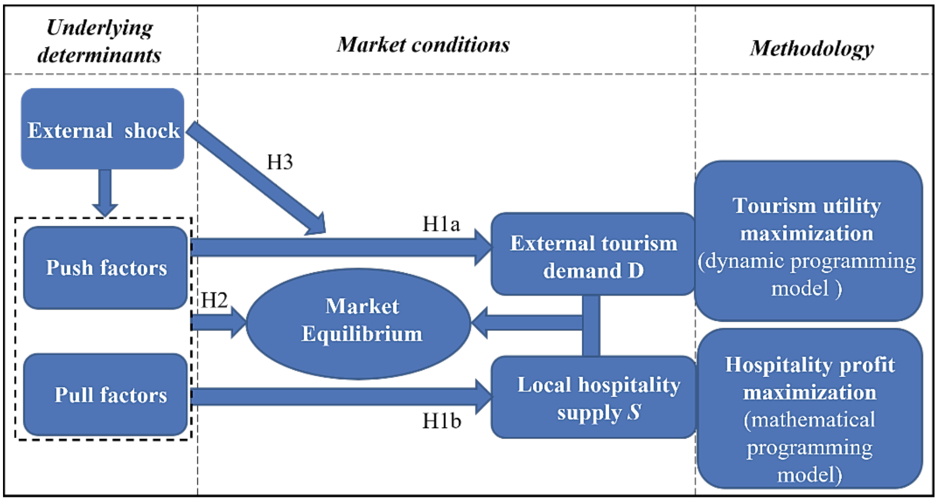

Fig. 1. Conceptual framework for the theory

Source: Sheng (2013).

The two largest casino hotel resort markets in the world – Las Vegas in the United States and Macao in China – were examined using the author's theoretical predictions depicted in Figure 1. Gaming is crucial to the expansion of these economies. The cities are affected by similar variables, such as Chinese visitors who are high-roller gamblers and baccarat fans, but they differ in many ways, including the mix of source markets and hospitality services. The data charts comparing the gross gaming revenues (GGRs) of Macao and Las Vegas are consistent with this proposition. Indeed, the two locations experienced both cyclical changes in gaming hospitality and co-movements of visitor flows. One can determine whether the proposed theoretical predictions match observable tourism flows, the ensuing hospitality cycles, and their underlying drivers (which, if properly recognised, can be used for policy-making and company management) by looking at their similarities and differences (Sheng, Yin, & Zhang 2022).

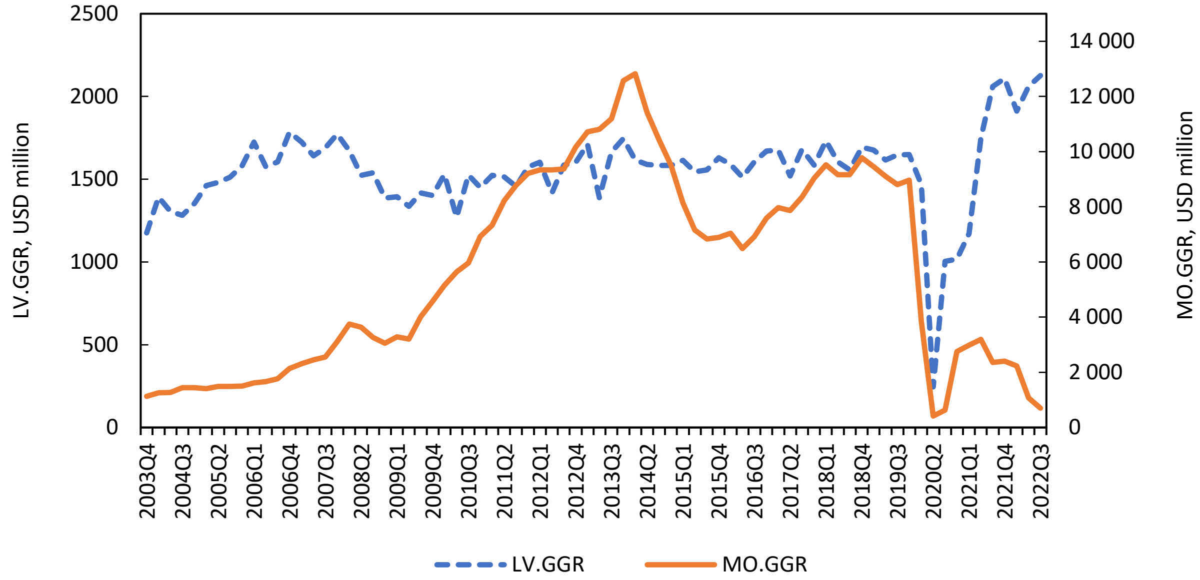

Fig. 2. Gross gaming revenues (GGR) in Las Vegas (LV) and Macao (MO)

Source: https://www.dsec.gov.mo/home_enus.aspx and https://gaming.unlv.edu/

The above model of tourism equilibrium determinants provides theoretical support for hypothesis development, with the three hypotheses formulated below and indicated in Figure 1. Utilising both the push and pull variables as the underlying parameters, the author proposed three hypotheses to identify the probable drivers of tourist flows, variations in the hospitality industry, and spreading processes. The theoretical phase of the model establishes and discusses more specific factors. The following hypotheses were developed using only the qualitative versions of these factors:

Hypothesis 1a. The demand for travel will increase if the push and pull variables change favourably.
Hypothesis 1b. The supply of accommodations will increase if the pull variables improve.
Hypothesis 2. In an equilibrium market, favourable adjustments in both the push and the pull variables significantly impact the sales and incomes of hospitality businesses. While favourable changes in the push variables have a positive impact on the hospitality industry's selling price, the impact of the pull variables on the selling price is insignificant.
Hypothesis 3. The transmission mechanism that converts foreign economic shocks into changes in local businesses depends on tourist preferences, income levels, and dynamic processes.

4. A DP model of tourism demand

The intertemporal decision of a typical customer arriving from a source market for tourism is described using a DP model that focuses on his/her ideal mode of transportation, which derives its utility $U_t = U(C_t, q_t)$ in period t by taking advantage of the out-of-town tourist trip q_t and consuming all other products C_t at home. Consumption variable C_t comprises all other outlays on products and services in the local neighbourhood, while travel variable q_t measures the total amount of time spent in all the visited localities. The utility function is the Cobb-Douglas type, defined as $U(C_t, q_t) = C_t^a q_t^b$, while ratio a/b of the two factors (a, b)indicates his/her preferences for the two activities in terms of consumption and travel, respectively. Higher tourism attractiveness, measured by and referred to as pull factor γ from a vacation destination, tends to boost a consumer's preference b for travel. As a result, the utility's travel elasticity, b, depends favourably on this index: $b = b(\gamma)$ with $b'(\gamma) > 0$.

The consumer's budget constraint, which accounts for all of his/her outlays and financial resources, is given by formula $A_{t+1} = R_t(A_t + Y_t - C_t - p_t q_t)$, where A_t stands for accumulated assets, Y_t for labour income, R_t stands for one-period gross rate of return on assets, and p_t for the tourism price calculated as the average cost of all visits divided by the number of days spent at each destination. For the sake of simplicity, the time spent travelling was omitted from the equation. The benefit of a dynamic model over a static one is that both wealth (i.e. assets) and income can be taken into account, allowing the consumer to smooth his/her expenditure flows by saving and spending less to account for changes in income over time.

The consumer's travel decision problem is formulated as follows:

$$\max_{\forall q_t} \sum_{t=1}^{\infty} \beta^t U(C_t, q_t), \text{ s.t. } A_{t+1} = R_t(A_t + Y_t - C_t - p_t q_t), \quad (1)$$

where β is the discount factor, often known as the rate of time preferences, utilised in all macroeconomic models. $C_t = vA_t$ is established using consumption propensity $v\epsilon(0, 1)$ for the infinite horizon, along with the assumption that current consumption expenditures are proportionate to the stock of accumulated assets. This inclination resembles Engel's index, which measures the proportion of household spending on food consumption alone, but it is far more inclusive. Note that the push factors for travel are Y, R, and $1/v$.

Although Equation (1) appears straightforward, it is challenging because it calls for a mathematical study of a DP model. Following Chow (1992), the author employed an alternative to the DP model to alleviate these issues. In the dynamic scenario, one may forgo time-backward recursion and instead concentrate on a steady-state solution, given the infinite horizon assumption. This simplification makes it easier to calculate Equation (1) for the tourism demand that fluctuates with the push and pull factors.

Lemma 1. The increase in tourism demand q^D results from favourable changes in push factors $(Y \uparrow,\ R \uparrow,\ v \downarrow)$ and pull factor $(\gamma \uparrow)$.

$Z = 1 - v[= \zeta(v)]$ was specified in this proof, and the steady-state solution was obtained for the ideal number of visits as the tourist demand from a source market:

$$q^* = \frac{Y}{p}\left\{1 + \frac{\partial}{b(\gamma)} \frac{\beta[1-R\zeta(v)]}{1-\beta R\zeta(v)}\right\}^{-1} = q^D(p; Y, \gamma, v, R). \quad (2)$$

Furthermore, $\omega = \beta(1-R\zeta)/(1-\beta R\zeta)$ was defined so that $\omega'(R\zeta) < 0$. The additional signs, such as $b'(\gamma) > 0$ and $\zeta'(v) < 0$, were derived from Equation (2) using this sign together with $\partial q^D/\partial(Y, R, \gamma) > 0$ and $\partial q^D/\partial v < 0$. The findings in Lemma 1 support Hypothesis 1a.

Lemma 1 implies that increased wealth directly influences the demand for tourism. As there is some substitution between consumption and travel when the propensity of spending on tourism rises relative to the consumption of goods $(i.e.\ v \downarrow)$, a decrease in competitive consumption tends to increase travel expenditures. The function of asset A_t in sustaining different expenditures in the steady state was replaced by its gross rate R of return in Equation (2) because asset A_t is a state variable. A higher rate is likely to increase consumer demand for travel. Additionally, pull factor γ re-enters the tourist demand schedule, positively affecting travel as expected because the proportionate preference shifts in favour of travel, given consumption: $\gamma \uparrow\ [a/(b \uparrow)] \downarrow$.

5. A mathematical programming model of hospitality supply

In this section, the supply behaviour of the hospitality sector in a tourism location is described using a standard optimisation model. This concept highlights the importance of pull factor $\gamma > 1$ (such as natural amenities and manmade facilities) in decreasing costs and increasing profits. A normal business runs its hospitality division to maximise its profit Π_t in period t. Let us first calculate its cost function C_t^* for the hospitality operation. To derive this function, the following constrained minimisation problem is solved (t is omitted to make notations simpler):

$$\min_{(x1,x2)} C = w_1 x_1 + w_2 x_2, \text{ s.t. } f(x_1, x_2;\, \gamma) = q,$$

where w_1 and w_2 are the wage and interest rates, respectively, and x_1 and x_2 are the labour and capital inputs used to create output $q.f(x_1, x_2;\, \gamma)$ is the production function of a hospitality business that has $\alpha_1 > 0$ and $\alpha_2 > 0$ as the output elasticities of the two inputs with $\alpha_1 + \alpha_2 < 1$. As a function of (α_1, α_2), the influence of pull factor γ on firm output q can be determined flexibly for the different scenarios indexed by parameter τ (> 0).

Next, the profit was obtained by comparing sales revenue $p_t q_t$ with production cost $C_t^* = C(q_t,\, \gamma) = c_o q_t^{1+\theta}/\gamma^{\tau}$, where $\theta > 0$ and c_o are defined in (A3). C_o was removed below for convenience. Note that τ estimates the amount by which the overall cost is decreased by pull factor γ, whereas θ reflects the fact that, as is customary, the marginal cost of production increases with output. To account for the impact of unique pull factors on each resort's cost function, each destination resort should have a unique value of τ. An unconstrained maximisation problem was used to represent the firm's production decision as follows:

$$\max_{q_t} \prod_t = p_t q_t - C(q_t, \gamma). \tag{3}$$

The resolution of this issue gives the company the ideal number of service hours needed to accommodate incoming tourists:

$$q_t^* = \left(\frac{p_t \gamma^{\tau}}{1+\theta}\right)^{\frac{1}{\theta}} = q_t^S(p_t; \gamma). \tag{4}$$

As seen below, lower operating costs have a major impact on the output and profitability of the hotel industry when a location's appeal to visitors increases, as shown by the higher value of γ.

Lemma 2. An increase in a vacation destination's pull factor, which is a measure of its tourist appeal, is beneficial to both its supply of accommodation and its financial performance.

Proof. This result is demonstrated by noting that $\partial q_t^S/\partial\gamma = q_t^* \tau/(\gamma\theta) > 0$ and using the envelope theorem to establish that $d\Pi_t^*/d\gamma = \partial\Pi(q_t, \gamma)/\partial\gamma_{q=q*} = \tau q_t^{*1-\theta}/\gamma^{1+\tau} > 0$ for the profit function in Equation (3).

According to this lemma, Hypothesis 1b is supported. Indeed, the more appealing a tourism destination, the greater the increases in both the supply of its hotel industry and its operational profits.

6. A tourism-economy model of market equilibrium

To determine the market demand and industry supply, an aggregate of all of the private agents in a resort location and its tourist sources may be required. The nature of the findings to be produced is unaffected by the simplicity with which this aggregate is ignored. As representative agents (visitors and businesses) are supposed to derive their demand and supply behaviour from the tourist price, this omission can be justified in the literature. Accordingly, the author demonstrated how, from the market's standpoint, local tourist cycles are connected to external business cycles in the steady state.

The interplay between the local hospitality supply and the demand for inbound tourists ultimately leads to a cross-border market equilibrium. In the steady state, comparative statics can be used to deduce the significant economic implications of this market equilibrium, as demonstrated below.

Proposition 1. In an equilibrium, favourable changes in all of the push variables ($Y \uparrow$, $R \uparrow$, $\nu \downarrow$) have a positive impact on the hospitality industry's overall revenue, transaction amount, and selling price. Although pull variable γ has a favourable impact on both the total revenue and the transaction amount, its impact on the selling price is less obvious.

Proof. Setting q^D in Equation (2) equal to q^S in Equation (4) yields market equilibrium outcomes, including selling price p^{**}, transaction amount q^{**}, and total revenue TR^{**}:

$$p^{**} = \left(\frac{1+\theta}{\gamma^\tau}\right)^{\frac{1}{1+\theta}} \left\{Y\left[1+\frac{a}{b(\gamma)}\frac{\beta[1-R\xi(v)]}{1-\beta R\xi(v)}\right]^{-1}\right\}^{\frac{\theta}{1+\theta}},$$

$$q^{**} = \left\{\frac{\gamma^\tau Y}{1+\theta}\left[1+\frac{a}{b(\gamma)}\frac{\beta[1-R\xi(v)]}{1-\beta R\xi(v)}\right]^{-1}\right\}^{\frac{1}{1+\theta}}, \tag{5}$$

$$\mathrm{TR}^{**} = p^{**}q^{**} = Y\left[1+\frac{\partial}{b(\gamma)}\frac{\beta[1-R\xi(v)]}{1-\beta R\xi(v)}\right]^{-1}.$$

As $\omega'(R\zeta) < 0$, $b'(\gamma) > 0$, and $\zeta'(v) < 0$, it follows from Equation (5) that $\partial(TR^{**}, q^{**}, p^{**}) / \partial(Y, R) > 0$, $\partial(TR^{**}, q^{**}, p^{**}) / \partial v < 0$, $\partial(TR^{**}, q^{**}) / \partial\gamma > 0$, and $\partial p^{**}/\partial\gamma \langle \mathrm{or} \rangle 0$.

As shown in Equation (5), the performance of the tourist and hospitality industries, measured by sales volume q^{**}, gross revenue TR^{**}, and net profit $\Pi^{**} = [\theta/(1+\theta)]TR^{**}$, was demonstrated to positively depend on pull factor γ, although the pull factor's impact on tourism price p^{**} is complex. The price effect of γ was typically confusing: $\partial p^{**}/\partial\gamma < 0$ was observed if $b = b_o\gamma^2$, $\tau = 2\theta$, and $b_o = 1$. To decrease the selling price, the pull factor must often cut production costs.

Hypothesis 2 is supported by Proposition 1. As set below, Proposition 2 and its corollary provide evidence which supports Hypothesis 3.

Proposition 2. The propagation mechanism that converts foreign economic shocks into local business fluctuations is determined by the underlying parameters of tourist preferences and dynamic processes, $\Omega = [\beta,\ a/b(\gamma),\ \xi(v),\ R]$, and income factor *Y*. The relative magnitudes of the push and pull elements determine the extent to which hospitality performance $(q^{**},\ TR^{**}, \Pi^{**})$ will improve or decline.

Proof. Since $\omega \to \infty$ as $R\zeta(v) \to 1/\beta$ (the right-sided limit), it is known that $(q^{**},\ TR^{**}, \Pi^{**}) \to 0$, and thus may infer that a local business should perform badly in this scenario. In contrast, a company may perform incredibly well if $R\zeta \to [1 + b(\gamma)/(a\beta)][1 + b(\gamma)/a]^{-1}$ $[\equiv\ X_\Delta\ \in\ (1,\ 1/\beta)]$ (the left-sided limit), because in this instance $1 + a\omega/b(\gamma) \to 0_+$ and $(q^{**},\ TR^{**}, \Pi^{**}) \to +\infty$. Note that for $(q^{**},\ TR^{**})$ to be positive, interval $[X_\Delta,\ 1/\beta]$ for $R\zeta(v)$ must be ruled out. Naturally, whether the propagation is strong or weak and whether its influence is positive or negative depends heavily on subjective discount factor *β* of the consumer's intertemporal decision.

This proof's conclusion illustrates the theoretical possibility that the tourist and hospitality industries may perform either very well or very badly, depending on the relative magnitudes of the push and pull elements. Such severe results only arise in extremely uncommon situations that include unique or excessive shocks to the push and pull components. The fundamental element of Proposition 2 is that relatively small (large) economic shocks from the source markets can be translated into large (small) changes in the tourism and hospitality at a destination. The sensitivity of local hospitality to the external shocks caused by tourism flows must be empirically assessed.

In terms of total revenue TR^{**} and business profit Π^{**}, adverse shocks δ to consumer preference *b* and/or tourist income *Y* from the source markets have a negative impact on a travel destination's hospitality performance. Depending on both the type of unfavourable shock δ that predominates in the tourism markets and whether the transmission follows a dampening or an amplifying pattern, these effects can range from mild to catastrophic.

Proof. For ease of use, rewrite the total revenue from Equation (5) as $TR^{**} = Y/X$, where $X = 1 + \omega a/b > 0$. $b = b(\delta)$ and $b'(\delta) < 0$ capture the effect of unfavourable shock δ on consumer preference *b* for tourist travel. If such shocks also have a negative impact on consumer income *Y*, then $Y = Y(\delta)$ and $Y'(\delta) < 0$. As a result of $X = X(\delta)$ and $X'(\delta) = -b'(\delta)\omega a/b^2 > 0$, $\partial TR^{**}/\partial\delta = TR^{**}[Y'(\delta)/Y - X'(\delta)/X] < 0$. In this situation, TR^{**} can decline significantly after an adverse shock

δ if parameter Ω (as described in Proposition 2) constitutes an amplifying mechanism of propagation as a result of $R\zeta$ approaching $1/\beta$, as suggested by Proposition 2. Due to its linear relationship with TR^{**}, the results for Π^{**} are likewise poor.

7. A brief discussion of managerial implications

This section provides a further discussion of the practical consequences of the theorisation described above, and summarises the key ideas of the proposed theory to enable its application to vacation resorts. The first is that the hospitality industry's performance benefits (or suffers) from changes in the push and pull elements of the tourism markets. The second is that depending on whether the transmission mechanism is amplifying or dampening, the influence of those elements on local economic cycles might be significant or mild. The third is that depending on the relative magnitudes of the underlying factors, a negative shock to consumer preferences or tourist spending can have either a catastrophic or a negligible effect on local economic cycles. Some empirical studies (Smeral, 2012; Bronner & de Hoog, 2017; Croes & Ridderstaat, 2017) addressed the tourist and hospitality cycles of various vacation locations. Their findings are broadly compatible with the author's first theoretical argument; Macao and Las Vegas were as examples to show the real-world applicability of the theory.

By 1970, Las Vegas and Nevada's major industries were casino travel and resort stays, and for the following decades Nevada was the fastest-growing state in the United States (Eadington, 1999). Prior to the tragedy of 11 September 2001, Las Vegas's business was thriving and had never been vulnerable to outside shocks, yet the industry did not recover its position as the most popular playground in the world until 2005 (Schwartz, 2006). Las Vegas was severely impacted by a second mega-event in 2007–2009, the subprime lending and financial crises associated with the Great Recession, which resulted in the cancellation or postponement of tourism-related projects and events. Due to an increase in visitors from all over the world, particularly from developing Asian countries, the local economy started to rebound in 2010 and continued to do so through 2013 (NRA, 2018).

Macao is another gambling tourism success story that has had unpleasant experiences with economic turbulence (Hao et al., 2017). Due to the large increase in Macao's GGR, which rose by an average of 28.2% per year between 2002 and 2013, the country's GDP expanded at a rate of 13.0%. The GGR of Macao was seven times that of Las Vegas in 2013; as a result, its GDP per capita was twice as high as that of Hong Kong (Wu et al., 2017). However, the Great Recession of 2007-2009 and China's 2014–2016 anticorruption drive rendered Macao's tourist industry vulnerable to outside shocks. From 2014 to 2016, Macao's GGR decreased by 49.4% and its GDP dropped by 28.9%. The decline of gross gaming revenue stopped in late 2016 and started to bounce back in 2017. The recovery was largely due to the Macau government's effort to promote the tourism industry with nongambling elements and the development of the mass market segment in casinos. Even though Macao's recovery began in 2017, economic instability still persists because of the local hotel industry's vulnerability to outside shocks. Since tourism and gaming, as the pillar industry in Macau, relies heavily on mainland Chinese tourists, China's economy and the policy regarding Macau are closely related to Macau's economy and the hospitality industry (Sheng, Li and Wang, 2017). China has been moving to wipe out the illegal capital outflow activities, for instance stopping illegal transactions in Macau using mobile UnionPay cards in 2015. As China has been tightening the policy to stop capital outflow, this will affect the stability of the hotel industry in Macau (Liu et al, 2020). The Covid-19 pandemic has once again caused a major downturn in Macao's economy and casino industry.

As seen in Figure 3, pull factors (γ) are significant to Las Vegas, which has recently rebuilt and expanded its non-gaming hotel facilities. During this time, the number of American states that allow casinos and thus compete with Nevada has increased, despite the decreased demand for casino gaming (Fitch Ratings, 2015). Therefore, Las Vegas had to continue investing despite the growing domestic visitor demand for various forms of entertainment. As a result, Las Vegas revenues from non-gaming businesses rose from 39% of total income in 1990 to 63% in 2014 (Bumazhny, 2015).

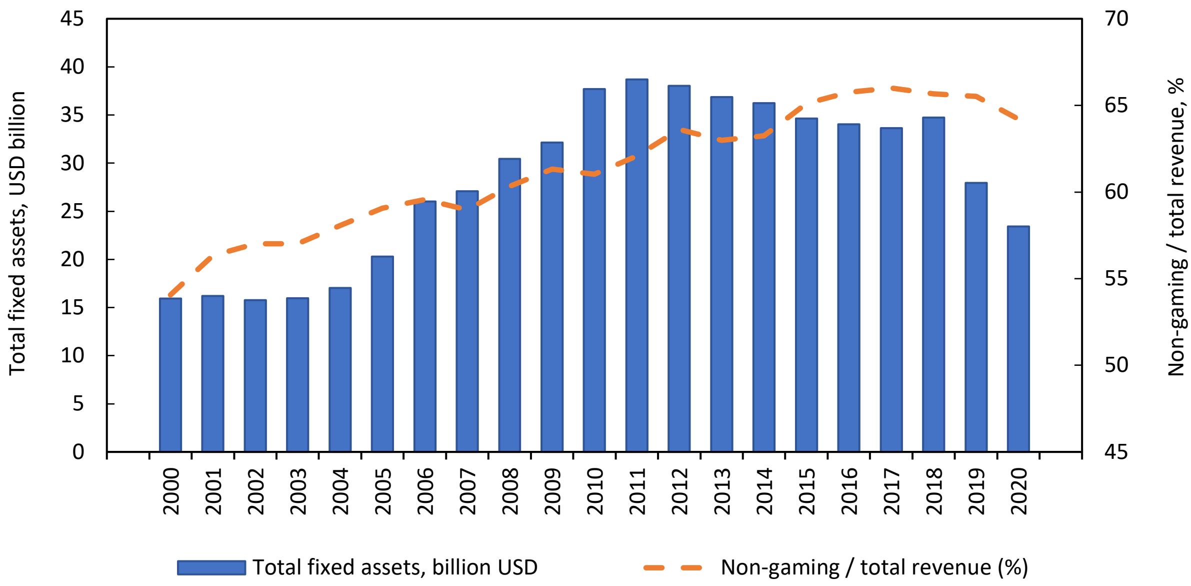

Fig. 3. Fixed investment in hospitality and the ratio of non-gaming receipts to total revenue in Las Vegas

Source: https://gaming.nv.gov/about/abstract/report/ and https://gaming.unlv.edu/

In contrast, push factors $(Y,\ R,\ \xi,\ b,\ \beta)$ are essential for Macao because a large number of its Chinese visitors come for indoor gaming rather than outdoor tourism. Although Macao may benefit from the super-profitability of gaming hospitality thanks to the high level of Chinese demand, its economy is stuck on a metaphorical roller coaster because of its insufficient diversification. The problem faced by Macao, a tiny Chinese city with a geographical area less than one twelfth the size of Las Vegas, is the lack of any outdoor activities or natural settings for non-gambling tourists. For this reason, despite its aggressive diversification efforts, Macao struggled to achieve the diversity of Las Vegas, with non-gaming activities comprising less than 10% of its overall tourism income (Cheang, 2016, Li & Sheng, 2018). Due to the instability of tourism cycles, Macao recently attempted to achieve diversity. In 2016, the Macao government put forward the Five-Year Development Plan and suggested the development objective to raise the nongambling revenue at the city's integrated resorts in relation to the entire revenue (Macau Government, 2016). The Macau government realised that it was too dangerous and passive for Macau to continue with a high dependency on gambling industry. Thus, i order to develop in a sustainable way and enhance its resilience against financial risk, Macau government started to diversify the economic structure to other emerging industries, such as events, culture and creativity, Chinese medicine, and embraced financial business (DSEC, 2020). Moreover, it has been trying to promote economic diversification through promoting tourism industry with nongambling elements, developing nongambling amenities and investing and upgrading resorts (Liu et al., 2020).

According to Deng et al. (2020), while the economic efficiency of Las Vegas's casino tourism is extremely responsive to US business cycles, particularly during the 2008-2009 global financial crisis, this does not appear to have been the case in Macao. Two factors might explain this phenomenon. The first factor being the United States, which is Las Vegas's primary supply market and Macao's main consumer base, was affected more severely than China by the recent global crises. The second factor is that propagation can be robust in the United States but weak in China. The relative magnitudes of several underlying characteristics, such as tourist preference *b*, asset return *R*, consumption propensity *v*, and discount factor *β* affect the intensity of propagation. The United States and China differ in income levels, growth rates, asset returns, consumption patterns, and time preferences. In China, more than in the United States, the desire for travel is likely to outweigh the drive for asset accumulation. The impact of income on Macao's tourism demand can become so strong that although its casino revenue might substantially increase, it is susceptible to dynamic swings in the other push factors because of the relative rapidity of Macao's GDP growth (a push factor).

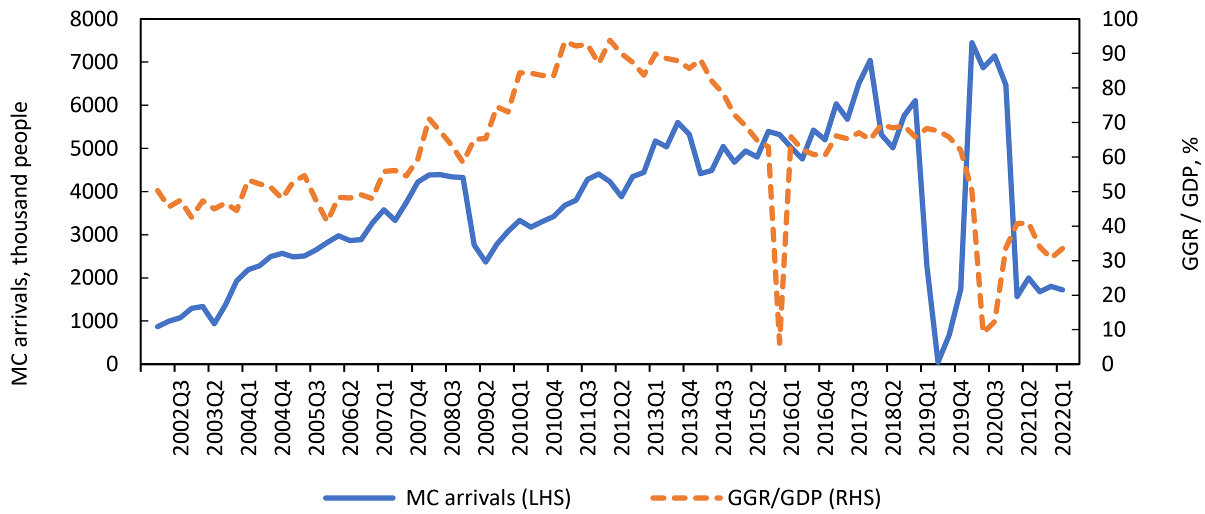

Fig.4. Mainland Chinese (MC) arrivals in Macao and its ratio of GGR to GDP

Source: https://www.dsec.gov.mo/home_enus.aspx

As seen in Figure 4, the performance of Macao's casinos was far more sensitive to China's anti-corruption campaign than to the recent financial crises. The unique characteristics of casino gambling as a combined recreational and criminal activity accounted for this phenomenon. More than 95% of the VIP clients in Macao were government and business leaders from mainland China, and the secretive VIP operations in Macao casinos generated 58-74% of Macao's GGR (Lam, 2010). Each VIP guest bets a minimum of US$125,000 during each trip, and each VIP room averages US$21,000 per game. It is believed that China's anticorruption drive, which is an external shock indexed by δ (as of 2014), has had a direct and detrimental effect on government officials' disposable income $Y(\delta)$ and interest in gambling $b(\delta)$. These officials are Macao's main source of revenue. Even though additional Chinese tourists continued to visit Macao for mass-market gambling (making modest bets), the impact of this external shock was so sudden and overwhelming that Macao's GGR decreased by nearly half over the two years following the anticorruption efforts. To reduce the incidence of money laundering, compulsive gambling, and other societal costs while working toward horizontal diversification, Macao should encourage responsible gaming in local casinos (Sheng, 2017). As Macao has amassed more than US$80 billion in public savings from its prior budgetary surpluses, this endeavour is both practical and morally correct. Due to the fact that nominal deposit rates are below local inflation rates, 70% of this public money is held in Hong Kong banks, where it loses value every year. While leaving local casino hospitality alone and allowing the 'invisible hand' of the market to steer tourism expansion, Macao has no time to spend a portion of its public savings on profit-oriented horizontal diversification (Beitler, 2017). Another tiny city that has effectively diversified its economy away from casino gambling toward financial and other high-value-added businesses with minimal land occupation is Monaco, which sets a good example for Macao.

8. Conclusion

To explain how external shocks from source markets are disseminated via visitor flows to a travel destination, ultimately impacting its hospitality performance, the author proposed a DP model with a microeconomic base. The study applied operations research to the cross-border interactions between inbound tourists and local hospitality to demonstrate that the propagation mechanism may be so potent that a small shock in the external business cycle can have a significant impact on the local hospitality cycle. A poor mechanism may also allow a strong external shock to have only a small local impact. By simulating this process, one can pinpoint the dynamics that drive tourist and hospitality cycles and create a theoretical framework for relevant empirical studies. This research enhances theoretical studies of tourism economics, which are far scarcer in the literature than their empirically based counterparts.

The created model offers a thorough framework for investigating all of the effects of the push and pull factors on hospitality performance (Nikjoo & Ketabi, 2015), accounting not only for their intertemporal substitution but also for the overall utility of both consumer-goods consumption and travel for pleasure. Due to the flexibility of tourists' consumer preferences, one can include both push and pull components in the function of tourism demand. In this study, the author performed a formal analysis of the hospitality supply to determine the impacts of the pull variables, and then used comparative statics for the market equilibrium to determine the primary effects of all of the underlying factors on hospitality revenue and profit. This made it easier to understand how the hospitality industry changes in response to changes in travel demand. The paper demonstrated that the majority of the findings are in line with real-world observations in Macao and Las Vegas.

To better understand the economic effects of the push and pull factors and address other relevant concerns with respect to tourism and hospitality cycles, this work can be expanded in two different directions. First, using Chow's (1992) DP approach, the author examined the model while taking into account its steady-state solution, as is typical of most macroeconomic research. However, many of the intermediate dynamics have been lost because of the shift in focus to a time-invariant equilibrium. Future research could address this constraint by instead examining the steady-growth alternative. Second, an external shock might have either a short-term or a long-term local influence because, in real life, a spreading mechanism can operate either quickly or slowly. Accordingly, it would be interesting to study the magnitude and length of local variations caused by external shocks, but this is only possible in the context of dynamic (not static) models. This topic should be the subject of future theoretical work with empirical implications in the field of tourism and hospitality management.

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Received: July 2022, revised: February 2023