Time Series Seasonality: Tourism in Mali

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Abstract: The purpose is to delimit, with seasonality (in part caused by weather) certain economic indicators in order to explain European demand for Malian tourist services: price, income and supply. These relevant indicators were included in a Structural Model to explain tourist demand. Modeling methodologies, allow apprehending tourist time series variability, were proposed. It is also suggested transfer function Model and Autoregressive distributed Lag Distribution. Final equations based on diagnostic checking were suitably fitted tourist demand. The estimated values of the flexibility of the demand are coherent in sign and in module with the economic theory.

Keywords: Supply induced demand, seasonality, Basic Structural Model, Transfer Function Model Auto regressive Distributive Lag Model

INTRODUCTION

Tourism was maintained out of the great concerns of the authorities because suspect to only interest most rich people. The statistics of the OMT show with sufficiency the tourism place in the world trade. It seems one of the greatest creators of incomes by his capacity to generate employment.

The tourism is an important factor of the economy of Mali. This sector shows a strong seasonal behavior (the demand is concentrated in July, August, September months).

We want to come out again to rating of the seasonality some economic indicators to explain the demand addressed to the tourist industry of Mali: the price, the income, the supply.

As specification, I keep the structural model of basics with explanatory variables, the approach of Harkey (1990) to estimate the unknown parameters. The procedures based on the method of the maximum likelihood process of inference will be driven. From the diagnostic tests of AIC type procedure of selection and the estimated values of the variances of the different components permit us to identify these components nature.

For modeling the tourist demand we have considerate the transfer function model (MFT) and the specification ‘Autoregressive with gradual lags (SARE). We use Malian and Europeans monthly tourism data from January 1991 to December 2003.

MATERIALS AND METHODS

Specification of the tourist demand: Favorable economic conjuncture, (γ') auspicious political climate, the political authorities good willing.

Quantification of the tourist demand: Numbers of European tourist entries and how long they have stayed.

Determinants of the tourist demand: The demand (γ') is closely bound to the price (P), to the income (R) and especially to the tourist supply: (γ') (the natural wealth (climate), the capacity of the hotels).

Cost of the stay: Global recipe = Price×quantities = (recipe of the night)×(number of nights).

Function of the demand: γ t = γ (P, R, γ t) with ∂γ/∂P<0; ∂γ/∂R>0; ∂γ/∂γ>0 indicates that the supply induce the demand.

The seasonal unit roots process test by Hylleberg et al. (1990) and its application to the Malian tourist series, one admits extensively that the seasonal shapes fluctuate weekly in the time (Ouerfell and Pichery, 1998).

Construction of the sample

• Short interval of time
• Important size of sample
• Representative ness of the sample.

The sample is provided by the tourism office (156 monthly observations concerning the French tourists, Germans, English and Italian)

Function form
Structural Basic model

\[ y_t = \mu_t + S_t + \epsilon_t \]

Chronological series \( y_t \), \( \mu_t \): trend; \( S_t \): seasonal component

Global model

\[ y_t = \mu_t + S_t + X_t \delta + \epsilon_t \quad ; t = 1, \ldots, T \]

\( X_t \): Vector of \( k \) variables; and \( \delta \): vector of the unknown parameters associated to these variables

Specification

\[ \begin{bmatrix} \mu_t = \mu_{t-1} + \beta_{t-1} + \eta_{t-1} \\ \beta_t = \beta_{t-1} + \xi_t \end{bmatrix} \quad \eta_t \rightarrow N(0, \sigma^2_{\eta}) \quad \epsilon_t \rightarrow N(0, \sigma^2_{\epsilon}) \]

\( S_t = \sum_{j=1}^{s-1} Y_{j} D_{jt} \) where \( D_{jt} \) are seasonal indicator variables given by

\( D_{jt} = 1 \) if \( t = j, j+s, j+2s, \ldots \ldots \),

\( D_{jt} = 0 \) if \( t \neq j, j+s, j+2s, \ldots \ldots \),

\( D_{jt} = -1 \) if \( t = s, 2s, 3s, \ldots \ldots \)

if \( t - s, 2s, 3s, \ldots \)

\[ \sum_{j=1}^{s-1} Y_{j} D_{jt} = -\sum_{j=1}^{s-1} Y_{j} = Y_s \] which implies that \( \sum_{j=1}^{s-1} Y_{j} = 0 \) or if \( Y_t = \) the seasonal effect at time \( t \): \( \sum_{j=0}^{s-1} Y_{t-j} = 0 \)

we suppose \( Y_t = -\sum_{j=1}^{s-1} Y_{t-j} + \omega_t \quad \omega_t \rightarrow N(0, \sigma^2_{\omega}) \)

\( \eta_t, \xi_t \) are independent and non correlated to the component \( \epsilon_t \)

Kalman filter iterative procedure permits to estimate the values of the unknown parameters.

Approach of Box and Jenkins (1976)

**Specification 1:** (Transfer Function Model with seasonal indicator variables V.I.S.)

\[ y_t = \gamma_0 + \sum_{j=1}^{11} \gamma_j D_{jt} + \sum_{i=1}^{k} \frac{\beta_i^L t}{1-L \lambda_i} X_{it} + \frac{b(L)}{a(L)} \epsilon_t \]

\( \epsilon_t \rightarrow \text{iidN}(0, \sigma^2) \)

\[ \sum_{j=1}^{k} \frac{\beta_i^L}{} \text{ retrace the dynamics of the model} \]

\[ \frac{b(L)}{a(L)} \text{ describe the dynamics of the disruptions} \]

\( a(L) = 1 - a_1 L - a_2 L^2 - \ldots - a_p L^p \)

\( b(L) = 1 + b_1 L + b_2 L^2 + \ldots + b_q L^q \)

The \( D_{jt} \) is the 11 V.I.S. and \( \lambda_i \) represent the coefficient of the auto regressive lag associated to the transfer term of \( i \). \( L \) indicates the lag that precedes the impact of the exogenous value \( x_t \).

**Specification 2:** Detects the two aspects of the seasonality: stochastic and deterministic aspect according to Franses (1991).

\[ a(L) Y_t = \gamma_0 + \sum_{j=1}^{11} \gamma_j D_{jt} + S_t \beta + \epsilon_t \quad \epsilon_t \rightarrow \text{iidN}(0, \sigma^2) \]

where \( y_t \) and \( x_t \) are series gotten after elimination of all unit roots to the existing frequencies. \( a(L) \) is an auto-regressive polynomial which general expression is given over and \( \beta = (\beta_1, \beta_2, \beta_3) \) the vector of the coefficients of the explanatory variables.

**Specification 3:** (Auto regressive distributed Lag Model)

\[ A(1) y_t = B(L) x_t + \epsilon_t \quad \epsilon_t \rightarrow \text{iidN}(0, \sigma^2) \]

\[ A(L) = 1 - A_1 L - A_2 L^2 - \ldots - A_p L^p \]

\[ B(L) = 1 + B_1 L + B_2 L^2 + \ldots + B_q L^q \]

We used (RATS 4.2 software)

**Preliminary results and comments**

**Basis Structural Model estimation**

**Final equation:** (STAMP, version 5.0 program: structural
time analyzer modeler and predictor) elaborated by Koop man

$$y_t = \mu_t + S + X_t \delta + \varepsilon_t \quad t = 1, \ldots, T$$

The criteria of selection permitted to keep the specification with a stochastic trend and a seasonal deterministic component. It has been estimated with using Kaman filter iterative procedure

$$y_t = \mu_t + \gamma_t + \delta_t \text{CME}_t + \delta_t \text{P}_{t-12} + \delta_t \text{R}_{t-1} + \varepsilon_t \quad t = 1, \ldots, T = 156$$

\(\mu\) is a random walk with \(\mu_t = \mu_{t-1} + \beta + \eta_t\) and \(\gamma_t = -\sum_{j=1}^{12} \gamma_{t-j}\) is relative to the coefficient of month \(t\). (the variables are expressed in logarithm).

<table>
<thead>
<tr>
<th>Structure</th>
<th>Statistics</th>
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<tbody>
<tr>
<td>Components</td>
<td>Hyper variables</td>
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<tr>
<td>Variances</td>
<td>Trend (\hat{\sigma}_t^2)</td>
</tr>
<tr>
<td></td>
<td>Stationarity (\hat{\sigma}_t^2)</td>
</tr>
<tr>
<td></td>
<td>Error (\hat{\sigma}^2)</td>
</tr>
<tr>
<td>Elasticities</td>
<td>CME (\hat{\delta}_t)</td>
</tr>
<tr>
<td></td>
<td>(\hat{\delta}_t)</td>
</tr>
<tr>
<td></td>
<td>(R\hat{\delta}_t)</td>
</tr>
</tbody>
</table>

- V.E.P.: Variance of Prevision Error
- *: Like hood ratio statistics \(RV = 143\log (0.0148/0.0086)\) for the tendency, \(RV = 0.144\log (0.0091/0.0086)\) for the seasonality
- *: The critical value of \(\chi^2(1)\) table at the significance level of 5%
- *: The value of the statistic t-Student at \(t=6-k=1\) degree of freedom
- *: The critical value of Fisher table for \(F (11, 125)\) at the significance level 5%

A more refined analysis of these aspects detected for the different components (i.e., the stochastic aspect of the tendency and the seasonality deterministic aspect) conduct to the following interpretations:

Knowing that the tendency represents some psychological factors, its stochastic feature implies a volatility of Malian products preferences.

With regard to the seasonality, the deterministic character explains an important part of the variance of the set. The detected deterministic aspect proves that the effort of the professionals of tourism in order to promote a better exhibit of the tourist activity on the year remains henceforth insufficient to the level of the hotel.

**Results of the models 1, 2, 3:** The evaluations are done while adopting strategies of different selections depending on if about the transfer function model (specification 1) of the specification 2, or of the specification 3.

**Specification 1:** The valued equation is the following:

$$NT(t) = \gamma_t + \sum_{j=1}^{12} \gamma_{t-j} D_{j} + \beta_1 \text{CME}(t) + \beta_2 \text{P}(t-12) + \beta_3 \text{R}(t) + \nu_t$$

Where \((1 - \rho_1L - \rho_2L^2) \nu_t = \varepsilon_t\) and \(\varepsilon_t\) is white noise.
**Specification 2:** The valued equation is given by:

\[
(1 - a_1L - a_2L^2)(1 - L^2)NT(t) = \gamma_0 + \sum_{j=1}^{10} \gamma_j D_{it} + \beta_1 (1 - L^2) CME(t) + \beta_2 (1 - L^2) P(t - 12) + \beta_3 (1 - L^2) R(t - 1) + \varepsilon_i
\]

\(\varepsilon_i\) is a white noise

**Specification 3:** The equation 3 has the following expression:

\[
(1 - \phi_1L - \phi_2L^2 - \phi_3L^3) NT(t) = \alpha_0 + (\alpha_1 + \alpha_2L) CME(t) + (\beta_1 + \beta_2L^3 + \beta_3L^4 + \beta_4L^5) P(t) + \gamma R(t - 7) + \varepsilon_i
\]

\(\varepsilon_i\) are a white noise

The variables are expressed in logarithm.

### Short equation 1

<table>
<thead>
<tr>
<th>Coefficients</th>
<th>Estimated values</th>
<th>Elasticities</th>
<th>Estimated values</th>
</tr>
</thead>
<tbody>
<tr>
<td>(\gamma_1)</td>
<td>2.4178</td>
<td>(1.44)</td>
<td>Supply(51)</td>
</tr>
<tr>
<td>(\gamma_{12})</td>
<td>2.5994</td>
<td>(1.44)</td>
<td>Price(22)</td>
</tr>
<tr>
<td>(\gamma_3)</td>
<td>3.9977</td>
<td>(1.44)</td>
<td>Income(3)</td>
</tr>
<tr>
<td>(\gamma_4)</td>
<td>3.3088</td>
<td>(1.45)</td>
<td>Autoregressive coefficients</td>
</tr>
<tr>
<td>(\gamma_{510})</td>
<td>3.3659</td>
<td>(1.46)</td>
<td>(\rho_1)</td>
</tr>
<tr>
<td>(\gamma_6)</td>
<td>3.3965</td>
<td>(1.46)</td>
<td>(\rho_2)</td>
</tr>
<tr>
<td>(\gamma_7)</td>
<td>3.5121</td>
<td>(1.46)</td>
<td>R2</td>
</tr>
<tr>
<td>(\gamma_8)</td>
<td>3.8323</td>
<td>(1.46)</td>
<td>JB</td>
</tr>
<tr>
<td>(\gamma_11)</td>
<td>2.8203</td>
<td>(1.49)</td>
<td></td>
</tr>
</tbody>
</table>

**Errors of structures**

\(\delta_i = (1 - 0.5120L - 0.2777L^2) \varepsilon_i\)

- The coefficients \(\gamma_{ij}\) reflect the specific effect of the two dummy variables indicated by \(i\) and \(j\), \(D_{it} = D_i + D_j\) in other words the effect of the two months \(i\) and \(j\)
- The coefficients \(\gamma_i\) reflect the specific effect of the month \(i\)
- Bold and italic values are significantly different from zero at the threshold of 10

### Short equation 2

<table>
<thead>
<tr>
<th>Coefficients</th>
<th>Estimated values</th>
<th>Elasticities</th>
<th>Estimated values</th>
</tr>
</thead>
<tbody>
<tr>
<td>(\gamma_1)</td>
<td>-0.1537</td>
<td>(0.07)</td>
<td>supply(51)</td>
</tr>
<tr>
<td>(\gamma_3)</td>
<td>0.5069</td>
<td>(0.04)</td>
<td>Price(22)</td>
</tr>
<tr>
<td>(\gamma_4)</td>
<td>0.5288</td>
<td>(0.07)</td>
<td>Income(3)</td>
</tr>
<tr>
<td>(\gamma_5)</td>
<td>0.1664</td>
<td>(0.07)</td>
<td>Autoregressive coefficients</td>
</tr>
<tr>
<td>(\gamma_6)</td>
<td>0.1691</td>
<td>(0.05)</td>
<td>(a_1)</td>
</tr>
<tr>
<td>(\gamma_7)</td>
<td>0.2601</td>
<td>(0.04)</td>
<td>(a_2)</td>
</tr>
<tr>
<td>(\gamma_8)</td>
<td>0.3608</td>
<td>(0.04)</td>
<td>R2</td>
</tr>
<tr>
<td>(\gamma_9)</td>
<td>-0.1729</td>
<td>(0.04)</td>
<td>JB</td>
</tr>
<tr>
<td>(\gamma_{10})</td>
<td>-0.3507</td>
<td>(0.04)</td>
<td>(\delta_{12})</td>
</tr>
<tr>
<td>(\gamma_{11})</td>
<td>-0.5752</td>
<td>(0.05)</td>
<td></td>
</tr>
<tr>
<td>(\gamma_{12})</td>
<td>-0.6703</td>
<td>(0.06)</td>
<td></td>
</tr>
</tbody>
</table>

### Short equation 3

<table>
<thead>
<tr>
<th>Elasticities</th>
<th>Estimated values</th>
<th>Coefficients</th>
<th>Estimated values</th>
</tr>
</thead>
<tbody>
<tr>
<td>(\alpha_1)</td>
<td>Supply</td>
<td>0.3339</td>
<td>(\alpha_0)</td>
</tr>
<tr>
<td>(\alpha_2)</td>
<td>-0.2351</td>
<td>(0.16)</td>
<td>(\alpha_1)</td>
</tr>
<tr>
<td>(\beta_1)</td>
<td>-0.1380</td>
<td>(0.06)</td>
<td>(\alpha_2)</td>
</tr>
<tr>
<td>(\beta_2)</td>
<td>0.2067</td>
<td>(0.05)</td>
<td>(\alpha_3)</td>
</tr>
<tr>
<td>(\beta_3)</td>
<td>-0.1153</td>
<td>(0.05)</td>
<td>Statistics</td>
</tr>
<tr>
<td>(\gamma_4)</td>
<td>Income</td>
<td>0.1761</td>
<td>QLB (30) = 24.97</td>
</tr>
<tr>
<td>(E)</td>
<td>6.0732</td>
<td>(0.08)</td>
<td>DW</td>
</tr>
</tbody>
</table>

- The numbers in brackets represent the estimated gaps
- The missed variables in the equation are not significant at the threshold of 10
- \(\delta_i\) is an estimation of statistic test elasticity significant ness the values which are significantly different from zero at threshold of 5 are bold
CONCLUSIONS

The gaps in brackets indicate that the explanatory variables coefficients are significant. The estimated values of the flexibility of the demand are coherent in sign and in module with the economic theory. These variables seem to explain an important part of the dependent variable, having captured the deterministic seasonality, which explains the weak value of the flexibility of the price presumably. This aspect of seasonality presence is distinctly shown by the significant coefficients of the seasonal indicatory variables even while considering the filtered series. These results confirm the mixed character of the seasonality that characterizes the tourist demand and bring up the advantage of the seasonal models esteemed on raw series as suggested by several authors.

REFERENCES