



**Universitat de les
Illes Balears**

University of Balearics Islands



Economic Research Center

A NEW APPROACH FOR ESTIMATING TOURISM-INDUCED ELECTRICITY CONSUMPTION



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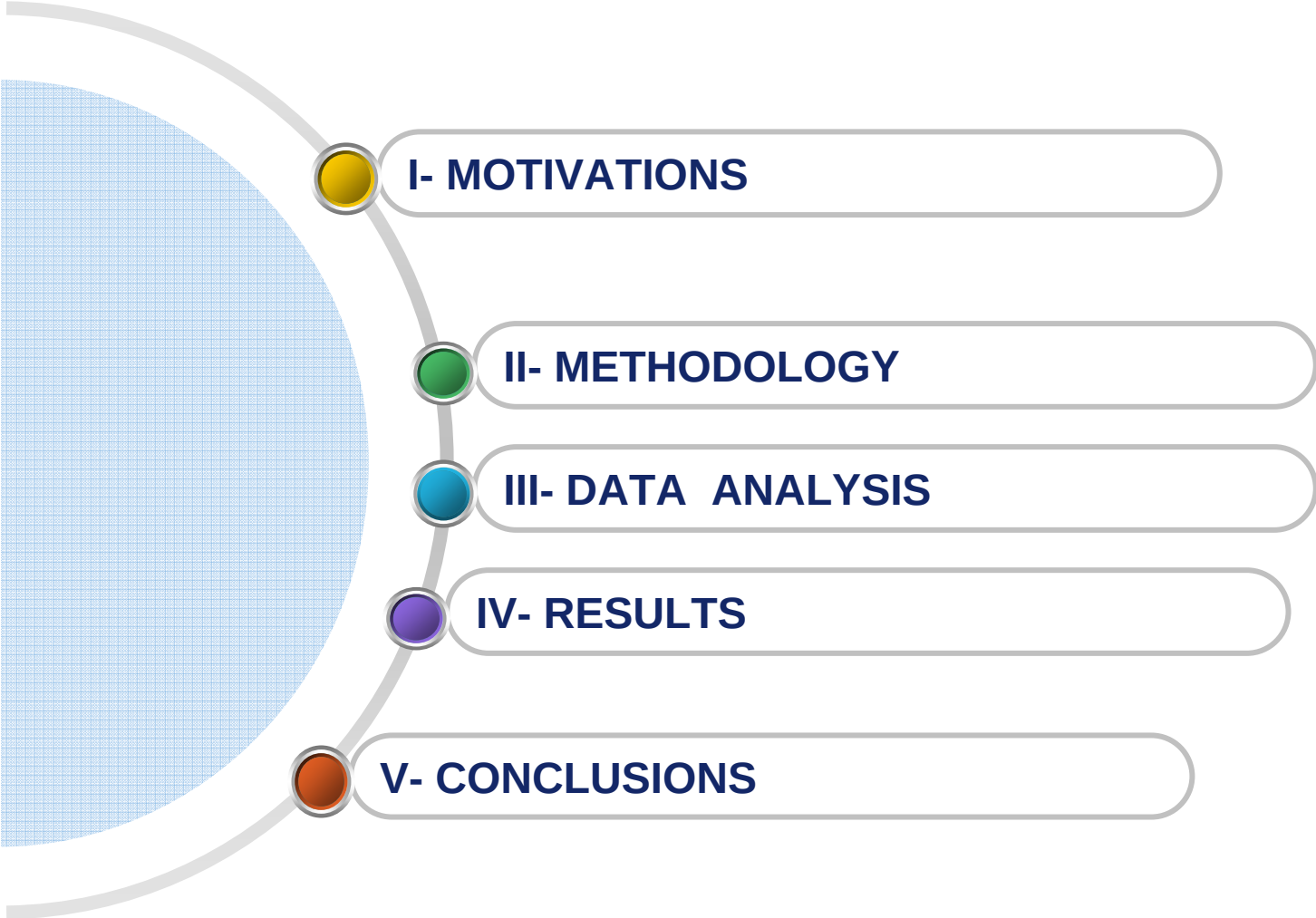
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STRUCTURE



I- MOTIVATIONS

II- METHODOLOGY

III- DATA ANALYSIS

IV- RESULTS

V- CONCLUSIONS



I- MOTIVATIONS

Economic significance of tourism ← Tourism Satellite Accounts

Tourism → Source of environmental impacts and resource consumption



Performance
Audit

- Lifecycle assessment (Hernández and León, 2007; Becken and Simmons, 2008)
- Ecological footprinting (Gössling et al., 2002; Patterson et al. 2007).



I- MOTIVATIONS

- Environmental damage contributed by Tourism has been recognized as **“Potentially Considerable”** (Gössling, 2002)

Tourism industry → Important energy consumer

(Becken, 2002; Becken & Simmons, 2002, Becken et al., 2001, 2003; Gossling, 2000; Gossling et al., 2002; Tabatchnaia-Tamirisa et al., 1997).

Energy Use and Greenhouse Gas (GHG) emissions → Air Transport

Price & Probert (1995), Penner et al. (1999) Gössling (2000), Gossling et al. (2005) and Peeters and Schouten (2006) Janic (1999). Becken (2002a)

Energy Use → Accomodation

(Becken et al., 2001; Deng and Burnett, 2000; Simmons and Lewis, 2001).



I- MOTIVATIONS

Tourism was considered in disaggregated way to evaluate its contribution to energy consumption.

Environmental costs from the Tourism industry → Sector Perspective (Air transport, accommodation,...)

Case Study:

- Balearic Islands
- Electricity consumption



III-MOTIVATIONS



IV- METHODOLOGY

II- METHODOLOGY



II-

METHODOLOGY

Energy demand is very sensitive to some factors:

- Time factors
- Weather variables
- Other factors....



Exogenous variables

Electricity cannot be stored → anticipate future demand



The model

II- METHODOLOGY



II- METHODOLOGY

Exogenous variables Models

- Periodic Patterns and trend.
- Special Days.
- Weather Conditions.
- Others: Price; GDP.
- Artificial Intelligence Based Methods.
- Statistical Approaches.

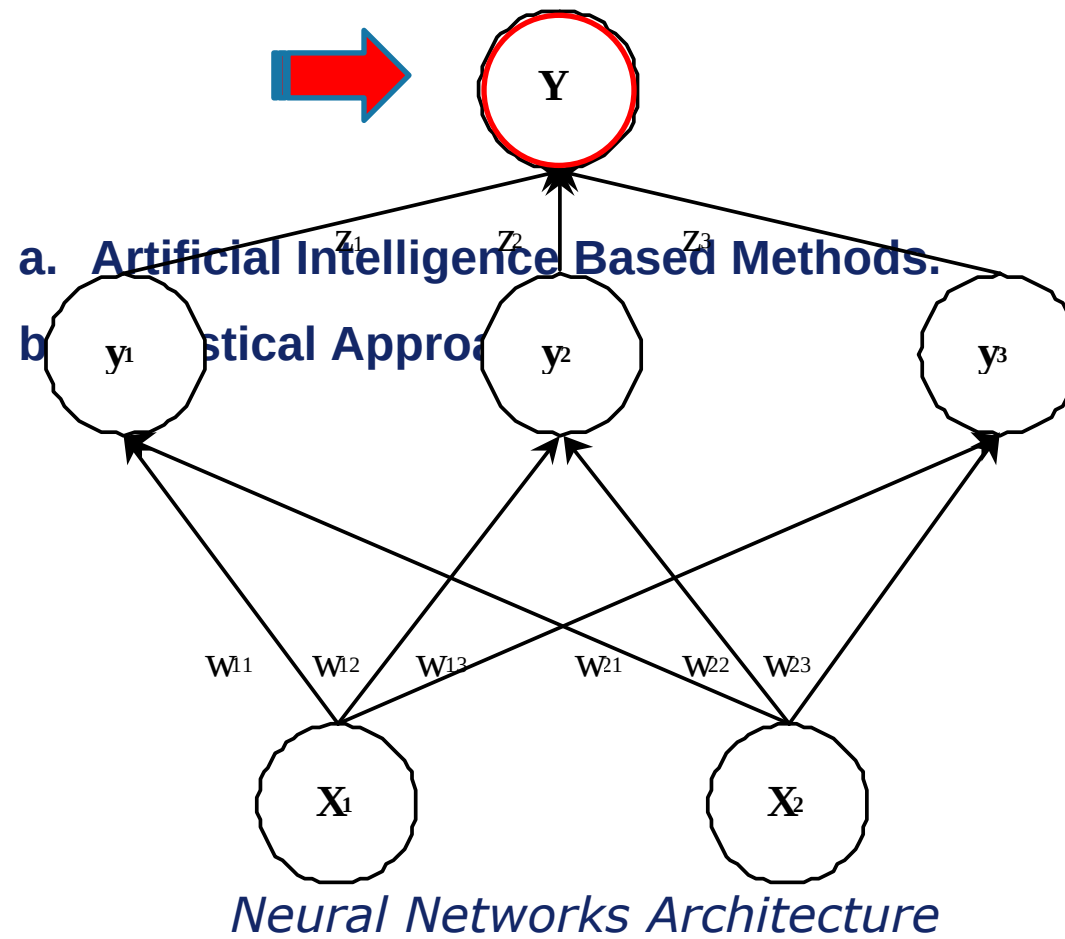
1. Exogenous variables

2. The model

II- METHODOLOGY

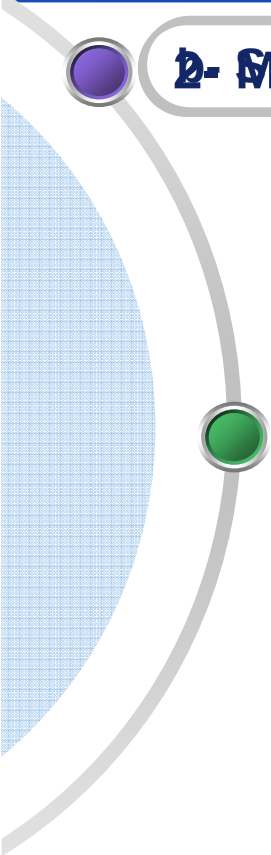
2- Models

Artificial Intelligence Based Methods



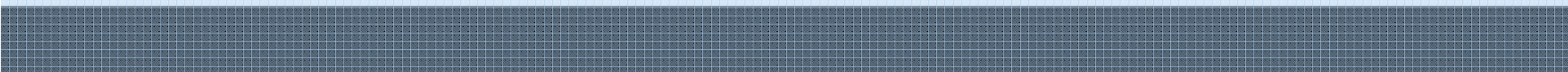


II- METHODOLOGY



2- Models

2- Statistical approaches

- a. Artificial Intelligence Based Methods.
 - b. Statistical Approaches.
- 



II- METHODOLOGY

b- Statistical approaches

- Assuming the traditional aggregated energy demand relationship:

$$\ln(E_t) = t + s_t + CSD_t + CWEA_t + U_t$$

- A Traditional structure decomposes the observed load into:

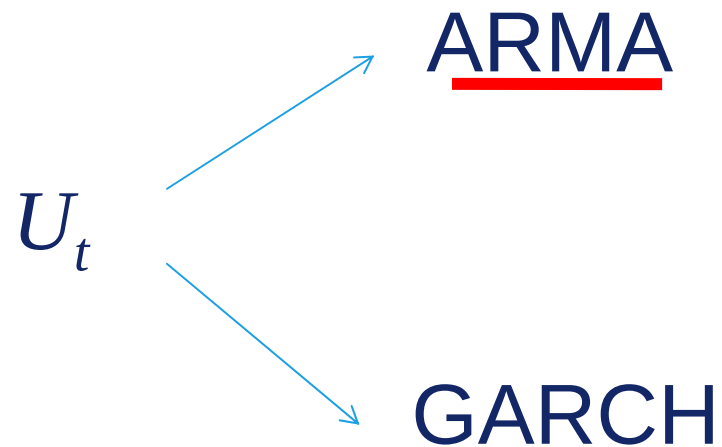
- | | |
|-----------------------|-----------------------------|
| 1) Trend | 4) Meteorological variables |
| 2) Seasonal Component | 5) Disturbance |
| 3) Special Days | |



II- METHODOLOGY

b- Statistical approaches

- Many approaches have been applied to model the stochastic nature of demand :





II- METHODOLOGY

a. Electricity data

b. Weather data

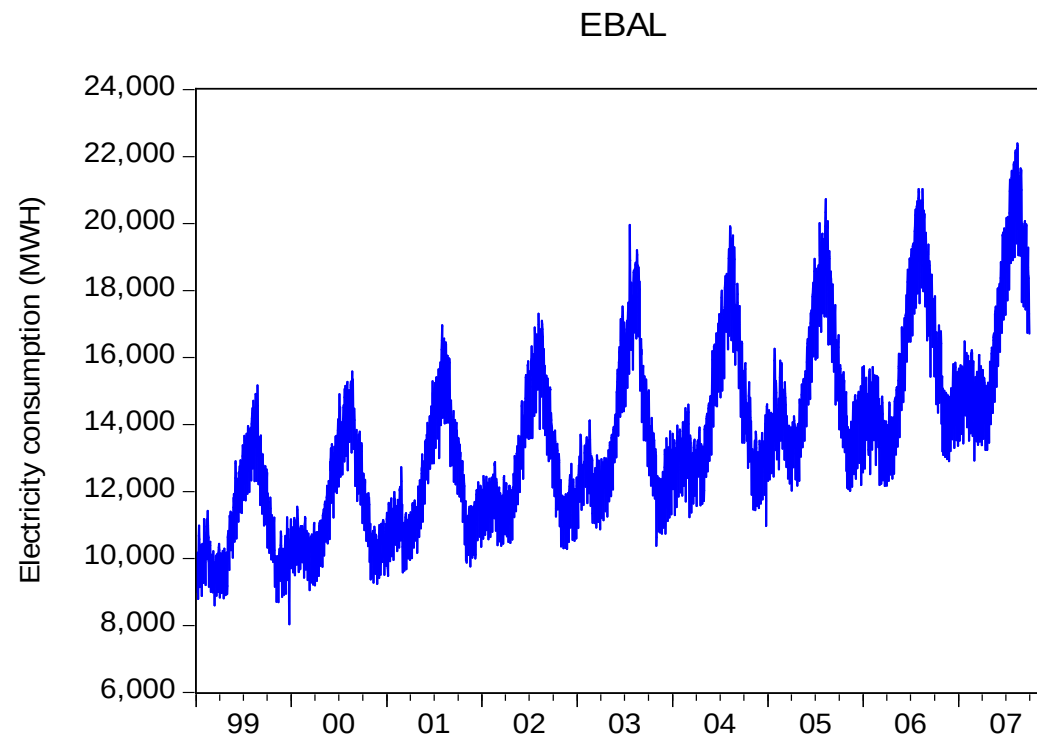
c. The daily population stock

III- DATA ANALYSIS

II- DATA ANALYSIS

II- DATA ANALYSIS

Daily electricity consumption in the Balearic Islands





II- DATA ANALYSIS

a. Electricity data

➤ **TREND : Linear**

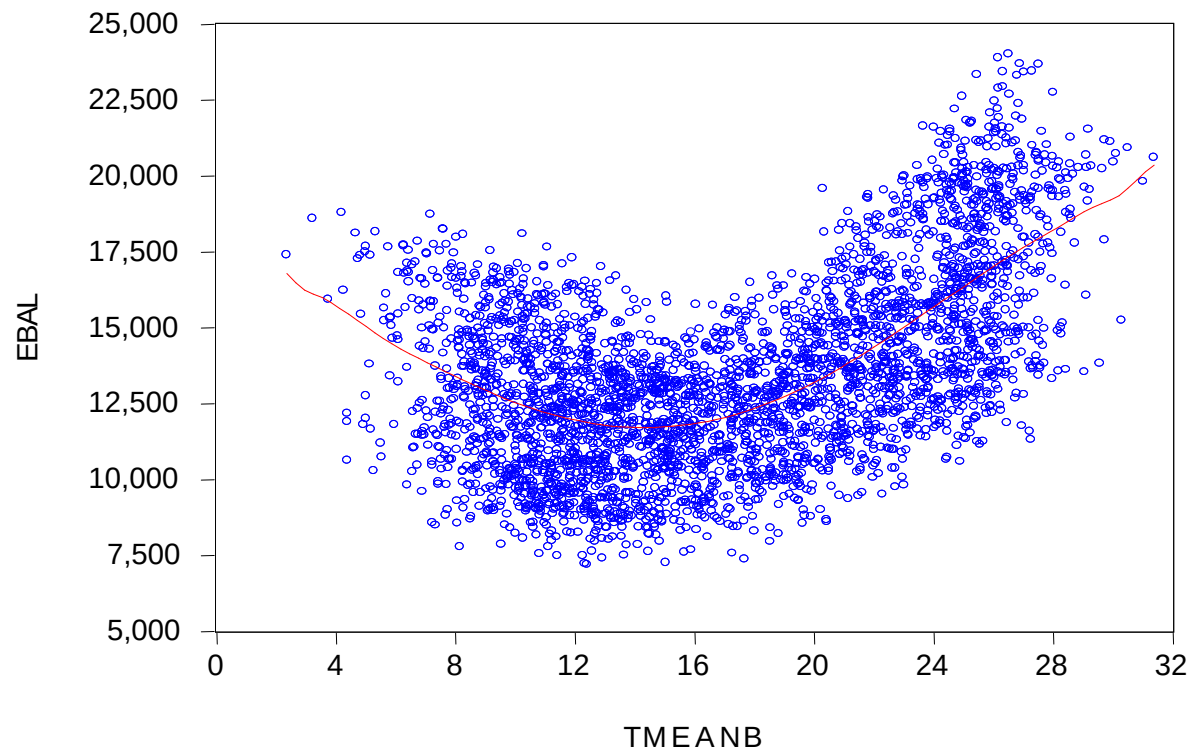
➤ **DUMMY VARIABLES**

- Day of the week ($D_1, \dots, D_7$)
- Month of the year ($M_1, \dots, M_{12}$)
- Special days

II- DATA ANALYSIS

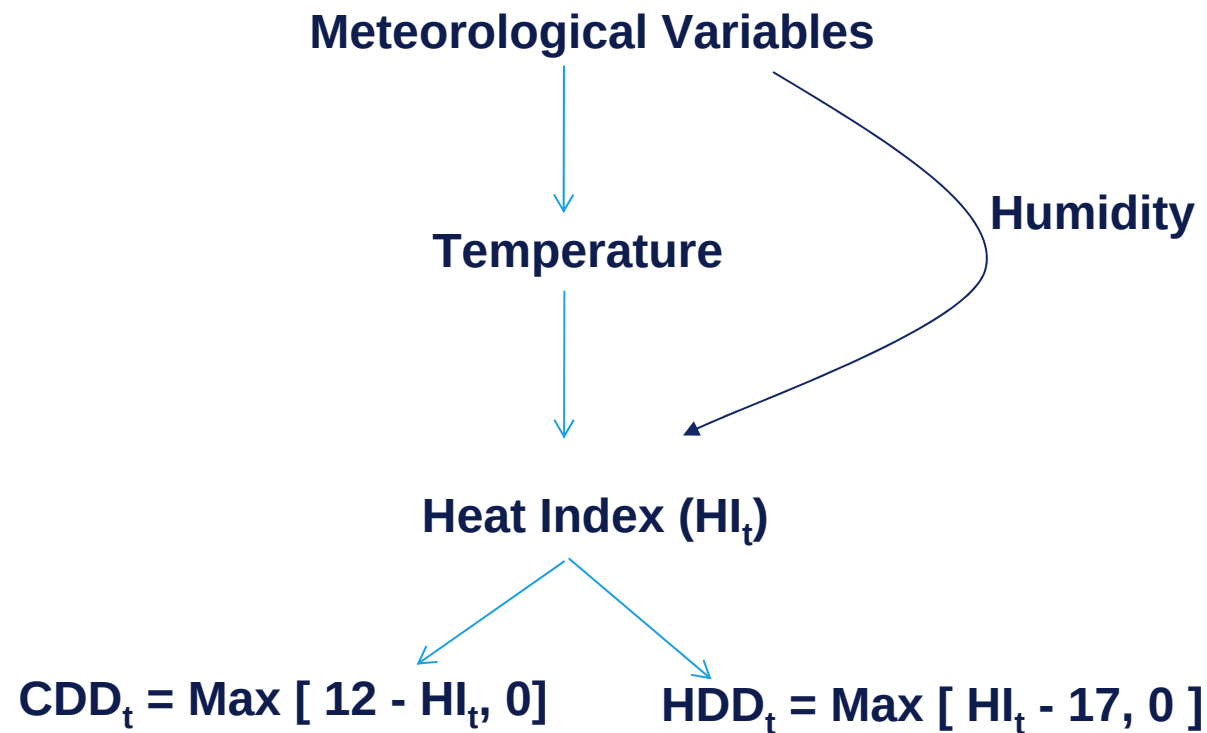
II- DATA ANALYSIS

Daily load and mean temperature in Balearics



II- DATA ANALYSIS

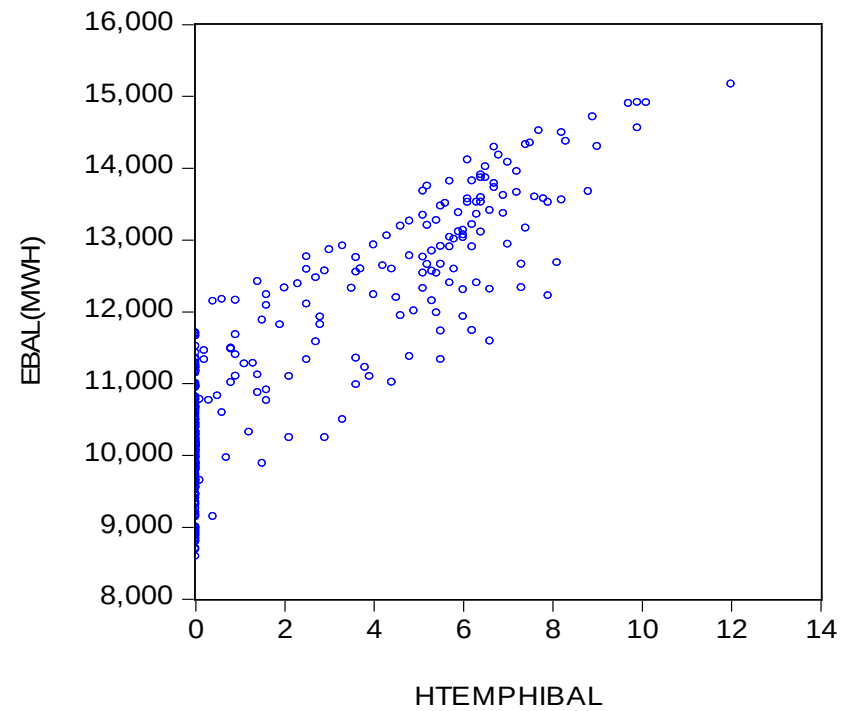
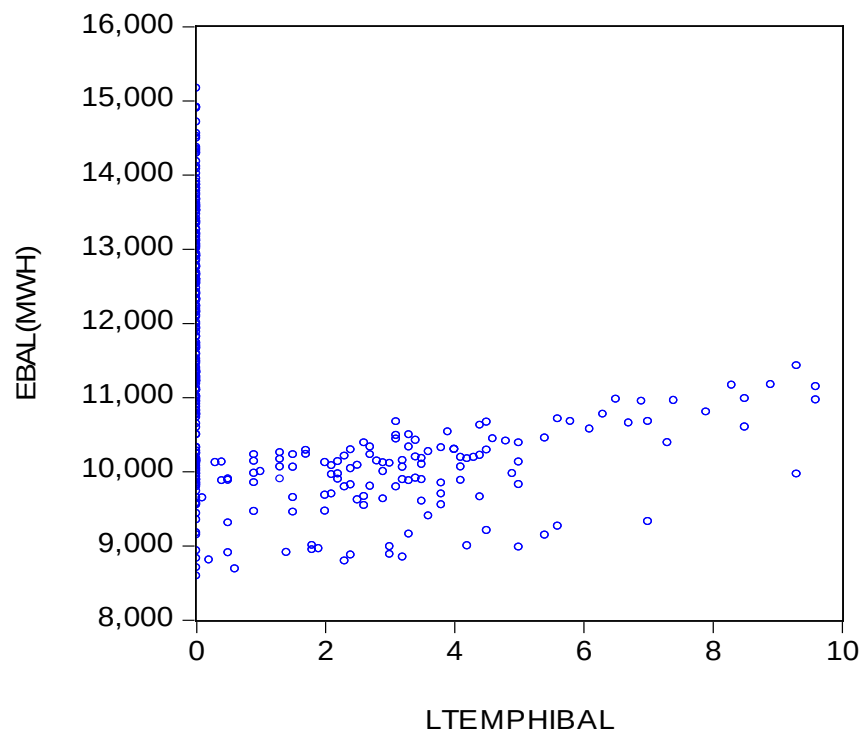
a. Weather data



II- DATA ANALYSIS

a. Weather data

Daily electricity consumption & HDD and CDD in Balearics





II- DATA ANALYSIS

II- Data Analysis on stock data

- To capture a daily pressure of the stock population an indicator was built by Mateu and Riera (2007):

$$IDPH_t = POP_0 + \sum_{t=1}^{365} (A_t - D_t) + \sum_{t=1}^{365} V_t$$

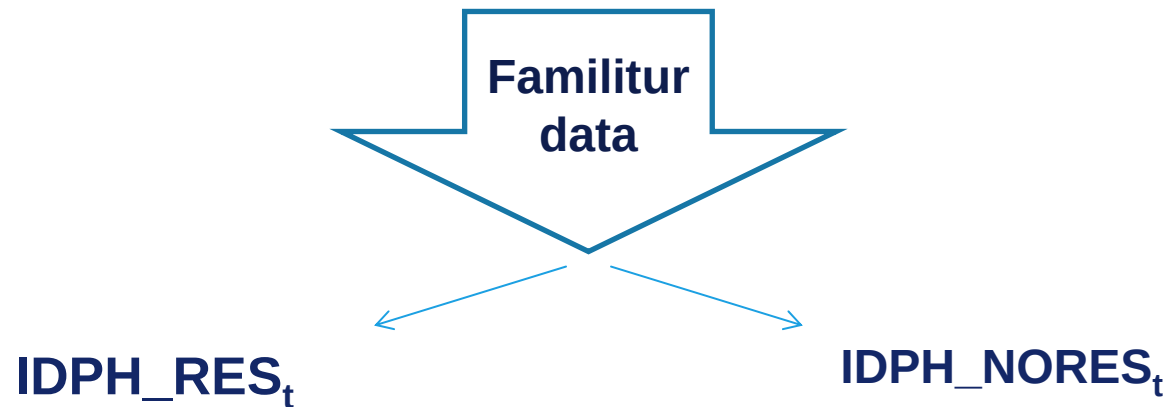
- 1) Resident population on 1st day of each year
- 2) The difference between Arrivals and Departures
- 3) Natural growth (birth & death)

II- DATA ANALYSIS

a. The daily population stock data

- To capture a daily pressure of the stock population an indicator was built by Mateu and Riera (2007):

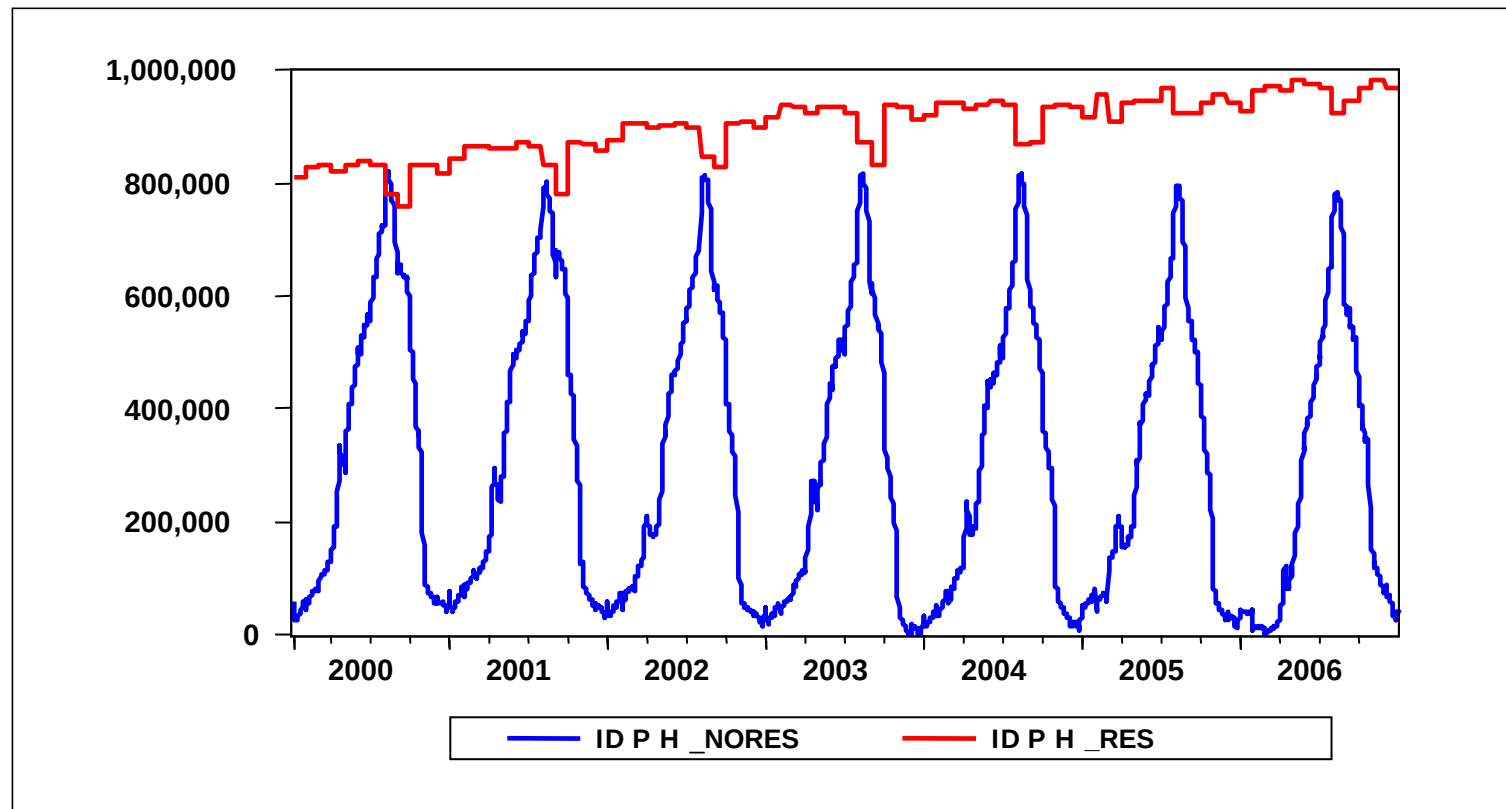
$$IDPH_t = POP_0 + \sum_{t=1}^{365} (A_t - D_t) + \sum_{t=1}^{365} V_t$$



II- DATA ANALYSIS

a. The daily population stock

IDPH for residents and tourists in Balearics Islands





III- DATA ANALYSIS



IV- RESULTS

IV- RESULTS

	Balearics	
	SARMA	GARCH
C	8.480177***	8.325717***
@TREND	0.000121***	0.000116***
HTEMPHIP	0.010488***	0.005321***
HTEMPHIP^2	0.000278**	0.000351***
LTEMPHIP	0.007386***	0.005248***
LTEMPHIP^2	0.000537***	0.000392**
IDPH_RES	4.34E-07***	5.86E-07***
IDPH_NORES	3.71E-07***	3.93E-07***
Adjusted R-Squared	0.971475	0.965592
Log likelihood	6154.008	6331.140
Durbin-Watson stat	1.893018	2.316683
AIC	-3.840886	-3.950403
SC	-3.751251	-3.855047
F-statistic	2354.644	1821.676
Proba(F-Statistic)	0.000000	0.000000

Note: *** significant at 1%, ** significant at 5%, * significant at 10%

IV- RESULTS

IV- RESULTS Regulation of electricity consumption growth of Balearics

			5% increase		8% increase		10% increase	
			resident	non resident	resident	non resident	resident	non resident
ARNIA	Max	1999	1.8%	1.4%	2.9%	2.3%	3.6%	2.9%
	Mean	→ 1999	1.7%	0.6%	2.8%	1.0%	3.5%	1.2%
	Max	2006	2.2%	1.5%	3.6%	2.4%	4.5%	3.0%
	Mean	→ 2006	2.1%	0.5%	3.4%	0.8%	4.3%	1.0%
GARCH	Max	1999	2.4%	1.5%	3.9%	2.4%	4.9%	3.0%
	Mean	→ 1999	2.4%	0.6%	3.8%	1.0%	4.8%	1.3%
	Max	2006	3.0%	1.6%	4.8%	2.5%	6.1%	3.1%
	Mean	→ 2006	2.9%	0.5%	4.6%	0.8%	5.8%	1.0%



IV- RESULTS



IV- RESULTS

- What would happen if the resident or non residents' population increased by a fix amount?
- What would happen if we had no tourists?



IV- RESULTS

IV- RESULTS Simulation from tourist and residents population growth

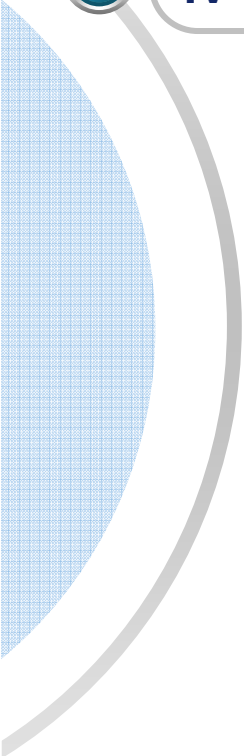
		3% increase		5% increase		10% increase	
		resident	non resident	resident	non resident	resident	non resident
ARMA	Mean	49.5%	12.2%	50.7%	12.5%	53.7%	13.1%
GARCH	Mean	72.10%	12.99%	73.92%	13.26%	78.56%	13.94%



IV- RESULTS



IV- RESULTS Simulation with absence of tourists in Balearics Islands



For both models (ARMA and GARCH) the simulation showed a decrease of an average of 12% of the total electricity consumption



IV- CONCLUSIONS



IV-RESULTS



IV- CONCLUSIONS



IV- CONCLUSIONS

- **Sector perspective when tourism environmental cost are evaluated**
- **Proposal to filling this gap: Electricity consumption in the Balearics**
- **Increasing sensitivity of electricity demand to population stock with higher sensitivity for resident case**
- **Simulations show high growth rates of electricity demand for both residents and nonresidents in the summer**
- **Good performance of GARCH model with comparison to ARMA**
- **Results could be useful for estimating the relative effects of energy use and its concomitant GHG emissions in tourism destinations.**



IV- CONCLUSIONS

- **An increase of nonresident population during the low season associated to a low growth rate of electricity consumption.**

→ Seasonality policies

- **Future research**

- ☐ Comparing the efficiency of different GARCH class models
- ☐ Evaluate tourism responsibility in each one of the Balearic Islands
- ☐ Translate electricity consumption in terms of tourist GHG emissions



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THANK YOU!



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