Role of Monetary Policy in the Nonlinearity and Persistent Effect of Inbound Tourism in Taiwan

Chin-Mei Chou*

Abstract

This study adopts a nonlinear panel smooth transition autoregressive model (PSTAR) model with monetary policy as the transition variable. This model is used to test hypotheses on inbound tourism in Taiwan and its long-term evolution. In addition, we evaluate whether monetary policy has exerted a threshold effect on inbound tourists to Taiwan; to do so, we examine inbound tourist arrivals from 12 major countries from 2001 to 2017 as the research samples. The empirical results indicated Taiwan's monetary policy has persistently exhibited a nonlinear dynamic relationship with domestic tourism demand, and this relationship has evolved differently depending on visitors' country of origin and visiting period. In addition, regardless of whether the real interest rate differential model or the real effective exchange rate return model is used, past inbound tourism in Taiwan explains at least 91% of the variance of the current volume of inbound tourism, and this effect intensifies if the model's transition variables exceed their threshold.

Keywords: Persistence of Inbound Tourism, Monetary Policy, Threshold Effect, Panel Smooth Transition Autoregressive Model

JEL Classification: E52, Z30

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I. Research Background and Purpose

The tourism industry is universally regarded as the crucial industry of the 21st century. Thus, the tourism industry has much promise, and interest in the sustainable development of tourism has been increasing. According to statistics released by the World Travel and Tourism Council (2019) for 185 countries in 2018, tourism accounted for approximately 10.4% of the world's gross domestic product (GDP) and 320 million jobs were created (10% of all jobs in the world). These statistics not only highlight the substantial economic benefits of tourism for a country but also underscore that the tourism industry's capacity to generate tangible value is comparable to that of the high-tech industry. Therefore, attracting tourists to not only visit but also consume has become essential to a country's economic development policy.

More tourists have been visiting Taiwan throughout the years. According to statistics by the Tourism Bureau of the Ministry of Transportation and Communications, the number of tourist arrivals in 2018 has, like all other years, hit a record high. However, the increase in tourist arrivals has been slowing over the years. In addition, since 2015, the average tourist has been spending gradually less. Furthermore, because cross-strait relations have become more unstable, Taiwan has seen an accelerating decline in incoming Chinese tourists since 2015. In summary, growth in the number of tourists to Taiwan has been sluggish and may stagnate or decline in the future.

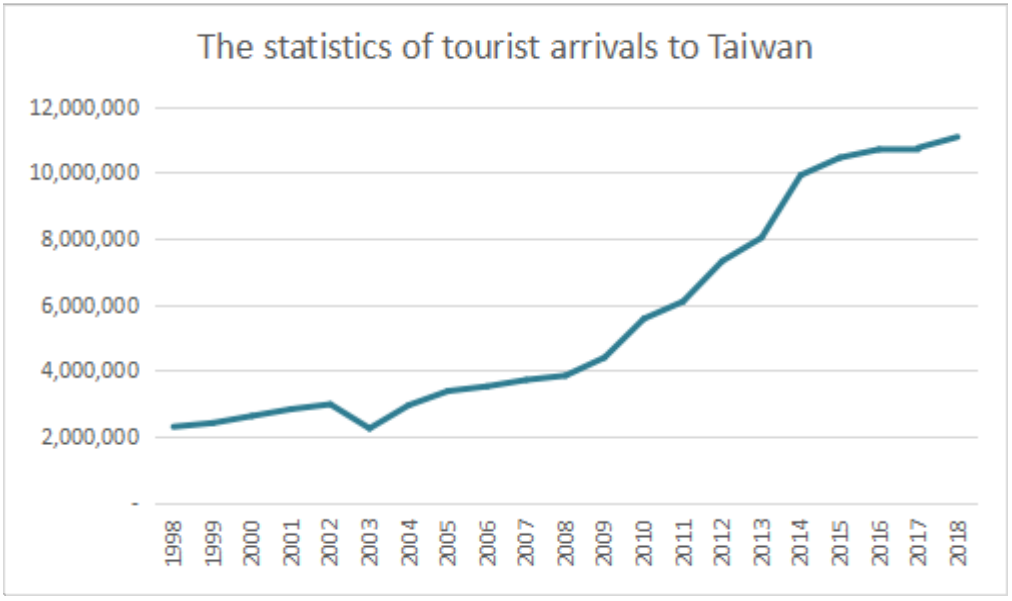

Figure1 The Yearly Number of Tourists in Taiwan (1998-2018)

Source: Tourism Administration, Ministry of Transportation and Communications, R.O.C.

Because tourism has remained integral to Taiwan's economy despite facing such severe challenges, government authorities have actively developed prospective tourism strategies as a matter of national economic policy. In addition, scholarship on tourism in Taiwan has grown, and scholars have aimed to formulate specific, effective, and feasible policy solutions; such works have included Hsu (2017), Lee (2016), Chen (2019), and Tsaur and Chen (2017). Upon reviewing the recent literatures on inbound tourists to Taiwan, this study noted that most scholars focused on research topics such as the factors influencing tourism demand in Taiwan, the contribution of the tourism industry to Taiwan's economy, and the effect of China's policies on tourism demand in Taiwan. Despite being robust and diverse, the literature has overlooked the following methodological and policy-related matters:

First, few studies have explored tourism demand in Taiwan from the perspective of persistent variation. Most studies have instead focused on the key factors that affect inbound tourism, and a persistence perspective has been lacking despite some scholars deeply analyzing

tourism in the context of a host of issues, such as culture, crisis events, and the climate. Although studies on persistence of tourism demand cannot simultaneously discuss individual factors, such studies can comprehensively present the long-term evolution of tourism demand, the effect of past tourism demand on current tourism demand, and even forecasts of tourism demand. Such results are invaluable to policymakers. Most studies have used conventional linear models for empirical estimations. However, most macroeconomic variables have asymmetric relationships, and biased empirical results may occur from first, the nonlinear structure of inbound tourism and second, unknown heterogeneity in the cross-sectional structure. In fact, when a country faces major external environmental shocks and internal policy adjustments (e.g., the 2008 global financial crisis, European debt crisis, and Taiwan's policy of allowing Chinese tourists to visit), the trend of tourist numbers may undergo structural changes. These changes may cause different regimes and effects in the persistence of inbound tourism, which cannot be evaluated by conventional linear models.

Monetary policy is a key factor that affects a country's tourism industry. Kim et al. (2018) investigate whether Abenomics in Japan has affected the number of incoming South Korean tourists (the main tourist group in Japan). The study confirmed the importance of economic policy in stimulating tourism demand. Although some tourism-related studies have included monetary policy as an independent variable, most studies still have only examined the direct relationship between monetary policy and tourism demand, and few have discussed the possible threshold relationship between the two from indirect and nonlinear perspectives. In reality, monetary policy is an indispensable policy tool for promoting economic development and growth. Nonetheless, monetary policy tools must be used judiciously to avoid unnecessary risks. Therefore, the proper application of monetary policy is a crucial issue for governments with regard to maintaining stable economy growth. To address the limitations in the literature with regard to the aforementioned empirical results, this study employed a nonlinear panel smooth transition autoregressive (PSTAR) model to test hypotheses on inbound tourism to Taiwan and changes in persistence. Moreover, to highlight the vital role of monetary policy in the persistence of inbound tourism, this study selects the real interest rate differential (DRIR) and real effective exchange rate (REER) as the transition variables in the PSTAR model. In addition

to assessing whether inbound tourism to Taiwan has a nonlinear trend, it also examines how the monetary policy affects persistence of inbound tourism with different regimes and effects.

This study's contributions are as follows. First, we apply stepwise regression to determine the persistence of inbound tourists to Taiwan. This method not only avoids possible estimation errors due to subjective judgment but also accurately estimates the persistence of inbound tourists to Taiwan. Furthermore, we avoid the potential estimation error from conventional linear models by using appropriate econometric methods under the nonlinear and cross-sectional framework (PSTAR model) to assess changes in the persistence of inbound tourism to Taiwan. Moreover, the estimation procedure of the model can be used to test whether inbound tourism to Taiwan undergoes a smooth and dynamic transition process. These estimation processes and results cannot be provided by conventional linear models. In fact, these results are extremely crucial for accurately assessing changes in inbound tourists to Taiwan. Finally, monetary policy is used as the transition variable to first, evaluate whether Taiwan's monetary policy has a nonlinear effect on Taiwan's current volume of inbound tourism and second, examine how monetary policy can lead to persistence differences in inbound tourists to Taiwan. These characteristics aid the government in the formulation of economic policies, particularly with regard to the travel and tourism industries; these findings also aid business in formulating strategies for attracting tourists to Taiwan.

The remainder of this study is organized as follows. Section 2 summarizes the literature on inbound tourists to Taiwan, the effect of monetary policy on inbound tourism, and related research models. Section 3 presents the estimation procedure of the PSTAR model. Section 4 introduces the source of research data, empirical model testing (including unit root test for panel data, linearity test, and threshold test), and empirical results. Finally, Section 5 concludes the empirical results and recommendations.

II. Literature Review

A. Inbound Tourism to Taiwan

According to the Travel & Tourism Economic Impact 2018 Taiwan report published by the World Travel and Tourism Council, the tourist industry contributed NT$742.6 billion (4.3%) to Taiwan's GDP. The NT$742.6 billion figure was predicted to grow by an average of 2.8% yearly in 2018–2028 to comprise 4.7% of Taiwan's GDP in 2028. Taiwan's tourism industry still has plenty of room for growth, especially in comparison with those of other countries. To develop the tourism industry, the Tourism Bureau of the Ministry of Transportation and Communications has successively launched a series of tourism plans in recent years, including "Time for Taiwan," "Diversified Layout, Global Vision," and "Tourism 2020: A Sustainable Tourism Development Plan for Taiwan." Because these plans have been well implemented, the number of inbound tourists to Taiwan increased by approximately 3.05% from 2017 to reach NT$11.06 million in 2018.

Issues relating to tourists visiting Taiwan and the development of Taiwan's tourism industry have received much attention from scholars and policymakers in recent years. According to the recent development trend of tourism in Taiwan, relevant research has focused on the following aspects: Most scholars have employed the gravity model of trade to analyze tourism to Taiwan, with bilateral income and price levels between countries used as key factors. Other scholars have added characteristic variables to the model, such as crisis, culture, religion, weather, and personal experience, to more deeply analyze the relationships involving tourism demand (Min et al., 2011; Chen, 2019; Hsu, 2013). Wang (2009) empirically demonstrates the long-term equilibrium among variables, such as exchange rate, income, relative prices, and transportation costs, implying that macroeconomic variables can be used to determine the effect of factors on inbound tourist arrivals. In addition, Wang also discusses the effect of crisis events on tourism demand, noting that tourist numbers declined the most during the severe acute

respiratory syndrome epidemic, followed by the 1999 Jiji earthquake and the September 11 attacks. Finally, scholars have reported that ensuring the safety and health of tourists constitutes a key factor in maintaining tourist demand.

Several scholars have adopted a variety of theories and measurement methods (e.g., time series models, generalized autoregressive conditional heteroskedasticity models, and grey forecasting models) to better forecast tourist numbers by controlling for uncertainty from the external environment. One such study conducted in Taiwan is that of Chen et al. (2010), who uses an adaptive neuro-fuzzy inference system; their system is demonstrated to forecast better than did the fuzzy time series model, grey forecasting model, and Markov residual correction model. Liang (2014) uses the seasonal autoregressive integrated moving average-generalized autoregressive conditional heteroskedasticity (SARIMA-GARCH) model to analyze and forecast tourism demand in Taiwan. He demonstrates that his model produces more accurate and interpretable forecasts that better aid policymaking with regard to tourism in Taiwan. To overcome the influence of political and economic uncertainty, Nian (2016) uses a genetic algorithm to optimize the conventional grey model value $GM(1, 1)$ and integrated their algorithm with the grey theory and a genetic algorithm to establish a new forecasting model. They demonstrated that their model has better fit and furnishes better predictions than does the original grey model.

Other scholars have also discussed inbound tourism to Taiwan in the context of Taiwan opening its borders to visitors from China, cross-strait political relations, and other issues pertinent to Chinese tourism to Taiwan (e.g., political strategy, economic contribution, and the crowding out effect). Su et al. (2012) report that Chinese tourists to Taiwan has exerted a crowding out effect on tourists from Japan and the United States but not Hong Kong. This finding suggests for authorities to allocate more resources to tourism or slow down Taiwan's easing of its opening-up policy to reduce such a crowding out effect. Chou et al. (2014) empirically analyze data on tourism from 12 major countries to Taiwan; they observe that Chinese visitors to Taiwan have crowded out tourists from other major countries except Australia and the United Kingdom. Nonetheless, the number of tourists from every country has been increasing despite Taiwan opening its borders to visitors from China. Lin and Lee (2018)

demonstrate that Taiwan opening-up policy increased the number of Chinese visitors to Taiwan, and that visitors (from China or elsewhere) have not crowded out visitors from other countries. Furthermore, Chinese tourists to Taiwan have visited primarily for economic and political reasons.

Although the literature is methodologically and substantively comprehensive, two research gaps remain: the long-term trend of tourist numbers remains unexplored, and threshold effects remain unaccounted for. Persistence evaluation can be used to fill these research gaps: such evaluation can not only capture the evolution of the data structure of time series data pertaining to tourist numbers and tourist characteristics from various countries but is also indispensable to measuring the value of each country's contribution to the Taiwanese economy from sending tourists. Nonlinear models can also be used to not only remedy bias in the estimation results of linear models but also capture possible heterogeneity in the model and accurately describe the effects of time and of individual variables on the numbers of tourists to Taiwan. Considering the advantages of these two approaches, this study employs a nonlinear model to evaluate the persistence effect in tourism to Taiwan.

B. Effect of Monetary Policy on Inbound Tourism

To stabilize domestic prices, improve financial development, and promote economic growth, most governments control their money supply through a central bank (that acts by, for example, adjusting benchmark interest rates, the statutory reserve, and operation on the open market). Since the 2008 global financial crisis and economic recession, various countries have adopted unconventional monetary policies to stabilize domestic prices and promote economic development. However, monetary policy carries both advantages and disadvantages, and the proper use of monetary tools is a highly critical issue for economic policymakers.

Considering that the real interest rate differential reflects differences in actual interest rates among different economies, providing insights into capital flows and investment decisions. Meanwhile, the real effective exchange rate comprehensively assesses a currency's overall

competitiveness, influencing trade dynamics and international competitiveness. Although there are other variables to consider, these two variables are often regarded in the literature as typical substitutes for monetary policy and are deemed to have significant influence and relevance in studying inbound tourism. Therefore, we prioritize selecting these two variables as proxies for monetary policy in conducting empirical research for this paper.

From a macroeconomic perspective, interest rate volatility tracks the supply and demand of capital in the market. When other conditions remain unchanged, increasing interest rates decrease savings and loans, which dampens consumption in general and tourism demand in particular. By contrast, lowering interest rates cause a two-way expansion of demand and supply, which stimulates consumption in general and tourism demand in particular. The real interest rate represents the intertemporal distribution of commodity prices, which determine savings, investment, and economic growth. Gul et al. (2014) discovers that low interest rates are crucial to tourism growth and tourist consumption. However, some studies have furnished opposite conclusions. According to Gu (1995), low interest rates dampen the demand for tourist activities that involve much time and money. Furthermore, according to Liu and Yan (2012), low interest rates and a low consumer price index dampen tourism demand. On balance, the evidence remains inconsistent with regard to the effect of interest rates on inbound tourism.

Another common monetary policy tool is the exchange rate, which is a crucial influence on international tourism flows (Crouch, 1994; Lim, 2006). It also reflects how the simulation of economic growth through exchange policy implemented by the government affects inbound tourism. According to exchange rate determination theory, exchange rates affect relative price levels. In other words, the exchange rate between Countries A and B determines how expensive Country A's goods are to incoming tourists from Country B, which affects the volume and expenditure of inbound tourists. Some scholars have argued that the exchange rate is an indicator of price, making the exchange rate a significant factor affecting tourism demand. In an empirical study, De Vita and Kyaw (2013) report that exchange rate influences the number of German tourists to Turkey. However, some studies have furnished opposite findings. For example, Quadri and Zheng (2010) report that exchange rate is not a factor affecting the volume of incoming tourists from 11 of 19 major countries to Italy. On balance, empirical studies,

probably due to their use of different indicators of exchange rate, have furnished opposing findings on the relationship between exchange rate and tourism demand.

Scholars have treated this aforementioned relationship as a direct one, and few have adopted indirect and nonlinear perspectives in their analysis. In practice, a government using monetary policy to promote economic development may see such policy dampening inbound tourism. Therefore, effective monetary policy lies in not only adopting the best tools but also on deploying these tools at the right time. Thus, this study deepens its analysis by using monetary policy as a transition variable in relation to the evolution of inbound tourism to Taiwan and the threshold effect of the persistence of inbound tourists to Taiwan.

C. Nonlinear Models

Most studies have focused on the correlation between factors and inbound tourism, and they have assumed that the time series undergoes a linear adjustment process. However, the magnitude of correlation between the two in a time series may be affected by exogenous effects, which may lead to inconsistencies in such a magnitude between given intervals. From the perspective of exchange rate theory, the appreciation or depreciation of a currency can potentially heighten or reduce individuals' willingness to participate in tourism. Nevertheless, due to the influence of improved living standards and their reliance on such necessities, the extent to which currency appreciation increases people's willingness to engage in travel activities may be greater than the extent to which currency depreciation decreases their participation in travel activities. In addition, because most macroeconomic variables generally exhibit nonlinear characteristics, conventional linear regression models yield misleading estimates due to the heterogeneity of the variables and model configuration errors (Granger and Teräsvirta, 1993). Thus, scholars have increasingly opted for nonlinear models to track the nonlinear characteristics of economic and financial variables. The regime switching model is commonly used, and it is briefly described as follows.

Tong (1978) first proposes the threshold autoregression model that used the threshold

variable in the interval of various threshold values to determine the autocorrelation of variables. However, because the model assumes that the transition of threshold variables in the two-end interval occurs unexpectedly, the empirical process may be excessively intense and discrete due to the transition process, which often fails to capture the actual situation of changes from model transitions. Thereafter, Chan and Tong (1986) propose a smooth threshold autoregressive model. The model is formed by linking two autoregressive parts through a transition function, and it allows the variables to move smoothly in two different ranges; as for the smooth transition process, it follows the value of the transition variable. McMillan (2001) expanded the smooth threshold autoregressive model, replacing the lag period endogenous variables in the model with exogenous variables, forming a smooth transition autoregressive exogenous model. Nonetheless, these two models are unsuitable for cross-sectional data structures. In addition, Hansen (1999) proposes a panel threshold model, which includes threshold variables that change with time to divide the cross-sectional data into several intervals. When the observation data reach the transition threshold, the model transition process produces a jump effect; this allows the specific independent variable to be within the different threshold intervals and the corresponding variable to explain different phenomena. Nevertheless, because most of the threshold changes in the empirical process may be gradual, the jump effect caused by the threshold variables of this model may not necessarily exist.

González et al. (2005) revise the jump transition process, which may occur when the threshold variable reaches the threshold value in the panel threshold model, to a smooth transition method, and they propose a panel smooth transition regression (PSTR) model. They also add a transition speed design for the threshold variable to the model to describe the smooth transition process of the transition variable near the threshold value. Furthermore, the threshold value of the transition variable is estimated through the measurement method instead of the conventional method where the model is manually configured. Therefore, in addition to accurately and objectively describing the model transition process, their method can also avoid estimation bias from researcher subjectivity. Wu et al. (2015) extend the PSTR model, used the smooth transition autoregressive model to estimate the linear part of the model, employed the stepwise regression model to confirm the optimal multiperiod dependent variable of the model,

and replaced the multiperiod variable with the exogenous variable in the PSTR model to form a PSTAR model. Their model not only has the original advantages of capturing the heterogeneity of the data and accurately describing the individual and time effects in the model but also allows researchers to study the lag period of the dependent variable over a long period and have a model with better estimation performance. This study mainly explores the threshold effect of monetary policy on the persistence of inbound tourists to Taiwan. Moreover, the model variables are macroeconomic variables and in a time series. To solve both the problems of nonlinearity and heterogeneity, this study applies the PSTAR model to empirically analyze the persistence of inbound tourists to Taiwan.

III. Research Methods and Procedures

A. Model and Methods

This study refers to Wu et al. (2015), which follows the concept underlying the PSTR model proposed by González et al. (2005), and expands the PSTAR model to evaluate the trend of the persistence of inbound tourists to Taiwan. In addition, the DRIR and the REER proxy for Taiwan's monetary policy and function as transition variables in this study's test of the nonlinear characteristics of the monetary policy on the persistence of inbound tourists to Taiwan. Monetary policy usually has a delayed effect on macroeconomic variables, the exchange rate between a source country and Taiwan, and the interest rate. If nominal data are directly used for research, the empirical results may not reflect the true characteristics due to interference from the difference in price level between the data and from neglect of the relative change of tourism opportunity cost. Therefore, this study uses the lag period of the DRIR and the REER to replace the current nominal interest rate and exchange rate in the empirical estimation of the persistence of inbound tourists to Taiwan.

The PSTR model proposed by González et al. (2005) is a fixed effect model for panel data with exogenous regression coefficients. In addition to linking two linear intervals through a nonlinear transition function with the assumption that the time series variables have the characteristics of smoothly transitioning in two different regimes, it can also capture the heterogeneity in the empirical data and accurately describe the individual and temporal effects in the data. Moreover, the model estimation result is determined by the values of the transition variables in the two extreme states, and the parameters of the transition function are assumed to be capable of changing smoothly. In short, when the relationship between variables changes, the path of observation data transfer is to change gradually and smoothly rather than immediately. This characteristic of the transition process is suitable for use when the macroeconomic variable is used as a model variable or when the model variable contains time series characteristics. The PSTR model developed by González et al. (2005) can be expressed as follows:

$$y_{it} = \pi_i + \omega_0 X_{it} + \omega_1 X_{it} G(Z_{it-d}; \gamma; C) + \mu_{it} \tag{1}$$

where $i = 1, 2, ..., N$; N is the number of major countries where their residents visited Taiwan as tourists; $t = 1, 2, ...$ denotes the time; y_{it} is the dependent variable of country i and year t; X_{it} is the independent variable of the k-dimensional vector that changes with time; π_i is the fixed effect of an individual; $G(Z_{it-d}; \gamma; C)$ is a continuous function with a value between 0 and 1; Z_{it-d} is the transition variable at lag period d and is also an exogenous variable; γ is the transition speed parameter that represents the smooth transition phenomenon of the model near the threshold value; C is the transition threshold value; and μ_{it} is the residual term. In addition, the transition function represents a continuous and smooth transition process, and the transition variables can be estimated from the current and lagged transition variables using the minimum Akaike information criterion (AIC) and Bayesian information criterion (BIC) methods. The settings are as follows according to the transition function proposed by Granger and Teräsvirta (1993):

$$G(Z_{it-d};\gamma,C)=\left\{1+exp[-\gamma\prod_{j=1}^{m}(Z_{it-d}-C_j)]\right\}^{-1} \quad (2)$$

or

$$G(Z_{it-d};\gamma,C)=1+exp[-\gamma\prod_{j=1}^{m}(Z_{it-d}-C_j)^2] \quad (3)$$

where $\gamma>0$ and $C1\le C2\le...\le Cm, C=(C1,C2,...,Cm)$ is defined as the m-dimensional location parameter, and the value of γ determines the slope of the transition function $G(.)$. A larger γ value entails a steeper slope of $G(.)$. According to the recommendation of González et al. (2005), only $m=1$ or $m=2$ must be considered in the empirical process to evaluate the nonlinear characteristics of state transitions. When $m=1$, it is a logistic model (e.g., Eq. [2]), and the model transition function $G(.)$ is, in this case, divided into two intervals according to the value of Z_{it-d}. $G(.)=1$ when $\gamma\to\infty$, and $G(.)=0$ when $\gamma\to 0$. This model transfer function is similar to the structural change at a single time point, and the PSTR model is simplified to the panel threshold model. The result is similar to the two-interval single-point jump models proposed by Hansen (1999). In addition, when $m=2$, it is an exponential model (e.g., Eq. [3]), and the value of Z_{it-d} determines whether the transition function $G(.)$ equals 1 or $(C1+C2)/2$. When $\gamma\to\infty$, the transition function $G(.)$ divides the data into three intervals. By contrast, when $\gamma\to 0$, the transition function approximates a linear form, representing a less obvious structural change at a single time point. The transition function approximates a linear form, and the PSTR model transitions into a homogeneous or fixed-effect panel-data model. The generalized PSTR model can have multiple different transition intervals simultaneously. The model is expressed as follows:

$$y_{it}=\pi_{0i}+\sum_{j=1}^{j}\pi_j X_{it-j}+\sum_{j=1}^{j}\pi'_j X_{it-j}G(Z_{it-d};\gamma,C)+\tau_{it} \quad (4)$$

where j = 1, 2,... and γ is the number of transition functions and transition intervals in the model. τ_{it} is the residual term. The form of the transition function can be determined by the

estimation results of Eq. (2) or (3).

Before constructing the PSTAR model, this study applies a stepwise regression model by using the past cross-sectional data of inbound tourism to Taiwan to identify the linear characteristics of inbound tourists to Taiwan. In addition, considering the periodic characteristics of the variable data used in this study, this study estimates the length of the lag period j of inbound tourism to Taiwan to be eight lag periods. The autoregressive model of inbound tourism to Taiwan is expressed as follows:

$$LNT_{it} = \alpha_{i0} + \sum_{j=1}^{j} \alpha_j LNT_{it-j} + \mu_{it} \tag{5}$$

where LNT_{it} and LNT_{it-j} are the number of inbound tourists to Taiwan of country i in time t and lag period j; α_{i0} and μ_{it} are the intercept term and the residual term, respectively; and α_j is the persistence effect coefficient of inbound tourists to Taiwan.

To complete the estimation of the linear characteristics of inbound tourists to Taiwan, this study follows the recommendations of Wu et al. (2015), which uses the multiperiod lagged dependent variables estimated by Eq. (5) to replace the exogenous variables in the PSTR model. In addition, two proxy variables of Taiwan's monetary policy (i.e., DRIR and REER) are used as model transition variables to evaluate their effects on the persistence of inbound tourism. The PSTAR model used in this study is defined as follows:

$$LNT_{it} = \beta_{i0} + \sum_{j=1}^{j} \beta_j LNT_{it-j} + \sum_{j=1}^{j} \beta_j' LNT_{it-j} G(MP_{it-d}; \gamma, c) + \varepsilon_{it} \tag{6}$$

where $G(MP_{it-d}; \gamma, c)$ represents the transition function; MP_{it-d} is the lagged DRIR and REER in period d; ε_{it} is the residual term; γ is the transition parameter that describes the transition speed of the two extreme forms in the model when the observation data reach the transition threshold; and C is the transition threshold. The transition function can describe the smooth transition process of inbound tourism to Taiwan by considering the delayed effect of monetary policy on the macroeconomic variables (i.e., the threshold effect on inbound tourists

to Taiwan may have a lag). Therefore, this study uses the lagged transition variable (MP_{it-d}) to replace the current transition variable (MP_{it}) and uses the minimum AIC and BIC test methods to determine the most appropriate lagged transition variable period.

B. Model Configuration and Testing

According to the model estimation recommendations of González et al. (2005) and Wu et al. (2013), this study adopts three testing procedures pertaining to model type: a homogeneity test, threshold test, and nonlinear least square test. These tests are used to estimate the smoothly transitioning relationship between Taiwan's monetary policy and persistence of inbound tourism.

Because the PSTR model test results have heterogeneous characteristics, the empirical model is regarded as a nonlinear panel model. The model changes with time due to the transition variables, and the estimated parameters of each individual cross-section also varies with the transition variables. In other words, the model estimation parameters contain characteristics that change with time. In addition, the PSTR model can also be regarded as a nonlinear homogeneous panel model, that is, the model can be divided into different numbers ($\gamma+1$) of intervals through the transition variable setting, and the panel model in each interval has characteristics of homogeneity. Therefore, before estimating the PSTR model, a homogeneity test must be conducted on the panel data to confirm whether the model has nonlinear characteristics. Specifically, the null hypothesis $H_0:\gamma=0$ is tested as a linear model (the alternative hypothesis is $H_1:\gamma\neq 0$, which the model has at least one transition variable). In addition, although $H_0:\gamma=0$ can be theoretically regarded as a linear model without transition effects, the test process may still include interference parameters (giving rise to, for example, the location parameter problem), making the test statistics unable to fall into a standard distribution. To solve the parameter identification problem, this study follows the suggestion of González et al. (2005), and replaces the PSTR model transition function $G(Z_{it-d};\gamma,c)$ with the

first-order Taylor polynomial to test the linear characteristics of Eq. (6). The regression equation is as follows:

$$\delta_{it} = \theta_{i0} + \sum_{j=1}^{j} \theta_j LNT_{it-j} + \sum_{j=1}^{j} \theta_j' LNT_{it-j} G(MP_{it-d}; \gamma, c) + \pi_{it} \quad (7)$$

Where δ_{it} is the residual term in Eq. (6); θ_{i0} is the intercept term; LNT_{it-j} is the number of inbound tourists to Taiwan in the lag period j; and $d = 1,2,3$ is the lag period of the real interest rate differential and REER. The homogeneity test is primarily used to test whether the null hypothesis $H_0 : \theta_1' = \theta_2' = ... = \theta_j' = 0$ in Eq. (7) and $H_0 : \gamma = 0$ in Eq. (1) have the same statistical significance. Empirically, the Lagrange Multiplier (LM) test is performed based on the x^2 or the F statistic, and the LM test statistic with different distributions is used to confirm whether the empirical model has characteristics of heterogeneity. The LM test model is expressed as follows:

$$LM = TN(SSR_0 - SSR_1) / SSR_0$$

$$LM_F = \left[\left((SSR_0) - (SSR_1) \right) mk \right] / \left[SSR_1 / (TN - N - m(k+1)) \right] \quad (8)$$

where SSR_0 is defined as the residual sum of squares of the null hypothesis (i.e., the model is a linear panel model with individualized effects); SSR_1 is defined as the residual sum of squares of the alternative hypothesis (i.e., the model is a PSTR model with m intervals); k is the number of independent variables; T is the time; N is the number of countries in the cross-section data; and m is the number of transition parameters. The progressive $x^2(mk)$ and $F(mk, TN - N - m(k+1))$ statistics of different distributions are used to perform the LM test, and the test statistics of different distributions are used to determine whether a nonlinear relationship exists between the models.

After confirming that the linearity test rejected data containing characteristics of

homogeneity, the test for the transition model type and the test for the estimation of the number of transition functions are performed to confirm whether the empirical model includes other transition effects. According to the suggestion of González et al. (2005), when the linear hypothesis is rejected, the model containing one transition function ($\gamma = 1$) should be estimated first, and the number of transition parameters should be determined through an auxiliary regression test, which involves a null hypothesis test ($H_0 : \gamma = 1$) with one threshold corresponding to two thresholds. If the test result cannot reject the null hypothesis, the result signifies that the model has at least two intervals. Therefore, the optimal number of threshold testing procedures will continue to be conducted until the test result accepts the null hypothesis, in which the γ value is the optimal threshold number of the model. Finally, after completing the estimation of both the model type and threshold number, the nonlinear least square method is used to estimate the nonlinear and persistence effects of monetary policy on inbound tourists to Taiwan.

IV. Empirical Results

A. Data Sources and Measurement

This study selects 12 major countries with the highest number of inbound tourist arrivals in Taiwan from 2001 to 2017 as the research samples. These countries are China, Japan, South Korea, Malaysia, Singapore, the Philippines, Canada, US, Italy, the Netherlands, UK, and Australia. The panel data on the samples are retrieved from the International Financial Statistics, Taiwan Economic Journal, and Taiwan Tourism Bureau. The dependent variable of the empirical model is the inbound tourist arrivals from these major countries to Taiwan, and the transition variables are the DRIR and REER, which are two common monetary policy tools (see “Appendix Table A1”). Table 1 presents the descriptive statistics of tourist arrivals in Taiwan

(LNT), DRIR, and REER.

The variables used in the empirical model contain time-series, cross-section, and macroeconomic attributes. To avoid biased empirical results or spurious regression, three cross-sectional unit root tests are conducted, which are the Levin et al. (2002) test, augmented Dickey–Fuller (ADF) test, and Phillips–Perron test. These tests are used to determine whether the volatility of the sample data series has a stationary state characteristic of gradually concentrating within a certain interval over time (volatility convergence). The test results are displayed in Table 2.

According to the results in Table 2, all the empirical model variables reject the null hypothesis that the series has a unit root, implying that all variables in the empirical model are stationary. Subsequently, this study uses a stepwise regression model to estimate the persistence characteristics of inbound tourists to Taiwan. To understand the long-term persistence effects of inbound tourism to Taiwan and to determine the fit of the empirical model, this study examines the lag length of inbound tourism to Taiwan to the eighth lag period. In addition, the model residual estimation is used to properly test the model fit. The estimation and test results are shown in Table 3. According to the estimated results in Table 3, inbound tourism to Taiwan with the lag periods of 1, 2, 3, 4, and 6 exhibits a persistence effect on current inbound tourism. Furthermore, the results for the model residual estimation significantly reject the null hypothesis of non-normal residuals but cannot do so without serial correlation in the residuals.

Table 1 Descriptive Statistics

Variable	Min	Max	Mean	Median	Std. Dev.
LNT	8.948	15.247	11.714	11.505	1.505
DRIR	–6.211	8.842	0.462	0.632	2.474
REER	–8.358	5.051	–0.062	0.002	0.998

Table 2 Panel Unit Root Test

Variable	LLC		ADF		PP-FISHER	
	Statistic	Prob.	Statistic	Prob.	Statistic	Prob.
LNT	–2.738	0.003***	33.805	0.088*	36.836	0.045**
DRIR	–4.004	0.000***	47.104	0.003***	64.364	0.000***
REER	–5.298	0.000***	59.087	0.000***	87.662	0.000***

Note: H_0: Unit root (assumes common or individual unit root process). *, **, and *** indicate significance at the 10%, 5%, and 1% levels, respectively.

Table 3 Persistence Estimation of Tourism Demand

AR Model Variable Parameter	*P*	
	Coefficient	*p-value*
α_1	1.229	0.0000***
α_2	–0.215	0.1036
α_3	0.212	0.1036
α_4	–0.303	0.0009***
α_6	0.082	0.1162
$Q(1)$	0.095	0.7580
ARCH(4)	0.594	0.6679
Jarque-Bera	948.772	0.0000***
Adjusted R^2	0.991	

Note: $Q(1)$ and Jarque–Bera are tests of series correlation and normality, respectively; *, **, and *** indicate significance at the 10%, 5%, and 1% levels, respectively.

This study also follows the recommendations of Wu et al. (2015) to replace the exogenous independent variables in the PSTR model with inbound tourism to Taiwan data with lag periods of 1, 2, 3, 4, and 6[1]. In addition, considering that monetary policy affects economic activities through various channels, which generally results in a delayed effect, past monetary policy may have a significant effect on current inbound tourism to Taiwan. Therefore, this study (1) selects monetary policy with the lag periods of 1 to 3 as the transition variable of the empirical model and (2) constructs the most suitable PSTAR empirical model for the persistence of inbound tourism to Taiwan through the selection of the model's minimum AIC and BIC values.

B. Analysis of Smooth Transition Effect for Panels

After confirming the specific structure of the empirical model, said model is tested on the threshold number of model transition variables and whether it has asymmetry and gradual characteristics. The estimated results are shown in Tables 4 and 5. According to Table 4, all models significantly reject the null hypothesis ($H0$: Linear model) for the monetary policy transition variable of the lag periods 1 to 3, implying that all the empirical models in this study have nonlinear structures and characteristics. To further avoid the problems of collinearity and spurious regression that often occur in linear structural models, this study selects the PSTAR model that captures the heterogeneity of the data and accurately describes the characteristics of individual and time effects in the model for the persistence of inbound tourists to Taiwan. Moreover, as presented in Table 5, in addition to the test results of DRIR lag periods 1 and 2 in the $m = 2$ model that is suggested to have two transition thresholds in the PSTAR model, the

[1] To provide a more comprehensive representation of the actual situation of the travel demand persistence model, this paper includes not only the lagged 1st and 4th periods of tourists arriving in Taiwan but also incorporates the lagged 2nd, 3rd, and 6th periods of tourists with P-values slightly above 0.1 as variables in the second-stage non-linear empirical model.

Table 4 Linearity Test

Lag length of transition variable	**Test Statistic**	**Number of Location Parameters**			
		$m=1$		$m=2$	
		Transition variable		Transition variable	
		DRIR	REER	DRIR	REER
$d=1$	LRT	12.909(0.000)	2.946(0.015)	31.361(0.000)	9.821(0.000)
$d=2$	LRT	3.527(0.005)	2.489(0.035)	11.949(0.000)	15.246(0.000)
$d=3$	LRT	15.372(0.000)	5.321(0.000)	22.601(0.000)	11.333(0.000)

Note: *H*0: linear model; *H*1: PSTAR model with at least one threshold variable (r = 1); *LRT*: likelihood ratio test. *, **, and *** indicate significance at the 10%, 5%, and 1% levels, respectively.

Table 5 Test of No Remaining Nonlinearity

Lag length of transition variable	**Test Statistic**	**Number of Location Parameters**			
		$m=1$		$m=2$	
		Transition variable		Transition variable	
		DRIR	REER	DRIR	REER
$d=1$	LRT	1.911(0.861)	2.343(0.800)	25.576(0.004)***	12.889(0.230)
$d=2$	LRT	6.731(0.241)	0.879(0.972)	21.407(0.018)**	6.088(0.808)
$d=3$	LRT	3.219(0.666)	0.000(1.000)	8.070(0.622)	5.403(0.863)

Note: *H*0: PSTAR with $r=1$; H1: PSTAR with at least $r=2$; *LRT*: Likelihood Ratio test. *, **, and *** indicate significance at the 10%, 5% and 1% levels, respectively.

rest of the model test results cannot reject a null hypothesis with a threshold of 1 (H0: PSTAR with $r=1$), signifying the remaining models have only one transition threshold.

After verifying that the empirical model in this study has a nonlinear structure with at least one transition function, this study adopts the minimum AIC and BIC values to determine the most suitable model. This study selects the most suitable empirical models as the lag 1 DRIR

and lag 2 REER. The model parameter structure is defined by location parameter 1 ($m=1$) and the transition function 1 ($r=1$). The related parameter estimation results are shown in Table 6 and are detailed as follows. The estimated threshold *C* of the DRIR model and the REER model are 2.311 and 0.084, respectively, and the transition parameter γ takes the values of 3657 and 275. In the two empirical models, past inbound tourism to Taiwan has a high positive and persistent effect on current inbound tourism, and the magnitude of this effect is amplified differently depending on monetary policy.

In the DRIR model, the marginal effect of past inbound tourism to Taiwan on current inbound tourism is $0.952+0.002*G(DRIR_{it-1};3,657,2.311)>0$; that is, the persistence effects of inbound tourism to Taiwan are 0.952 and 0.954 when $G(DRIR_{it-1};3,657,2.311)=0$ and 1, respectively. In other words, when past DRIR exceeds the threshold of 2.311, the transition function quickly adjusts to an upward interval. The effect of past inbound tourism on current inbound tourism undergoes a smooth upward transition from 0.952 to 0.954. Such non-linear effects may stem from the impact of interest rate differential fluctuations on investment returns or capital flows. Within a smaller range of interest rate differentials, tourists might be less sensitive to variations among different rates. However, when the interest rate differential fluctuates beyond a certain threshold, it could bring about significant changes in investment or savings behavior, thereby influencing travel costs or capital liquidity. This threshold effect might signify the non-linear impact of interest rate differential fluctuations on travel behavior, wherein fluctuations within a specific range have a relatively minor effect on inbound tourism, while fluctuations surpassing the threshold tend to have a more pronounced impact on travel.

Table 6 Estimation Results for Tourism Demand

Chosen Model **Variable Parameter**	PSTAR $r = m = 1$	
	DRIR $d = 1$	REER $d = 2$
γ	3657	275
C	2.311	0.084
β_1	0.806(9.780) ***	0.815(6.392) ***
β_2	0.058(0.431)	0.022(0.153)
β_3	0.380(2.271) **	0.291(2.002) **
β_4	−0.236(-2.600) ***	−0.267(-2.718) ***
β_6	−0.090(-1.313)	0.091(1.113)
β_1'	0.572(4.182) ***	0.850(4.633) ***
β_2'	−0.439(-1.384)	−0.474(-1.435)
β_3'	−0.325(-1.086)	−0.550(-1.893) *
β_4'	−0.200(-1.231)	−0.430(-1.748) *
β_6'	0.396(3.774) ***	0.606(3.138) ***
N	204	204
AIC	−4.4521	−4.3941
BIC	−4.2569	−4.1989
Persistence effect		
$G(SR_{it-d};\gamma,c)=0$	0.952	0.918
$G(SR_{it-d};\gamma,c)=1$	0.952 + 0.002	0.918 + 0.004

Note: The digits in parentheses are the t statistic.; γ and C are the transition speed parameter and the transition threshold value, respectively; *, **, and *** indicate significance at the 10%, 5%, and 1% levels, respectively.

In the REER model, the marginal effect of past Taiwan inbound tourism on current inbound tourism is $0.918+0.004*G(REER_{it-2};275,0.084)>0$; that is, the persistence effect of inbound tourism to Taiwan are 0.918 and 0.922 when $G(REER_{it-2};275,0.084)=0$ and 1, respectively. When past REER exceeds the threshold of 0.084, the transition function quickly adjusts to an upward interval. The effect of past inbound tourism on current inbound tourism undergoes a smooth upward transition from 0.918 to 0.922. Such non-linear effects could stem from exchange rate movements altering travel costs or the attractiveness of tourist destinations to some extent. Within a certain range of exchange rate fluctuations, tourists might be less sensitive to price changes. However, when the exchange rate moves beyond a certain threshold, it could lead to significant fluctuations in travel costs, thereby influencing their willingness to travel and destination choices. This threshold effect might signify the non-linear impact of exchange rate fluctuations on travel behavior, wherein fluctuations within a specific range have a relatively minor impact on inbound tourism, while fluctuations surpassing the threshold tend to have a more pronounced effect on travel.

Because different countries and times have different DRIR and REER, the persistence of inbound tourism to Taiwan also varies with changes in DRIR and REER. In addition, a larger DRIR and REER result in a higher persistence effect of inbound tourism and a lower current inbound tourism. This result implies that past differences in DRIR and REER can motivate international tourists to travel to Taiwan, and this effect is more likely to have a delayed effect over time. Moreover, once the differences between past DRIR and REER exceed the threshold, this delayed effect on the persistence of inbound tourists to Taiwan is amplified.

V. Conclusions and Recommendations

A. Conclusion

In addition to observing variations in the time series data of inbound tourism from various countries to Taiwan, persistence research on inbound tourism is an essential tool for measuring how much each country contributes to Taiwan's economy by sending tourists. This study adopts a PSTAR model that can solve the biased estimation result caused by the conventional linear model, and this model can capture the possible model heterogeneity and accurately describe the characteristics of individual and temporal effects. In addition, this study also incorporates monetary policy (proxied by DRIR and REER) as a transition variable in its construction of a model of the persistence of inbound tourists to Taiwan; this was done to assess the threshold effect of monetary policy on inbound tourism to Taiwan from 2001 to 2017 for 12 major visiting countries. The empirical results are as follows.

First, Taiwan's monetary policy has continuously exhibited a nonlinear dynamic process in relation to tourism demand, and this process has evolved differently between visiting countries. In addition, the empirical results reveal that when the transition variables, namely the DRIR and REER, do not exceed the threshold, the persistence effect of inbound tourism to Taiwan are 0.952 and 0.918, respectively, indicating that past inbound tourism to Taiwan has a persistence effect on at least 91% of current inbound tourism. Furthermore, the threshold values of the DRIR and REER models are 2.311 and 0.084, respectively. The results mean that when the transition variables in the two models exceed the threshold, the persistence effect of inbound tourism will expand by 0.002 and 0.004 and increase by 0.954 and 0.922, respectively. Finally, the most appropriate models for the DRIR and REER are those with lag periods of 1 and 2, respectively. Compared with the REER model, the DRIR model exhibits a faster persistence

effect for inbound tourism.

This study makes the following policy recommendations based on the aforesaid results.

First, when formulating tourism-related policies, government authorities should account for the nonlinear effect of monetary policy on the persistent demand in inbound tourists to Taiwan. In addition to avoiding possible estimation errors in the conventional linear model, the transition process can be further modeled regarding the dynamics of inbound tourism to Taiwan to ensure the achievement of tourism-related policy objectives. Moreover, when evaluating inbound tourism to Taiwan, the focus can be placed on factors that have affected inbound tourism to Taiwan in the past, and not just present and future. When regulating monetary policy to formulate the most appropriate economic policy and develop tourism demand, government authorities can consider, in their evaluation, the currency appreciation and depreciation in countries sending tourists to Taiwan and the differential factors affecting the real interest rate of these countries. In addition, through regular inspection and monitoring of the threshold indicators of monetary policy, tourism authorities can formulate the most appropriate operational strategies for dealing with fluctuations in the economy. Finally, monetary policy tools differ in their effects, especially on the persistence effect in inbound tourists to Taiwan. Government authorities can choose appropriate monetary policy tools based on long-term and short-term goals and individual needs to increase the quantity and improve the quality of inbound tourism to Taiwan.

B. Limitations and Recommendations

This study is limited by its findings not being generalizable to countries other than the 12 analyzed herein. Future studies should thus analyze a larger sample of countries. The recommendations for future research are presented as follows.

First, sending countries can be segmented by level of development, geographical location, and type of economy depending on a study’s research goals. In addition to verifying whether the aforementioned characteristics has persistent differences, doing so can elucidate whether the

monetary policies of countries of each segment play the same crucial role in inbound tourism to Taiwan as that noted in this study. Second, future studies can use other economic indicators as transition variables (e.g., indicators of uncertainty in economic policy) in the empirical model to test whether different economic indicators have the same nonlinear relationship with inbound tourists to Taiwan, as monetary policy does. Third, and finally, future studies can comprehensively implement the two aforementioned recommendations simultaneously to obtain more robust findings for scholars and policymakers.

Appendix

Table A1 Variable Definitions and Measurement

Variable	**Code**	**Measurement**	**Data source**
Tourist arrivals to Taiwan	*LNT*	The natural logarithm of the tourist arrival figures from each country of origin to Taiwan	*Taiwan Tourism Bureau*
The differential of real interest rate	*DRIR*	The differential of real interest rate is the lending interest rate adjusted for inflation as measured by the GDP deflator between each origin country and Taiwan.	*IFS, TEJ*
The real effective exchange rate return	*REER*	The change of the real effective exchange rate of each origin country.	*IFS, TEJ*

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台灣入境旅遊的非線性和持續性效果：貨幣政策的作用

周錦梅 *

摘　要

本文採用非線性的縱橫平滑轉換自我迴歸(panel smooth transition autoregressive model, PSTAR)模型，並選擇貨幣政策爲模型轉換變數檢驗台灣入境旅遊與持續性變化，評估 2001 年至 2017 年 12 個主要來台旅遊的國家爲研究樣本，探討貨幣政策是否對台灣入境旅遊具有門檻效果。實證結果顯示國家的貨幣政策對台灣旅遊需求持續性表現出非線性動態過程，且是隨著時間的推移和不同旅遊來源國家存在著的不同的變化。另外，無論於實質利差模型或實質有效匯率指數報酬模型，過去的台灣入境旅遊對當期的入境旅遊至少存在91%以上持續效果，且持續效果隨著模型轉換變數超過門檻值會有擴大的情形。最後，相對於實質有效匯率指數報酬爲轉換變數的模型，實質利差爲轉換變數的模型對於入境旅遊持續性的影響速度更爲快速。

關鍵詞：入境旅遊持續性、貨幣政策、門檻效果、縱橫平滑轉換自我迴歸模型

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