How resilient is La Reunion in terms of international tourism attractiveness: an assessment from unit root tests with structural breaks over 1981-2015

Amélie CHARLES (Audencia Business School)[*]

Olivier DARNÉ (LEMNA, University of Nantes)[†]

Jean-François HOARAU (CEMOI, University of La Réunion)[‡]

Abstract

Even if local policy makers increasingly claim that tourism is one of the key-factors of future economic development for the French small island La Réunion, international tourist arrivals seem to be lock-in a phase of stagnation since the beginning of the 2000s. Starting from this stylized fact, this article aims at studying if this phenomenon results from major external events hurting this economy regularly. Then using univariate unit root procedures with structural breaks we test for evidence of permanent or transitory impact of external shocks on international tourist inflows (total, by source markets, and by category) over the period 1981-2015. Finally, the empirical analysis allow us to reject the null of a unit root. Then stagnation of tourism arrivals to La Réunion is not due to exogenous shocks but probably results from endogenous impediments within the domestic tourism industry and unsuitable public policies.

Keywords: External shocks, La Réunion, life cycle model, tourism, unit root.
JEL Classification:

[*]Audencia Nantes, School of Management, 8 route de la Jonelière, 44312 Nantes, France. Email: acharles@audencia.com.

[†]LEMNA, University of Nantes, Chemin de la Censive du Tertre, BP 52231, 44322 Nantes, France. Email: olivier.darne@univ-nantes.fr.

[‡]CEMOI, University of La Réunion, 15 avenue René Cassin CS 92003 97744 Saint-Denis Cedex, France. Email: jfhoarau@univ-reunion.fr.

1 Introduction

Undoubtedly tourism is one of the most dynamic exporting sector in the world economy. For numbers of countries this activity contributes more to domestic economic growth than traditional exports' sources like agriculture or manufacturing industry. The role of tourism is even more relevant in the context of small island economies (SIE thereafter). For most of SIEs, it is an interesting and perhaps the only alternative to the industrial way (Logossah and Maupertuis, 2007; Bertram and Poirine, 2007). However, in spite of positive economic spillovers tourism is prone to vulnerability then weakening sustainable development for small entities in the long run. Four main troubles must be exposed. First, the increase in domestic income due to tourist expenditures can be offset by several leakages (Nowak and Sahli, 2010). Second, a high competition may appear between sectors in terms of land, labour and capital which generates a "Dutch disease" dynamics resulting to the fall of earlier exporting sectors (Nowak and Sahli, 2007). Third, tourism specialization can be the cause of its own destruction. Indeed, beyond a specific threshold (the so-called tourist carrying capacity) the number and the behavior of tourists damage the attractiveness of the destination based on ecological and cultural balance, then leading to decline (Butler, 2011). Fourth, tourism is prone to instability (UNEP and WTO, 2006) owing to both conjunctural fluctuations in the foreign source markets and international events like financial and economic crisis or unexpected large external shocks (heath care crisis, natural disasters, wars, terrorism, ...).

The case of La Réunion is a good illustrative example (Perrain and Jean-Pierre, 2016). The importance of the tourism sector for the local economy is significant: by 2012 foreign tourists' expenditures amounts to €315 millions so that tourism is the first export, followed by goods (€307 millions). Nevertheless in spite of a hopeful growth in the 1980s and 1990s (an annual average rate around 8%), since the beginning of the 2000s international arrivals to the French overseas territory seems to be lock in a stage of stagnation with an average about 425,000 tourists. Evolution of the share of foreign tourism expenditures in the GDP confirms this global trend: we observe first a phase of growth reaching a maximum in 2000 at 3.2% of GDP and then a phase of decreasing to 2.2% in 2012. Moreover, the destination is very exposed to large unanticipated exogenous shocks. Alongside potential natural disasters due to cyclone phenomena usually damaging the island, several major external events, namely the context of terrorism following the September 11th terrorist attacks, the health care crisis of "Chigungunya" in 2005/2006, the international financial crisis in

2008 and the shark crisis since 2012, could have hurt dramatically the local economy. Considering this high degree of exposure to natural risks some observers question today the vulnerability of the destination that is the real possibility of a sustainable development process based on tourism for the French small island.

This is precisely what we want to assess in this work. Then this article aims at testing for the random walk hypothesis, that is evidence of a unit root, for international tourist arrivals (total arrivals, by source markets, and by category) to La Réunion over the period 1981-2015, taking into account the possible presence of structural breaks. In other words, we identify whether the external shocks striking this territory have permanent or transitory effects (Bhattacharya and Narayan, 2005). If the series contain a unit root, then following a shock tourist arrivals does not return to their stable growth path and the impact of the shock is permanent. This would provide support for questioning the sustainability of the tourism sector. On the contrary, if the null of random walk is rejected, then following a shock tourist arrivals tend to return to their long-run growth path and the effect of the shock is only transitory. This latter result would indicate that the long-run returns from investment in tourist industry in La Réunion are sustainable. This would also be indicative that external shocks would not cause the trend of stagnation prevailing since 2000 in La Réunion. Accordingly the "true" factor would lie in the presence of potential structural impediments within the tourist industry or/and the implementation of inefficient public policies.

For testing the hypothesis of random walk, we propose an empirical strategy in three stages. First, we investigate whether the series has been affected by additive outliers (immediate or transitory shock) or structural breaks (permanent shocks) due to exogenous shocks (also called rare or infrequent shocks), based on the intervention analysis (Box and Tiao, 1975, Chen and Liu, 1993). However, this approach does not allow for detecting structural breaks in the slope of the trend, which seems to be the case for La Réunion from the early 2000s. Second, we thus test for the presence of a break in the slope of the deterministic linear trend (Perron and Yabu, 2009) whose break would be rather endogenous. Finally, we will apply appropriate unit root tests according to the breaks detected in the previous step to determine whether the series of interest are described by a random walk or not, and thus decide on the temporary or persistent nature of the shocks. Note that this work adds to the literature on the tourism in small island economies in two novels ways. On the one hand, several works are already available in the literature (Huang and Min, 2002; Bhattacharya and Narayan, 2005; Narayan, 2005; Narayan and Prasad, 2008; Lean and Smyth, 2009; Saleh *et al.*, 2011) but it is the first time that such an analysis is run for La Réunion. On the other hand, the three step empirical approach presented above has not been previously used in studying the tourism sector.

The rest of the paper is organized as follows. Section 2 highlights major stylized facts of La Réunion in the field of tourism development. Section 3 gives the theoretical framework putting forward the usual suspects explaining the potential vulnerability of the small French island in terms of tourism arrivals. Section 4 exposes the empirical methodology. Section 5 displays and analyzes the empirical findings. Finally, Section 6 concludes.

2 Main stylized facts

By 2012 global tourism (foreign visitors and locals) in La Réunion accounts for 8% of GDP that is to say €846 millions. If we focus on the foreign side, tourism represents about 2.2% of GDP, corresponding to a receipt of €315 millions (Perrain and Jean-Pierre, 2016), and 3.2% of total employment. Then tourism is the first export of La Réunion far ahead of exports of goods. However, a contrasting conclusion emerges from international comparisons with the other small island economies. Indeed, this French overseas territory is one of the least dependent islands of tourism earnings with Suriname and Haiti (Table 1). This finding is still more obvious when considering its insular neighbours. Contrary to La Réunion tourism contributes significantly to the wealth creation in Maldives (14.0%), Seychelles (6.4%), and Mauritius (3.8%). The same conclusion holds for the other French overseas regions (Polynesia, Martinique, Guadeloupe and Guyana). The economic impact per capita for La Réunion (US$516) is also far behind that for the others islands, expect for Comoros. This relative weak economic contribution of tourism sector can be analyzed both in the quantitative and structural sides.

A first relevant explanation emerges from the evolution of tourist arrivals over the period 1989-2015 (Graph1). Two main regimes are present. From 1989 to the beginning of the 2000s, there is a phase of dynamic growth with tourist inflows to La Réunion increasing from $181,769$ to $429,999$ that is by a multiplicative factor of 137%. This boom resulted from two joined factors, namely a strong demand from the French market in search for new "sun" destinations, and a local supply, in terms of hotel infrastructures and air transport conditions, growing in accordance with this dynamic demand (Rochoux, 2016). Thereafter, since 2000 the destination seems to be lock in a phase of stagnation with total tourist numbers moving around an average of $425,000$. Here two arguments can be put forward. First, many large exogenous events

Table 1: Foreign tourism earnings for a several small island economies

Pays	in % of GDP (2012)	dollar per capita (2013)
Maldives	14.0	4741
Polynesia	6.9	1455
Seychelles	6.4	2593
Mauritius	3.8	1118
Martinique	3.6	1252
Guadeloupe	3.2	1433
Comoros	3.2	41
Guyana	2.4	..
La Réunion	2.2	516

Sources: Blancard and Hoarau (2016), Parrain and Jean-Pierre (2016).

deeply hurt La Réunion over the recent period: (i) the international tourism turmoil in 2001/2002 following the terrorist attacks of the September 11th terrorist attacks, (ii) the health crisis of "Chigungunya" in 2006, (iii) the international financial crisis in 2008/2009, and (iv) the shark attacks started since 2012. Second, some observers highlight a lack of a common vision from the stakeholders slowing down a further development of the destination. In particular, the absence of a consensual way did not allow to set up the necessary environmental conditions to create a clear identity for the destination and to "attract vibrant entrepreneurs who have the vision, the drive, and the cash to revolutionize the market" (Russell and Faulkner, 2004, p.564).

The vulnerability of La Réunion's tourism sector is even more relevant if we focus on the structural dimension. Disaggregating the total arrival flows by source markets, we observe a high and dangerous historical dependance from the mainland (Figure 2). Indeed, 75% of total inflows come from continental France, 8% from European Union (especially Belgium and Germany), and 17% from others (mainly Mauritius and Madagascar, Mayotte). Recently, local policy makers have attempted to diversify the source markets, and notably by developing promotion campaigns in direction of potential Chinese and Indian travelers but without significant success for the moment.

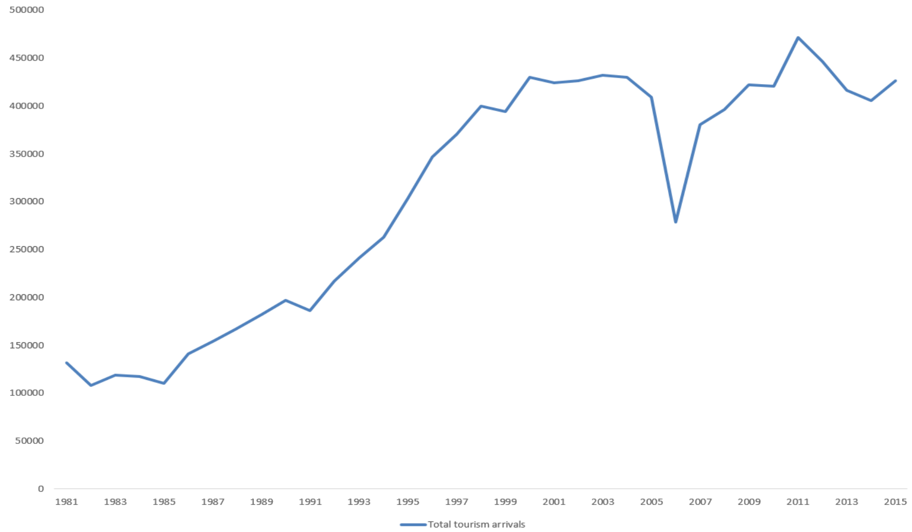

Figure 1: Total tourist arrivals to La Réunion

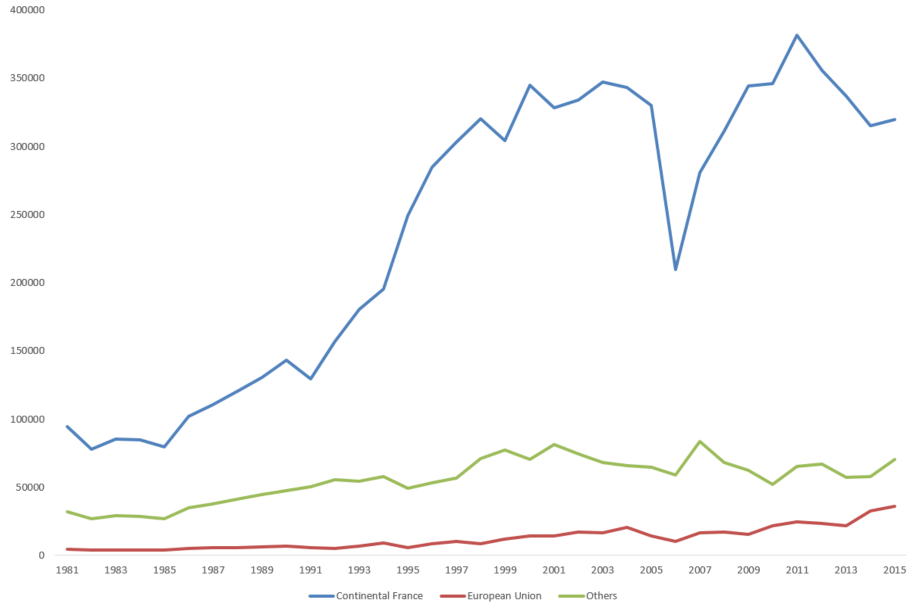

Figure 2: Tourist arrivals to La Réunion by source markets

Now, if we disentangle the total inflows between family or friends visitors, business tourism and leisure tourism, this difficult situation is still more evident (Figure 3). Business tourism is obviously marginal. Otherwise the evolution of leisure tourism, which is the more profitable form of foreign tourism in terms of financial earnings, shows several main periods: (i) a strong growth since 1981 until 1998; (ii) a phase of stagnation over the period 1998-2004; (iii) a brutal fall magnified by the "Chigungunya" crisis from 2003 to 2007; and (iv) a sensible recovery since 2007 up

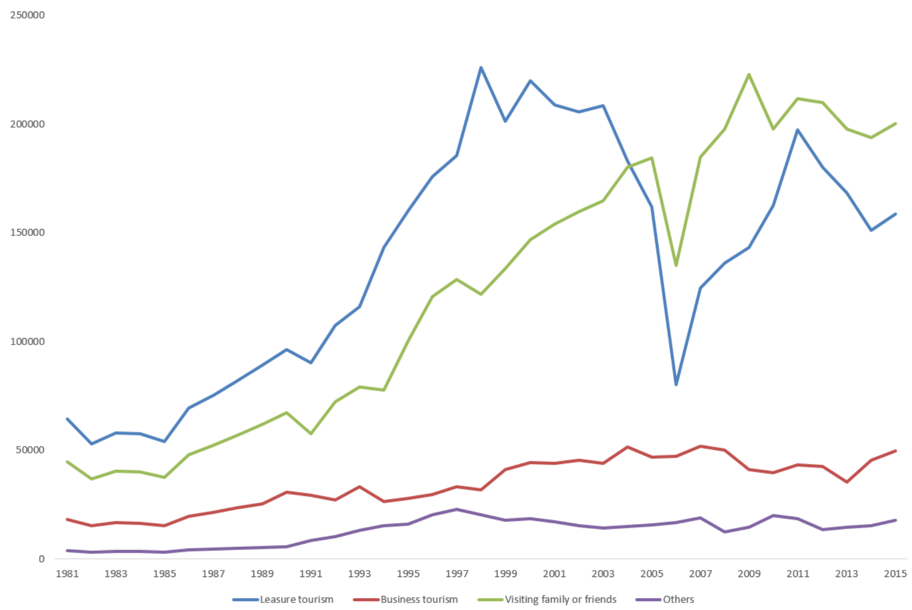

Figure 3: Tourist arrivals to La Réunion by motivations

to 2011, and (v) another phase of decline since 2011. All in all, the number of tourist arrivals for leisure has been divided by two over the period 1998-2015. Then, since 2004 foreign arrivals for visiting family or friends became the first form of tourism in La Réunion outpacing significantly leisure and business tourism.

3 The theoretical framework

Theoretical roots of tourism vulnerability of La Réunion can be found in the "tourism optimum" literature. The concept of tourism optimum is the alternative vision of the so-called "tourism-led-growth" hypothesis (Brida *et al.*, 2014). While nobody contests the positive role of tourism in the short run, no such evidence exists concerning the sustainability of economic growth in the long run due to the presence of negative economic, social and ecological spillover effects (Logossah and Maupertuis, 2007).[1] In other words, there is a maximum level, namely an optimal level, from which negative effects of tourism specialization dominates positive ones, overruling the sustainability of the tourist activity (Lozato-Giotart, 2003; Lozato-Giotart and Balfet,

[1] Adaou and Clerides (2010) and Holzner (2011) set out that tourism exerts a marginal time decreasing positive impact on economic growth. Jin (2011) states that tourism has a positive impact in the short run but a negative one in the long run. Geronimi *et al.* (2016) puts forward a non linear relationship between tourism and growth so that beyond a threshold of tourism specialization, vulnerability goes up slowing down economic growth.

2004).

3.1 The standard approach: the Tourism Area Life Cycle (TALC) model

In spite of several conceptual and empirical limits (Choy, 1992; Bianchi, 1994; Prideaux, 2000; Aguilo *et al.*, 2005; McKercher, 2006), the tourism area life cycle (TALC) model remains the more influent theoretical approach in the field (Butler, 1980, 2011).[2] Moreover, many applied works give strong support to its availability to the current context (Moss *et al.*, 2003; Dodds and McElroy, 2008; Cole, 2009; Komppula *et al.*, 2010). In short, the TALC approach relies on the hypothesis that, as all standard products, a tourism destination is designing and modifying over time to meet the demand of potential tourists.[3] Then, evolution of the tourism area must respect a life cycle path with a phase of growth when the market wants the product followed by a phase of decline when the product becomes obsolete. Therefore, the model states that all tourism destinations are characterized by a common dynamic process reproducing a S-shaped curve and experiencing a series of stages from exploration to involvement, development, consolidation, stagnation and post-stagnation (see Graph4).

- *The first step: exploration.* During this stage, the destination is characterized by small numbers of tourists, following infrequent visitation patterns. These tourists could be considered as pioneer, looking for a unique place considerably different from others by its natural and cultural features. Public infrastructures in terms of tourism are still less developed. Thus, using domestic facilities and contact with locals are likely to be predominant, which constitutes anyway by itself an attraction for the foreign visitors. The economic, social and environmental impacts of tourism activity is of course marginal.

- *The second step: involvement.* As time goes by the local community begins to organize the tourism sector introducing some facilities and services in favor of tourists. This leads to an increase while relatively weak in the numbers and the frequency of visits. Contact between visitors and locals is expected to strengthen

[2]Since its foundation, many conceptual improvements have been realized: (i) additional steps in the general path (Agarwal, 1994, 2002, 2006), (ii) the presence of heterogeneity of the tourism product and possible superposition of multiple cycles (Zimmerman, 1997; Baum, 2006), and (iii) introduction of micro-fundations within the standard framework (Coles, 2007, 2009).

[3]Note that there is a fundamental difference between a standard industrial product and the tourism product. The former depends on one single firm during the entire value chain (conception, production, marketing) although the latter involves many stakeholders making difficult its control (Butler, 2011).

again. At this stage we should observe the first pressures upon governments and public agencies to provide and to develop transport and other facilities for visitors. Although tourism visits are rising, its economic, social and ecological footprint stays weak.

- *The third step: development.* The destination enters into a phase of take off characterized by a well-defined and well-known tourist product supporting by strong promoting and advertising efforts. Here local involvement and control of development is likely to decline rapidly. Domestic actors are gradually substituted by external organizations particularly for visitor accommodation. In this stage natural and cultural attractions completed by some man-made imported facilities are marketed specifically. Now the footprint of tourism activity on the domestic economy is obviously apparent with the number of tourists which can equal or even exceed the number of permanent residents at peak periods.

- *The fourth step: consolidation.* It is the beginning of the slowdown of the tourism sector. The number of total visits continues to grow up even exceeding the number of local population but the rate of growth in numbers of visitors declines. Henceforth, tourism represents a large part of the domestic economy. Marketing and advertising are wide-reaching and efforts are made to extend the visitor season and market area. Major franchises and chains in the tourist industry are present but few additions are made. It is also the time of the rise of social protests due to some deprivations and restrictions resulting from "the preference for tourists" policies and affecting dramatically the well being of domestic residents.

- *The fifth step: stagnation.* This is the tourism optimum stage, that is the maximal number of visits per year that the destination experiences on its life cycle. Beyond this threshold tourism visitation decreases in the extent that the economic, social and environmental carrying capacity of the territory is now reached and even exceeded. The resort largely depends on repeat visitation. In spite of energetic efforts to sustain the level of visitation surplus, bed capacity becomes frequent. Otherwise, insofar imported artificial facilities supersede natural and genuine cultural attractions, the resort image begins to depart from its geographic environment that deteriorates progressively its attractiveness.

- *The sixth step: post-stagnation.* Several paths are possible after the phase of stagnation. All are variants of situations of decline or rejuvenation. Actually, the way the destination will follow obviously depends on the behavior and the ability of policy makers in charge of the territorial policy to put the tourism development process in line with its economic, social and ecological carrying capacity.[4]

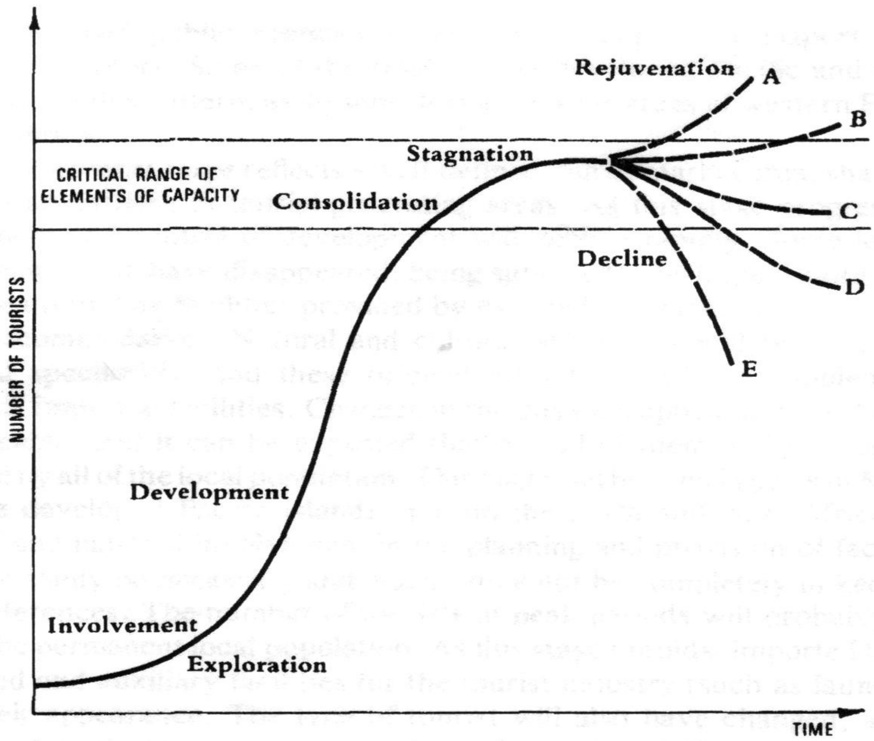

Figure 4: The TALC model

[4]In the case of a successful rejuvenation (massive investments in man-made attractions as gambling casinos, theme parks, labelling natural and cultural heritage, ... or taking advantage of previously untapped natural resources associated with sport events or specific recreation activities), the destination goes to a new path of sustained growth (Path A). If the policy makers decide to modify only marginally their strategy while protecting the resources and maintaining the territorial carrying capacity, then the destination still embraces a new growth process but with a weakest rate (Path B). If the authorities simply secure the carrying capacity, after an initial decreasing movement the destination could succeed in stabilize the number of visits (Path C). On the contrary, if nothing is done for securing the carrying capacity and changing the old attractions, the destination loses its attractiveness and the territory enters into a phase of decline with a significant fall in the number of visits (Path D). Moreover, if large adverse external events (natural disasters, wars, diseases, ...) hurt at the same moment the resort, the decline is even sudden and likely to be permanent (Path E).

Considering the time shape of the total tourist arrivals series (Figure 1), the TALC model tell us that La Réunion is entered into the phase of stagnation since 2000. Such a conclusion would be mistaken in the extent that this phase characterizes mature and mass tourism destinations that do not correspond to the situation of the small French island. More precisely, running a clustering analysis based on the components of the Tourism Penetration Index developed by McElroy and de Albuquerque (1998)[5] over a sample of 47 small island economies for the year 2013, Blancard and Hoarau (2016) put forward that La Réunion belongs to the cluster of the least penetrated tourism entities, that is the cluster corresponding to the exploration stage. Then, the standard TALC model is not very informative about the dynamics conditioning the evolution of this destination.

3.2 Adding Chaos principles

However, the quasi linearity of the evolution curve stated by the TALC approach is theoretically funded but actually corresponds to the very long run. On the contrary, observation shows that actual tourist destinations are confronted to strong instability generating gaps from the trend given by the TALC curve in the short and medium run. Butler (1980) admits that the TALC model conforms to old destinations but is not suitable for the new products which are characterized by differentiation and rapid innovative changes in a context of high international competition, strong mobility of potential visitors and unprecedented reduction in the distance (both transport times and costs). In particular, the model does not accommodate the unpredictable factors triggering development or decay.

Russel and Faulkner (2004), Russel (2006), and Cole (2009) argue that it is possible to give a better appreciation for the paradoxical nature of destination by combining the principles of chaos and complexity with the TALC model. Specifically, the transition of one stage to the next is not linear or deterministic insofar the tourism destination, whatever its maturity, highly depends on a set of unpredictable triggers. Moreover, the perturbations resulting from impacts of these latter are also unpredictable with a magnitude out of proportion to the initial shock. Actually, each phase of the life cycle may enter into a period of instability, driven by fundamental shifts in relationships between the stakeholders of destination and the tourists. In each phase of its development, specific manifestations of chaos are present

[5]This composite indicator is built from three variables, namely the visitor spending per resident population, the average daily visitors density per 1000 population, and the number of hotel room per square kilometer.

("butterfly" effect, lock-in effect, bifurcation, "edge of chaos"), implying that the tourism destination is a process continuously evolving and adapting. According to the specific combinations of the triggering factors, chaos effects can either facilitate or impede growth, progressing the cycle or bringing about stagnation and decline. Consequently, it seems more appropriate to represent the new approach combining the TALC model with chaos principles as cyclic (Graph5). Obviously, this theoretical framework is more informative about the case of La Reunion. Taking into account together these new conceptual insights and the empirical results from Blancard and Hoarau (2016), the French destination seems to be persistently locked in the stage of exploration.

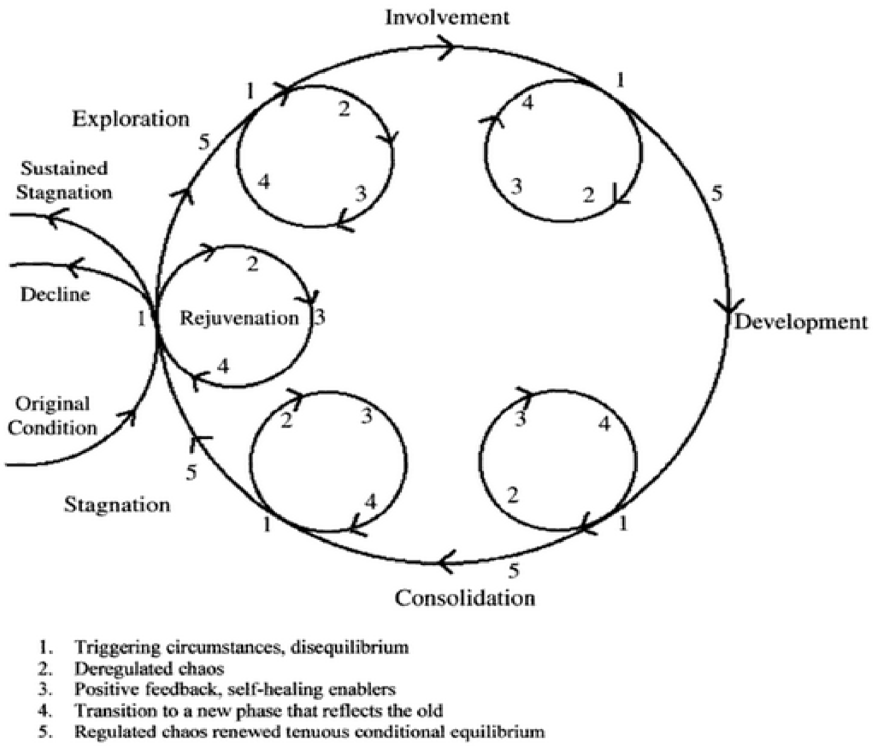

Figure 5: The TALC approach with chaos

On the whole the literature identifies two types of triggers according to their exogenous or endogenous nature (Faulkner and Russel, 2001). First, there are major extreme events which constitutes exogenous shocks as health care crisis, international economic and financial crisis, terrorism, wars, natural disasters, ... While being one-off shocks, these latter damage sharply and instantly the attractiveness of the destination (and in some cases boosting the attractiveness of competitors) with the possibility of a persistent impact in accordance with the butterfly effect principle. Second, the entrepreneurial skills of the territory and the presence of an economic, social and political environment prone to the entrepreneurship development are fundamentals. The transition of a stage to the next strongly depends on the role of entrepreneurs and the relationship between them and local community and governance bodies. Of course, the ability to identify the type of triggers at work is crucial for designing the adapted economic policies. If the resort is often hurt by disturbing and permanent external shocks, then it would be too dangerous for it to be reliant on tourism. In this case, policy makers must opt for a strategy of diversification rather than tourism specialization. If the problem is instead endogenous, due to a lack of underlying conditions for boosting entrepreneurial activities, policy makers must determine and implement a new tourism policy suited to the stage of the life cycle where the economy is. Indeed, the type of entrepreneurs and the environment they need to develop are stage-dependent (Russel and Faulkner, 2004).

4 Methodology

In order to assess the vulnerability of La Reunion relative to shocks' exposure, we implement an econometric strategy based on three stages. The first two steps aims at detecting the presence of both exogenous and endogenous breaks in the series of foreign tourism inflows. In a third step, we use a set of unit root tests adapted to the nature of identified breaks to conclude about the temporary or persistent effect of shocks.

4.1 Detecting breaks

4.1.1 Detection of exogenous breaks

Breaks in macroeconomic series reflect extraordinary, infrequently occurring events or shocks that have major effects on modeling macroeconomic time series. There are several methods stemming from the statistical field for detecting breaks or outliers based on the so-called *intervention analysis* approach, as originally put forward by Box and Tiao (1975). In this paper, we implement an improved detection algorithm proposed by Chen and Liu (1993), which is readily available with slight modifications by Gómez and Maravall (1997). Especially, we focus on break detection from AutoRegessive Integrated Moving-Average (ARIMA) models to emphasize the large shocks that have affected the series.

Let's assume that we observe (y_t) the annual series which follows the following process:

$$y_t = z_t + f(t) \tag{1}$$

where

$$z_t = \frac{\theta(L)}{\alpha(L)\phi(L)} a_t \qquad a_t \sim N(0, \sigma_a^2) \tag{2}$$

where z_t is an ARIMA(p,d,q) process[6] (L being the usual lag operator), and $f(t)$ contains exogenous disturbances or breaks. Following Chen and Liu (1993), we will consider three various types of breaks: additive outlier (AO), level shift (LS) and temporary change (TC). The specifications for different $f(t)$ are as follows:

$$\begin{aligned} \text{AO:} &\quad f_{AO}(t) = \omega_{AO} I_t(\tau_j) \\ \text{LS:} &\quad f_{LS}(t) = [1/(1-L)]\omega_{LS} I_t(\tau_j) \\ \text{TC:} &\quad f_{TC}(t) = [1/(1-\delta L)]\omega_{TC} I_t(\tau_j) \end{aligned} \tag{3}$$

where ω_i, for $i =$ AO, LS, TC, denotes the magnitude of the break[7], $I_t(\tau_j)$ is an indicator function that takes the value of 1 at time $t = \tau_j$ and 0 otherwise; τ_j being the unknown date at which the break occurs, with $j = 1, \ldots, m$, and m is the number of breaks. These various types of breaks differently affect the observations: AO causes an immediate and one-shot effect on the observed series; LS produces an abrupt and permanent step change in the series (permanent shock); TC produces an initial effect which dies out gradually with time (transitory shock). In this latter case, the parameter δ controls the pace of the dynamic dampening effect ($0 < \delta < 1$). Note also that the detection algorithm provides an estimated date for the break through a sequential procedure.

Chen and Liu (1993) and Gómez and Maravall (1997) suggest the following procedure: An ARIMA model is fitted to y_t in equation (2) and the residuals are obtained:

$$\hat{a}_t = \pi(B) z_t \tag{4}$$

[6]The orders p and q of the ARIMA model are based on specification tests and information criteria.

[7]More precisely, it is considered that AOs are outliers which are related to an exogenous change in the series with no permanent effects, whereas TCs and LSs are more in the nature of structural changes. TCs represent short-lived shifts in a series with a return to previous levels whereas LSs are more the reflection of permanent shocks. In the remainder of the paper, we use the term "break" for AO, TC and LS.

where $\pi(B) = \alpha(B)\phi(B)/\theta(B) = 1 - \pi_1 B - \pi_2 B^2 - \ldots$.

For the three types of breaks in (1), the equation (4) becomes:

$$\begin{aligned}
\text{AO:} &\quad \hat{a}_t = a_t + \omega_{AO}\pi(B)I_t(\tau) \\
\text{LS:} &\quad \hat{a}_t = a_t + \omega_{LS}[\pi(B)/(1-B)]I_t(\tau) \\
\text{TC:} &\quad \hat{a}_t = a_t + \omega_{TC}[\pi(B)/(1-\delta B)]I_t(\tau)
\end{aligned}$$

These expressions can be viewed as a regression model for $\hat{a}_t$, i.e.,

$$\hat{a}_t = \omega_i x_{i,t} + a_t \qquad i = \text{AO, LS, TC},$$

with $x_{i,t} = 0$ for all i and $t < \tau$, $x_{i,t} = 1$ for all i and $t = \tau$, and for $t > \tau$ and $k \geq 1$, $x_{AO,t+k} = -\pi_k$ (AO), $x_{LS,t+k} = 1 - \sum_{j=1}^{k} \pi_j$ (LS), and $x_{TC,t+k} = \delta^k - \sum_{j=1}^{k-1} \delta^{k-j}\pi_j - \pi_k$ (TC), with $k = 1, \ldots, T - \tau$.

The detection of the outliers is based on likelihood ratio [LR] statistics, given by:

$$\begin{aligned}
\text{AO:} &\quad \hat{\tau}_{AO}(\tau) = [\hat{\omega}_{AO}(\tau)/\hat{\sigma}_a]/\Big(\sum_{t=\tau}^{n} x_{AO,t}^2\Big)^{1/2} \\
\text{LS:} &\quad \hat{\tau}_{LS}(\tau) = [\hat{\omega}_{LS}(\tau)/\hat{\sigma}_a]/\Big(\sum_{t=\tau}^{n} x_{LS,t}^2\Big)^{1/2} \\
\text{TC:} &\quad \hat{\tau}_{TC}(\tau) = [\hat{\omega}_{TC}(\tau)/\hat{\sigma}_a]/\Big(\sum_{t=\tau}^{n} x_{TC,t}^2\Big)^{1/2} \\
\text{with} &\quad \hat{\omega}_i(\tau) = \sum_{t=\tau}^{n} \hat{a}_t x_{i,t} \Big/ \sum_{t=\tau}^{n} x_{i,t}^2 \qquad \text{for } i = \text{AO, LS, TC}, \\
\text{and} &\quad \hat{\omega}_{IO}(\tau) = \hat{a}_\tau
\end{aligned}$$

where $\hat{\omega}_i(\tau)$ (i = AO, LS, TC) denotes the estimation of the break impact at time $t = \tau$, and $\hat{\sigma}_a$ is an estimate of the variance of the residual process.

Breaks are identified by running a sequential detection procedure, consisting of outer and inner iterations. In the outer iteration, assuming that there are no breaks, an initial ARIMA(p,d,q) model is estimated and the residuals ($\hat{a}_t$) are obtained. The results from the outer iteration are then used in the inner iteration to identify breaks. The LR test statistics for the four types of outliers are calculated for each observation. The largest absolute value of these test statistics:

$$\hat{\tau}_{max} = max|\hat{\tau}_i(\tau)| \qquad i = \text{AO, LS, TC and } \tau = 1, \ldots, T$$

is compared with a critical value, and if the test statistic is larger, a break is found at time $t = \tau_1$ and its type is selected (i^*). When a break is detected, the effect of this break is removed from the data as follows: the observation z_t is adjusted at time $t = \tau_1$ to obtain the corrected y_t via (1) using the estimated magnitude $\hat{\omega}_{i^*}$ and the appropriate structure of break $f(t)_{i^*}$ as in (3), i.e.

$$y_t = z_t - f(t)_{i^*}$$

We also compare the second largest absolute value of the LR statistics for the three types of breaks to the critical value, i.e. $\hat{\tau}_{max} = max|\hat{\tau}_i(\tau)|$ with $\tau \neq \tau_1$, and so on. This process is repeated until no more breaks can be found. Next, we return to the outer iteration in which another ARIMA(p,d,q) model is re-estimated from the break-corrected data, and start the inner iteration again. This procedure is repeated until no break is found. Finally, a multiple regression is performed on the various detected breaks to identify (possible) spurious breaks.

4.1.2 Detection of endogenous breaks

We now study the presence of endogenous breaks , i.e. breaks in the level and/or the slope of the trend function.
The test is based on the following general model:

$$y_t = \mu_0 + \beta_0 t + \sum_{j=1}^{K} \beta_j DT_{jt} + u_t, \qquad t = 1, \ldots, T,$$

$$u_t = \alpha u_{t-1} + v_t, \qquad t = 2, \ldots, T, \qquad u_1 = v_1,$$

where $DT_{jt} = (t - T_j)\mathbb{I}(t > T_j)$, $j = 1, \ldots, K$. A break in the trend occurs at time $T_j = [T\lambda_j]$ when $\beta_j \neq 0$. The dates of breaks (T_j) and the number of breaks (K) are treated as unknown. The error u_t is allowed to be either $I(0)(|\alpha| < 1)$ or $I(1)(\alpha = 1)$. The stochastic process $\{v_t\}$ is assumed to be stationary but not necessarily i.i.d. thereby permitting a general error structure for u_t.

Firstly, we test for the presence of one structural break in the slope ($K = 1$) which is formulated by the null hypothesis that $\beta_1 = 0$ versus an alternative hypothesis $\beta_1 \neq 0$. Perron and Yabu (2009b) propose an hypothesis testing approach on the slope coefficient of a linear trend model when no information about the nature of the noise component is available. In case of rejection of the null, we test for the presence of two structural breaks in the slope ($K = 2$) using the testing approach of Kejriwal and Perron (2010). The null hypothesis is $\beta_2 = 0$ against $\beta_2 \neq 0$. Kejriwal and Perron (2010) extend the work of Perron and Yabu (2009b) and propose a sequential test that allows to test the null of K breaks versus an alternative hypothesis of $(K + 1)$ breaks and which is consistent whether the noise component is I(0) or I(1). The rejection of the null will suggest the existence of two breaks in the slope and one if the test fails to reject.

Perron and Yabu (2009b) extend the procedure of Perron and Yabu (2009a) to address the issue of testing for structural break in the trend function. The test starts by assuming a data generating process (DGP) for a scalar random variable y_t to have the following specification:

$$y_t = x_t'\Psi + u_t, \quad t = 1,..,T \tag{5}$$

$$u_t = \alpha u_{t-1} + \sum_{i=0}^{\infty} a_i^* L^i \Delta u_{t-i} + e_t, \tag{6}$$

where $x_t = (1, t, DT_t)'$, $\Psi = (\mu_0, \beta_0, \beta 1)'$, $DT_t = 1(t > T_1)(t - T_1)$, $T_1 = [\lambda_1 T]$=the break date. The null hypothesis of the test for a shift in slope (allowing for a shift in intercept) is $H_0 : \beta_1 = 0$ versus $H_1 : \beta_1 \neq 0$.

The Wald test statistic W^{RQF} is constructed for a given break fraction λ_1 and depending on the value of $\hat{\alpha}_{MS}$

$$W^{RQF}(\lambda_1) = \frac{\left(\hat{\beta}_1^{FG}(\lambda_1)\right)^2}{\sqrt{\hat{h}_\upsilon [(X'X)^{-1}]_{44}}} \tag{7}$$

where $X = [x_1, (1 - \hat{\alpha}_{MS} L)x_t (t = 2, ..., T)]$, and $\hat{\beta}_1^{FG}$ is quasi FGLS estimate of β_1.[8] Following Andrews (1993) and Andrews and Ploberger (1994), Perron and Yabu (2009b) consider the Exp functional of the Wald test for different break dates as they found the limit distributions to be nearly identical in the I(0) and I(1) cases. The test statistic needs to be evaluated for each break date candidate and then, the Exp functional as defined as follows is evaluated:

$$ExpW = log\left[T^{-1} \sum_{\lambda_1 \in \Lambda_1} exp\left(\frac{1}{2} W^{RQF}(\lambda_1)\right)\right] \tag{9}$$

Kejriwal and Perron (2010) extend the approach of Perron and Yabu (2009b) and propose a sequential test that allows to test the null hypothesis of l breaks against the alternative hypothesis of $(l+1)$ changes. The procedure is consistent to wether the

[8] The approach consists to consider the quasi FGLS estimate of the parameters of the equation (15) using $\hat{\alpha}_{MS}$:

$$(1 - \hat{\alpha}_{MS} L)y_t = (1 - \hat{\alpha}_{MS} L)x_t'\Psi + (1 - \hat{\alpha}_{MS} L)u_t \tag{8}$$

$t = 2, ..., T$, and $y_1 = x_1'\Psi + u_1$. Denote the resulting estimates by $\hat{\Psi}^{FG} = (\hat{\mu}_0^{FG}, \hat{\mu}_1^{FG}, \hat{\beta}_0^{FG}, \hat{\beta}_1^{FG})'$.

data are stationary or not. As in Perron and Yabu (2009b), Kejriwal and Perron (2010) use the Exp functional over all permissible break dates.

$$ExpW_{(i)}^{RQF} = log\left[(\hat{T}_i - \hat{T}_{i-1})^{-1} \sum_{\tau \in \Lambda_{i,\varepsilon}} exp\left(\frac{W_{RQF}(\hat{\lambda}_{i-1}, \tau, \hat{\lambda}_i)}{2}\right)\right] \tag{10}$$

where $\tau \in \Lambda_{i,\varepsilon} = \{\tau : \hat{\lambda}_{i-1} + (\hat{\lambda}_i - \hat{\lambda}_{i-1})\varepsilon \leq \tau \leq \hat{\lambda}_i - (\hat{\lambda}_i - \hat{\lambda}_{i-1})\varepsilon\}$ with $\hat{\lambda}_i = \hat{T}_i/T$ and $ExpW_{RQF}^{(i)}$ is the one break test in segment i. For $i = 1, ..., l+1$, the sequential test is the application of a single change in slope (allowing for shift in level) test in the $(l+1)$ segments and examine if the maximum is significant. The test is given by:

$$F_T(l+1|l) = \max_{1 \leq i \leq l+1} \{ExpW_{(i)}^{RQF}\} \tag{11}$$

The first step is to investigate if there at least one break ($F_T(1|0)$). In case of rejection, the test $F_T(2|1)$ is applied. If the statistic is sufficiently large we conclude in favor of two breaks in the DGP. Notice that the test is repeated by increasing l sequentially until the test fails to reject the null hypothesis of no structural change, the number of breaks corresponding then to the number of rejections. However, in our study we limited l to unity.

4.2 Stationarity tests

Given evidence of the trend function characteristics (change in slope or not), appropriate unit root tests have to be implemented. Due to the strong change in the behavior of the series, we test the presence of a unit root in subsamples, defined according to the break in slope. However, it is well-known that performance of unit root tests depends whether or not they include a deterministic trend. For that, we use the procedure suggested by Perron and Yabu (2009a) who propose a test on the slope of the trend function without no prior knowledge to the non-stationary properties of the noise component.

Perron and Yabu (2009a) propose a test on the slope of the trend function without no prior knowledge to the non-stationary properties of the noise component. The test assumes that y_t is generated by

$$y_t = \mu_0 + \beta_0 + u_t, \quad t = 1, .., T \tag{12}$$

$$u_t = \alpha u_{t-1} + \sum_{i=0}^{\infty} a_i^* L^i \Delta u_{t-i} + e_t, \tag{13}$$

where μ_0 a finite constant, $a_i^* = -\sum_{j=i+1}^{\infty} a_j$; $e_t \sim i.i.d.(0, \sigma^2)$. Here $-1 < \alpha \leq 1$ so that both stationary or integrated errors are allowed. Perron and Yabu (2009a) recommend the following steps:

1. Estimate the residuals $\hat{u}_t$ from detrended y_t by OLS.

2. Estimate α from the following regression:

$$\hat{u}_t = \alpha\hat{u}_{t-1} + \sum_{i=1}^{k} \zeta_i \Delta\hat{u}_{t-i} + e_{tk} \tag{14}$$

The order k is selected using the Modified AIC of Ng and perron (2001) (MAIC), with $k \in [0; 12(T/100)^{1/4}]$

3. Since the OLS estimate of α is biased downward, especially when α is near one, Perron and Yabu (2009a) recommend the bias correction proposed by Roy and Fuller (2001) $\hat{\alpha}_{MS}$.

4. Apply the quasi feasible generalized least square (FGLS) procedure using $\hat{\alpha}_{MS}$ to obtain the estimate of the trend parameter β_0

$$(1-\hat{\alpha}_{MS}L)y_t = (1-\hat{\alpha}_{MS})\mu_0 + \beta_0\left[t-\hat{\alpha}_{MS}(t-1)\right] + (1-\hat{\alpha}_{MS}L)u_t \tag{15}$$

$t = 2,...,T$, and $y_1 = \mu_0 + \beta_0 + u_1$. Denote the resulting estimates of β_0 by $\hat{\beta}_0^{FG}$.

5. Construct the t-statistic t_β^{RQF} (where RQF stands for robust quasi FGLS)

$$t_\beta^{RQF} = \frac{\left(\hat{\beta}_0^{FG} - \beta_0\right)}{\sqrt{\hat{h}_\upsilon[(X'X)^{-1}]_{22}}} \tag{16}$$

where $X = [x_1,\ldots,x_T]', x_t' = [(1-\hat{\alpha}_{MS}), t-\hat{\alpha}_{MS}(t-1)]$ for $t = 2,...,T$, and $x_1' = (1,1)$. h_υ is a consistent estimate of (2π times) the spectral density function at frequency zero of $\upsilon_t = (1-\alpha L)u_t$. They use an autoregressive spectral density estimate.

Following the results on the presence or not of the linear trend (t_β^{RQF}) we apply the unit root tests of Elliott et al. (1996) (ADF^{GLS}) with the appropriate deterministic component.
The test proposed by Elliott et al. (1996) is based on the following regression:

$$\Delta\tilde{y}_t = \beta_0\tilde{y}_{t-1} + \sum_{j=1}^{k} \beta_j \Delta\tilde{y}_{t-j} + \varepsilon_t$$

in which $\tilde{y}_t$ representing the locally detrended data process under the local alternative α, is given by:

$$\tilde{y}_t \;=\; y_t - \hat{\psi}' z_t$$

where $z_t = (1,t)'$ in the case with drift, and $\hat{\psi}$ being the generalized least squares (GLS) regression coefficient of $\bar{X}_t$ on $\bar{z}_t$ defined by:

$$\begin{aligned} (\bar{y}_1, \bar{y}_2, \ldots, \bar{X}_T) &= (y_1, (1-\alpha B)y_2, \ldots, (1-\alpha B)y_T) \\ (\bar{z}_1, \bar{z}_2, \ldots, \bar{z}_T) &= (z_1, (1-\alpha B)z_2, \ldots, (1-\alpha B)z_T) \end{aligned}$$

The test statistic ADF-GLS is the usual t-statistic for the null hypothesis $\beta_0 = 0$ against the alternative of $\beta_0 < 0$. Elliott et al. (1996) recommend that the parameter c, defining the local alternative through $\alpha = 1 - (c/T)$, be set equal to 13.5 if the series seems to contain a trend (drift), and 7 for an intercept. The lag order k is selected using the modified information criteria suggested by Ng and Perron (2001) with the modification proposed by Perron and Qu (2007).

5 Empirical results and comments

In the empirical study we use annual data collected from several statistical surveys, entitled "Enquête sur la fréquentation touristique à La Réunion", generated over the period 1981-2015 by the National Institute of Statistics and Economic Studies.[9] Three series are considered: (i) the total tourist arrivals to La Réunion, (ii) tourist arrivals to La Réunion by major source markets, namely from France, European Union, and others (Mauritius, Madagascar, Mayotte, China, ...), and (iii) tourist arrivals to La Réunion by visiting motivations so that leisure tourism, business tourism, visiting family or friends, and others forms (sport, healthcare, ...). The selection of samples and time series span is of course dictated by data availability. Moreover, all data was converted in natural logarithmic form.

5.1 Breaks detection and unit root tests

Following the methodology detailed above, we begin our investigation by testing if the tourism series have been affected by exogenous breaks. In Table 2, all detected exogenous breaks are given by series, with their type, t-statistics and timing. Our results state that the series relative to total arrivals, tourism from continental France, tourism from European union, leisure tourism and visiting family or friends are all impacted by one break in 2006. This break has a short-lived effect (AO), namely one

[9]For the period 1981-1988, the database was reconstructed from information given in DCBFODT (1994).

year, for total arrivals and visiting family or friends, and a temporary effect (TC) for tourism from European union and leisure tourism, with a dramatic negative impact which dies out gradually after few years (between 2 and 3 years), except for European Union arrivals. For this latter, the turbulence seems to have a permanent impact (LS), implying a change in the series, but only on the level and not on the slope of the trend. Then, no impact on the growth rate is found that is after the shock the growth rate of tourist arrivals converges towards its long run equilibrium path. The year 2006 corresponds to the heath crisis of "Chickgungunya" which led to several hundred deaths in only few months. On the contrary, no exogenous outliers or breaks (large shocks) are detected for the series of other source markets, business tourism and other tourism motivations.
Surprisingly, at this stage no statistical effect of well-known adverse events associated with a large shock, like the terrorism context associated to the September 11th terrorist attacks, the international financial crisis in 2008 or the shark crisis hurting dramatically the local economy since 2012 appeared from our simulations.

Table 2: Results of exogenous and endogenous breaks - 1981-2015

	Exogenous break			*Endogenous break*		
Series	type	t-stat	date	*ExpW*	$ExpW(2\|1)$	TB
Nb. of tourists						
Total	AO	-6.54	2006	30.1*	0.81	2000
Residence						
Metropole	TC	-7.66	2006	1.29***	1.60	2000
European Union	LS	-3.94	2005	13.6*	0.91	1995
Other resid.	–	–	–	5.57*	1.16	1999
Category						
Leisure tourism	TC	-6.97	2006	3.75*	0.56	1999
Business tourism	–	–	–	-0.13	–	–
Visit family	AO	-3.99	2006	8.77*	1.22	2004
Other visiting	TC	-6.06	2008	1.37***	0.75	1997

Notes: The test statistics *ExpW* and $ExpW(2|1)$ denote the Perron-Yabu (2009a) and Kejriwal and Perron (2010) statistics, respectively. The corresponding critical values are 1.67 and 2.56, respectively. *, ** and *** denotes significance at the 1%, 5% and 10% level, respectively. *Sources:* The authors.

Then, we examine if the tourism series has been subject of (endogenous) slope breaks. The tests of Perron and Yabu (2009b) and Kejriwal and Perron (2010) are employed for this purpose on the raw series for other source markets, business tourism and other tourism motivations, and the corrected-outlier series for total arrivals, tourism from continental France, tourism from European Union, leisure tourism and visiting family or friends. Table 2 displays the results of zero versus one slope break ($ExpW$), and one versus two slope breaks ($ExpW(2|1)$). Kejriwal and Lopez (2013) labelled the break in slope with possible shifts in the level the "growth shift" hypothesis.

Our empirical results are very interesting and potentially informative for economic policy. First, one endogenous break is detected in 2000 for total arrivals and continental France tourists. In the same vein, one slope break is present in 1999 for leisure tourism and other source markets, in 2004 for tourists visiting family and friends, and in 1997 for other visiting motivations. More precisely, before the break there is an increasing deterministic trend and no trend anymore after the break, except for the series of other visiting motivations where we observe a weak declining trend. Even if no apparent event can be associated to these dates at this point, we will see below that a lightning explanation relies on the structure of the domestic tourism industry in accordance with the theoretical insights exposed above. Note that no evidence of break in the slope emerged for business tourism.

The last important question is to know if shocks, driving the fluctuations of tourist arrivals, have permanent or transitory effects on tourist arrivals in La Réunion. Table 3 gives the results of univariate unit root tests. Four main findings must be underlined: (i) a difference stationary process for business tourism, (ii) a change in persistence after the break date in the slope from trend stationarity to difference stationarity for European visitors, (iii) a change in persistence from either difference stationarity or trend stationarity to stationarity without trend due to the break date in the the slope for the series of total arrivals, Leisure tourism, other visiting motivations, French tourist arrivals and tourists visiting family and friends, and (iv) a change in persistence resulting from the slope break from difference stationarity to trend stationarity for tourist arrivals from other market sources. Overall our simulations tend to support the transitory effect of external shocks, except for European tourist arrivals and business visitation. However, these two types of tourism represent only marginal inflows. Then, actual difficulties of La Réunion's tourism sector are not rooted in the presence of external shocks.

Table 3: Results of unit root tests

Series	Deter. comp.	*Full sample* t_β^{RQF}	*Full sample* ADF^{GLS}	*Full sample* I(d)	*1st subsample* t_β^{RQF}	*1st subsample* ADF^{GLS}	*1st subsample* I(d)	*2nd subsample* t_β^{RQF}	*2nd subsample* ADF^{GLS}	*2nd subsample* I(d)
Nb. of tourists										
Total	trend	–	–	–	2.97*	-1.88*	I(1)	–	–	–
	cst	–	–	–	–	–	–	0.38	-2.49	I(0)
Residence										
Metropole	trend	–	–	–	2.79*	-3.22	I(0)	–	–	–
	cst	–	–	–	–	–	–	-0.05	-1.81	I(0)
EU	trend	–	–	–	4.74*	-3.58	I(0)	16.7*	-2.23*	I(1)
Other resid.	trend	–	–	–	1.99*	-2.85*	I(1)	-1.97*	-4.23	I(0)
Category										
Pleasure	trend	–	–	–	3.06*	-2.33*	I(1)	–	–	–
	cst	–	–	–	–	–	–	-0.79	-2.11	I(0)
Business	trend	2.12*	-1.14*	I(1)	–	–	–	–	–	–
Family	trend	–	–	–	2.72*	-3.59	I(0)	–	–	–
	cst	–	–	–	–	–	–	-1.22	-2.34	I(0)
Other visit.	trend	–	–	–	3.37*	-2.49*	I(1)	–	–	–
	cst	–	–	–	–	–	–	-0.20	-2.01	I(0)

Note: * denotes significance at the 10% level. t_β^{RQF} denotes the Perron and Yabu (2009a) test for the deterministic trend. ADF^{GLS} represent the ADF-GLS statistic proposed by Elliot et al. (1996).
Sources: The authors.

5.2 Comparing to the existent literature

Note that our results are conformed to the literature in the extent that a consensus emerges about the reject of the hypothesis of non stationarity, then supporting the finding that external shocks have only a transitory effect on tourist arrivals. Using the Sen (2003) test for one break in linear trending data to investigate whether or not shocks to visitor arrivals to Fiji from three main source markets (Australia, New Zealand and the US) have permanent or transitory effect, Narayan (2005) concludes that tourism arrival over the period 1970-2002 are finally trend-reverting. Using the panel unit root tests of Maddala and Wu (1999) and Im, Pesaran and Shin (2003) for the period 1980-1999, Bhattacharya and Narayan (2005) state that visitor arrivals in India are inconsistent with the random walk hypothesis. Smyth et al. (2009) apply univariate and panel LM unit root procedures with one and two structural breaks to test for the null hypothesis that tourist arrivals to Bali contain a unit root. They show that the univariate unit root tests with and without structural breaks did not reject the null of non stationarity. However, the panel LM ones with one and two structural breaks are able to reject the joint null for the 11 major tourist source markets of Bali, then arguing for jointly trend stationary with transitory shocks. Lean and Smyth (2009) also consider the univariate LM unit root tests with one and two breaks to analyze the effect of shocks for the sustainability of Malaysian tourism sector over the period 1995-2005. However, they are unable to reject the unit root null for the 10 main source markets of Malaysia, then validating the hypothesis of trend-stationary with transitory shocks. Lastly, Saleh et al. (2011) conduct both univariate and panel LM unit root tests with structural breaks for tourist arrivals to Thailand from its 10 major sources from 1988 to 2007. Once again, the authors find evidence for trend stationarity.

6 Conclusion

This paper aimed at studying whether the lack of growth in international tourist arrivals to La Réunion since 2000 was due to large external shocks hurting regularly this economy (more precisely the September 11th terrorist attacks, the "Chigungunya" crisis in 2005/2006, the international financial crisis in 2008, the shark attacks since 2012). Implementing univariate unit root tests with structural breaks found no evidence of permanent impact of external shocks on tourism flows to La Réunion over the period 1989-2015, except for tourists coming from European Union. However, the European source market represent a small part of total tourism. Moreover, only one major shock, namely the Chigungunya crisis seems to had a significant effect on the level of inflows but without changing the growth rate.

Note that our findings have operational consequences for economic policy. La Réunion is locked into the phase of exploration of the TALC model. And this is not due to external events but potentially results from oppressive impediments inside the tourism industry. In short, the trouble is not exogenous but obviously endogenous. Then, following the TALC model the destination should improve firstly the supply side. Building new hotel infrastructures, opening the sky with new companies from emerging source markets and designing a strong and clear tourism identity are good examples of potential policies which have to be undertaken urgently. Otherwise, findings give strong support to the recent report of the National Court of auditors in 2014 about tourism performances of the French overseas regions including La Réunion. Resuming the conclusion of this report, "the decrease in tourist arrivals results especially from structural reasons and by the lack of dynamism of implemented public policies. The different regional councils do not succeed in coordinating a sector concerning all levels of local administration. A preference is conferred to promoting initiatives but they are largely inefficient, while the supply do not correspond to the expectations of international tourism" (National Court of auditors, 2014).

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