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Influence Of Ports On Catalonia's Development

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ABSTRACT

The paper shows the influence of ports on Catalonia's development. Barcelona and Tarragona ports were selected for this study. The point of departure was that ports define strategic plans which describe their reality and environment, specifying what they are and what they want to be and designing their future within a specified time frame. With this in mind, the strategic plans of several EU ports in the Mediterranean and Atlantic areas and of Barcelona and Tarragona ports were compared. Comparison items included initial basic ideas such as mission, vision, values and commitments, as well as a common goal of all ports which is regarded as one of their main indicators, i.e. forecast of port traffic data and their evolution. The paper examines port traffic data time series and compares their corresponding ARIMA forecasting models. The Box-Jenkins method was applied considering first all available data and second atypical data. Finally, the impact of the latter on the future of ports is determined. This objective work practice enables the influence of Barcelona and Tarragona ports on Catalonia's development to be assessed from a territorial, economic and social perspective. The conclusions of the paper focus on this aspect.

1. Introduction

The main purpose of this work is to show the influence of ports on Catalonia's development, that is, the importance of this kind of infrastructures for a country or a geographical area. The paper focuses on the definition of the strategic plans of Barcelona and Tarragona ports, which will serve as criteria for their comparison with those of other EU ports in the Mediterranean region, i.e. Taranto, Genoa, Valencia, Algeciras, and in the Atlantic region, i.e. Bilbao, Pasajes, Dunkirk, Ghent, Antwerp and Bremen (Olivella Cruset, J., 2016). Among the indicators specified in the strategic plans, port traffic data and their evolution stand as one of the most important to define the main goals of a port authority. This information was obtained from the above ports and studied by the Box-Jenkins method for data time series in order to choose an appropriate ARIMA forecasting model. The results and conclusions of this study are given in the last sections.

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2. Main Ideas, Strategic Plans And Port Traffic Indicators

This paper presents the most significant results obtained from the application of the Box-Jenkins method to port traffic data time series. It also provides conclusions of an extensive study on the strategic plans based on this information.

A preliminary study of a strategic plan should consider basic concepts such as mission, vision, values and commitments (Enríquez Argós, F., 2000). These initial ideas should lead to the achievement of some main targets that are sometimes common to all port authorities. As is common in the usual methodology for a Quality System, the objectives must be expressed as figures to allow comparison of the values of indicators with those of other port authorities.

Barcelona and Tarragona ports were selected for this study because they are the most important maritime infrastructures in Catalonia and may currently be properly compared with other European Union ports. The potentiality of other Catalan ports was investigated in a previous work by the authors.

The selection of the ports used in this study was based on several criteria, e.g. location in the EU maritime regions, i.e. Mediterranean and Atlantic, and dimension, regarded as the ab-

solute value of port traffic data. This enabled us to work in terms of (ingoing and outgoing) traffic data with not only port authorities of top EU ports, but also of ports with a lower level of traffic data but highly specialised and connected to their hinterland.

Since there is no communication policy common to all EU port authorities, some sent all the information requested, others sent port traffic data but no information about the strategic plan, and a minority sent no information at all. In order to improve communication with port authorities, it would be advisable to implement a common European communication policy with transparency as a priority.

There exist three forecasting models of port transport systems: ARIMA (Autoregressive Inputs and Moving Averages) using Box-Jenkins method, MLR (Multiple Linear Regression) and ANN (Artificial Neural Networks). In this work, the Box-Jenkins method was used as a first step. The other two models could be implemented in a possible further study (Rodríguez García, T. et al., 2013). Box-Jenkins method was chosen as an objective methodology to demonstrate the importance and influence of Barcelona and Tarragona ports on Catalonia's development. This methodology can also point to improvement elements for Catalan ports based on the information about the studied EU ports.

The use of strategic plans and statistical tools to study indicators like port traffic data by port authorities sheds light on the reality and future of ports and of all social actors involved. In case of unexpected external changes, an optimal definition of the strategic plan and a careful use of statistical tools should allow essential corrective actions to be implemented to redirect the course of a port (Enríquez Argós, F., 2000).

In order to define the final main indicators like port traffic data and have control of the forecast of these indicators, it is essential to first define the main ideas of a strategic plan like mission, vision and main goals for a set period of time (port authorities have recently been working with 5-year strategic plans).

Barcelona and Tarragona ports use strategic planning as an essential tool to define their future, and in turn, that of their hinterlands. This could mean that port authorities are defining Catalonia's future and the relationship of ports with their environment and all social actors involved in their activities.

Strategic planning can be used to evaluate and compare ports qualitatively, but a statistical tool like ARIMA is necessary to compare them objectively. In this study, all the theories about time series and forecasting were very useful to draw conclusions from the comparison between Barcelona and Tarragona ports and the other ports (Rodríguez García, T. et al., 2013). ARIMA enabled an objective comparison between models with initial time series and with the same time series considering atypical data.

One of the objectives of this study was to find similarities between the ARIMA models of Barcelona and Tarragona ports and of the other EU ports in order to find define an Airline model for all EU ports. As there was no exact model, it was interesting to find similarities between all the models with the initial time series and with the same time series considering atypical data.

The importance of Barcelona and Tarragona ports for Catalonia's economy as points of loading and unloading of goods is unquestionable. With this in mind, it is necessary to know whether the course of these ports is similar to that of the other studied ports or whether the Barcelona and Tarragona models can be used for improvement of their strategic plans using information about the other ports or vice versa.

Barcelona and Tarragona ports have defined their own strategic plans, with one of their main goals being to achieve a favorable position not only in the European market but also in the global market. This could be accomplished by saturating their facilities as much as possible. Barcelona port has recently presented the third 2015 - 2020 Strategic Plan whereas Tarragona port is developing its 2008 - 2020 Strategic Plan. Most strategic plans are due in 2020.

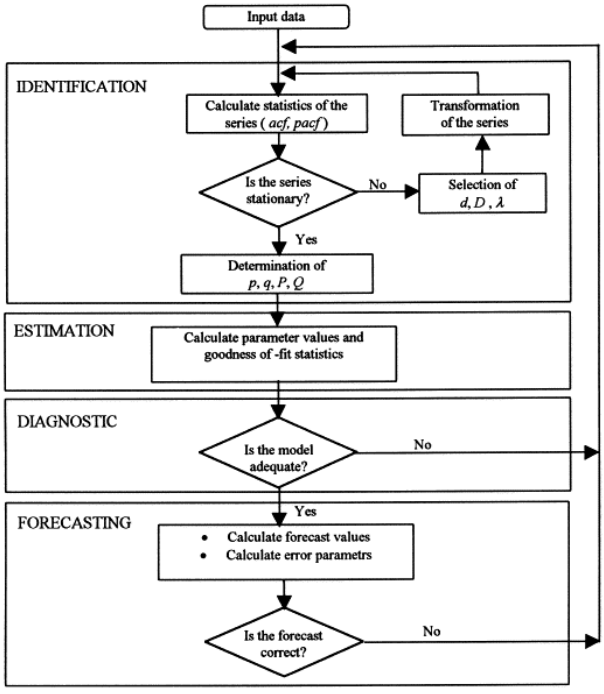
3. Forecasting Models: Arima

Models based on Autoregressive Inputs and Moving Averages are a special part of stochastic processes. Figure 1 shows the construction method of the model with its four main parts: Identification, Estimation, Diagnostic Checking and Forecasting.

Port traffic data was treated with R software. This is one of the most important free statistical software and is extensively used in different scientific fields (Cryer, J.D. and Chan, K-S, 2008).

R software was used to define all the scripts for every port according to its typology and some initial ideas about port traffic data time series (exploration of data and application of all possible transformations).

Figure 1: ARIMA Forecasting Model - Iterative Scheme citepart7-3



Source: Authors

4. Results Of Box-Jenkins Method: Arima Models

The following models are the final results obtained using the Box-Jenkins method to define the most accurate ARIMA model for each port. The first group allows a comparison between Barcelona and Tarragona ports and the other selected ports with initial data and the second one allows the same comparison using atypical data. As said before, the study was conducted in two stages: the first, considering data until December 2008 and the second, considering data until December 2014. Comparison between models 2014 and 2008:

Table 1: Comparison between models 2014 and 2008

	2014	**2008**
Barcelona	$ARIMA(0,1,1)(0,1,1)_{12}$	$ARIMA(3,0,0)(0,1,1)_{12}$
2009-2014	$ARIMA(6,1,0)$	
Tarragona	$ARIMA(2,0,1)$	$ARIMA(5,0,0)$
Valencia	$ARIMA(11,1,0)$	$ARIMA(11,1,0)$
Algeciras	$ARIMA(3,0,1)(0,1,1)_{12}$	$ARIMA(2,0,0)(0,1,1)12$
Genoa	$ARIMA(2,0,3)(0,1,1)_{12}$	$ARIMA(2,0,1)(0,1,1)_{12}$
Taranto	$ARIMA(2,1,0)$	$ARIMA(3,0,0)$
2009-2014	$ARIMA(2,1,0)$	
Bilbao	$ARIMA(5,0,0)(0,1,1)_{12}$	$ARIMA(1,0,2)(0,1,1)12$
Pasajes	$ARIMA(11,1,0)$	$ARIMA(1,0,1)(0,1,1)_{12}$
Dunkirk	$ARIMA(2,1,1)$	$ARIMA(2,0,1)$
2009-2014	$ARIMA(0,0,1)$	
Ghent	$ARIMA(4,0,2)$	No model available
Antwerp	$ARIMA(3,1,0)(0,1,1)_{12}$	$ARIMA(4,0,0)(0,1,1)_{12}$
2009-2014	$ARIMA(11,1,0)$	
Bremen	$ARIMA(0,1,1)(0,1,1)_{12}$	$ARIMA(0,1,1)(0,1,1)_{12}$

The Box-Jenkins methodology considering atypical data could be a useful tool to study time series because it improves data analysis and the forecast ability of the chosen ARIMA model to accurately explain the reality and future of ports.

As will be shown in subsequent sections, it is necessary to have enough information to correctly interpret atypical data considering their values and typology. Several possibilities must be explored to decide on a correct ARIMA model taking into account atypical data and their weight in the new model, i.e. Additive Outliers (AO), Transitory Changes (TC) and Level Shifts (LS).

Sometimes changes in the first steps of the Box- Jenkins method may require a revision of data, e.g. elimination of the seasonal component, resulting in a different definition of the ARIMA models.

5. Discussion

Accurate analysis of the Box-Jenkins method results using port traffic data time series until 2008 and until 2014 for Barcelona and Tarragona ports compared to the other EU ports leads to an interesting discussion about the ARIMA models identified for each port considering all data and also atypical data.

The typology of the ARIMA models obtained in 2008 and 2014 is generally maintained. This is true for the time series finished in 2008 and for the time series finished in 2014, but the situation changes slightly upon consideration of atypical data, especially in the second case.

Table 2: Comparison between models with atypical data 2014 and 2008

	2014	**2008**
Barcelona	$ARIMA(0,1,1)(0,1,1)_{12}$	$ARIMA(3,0,0)(0,1,1)_{12}$
2009-2014	$ARIMA(6,1,0)$	
Tarragona	$ARIMA(2,0,1)$	$ARIMA(5,0,0)$
Valencia	$ARIMA(11,1,0)$	$ARIMA(11,1,0)$
Algeciras	$ARIMA(3,0,1)(0,1,1)_{12}$	$ARIMA(2,0,0)(0,1,1)_{12}$
Genoa	$ARIMA(2,0,3)(0,1,1)_{12}$	$ARIMA(2,0,1)(0,1,1)_{12}$
Taranto	$ARIMA(2,1,0)$	$ARIMA(3,0,0)$
2009-2014	$ARIMA(2,1,0)$	
Bilbao	$ARIMA(5,0,0)(0,1,1)_{12}$	$ARIMA(1,0,2)(0,1,1)_{12}$
Pasajes	$ARIMA(11,1,0)$	$ARIMA(1,0,1)(0,1,1)_{12}$
Dunkirk	$ARIMA(2,1,1)$	$ARIMA(2,0,1)$
2009-2014	$ARIMA(0,0,1)$	
Ghent	$ARIMA(4,0,2)$	No model available
Antwerp	$ARIMA(3,1,0)(0,1,1)_{12}$	$ARIMA(4,0,0)(0,1,1)_{12}$
2009-2014	$ARIMA(11,1,0)$	
Bremen	$ARIMA(0,1,1)(0,1,1)_{12}$	$ARIMA(0,1,1)(0,1,1)_{12}$

Considering the time series without atypical data, the proportion between ports with seasonality and ports without seasonality is the same in 2008 and 2014. However, the level of seasonality decreases between these two years. The situation resulting from this decrease may well be a future trend.

The exact definition of the ARIMA models and their parameters suggest that the seasonal component is becoming increasingly irrelevant, with a clear trend towards disappearance. This means that it may be very difficult to identify the ARIMA model by considering only the seasonal component, regular differentiation or logarithmic transformation. The ACF and PACF graphs obtained by using a combination or either of the three options must be carefully observed, as well as the values of variances (Martí-Recober, M. and Muñoz Gracia, M.P., 2008).

Observation of the port traffic time series considering atypical data shows that the number of ports without the seasonal component has increased and it is more complicated to identify the ARIMA model for the other ports.

It can be verified that an ARIMA model without the seasonal component may have an autoregressive component which can be considered to be long. This type of model is known as long-AR model (Martí-Recober, M. and Muñoz Gracia, M.P., 2008).

Considering the above, studies were conducted for some ports using only port traffic data between January 2009 and December 2014. For example, Barcelona, Taranto, Dunkirk and Antwerp are defined with a model without the seasonal component and with a general predominance of the autoregressive part.

Observation of the atypical data of every port shows that the studied EU ports with atypical data classified as level shifts were more affected by the economic crisis.

The stability of the models according to the Box-Jenkins method for the series finished in 2008 and in 2014 and considering the initial time series and the time series with atypical data for Tarragona, Bilbao and Pasajes ports means that these ports

were less affected by the economic crisis than the others.

The presence of atypical data, especially level shifts with a positive trend, was detected between 1990 and 2000 whereas between 2005 and 2010 level shifts exhibit a clear negative trend. This further evidence of the effects of the economic crisis on Western Europe opens up the possibility to predict future recessions and implement proactive strategies by port authorities and related industries.

Atypical data at the end of port traffic data could make it difficult to correctly identify the ARIMA model (Box et al., 2008), leading to problems with forecasting values and the level of reliability. This was solved by cutting the time series. For example, in this study data between January 2009 and December 2014 were used in some cases.

It is almost impossible to account for every atypical data for all studied ports. Additive outliers are very difficult to explain without a deep knowledge of the history of the port and its port authority. Transitory changes could be explained considering the local geography and economic situation whereas a possible level shift could be regarded as a continuation of a transitory change. Finally, level shifts may be seen as changes with a positive trend, which means an important development of the port, or changes with a negative trend, which indicates a future economic crisis (Martí-Recober, M. and Muñoz Gracia, M.P., 2008). Both possibilities call for corrective actions in the strategic planning to be taken by the port authority in order to deal with the new reality (Box et al., 2008).

Data related to transitory changes located at the end of the time series should be carefully examined. For instance, all the data at the end of 2008 showed a transitory change eventually leading to a level shift which points to an economic crisis in the USA and EU. This change was one of the first signs of the crisis but was overlooked by too many decision makers involved.

No significant conclusions about the geographical situation of the ports could be drawn from the ARIMA models. Apparently, there is no specific relationship between the ports and their position in the Mediterranean or Atlantic area.

No significant conclusions about a possible relation between the typology of ports and their dimensions could be drawn, either. For example, the port of Antwerp has the same ARIMA model for the time series between January 2009 and December 2014 as Pasajes (considering all the time series without atypical data).

6. Conlusions

The study and comparison of port traffic data of Barcelona and Tarragona ports and other selected EU ports using the Box-Jenkins method led to the following conclusions:

1. It is impossible to find a global ARIMA model, like the Airline model, which is able to explain the reality and environment of port traffic data, and therefore to forecast long-term traffic data accurately.
2. Comparison of port traffic data time series using the Box-Jenkins method shows a decrease in seasonality. Moreover, it is sometimes difficult to choose between seasonal time series, time series with regular differentiation and time series with logarithm transformation.
3. The possibility that seasonality and calendar effects will disappear from models in the future has a crucial implication for the future of forecasting and strategic planning. It is obvious that the elimination of seasonality and calendar effects would have a positive effect on port traffic data control and operational needs (e.g. planning of loading and unloading processes).
4. The ARIMA models without the seasonal have been observed to have a long autoregressive part. A clear example of this kind of model is Valencia port. The port authority of this port uses the same model in 2008 and in 2014, with the same results being obtained upon consideration of atypical data.
5. Transparency in the communication policy is a priority for port authorities. This is the only way to have a clear relationship with all social actors involved in a port's daily activities.
6. Strategic planning should facilitate strategic decision making by port authorities to achieve an increase in port traffic data as well as the elimination of seasonality as an extremely positive goal for the future of ports and all companies and social actors involved.
7. The basis of strategic planning must be proactivity as a vital and essential behavior of port authorities and all companies and social actors involved. This is crucial in the short, medium and long term. A mathematic tool like Box-Jenkins method and ARIMA forecasting models can be very useful in this regard since they treat one of the most important indicators for a port, i.e. port traffic data, to evaluate strategic planning management.
8. Atypical data obtained during the application of the Box-Jenkins method should be considered essential by port authorities from the strategic point of view because they can be of help in the decision making process. Additive outliers are less significant than transitory changes and level shifts, but all should be equally considered if their trend is negative. A negative trend may be a reflection of a port's future. This can lead the port authority to take any corrective actions necessary to redirect the course of the port. A clear example of this is 2008 data: observation of these data enables a fast detection of the economic crisis that is still affecting Western Europe.

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