Case Study: Tourist Segmentation And Proposed Architecture

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Presentation Outline

- Neural Network Models
- Neural Network Models in Business and Economic Modelling
- Tourist Segmentation based on Political Instability
- Results
- Conclusions and future work

Neural Network Models

- An information-processing paradigm, which attempts to **mimic certain processing capabilities of the brain** with a distributed structure of the information processing system.

- Basic element is the node - a self-contained processing unit characterized by input, activation and output functions and a set of weighted connections with other nodes.

- **Supervised learning** – based on the difference between the desired and actual output of the network. Error Back-propagation algorithms allows propagation of the output error throughout the network and proportional adjustment of the weights

Neural Network Models

- **Analytical Power -** sophisticated non-linear modelling techniques make them capable of modelling extremely complex research functions.

- **Learning -** can be applied in cases where the form of the function is not known. **Training algorithms automatically learn the structure of the data**.

- **Generalization and Noise tolerance -** After successful training, a neural network is able to generalize in processing novel data, as well as adequately processing noisy input data which includes some level of error.

Neural Network Model in Business and Economic Modelling

- In economic data modelling the aim is to find "**relationships among economic entities such that the data sample at hand is approximated as well as possible and that new observations will be predicted accurately**".

- Although the neural networks approach is still regarded by many as a novel methodology, its practical application and use in business related applications are indicators that it has matured as a scientific methodology to the point of offering real practical benefits .

- Have a potential as a powerful tool for strategic planning and decision-making. Production/operations, finance, marketing/distribution and information systems are among the most popular application areas.

Neural Network Model in Business and Economic Modelling

- In the cases where non-linear patterns and discontinuities exist in the dataset, neural networks can be considered as an alternative to the existing parametric methodology of economic modelling.

- Neural networks “are a useful extension to the econometrician’s toolbox, but they do not replace established econometric modelling and inference techniques”.

Neural Network and Tourism Demand Analysis

- Several comparative studies outline the advantages in applying NN models

- Typical characteristics of tourism time series:
  - high degree of non-linearity
  - seasonality
  - general upward trend.

Modelling the Impact of Political on Tourism

- Attempt to extend the existing models by integrating the dimensions of political instability within a tourism demand model

- To investigate empirically the cause and effect relationships between political instability and tourism (for selected Mediterranean destinations).

Data

- Data availability, reliability of the data sources and quantification of the indicators.
- Tourist destinations: Cyprus, Greece, Israel and Turkey - a good level of diversity in terms of political instability phenomena
- Examination of the model under different (extreme) conditions and observation of different phenomena, e.g. structural breaks, seasonality, upwards trends.

Data Sources

- Tourism arrivals (from countries' NTOs)
- Income, Exchange rates, Price of Oil, Consumer Price Index
  - MIMAS database
  - State statistics departments
- Political instability indicators (from POLINST database – encoded data of all cases of political instability in the Middle East – Mediterranean region for the period 1977 – 1997)

Modelling the Impact of Political on Tourism

$$Y = f(\text{INC}, \text{ER}, \text{PO}, \text{CPI}, \text{F1pol}, \text{F2pol}, \text{F3pol}, \text{F4pol}, \text{F5pol}, \text{F6pol}, \text{F7pol})$$

Y	=	number of tourist arrivals at the destination
INC	=	average per capita income of tourists for five major European tourism generating countries
ER	=	foreign exchange rate (national currency/US$)
PO	=	price of oil
CPI	=	consumer price index at the destination as a proxy to the cost of living at the destination
F1pol,…,F7pol		denote the factors of political instability extracted from POLINST dataset.

Pre-Processing of Data

The dependent variable (tourist arrivals) as well as the first four explanatory variables (Exchange Rate, Consumer Price Index, Price of Oil, Income) were normalised with respect to the mean value of each variable.

the normalization of the tourist arrivals for month i ($i = 1,\ldots,12$) in year j ($j = 1, \ldots,21$):

$$Y_{norm}^{i,j} = \frac{Y^{i,j} - Y^{i,j-1}}{Y_{mean}^{i}}$$

where Y_{mean}^{i} is the average number of arrivals for month i ($i = 1,\ldots, 12$).

Pre-Processing of Data

For the factors of Political Instability (UK, Germany, POLINST) the normalisation procedure was based on the maximum value of each factor (variable) and reflected the absolute value of each variable for a particular month:

$$F_{norm}^{i,j} = \frac{F^{i,j}}{F_{\max}^{i}}$$

where $F_{\max}^{i}$ is the maximum value of the political instability factor for month i ($i = 1,\ldots, 12$).

Pre-Processing of Data

- Such normalization of the dependent variable tackles implicitly the problem of seasonality in tourism.
  - The model deals with the change in the number of tourist arrivals for a particular month compared to the same month in the previous year.

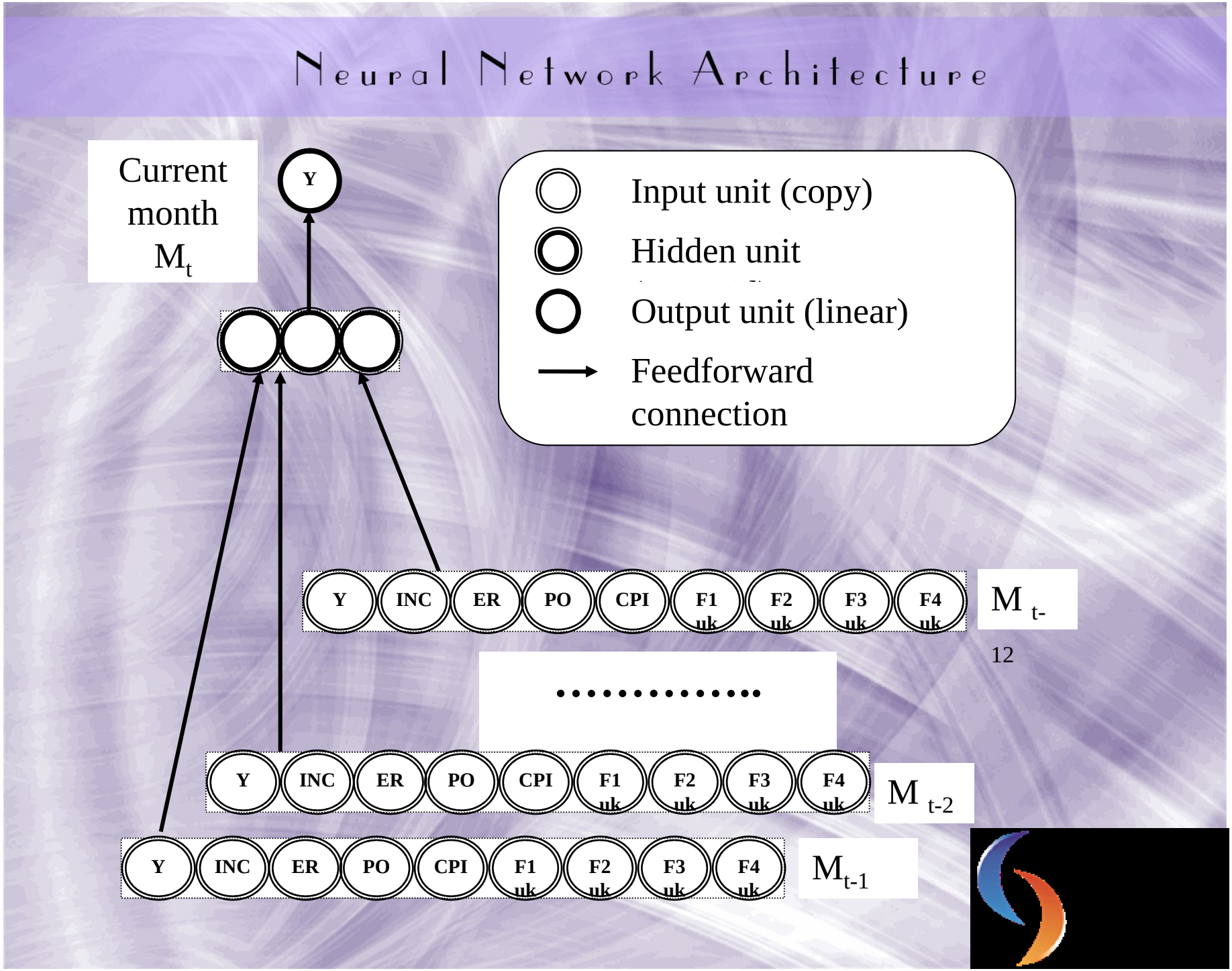
- In contrast, if the change over the previous month is used, which is a common practice, any periodic fluctuations will have to be explicitly calculated by the model.

Time Series Processing With Neural Networks

- **Sequential processing with recurrent neural networks**
  - Appropriate if the time lag is dynamic or cannot be estimated a priory
  - The recurrent layers of the network carry on the information from past time steps

- **Sliding time window**
  - assumption that the time series depend on explanatory variables and previous values of the dependant variable from a finite number of time steps in the past.
  - Having in mind the seasonal character of tourism, such an assumption could be justified. In such cases, a time window covering 12 months is an appropriate solution.

Neural Network Architecture



Neural Networks Models of The Impact of Political Instability on Tourism

What is the change in the number of tourist arrivals, given its change for each of the last 12 months, the change in the explanatory economic indicators for each of the last 12 months and the relative number of political instability events that happened in each of the last 12 months?

Training and Test

- **Separate NN for each set of political instability factors (i.e. Germany, UK and POLINST) and each of the countries being modelled (i.e. Cyprus, Greece, Israel, Turkey).**
- **Test set**
  - data for years 1980, 1990, 1995, 1996 and 1997,
- **Training set**
  - the data for the rest of the years.
- **Examination of the model**
  - at the beginning, the middle and the end of the observed period.
  - the extreme cases, such as structural breaks.

Evaluation

- **mean absolute percentage error (MAPE)**

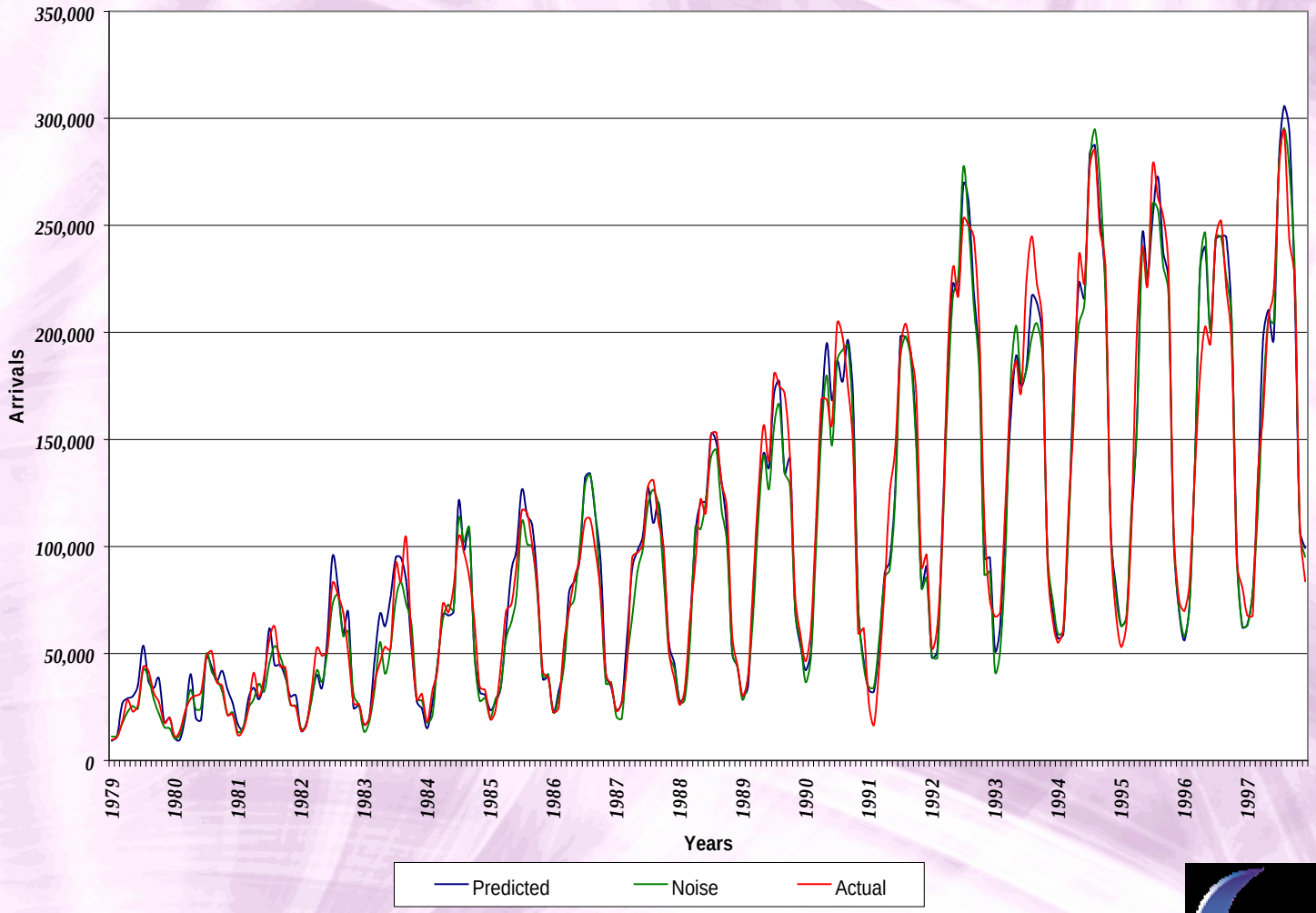
$$MAPE = \frac{\sum_{i=1}^{n} \frac{|X_i - Y_i|}{Y_i}}{n} * 100\%$$

- **normalised correlation coefficient (*r*)**

$$r = \frac{\Sigma_{i=1}^{n}(X_i * Y_i)}{\sqrt{\Sigma_{i=1}^{n}(X_i)^2 * \Sigma_{i=1}^{n}(Y_i)^2}}$$

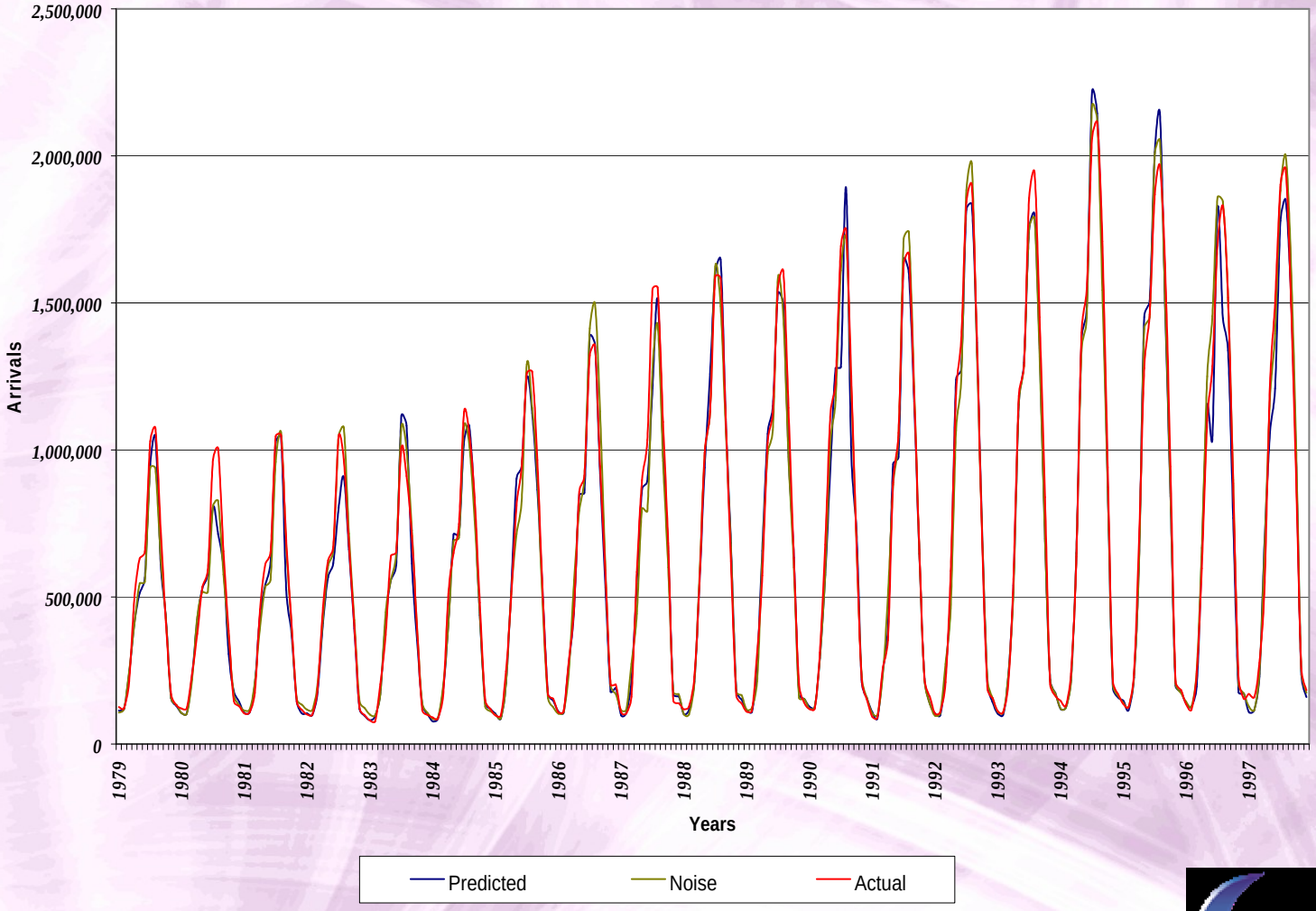
where X_i and Y_i represent the estimated and actual tourist arrivals for i = 1,…,228.

Neural Network Prediction For Cyprus- Factors From POLINST Database



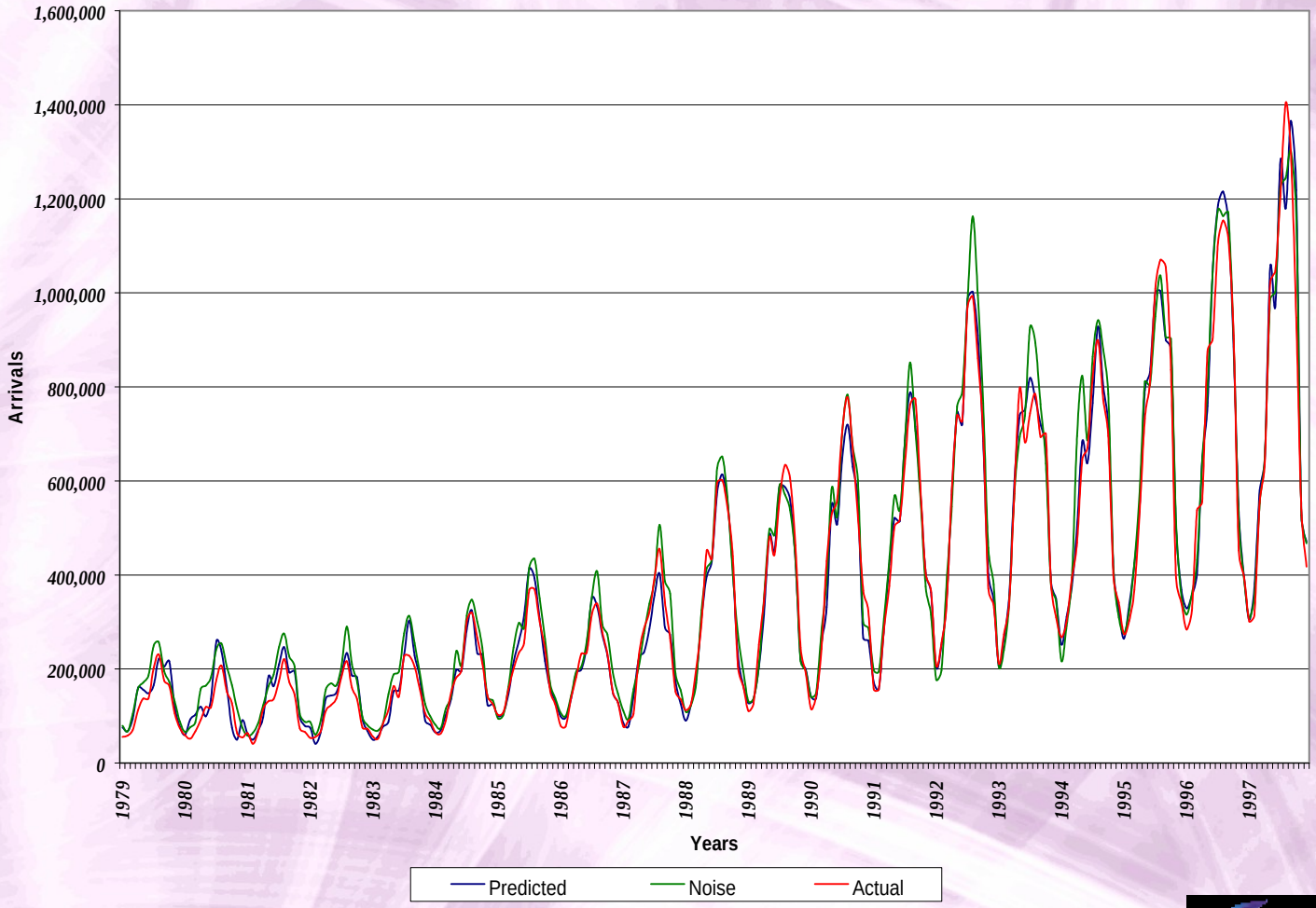
	MAPE (%)	r
Predicted	11.6254	0.9950

Neural Network Prediction For Cyprus- Factors From POLINST Database



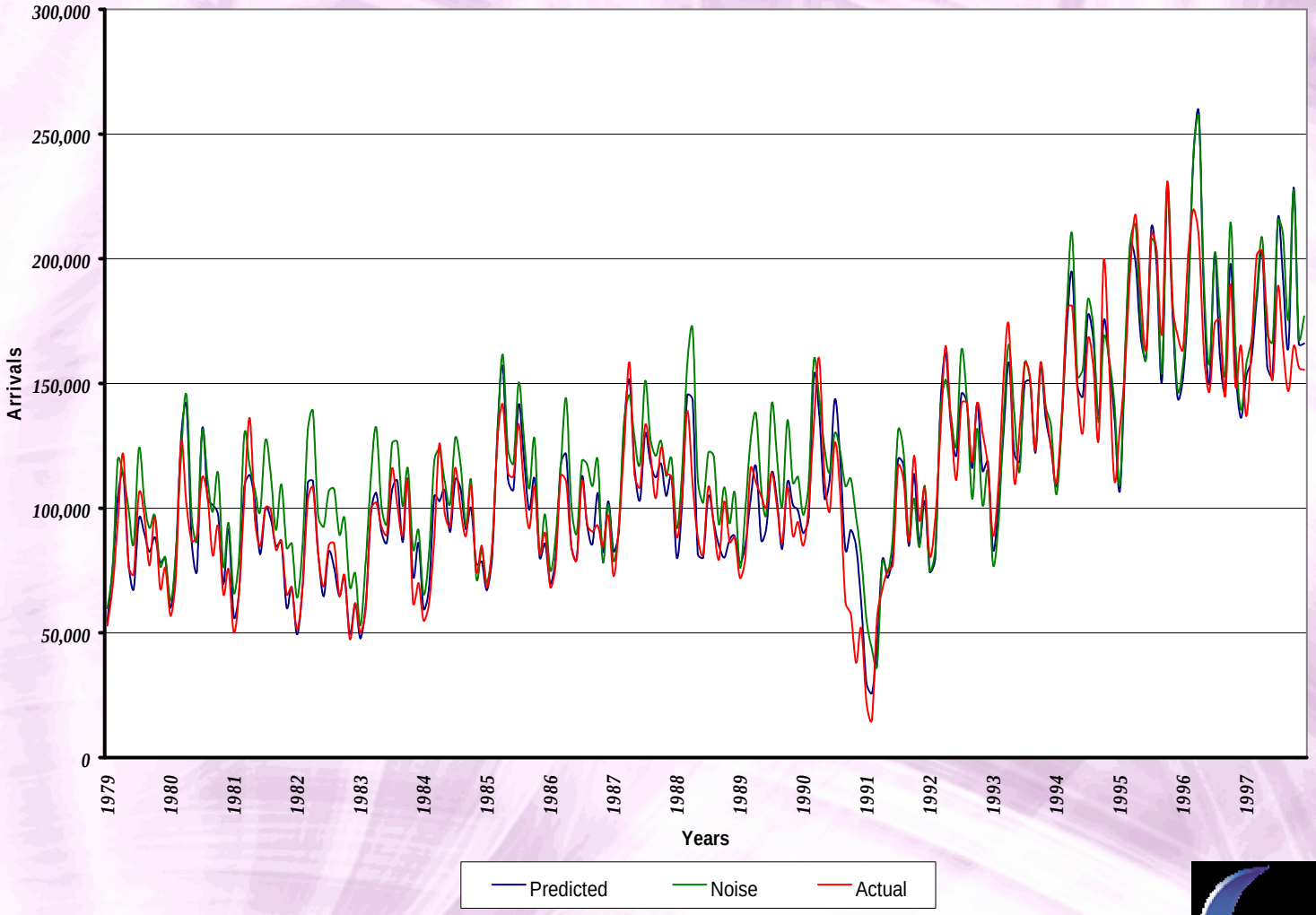
	MAPE (%)	r
Predicted	8.6018	0.9955

Neural Network Prediction For Cyprus- Factors From POLINST Database



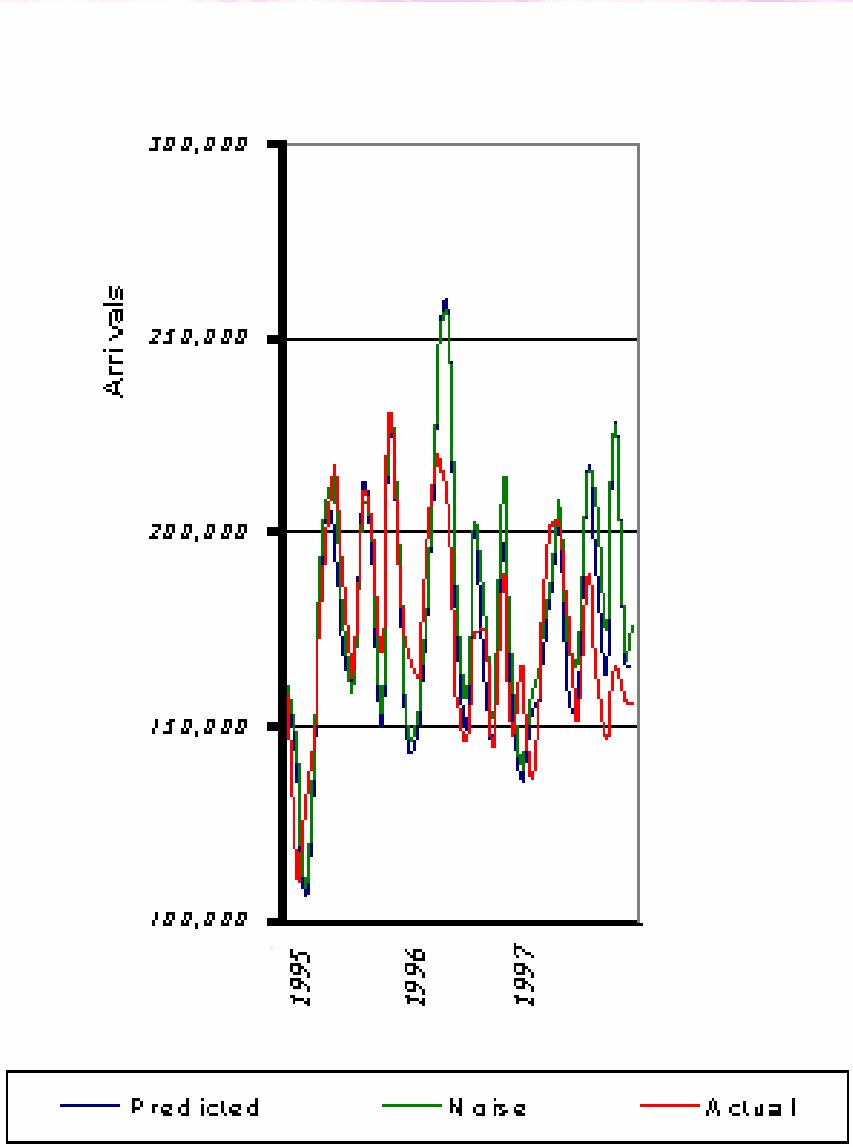
	MAPE (%)	r
Predicted	10.9796	0.9955

Neural Network Prediction For Cyprus- Factors From POLINST Database



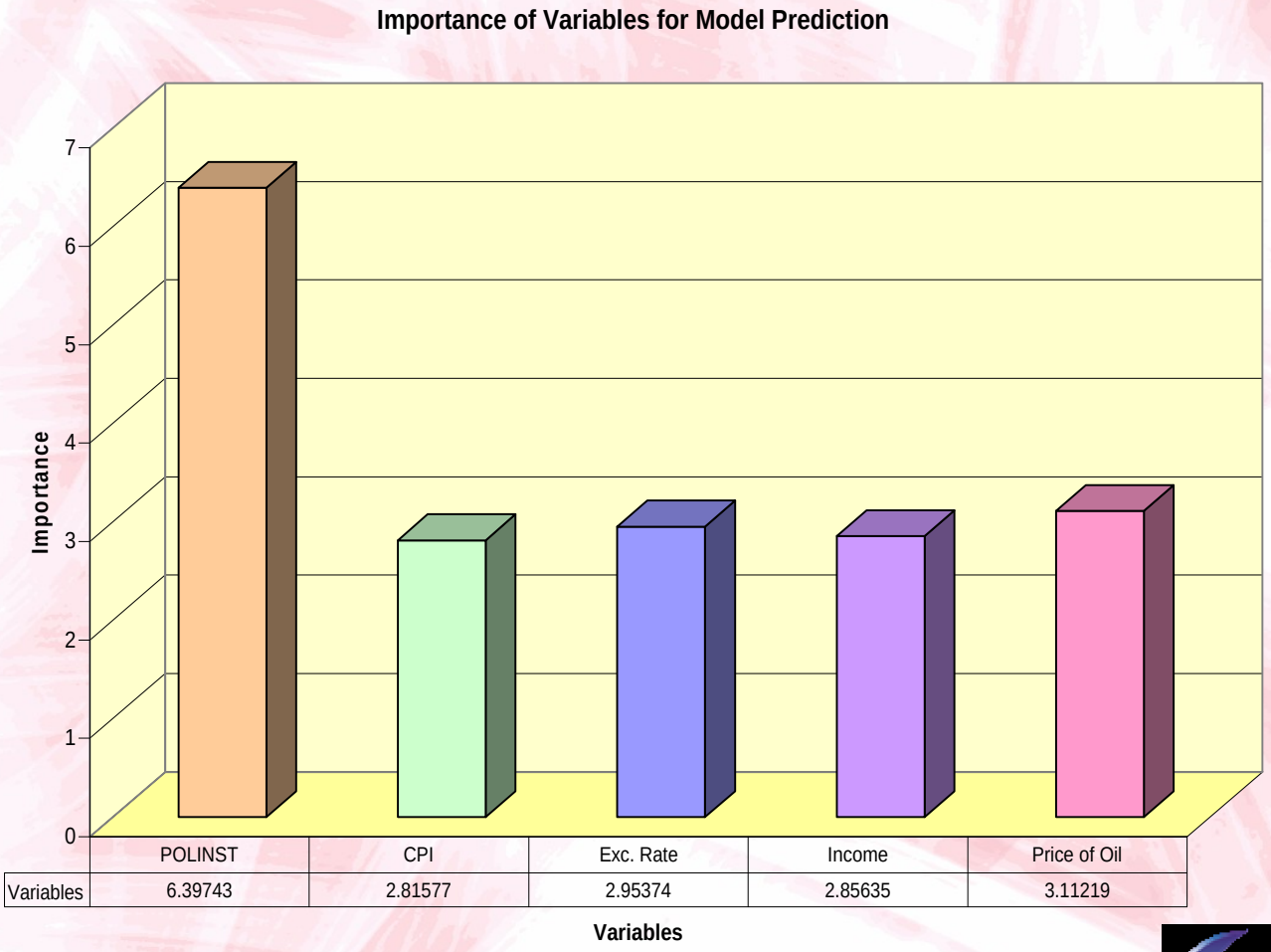
	MAPE (%)	r
Predicted	8.3942	0.9947

Neural Network Prediction For Cyprus- Factors From POLINST Database

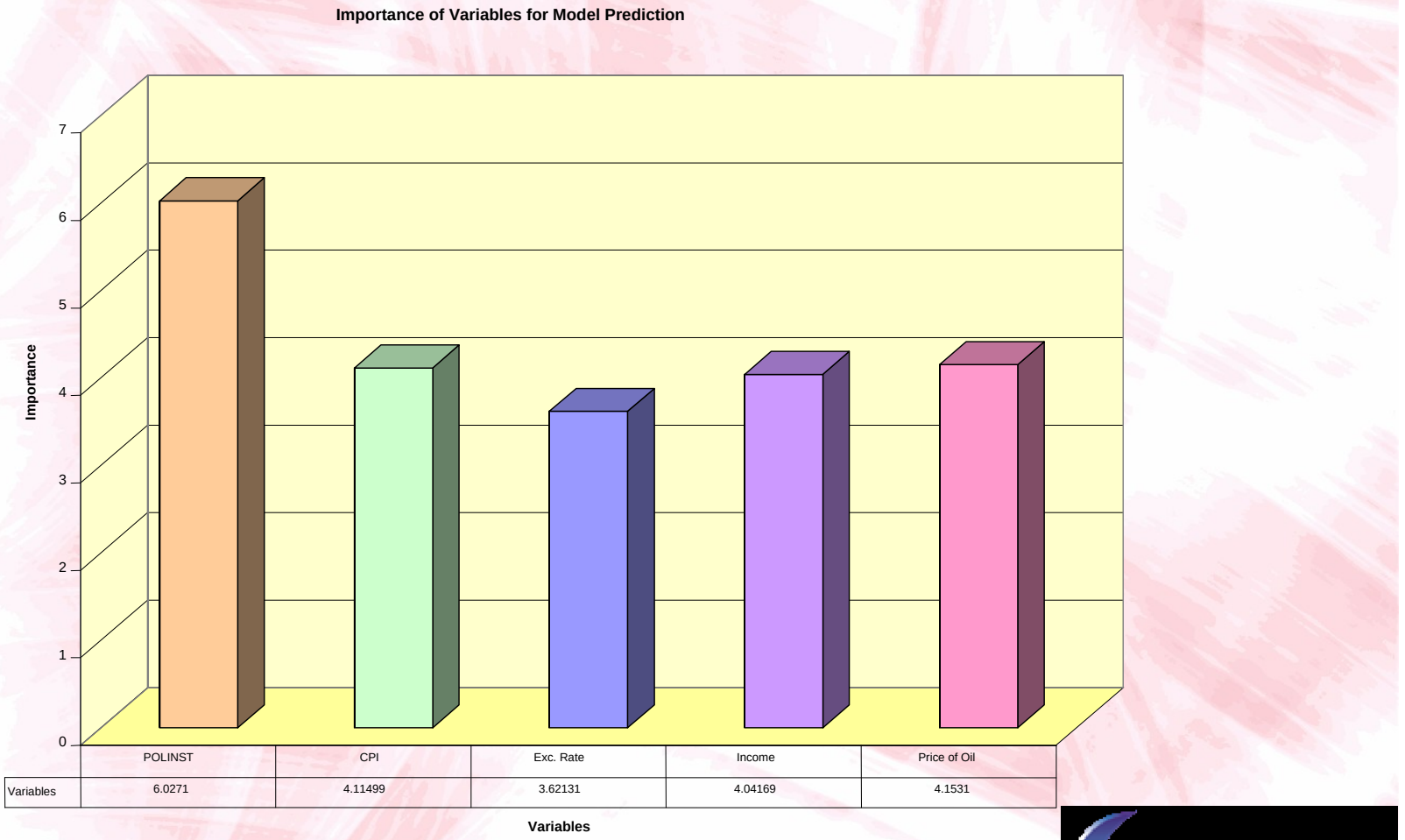


Test years 1995 - 1997

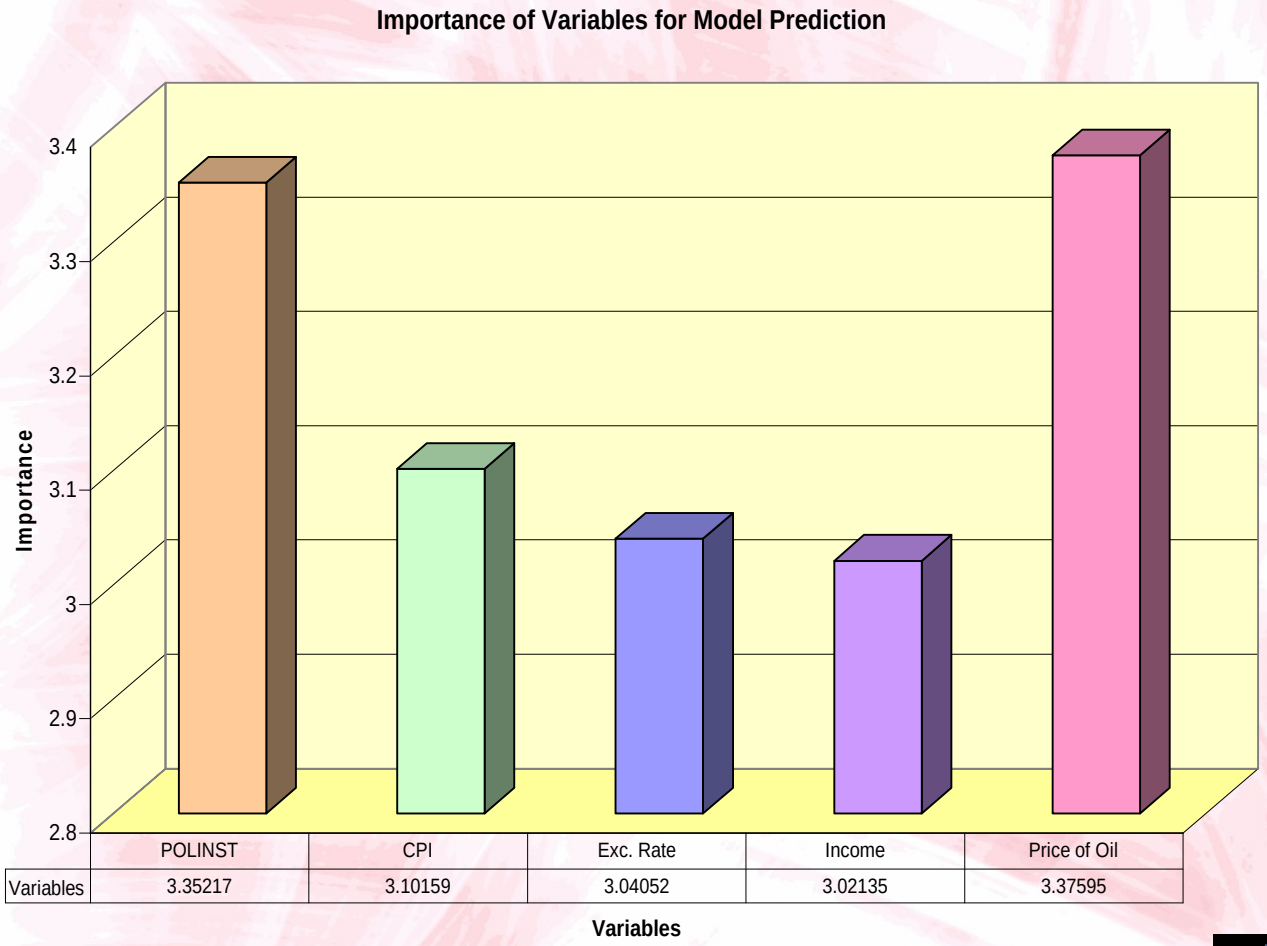
Israel- Importance of Variables For Model Prediction



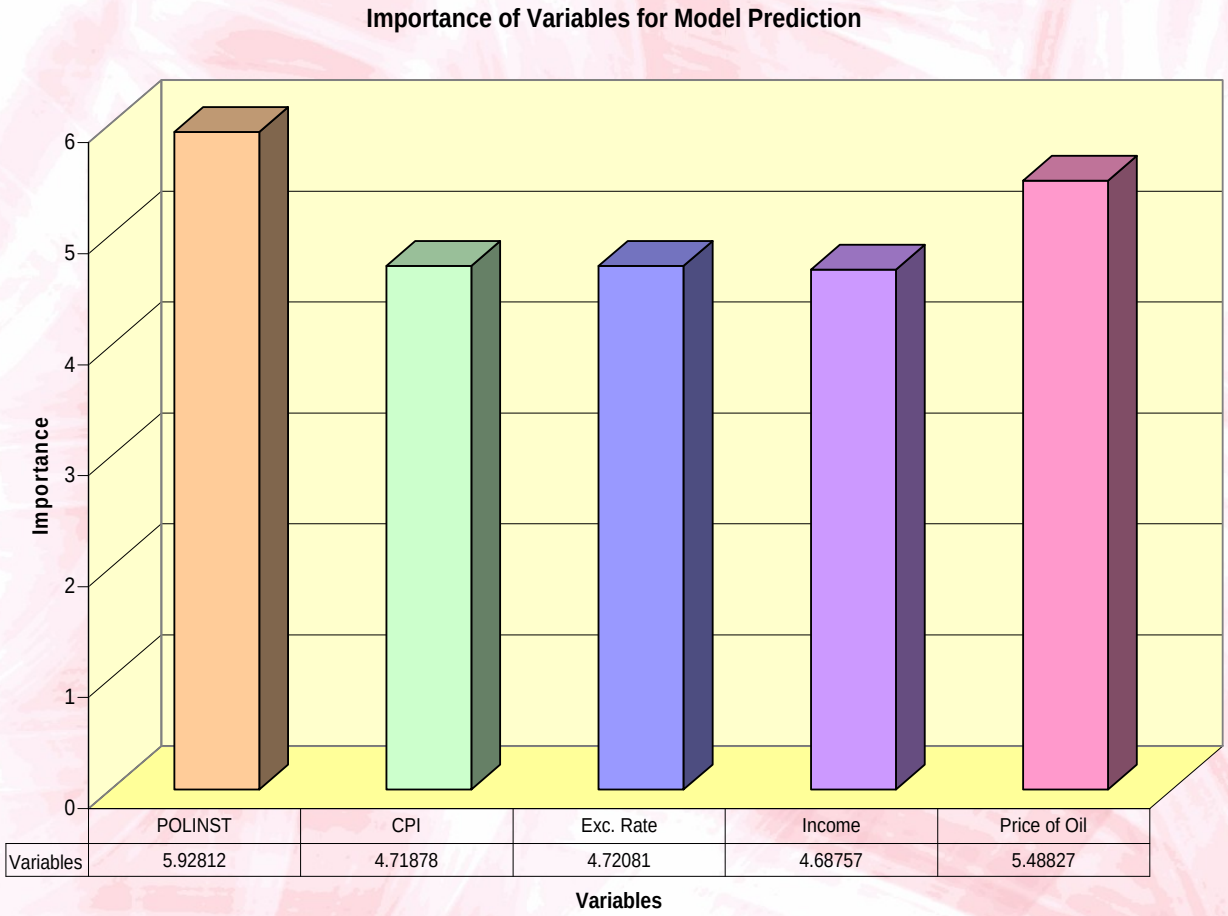
Turkey- Importance of Variables For Model Prediction



Greece- Importance of Variables For Model Prediction



Cyprus- Importance of Variables For Model Prediction



Conclusion

- Neural Networks
  - have the analytical power to provide accurate predictions
  - have the flexibility to incorporate various forms and types of independent variables that might be present in a tourism demand function.
  - can process non-linearly separable data, seasonality, structural breaks in time series, etc.

Conclusion

- Events of political instability can have strong influence on the tourism industry.

- The presented series of experiment revealed further details on the inter-relationship between the political instability factors and the number of tourist arrivals.

- To the best of our knowledge, the presented study is the first successful attempt to model the relationship of political instability and tourism in a neural networks analytical framework.

Conclusion

- The consequences of political instability events (terrorism in particular) in the last few month have shown that the close monitoring, assessment and evaluation of its impacts are vital for tourism policy makers in order to develop and/or readjust their business policies.

- The model presented here is a contribution towards a valuable assistance of a reliable and valid long term strategic planning.