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The advanced forecasting information system PYTHIA: An application in real estate time series

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An application in real estate time series

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Abstract

Purpose – The main scope of the paper is to demonstrate the capabilities of PYTHIA forecasting platform, to compare time series forecasting techniques, which were used to forecast mortgage loans in UK, and to show how PYTHIA can be useful for a bank.

Design/methodology/approach – The paper outlines the methods used to forecast the time series data, which are included in PYTHIA. Theta, the time-series used to forecast average mortgage loan prices, were grouped in: all buyers – average loan prices in UK; first-time buyers – average loan prices in UK; and home-movers – average loan prices in UK. The case of all buyers – average loan prices in UK, was presented in detail.

Findings – After the comparison of the methods, the best forecasts are produced by WINTERS and this is maybe due to the fact that there is seasonality in the data. The Theta method comes next in the row and generally produces good forecasts with small mean absolute percentage errors. In order to tell with grater certainty which method produces the most accurate forecasts we could compare the rest error statistics provided by PYTHIA too.

Originality/value – The paper presents the PYTHIA forecasting platform and shows how it can be used by the managers of a Bank to forecast mortgage loan values. PYTHIA can provide the forecasts required by practically all business situations demanding accurate predictions. It is designed and developed with the purpose of making the task of managerial forecasting straightforward, user-friendly and practical. It incorporates a lot of knowledge and experience in the field of forecasting, modeling and monitoring while fully utilizing new capabilities of computers and software.

Keywords Financial forecasting, Information systems, Real estate

Paper type Research paper

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1. Introduction

The main scope of the paper is to demonstrate the capabilities of PYTHIA forecasting platform and to compare time series forecasting techniques that were used to forecast

mortgage loans in UK. One of the methods used is the Theta method, introduced by Assimakopoulos and Nikolopoulos (2000, 1999) and presented thoroughly in previous papers (Pagourtzi *et al.*, 2007, 2006) as part of the Theta Forecaster application (Assimakopoulos and Nikolopoulos, 2001).

The paper also analyzes the recent trends concerning the mortgage market in UK, shows how the loan forecasts provided from PYTHIA can be useful to a Bank and compares the two forecasting applications developed at our Unit, PYTHIA that we present here and Theta Forecaster presented in previous papers (Assimakopoulos and Nikolopoulos 2001, Pagourtzi *et al.*, 2007, 2006).

The tool used to provide the forecasts, PYTHIA, is a forecasting platform designed and developed at the Forecasting Systems Unit of National Technical University of Athens. PYTHIA aims mainly at managers, as it provides managerial forecasting that includes data analysis and adjustments, budgets, long-term forecasts, monitoring, reporting, etc. It includes the Theta method and several others, well-established forecasting methods. The main feature of the Theta method is that it applies different techniques to deal with sort-term and long-term forecasts and allows giving different weights in the sort and long-term components (Assimakopoulos and Nikolopoulos, 2000, 1999). PYTHIA allows the combination of two or more techniques, which in many cases produces better forecasts than using a stand-alone method (Clemen, 1989).

The loans time series used for the forecasts cover the categories of all buyers, first-time buyers and home-movers. Data is organized in quarters, from the first quarter of 1979 up to the first quarter of 2007. The mortgage loan data was found from the Council of Mortgage Lenders (CML), the trade association for the mortgage lending industry, the members of which account for around 98 percent of UK residential mortgage lending (www.cml.org.uk/cml/about/).

The aim of the CML is to help to foster a favorable operating environment in the UK housing and mortgage markets. It is the representative voice for the residential mortgage lending industry, and the central provider of economic, statistical, legal, research and other market information. Its members are banks, building societies and other mortgage lenders. The CML also has associates, drawn from a variety of related businesses, including lawyers, conveyancers, search companies and management consultants.

2. UK mortgage market overview

The UK economy grew more strongly than expected in 2006 (CML, 2006). The annual rate of growth of gross domestic product increased from 1.8 percent at the start of the year to 2.6 percent by the end. Consumer price inflation was above the government's target of 2 percent from the spring onwards. Growing concern about inflation, particularly around the end of the year, led the Bank of England to increase the official bank rate by a quarter-point twice in 2006, in August and November (and again in January 2007). At the end of January 2007, the rate stood at 5.25 percent, its highest level for almost six years.

Despite rising borrowing costs, the housing market was substantially stronger than predicted early in 2006. Property sales were around 16 percent higher than in the preceding year, and annual house price growth strengthened from around 4 percent at the start of 2006 to 9 percent by the year-end (Figures 1 and 2). The high price of property relative to incomes did not constrain the market as much as we thought it would.

Competition between lenders put downward pressure on margins, reducing some of the impact of higher interest rates for borrowers. And changes to lending policy, including increasing use of measures of affordability rather than income multiples, continued to make home-ownership accessible to a wide range of people, despite rising property prices and interest rates.

The main reasons for the strength of the housing market were the stronger-than expected performance of the economy as a whole and the underlying strength of demand for housing, with the number of households rising much faster than the supply of available homes. Excluding the buy-to-let sector – which proved to be even more buoyant than the mainstream market – the number of loans for house purchase grew by 12 percent in 2006. Loans to first-time buyers and movers increased by 12 and 13 percent, respectively.

Across the UK as a whole, mortgage lending remained strong throughout 2006, and we recorded a succession of record monthly totals. Gross lending totaled £346 billion for the year, 20 percent higher than the £288 billion lent in 2005. Growth was driven largely by a combination of rising property prices and sales. The value of remortgaging increased by 7 percent during the year, but the number of home-owners pursuing this option fell by around 2 percent. The number of borrowers remortgaging with new lenders has now been falling since 2003, perhaps reflecting the pursuit of more successful strategies for retaining existing customers by lenders.

Net lending totaled £111 billion for the year, compared to £91 billion in 2005. At the end of 2006, outstanding mortgage debt was growing at an annual rate of more than 11 percent, compared to 10 percent the year before – a successful, buoyant operating environment for the mortgage industry (Figure 3).

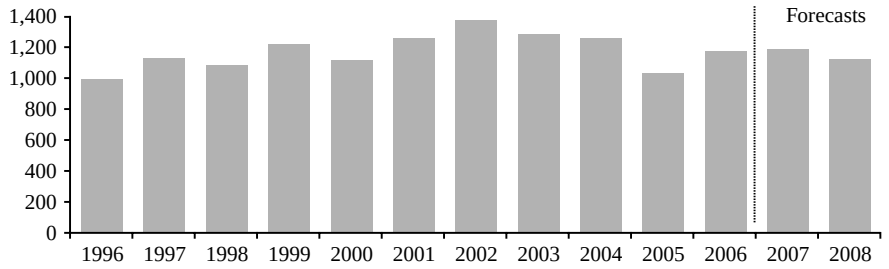


Figure 1.
Property sales, thousands

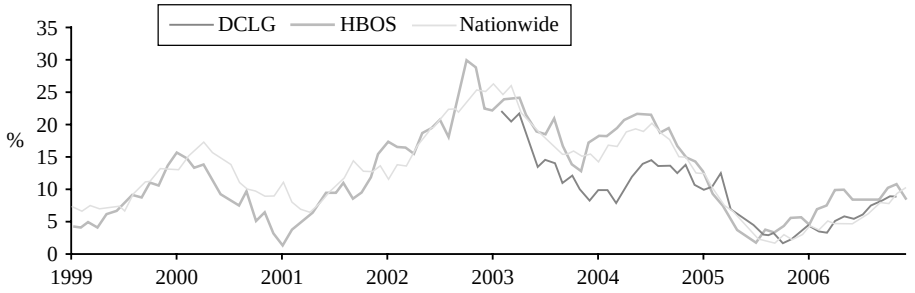


Figure 2.
House prices, annual percent increase

The buy-to-let market continued to grow strongly in 2006 – indeed, more strongly than the mainstream market. Gross advances in the sector totaled £38 billion, accounting for 11 percent of all mortgage lending. The expansion of buy-to-let has been the biggest factor in the revival of private renting, now enjoying a resurgence after decades of decline. Figure 4 plots the growth of the private rented sector in recent years and shows that around a quarter of properties in this sector are now funded by a buy-to-let mortgage.

The number of mortgages in arrears of more than three months fell by 7 percent in 2006 to 104,000 at the end of the year, surprising a number of commentators who had been predicting a significant increase. But the number of properties taken into possession was higher than expected, at 17,000. Part of the reason for increasing possessions, however, was that their numbers had declined to such historically low levels in the period from 2003 to 2005.

3. PYTHIA: business forecasting application

PYTHIA is basically aimed at practicing managers (at the level of financial directors, product managers, production/inventory managers and planners/analysts) and it is designed and developed with a single purpose in mind, that of making the task of managerial forecasting as straightforward, user-friendly and practical as possible. PYTHIA is designed and built to satisfy four objectives:

(1) Any manager, without a technical/statistical background, should be able to use it easily and intuitively.

(2) Since practically all data contains "systematic noise" from external sources, the user should be able to identify and adjust his/her data in a simple, straightforward manner.

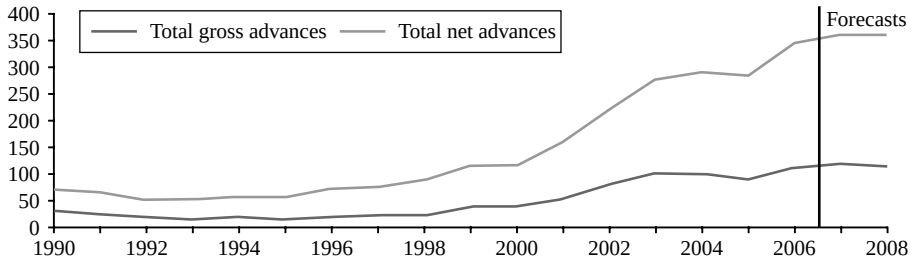


Figure 3.
Gross and net advances, £ billion

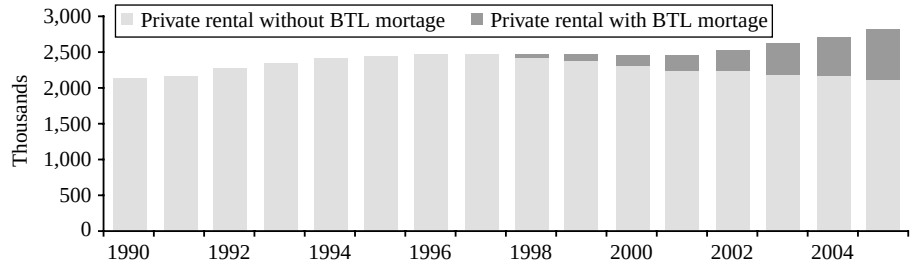


Figure 4.
Private sector rental housing stock, with and without a buy-to-let mortgage

(3) Information about the data and the forecasts should be readily available to the user who should, in addition, be able to input his/her knowledge and experience into such forecasts by incorporating judgmental knowledge and/or budgetary and other objectives in order to improve the accuracy of the statistical methods.

(4) Human forecasters are often overoptimistic while also including their own biases into their forecasts. Forecasters are, therefore, given comparative information about the accuracy of their own forecasts, in comparison to the statistical ones, in order to identify systematic biases and correct them in the future when forecasting again.

PYTHIA is made up of seven modules each focusing on a particular aspect. PYTHIA also utilizes a wizard which advises the user about ways of adjusting his/her data and the best module to utilize. Those modules and the wizard are briefly presented in following:

- *Data analysis and adjustments.* All data is influenced by external events and/or actions (strikes, extreme weather conditions, promotions/advertising, big price changes, etc. and even recording or other mistakes) that "corrupt" past patterns and established relationships. For this reason they need to be adjusted. The first module of PYTHIA recommends to the user ways of adjusting his/her data before forecasting. In addition, to the usual adjustments (trading/working days, missing values, outliers) PYTHIA also provides the option for adjusting for special events/actions (SEA) that usually exert a significant influence on sales/revenues and greatly affect the accuracy and reliability of forecasting that is based on such data. When data adjustments are made they are kept and are subsequently utilized by all modules.
- *Budgets.* PYTHIA makes available forecasts for the entire company, each division, country/geographical area, major product category, product and item. It also allows forecasting using a bottom-up approach, or basing its predictions at any specified level of aggregation. Consequently, the person in charge can modify the statistical forecasts to incorporate judgmental information and/or budget objectives. Once the adjusted forecasts are finalized they can be allocated proportionally to all categories below, or in some precise manner specified by the user.
- *Production/inventory.* Many organizations require many thousands of forecasts on a monthly, weekly or, in some cases, even daily basis. These forecasts need to be produced automatically, efficiently and as accurately as possible. PYTHIA supplies such forecasts in a mechanical manner when and where they are needed. It also provides an option to resolve the difference between bottom-up and aggregate forecasts, including judgmental and/or target adjustments, and allocates possible differences proportionally or according to the preferences of the user.
- *Long term.* Predicting long-term trends and estimating growth rates requires different methods and considerably more assumptions as environmental, competitive and technological changes affect long-term trends. This module provides information and advice about making long-term predictions while presenting information about their accuracy and reliability.

- *Estimating relationships.* The above modules deal with time series forecasting while the present module allows for the estimation of relationships based on multiple regression. In addition to such estimation it also provides pertinent information that can be used for forecasting purposes and for getting a better understanding of the factor driving changes in the future.
- *Monitoring.* Past patterns and established relationships can and do change invalidating the forecasts that inevitably are based on the extrapolation of such patterns and the continuation of relationships. The Monitoring module continuously checks for the difference between the actual and predicted values and provides a warning signal when such differences (i.e. the forecast errors) cease to be random. In such a case the user can re-forecast and/or take appropriate actions, if needed, to correct the situation.
- *Reporting.* PYTHIA supplies detailed reporting information on all aspects of data analysis and forecasting while also showing detail information about the accuracy of different types of predictions (original data without adjustments, adjusted data, statistical forecasts, judgmental overrides, budget objectives, and final forecasts). The reports can be customized and are exported in an Excel sheet for further usage.
- *Wizard.* PYTHIA uses a wizard which advises the user about ways of adjusting his/her data and the best module, from those listed above, to utilize. Once such a module has been selected, PYTHIA analyzes the available data, informs the user on their characteristics and selects the most appropriate method for such data with the objective of improve forecasting accuracy and efficiency. Expert users can override the suggested method and/or modify its utilization according to his/her preferences.

Some of the main screens of PYTHIA are indicatively presented in Figures 5-21. The example used and shown in the figures is forecasting sales of microsoft products.

4. Case study

4.1 Using PYTHIA at a bank

As we said previously, PYTHIA can provide the forecasts required by practically all business situations demanding accurate predictions. Since the data we use in this paper comes from mortgages in UK, it would be very useful to a bank. A bank would be interested to forecast time series concerning mortgages such as the average value of loans, the number of loans, the value of loans in total, the average advance of loans, etc. By taking into account this data, the bank could design its future products concerning loans, and be also able to make appropriate adjustments.

Within the bank, PYTHIA can be also used by financial directors at headquarters to set their budgets based on growth objectives as well as forecasting established trends by major product category, by country (in the case of multinational banks), by major customer or any other desired clarification. Country managers can prepare their own budgets (also based on the targets set by headquarters and local trends) and submit them to headquarters for approval, while product managers can prepare estimates for the sales of their own products.

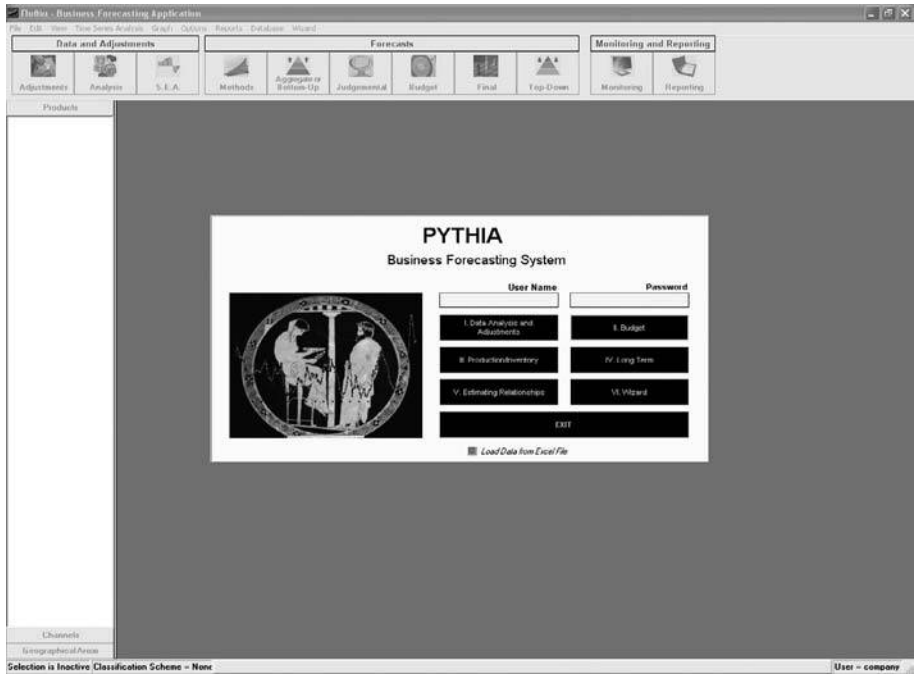


Figure 5.
PYTHIA logging in

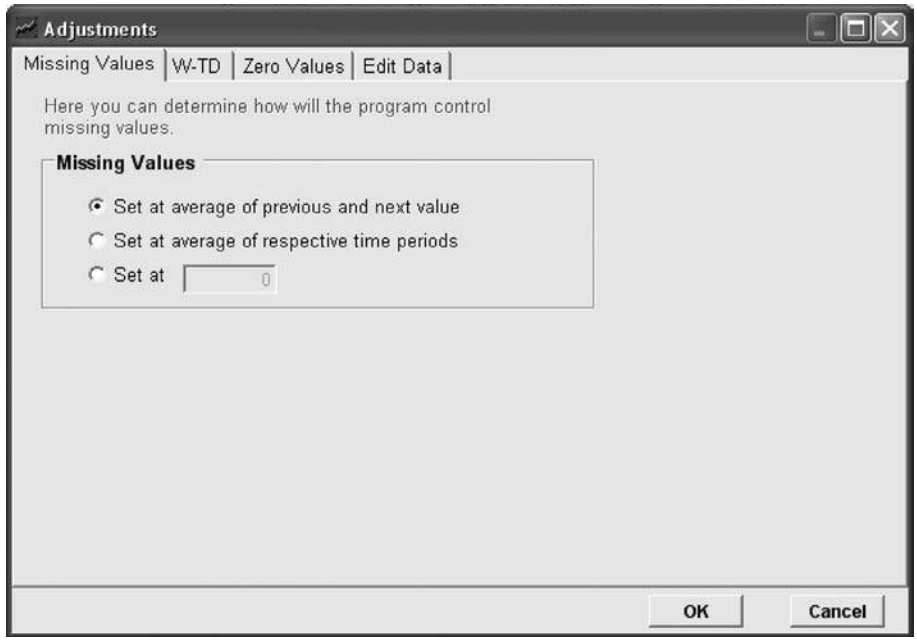


Figure 6.
Adjustments – missing values

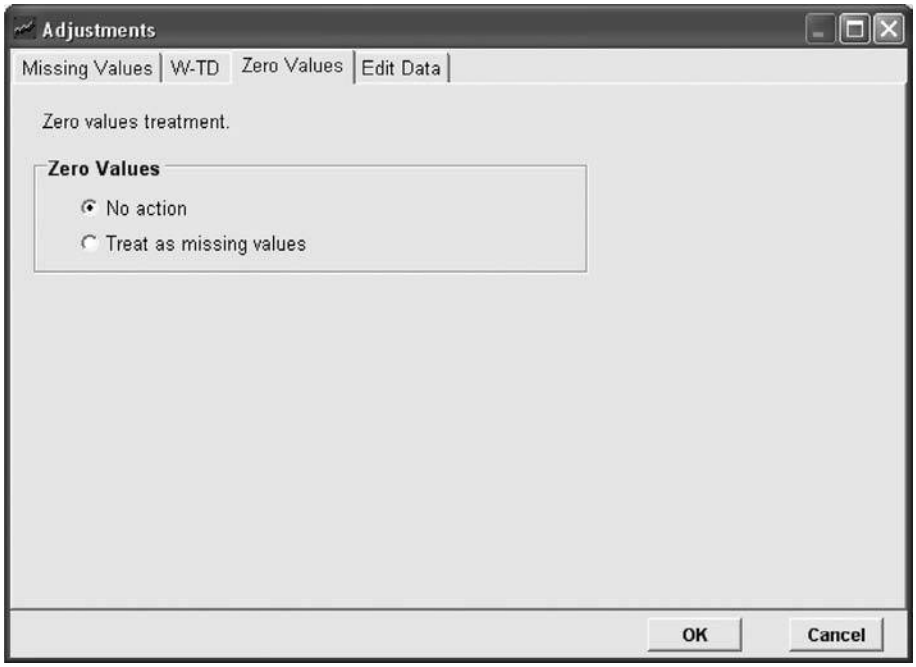


Figure 7.
Adjustments – zero values

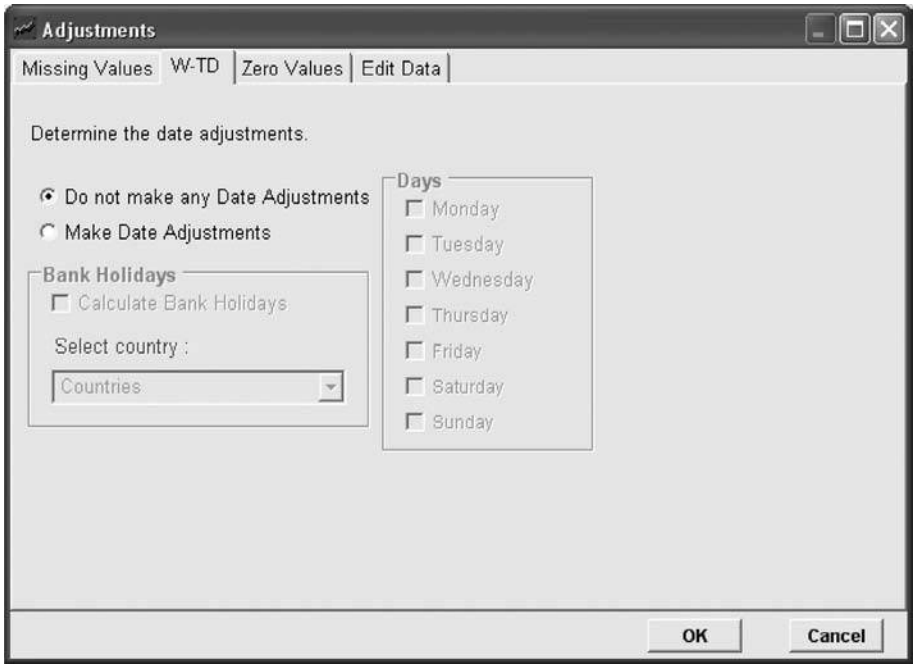


Figure 8.
Adjustments – working and trading days

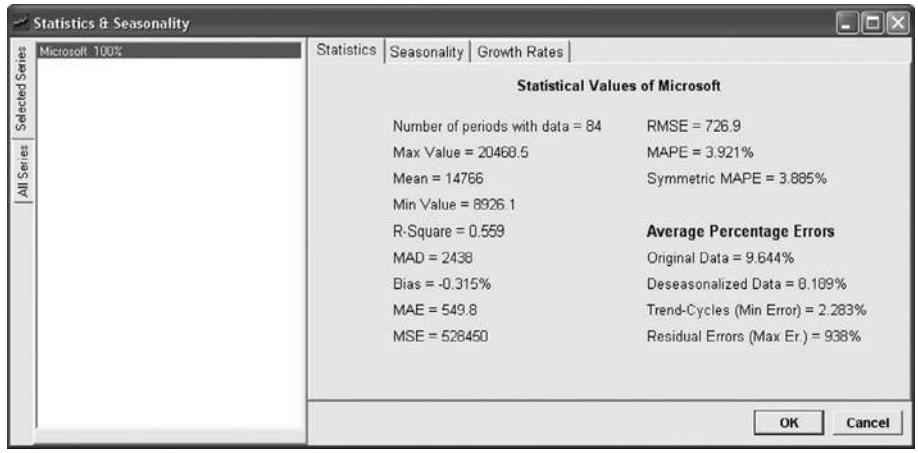


Figure 9.
Statistic analysis

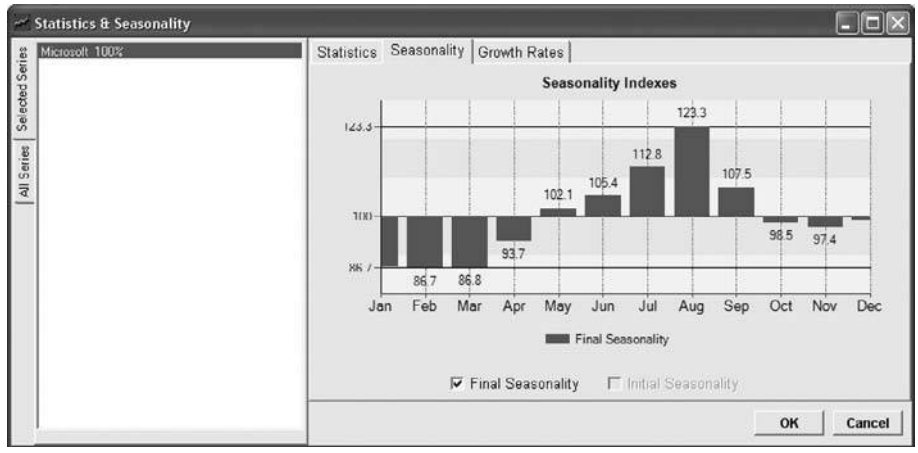


Figure 10.
Seasonality

4.2 Forecasting methods

The methods we used to provide the forecasts of the time series data are presented in following. These methods that are provided by PYTHIA, are:

- Theta method.
- Linear trend exponential smoothing (HOLT).
- Damped trend exponential smoothing (DAMPED).
- Simple exponential smoothing with multiplicative seasonality (WINTERS).

He won't provide a description for the first three methods, as they were presented in previous papers (Pagourtzi *et al.*, 2007, 2006). In those papers, we also analyzed the logic behind the Theta method that was developed at the Forecasting Systems Unit of

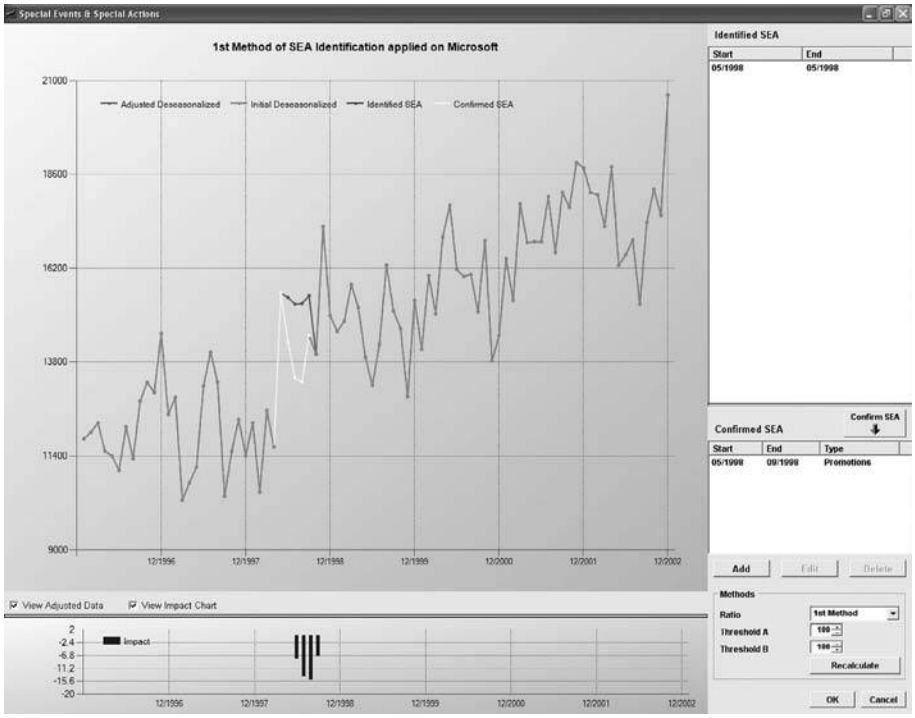


Figure 11.
Special events and actions (SEA)

National Technical University of Athens and introduced by Assimakopoulos and Nikolopoulos (2000, 1999). Here, we also choose to use the forecasting exponential smoothing method WINTERS, a method suitable for data with seasonality because, as will see in following, our data has a slight seasonal pattern.

4.3 Time-series data

In following, we point out some matters concerning the origin of the data provided by the CML. Totals are estimates grossed up from the sample of lenders reporting to reflect total market size. All figures from April 2005 onwards are based on Product Sales Data reported to CML. Figures pre-April 2005 are taken from the Survey of Mortgage Lenders. Prior to 1992-Quarter2 figures are taken from the Building Societies 5 percent sample of mortgage completions. There are material differences in both the reporting methodologies and the sample of contributing lenders for the different surveys. Figures after April 2005 are not strictly comparable with those up to that point.

The data we found from CML included among others, time-series with number of loans and value of loans in total. In our case study, it would be rather more useful to a Bank to forecast average values of loans, so we divided the respective elements of the two time-series to produce average values. Specifically, we use three time-series to forecast average mortgage loan prices that are grouped in:

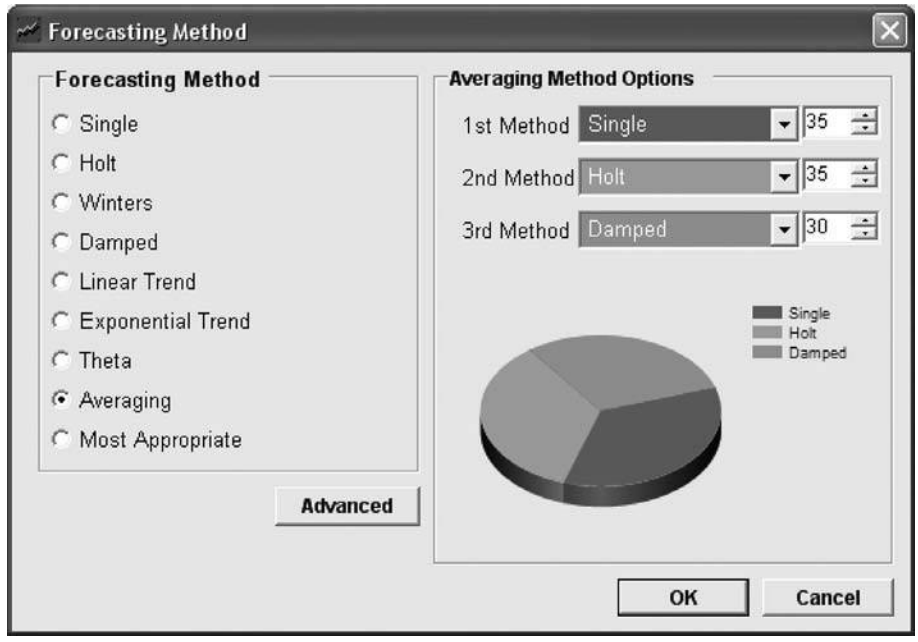


Figure 12.
Forecasting methods

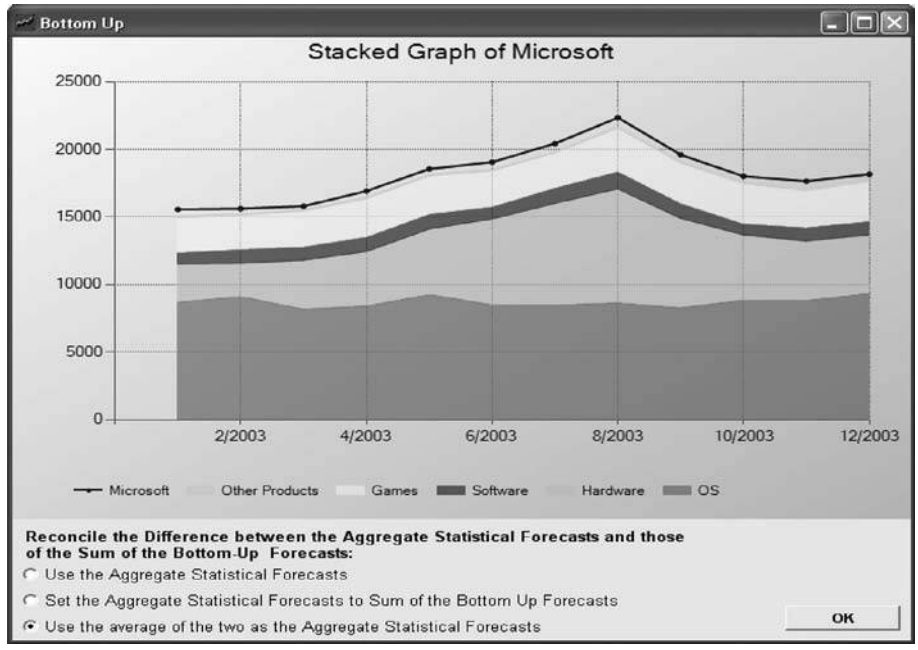


Figure 13.
Aggregate or bottom up forecasts

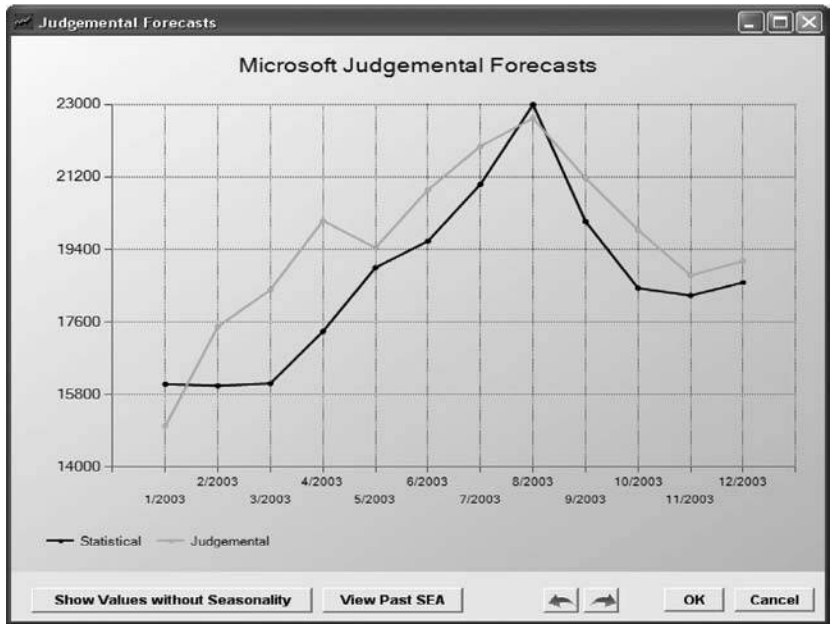


Figure 14.
Judgmental forecasts

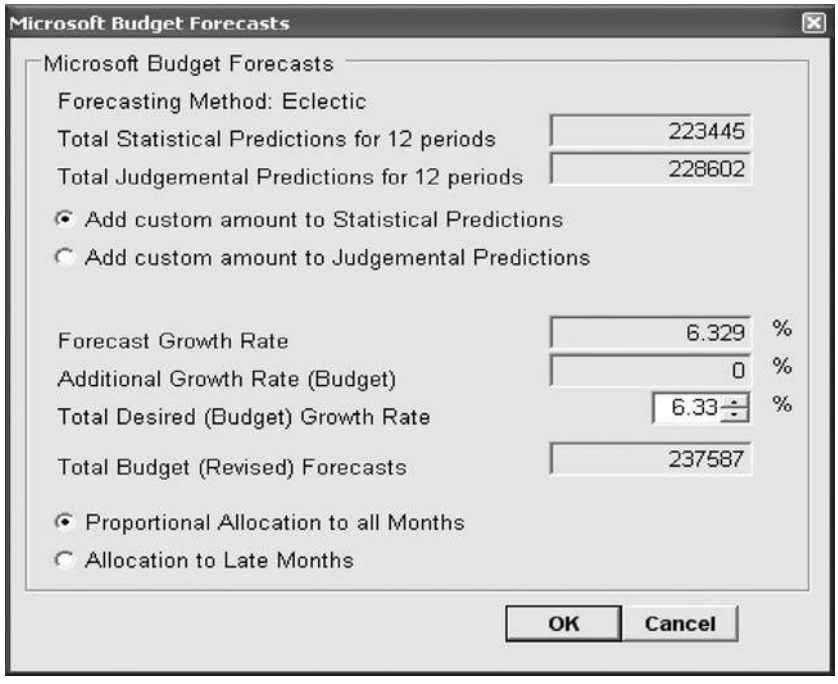


Figure 15.
Budget forecasts

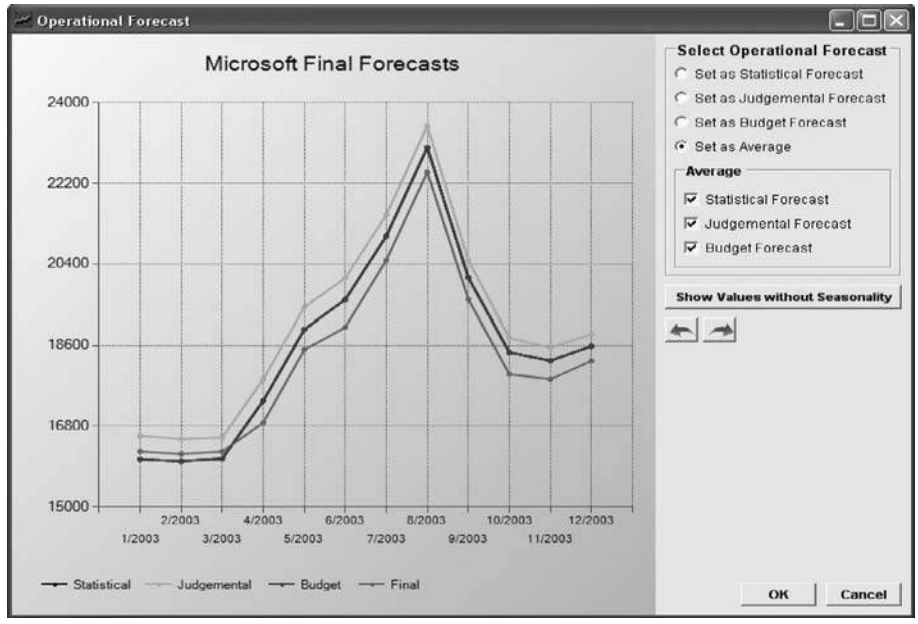


Figure 16.
Final/operational forecasts

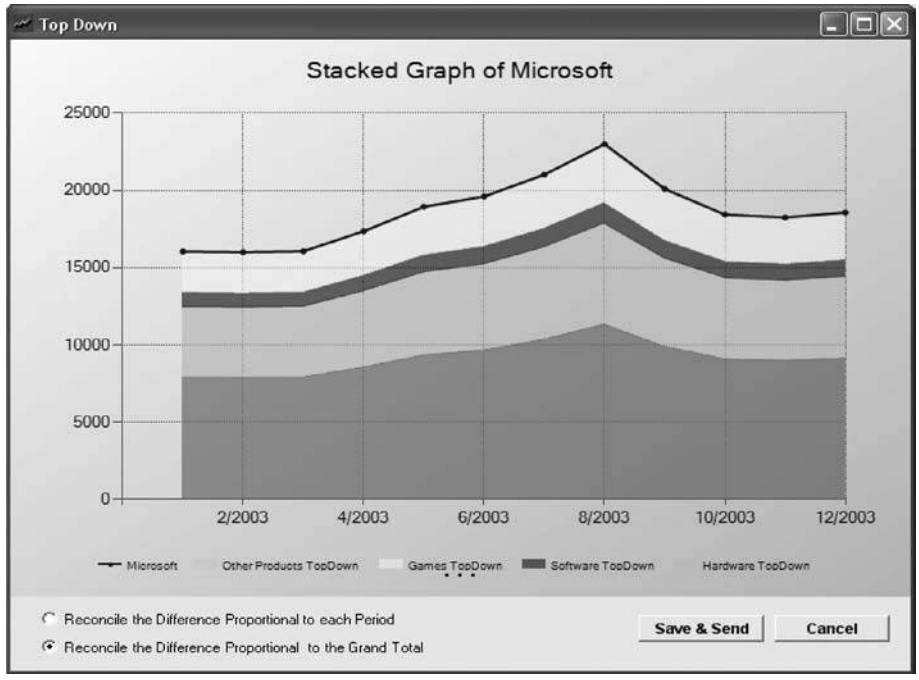


Figure 17.
Top-down forecasts

Figure 18.
Monitoring

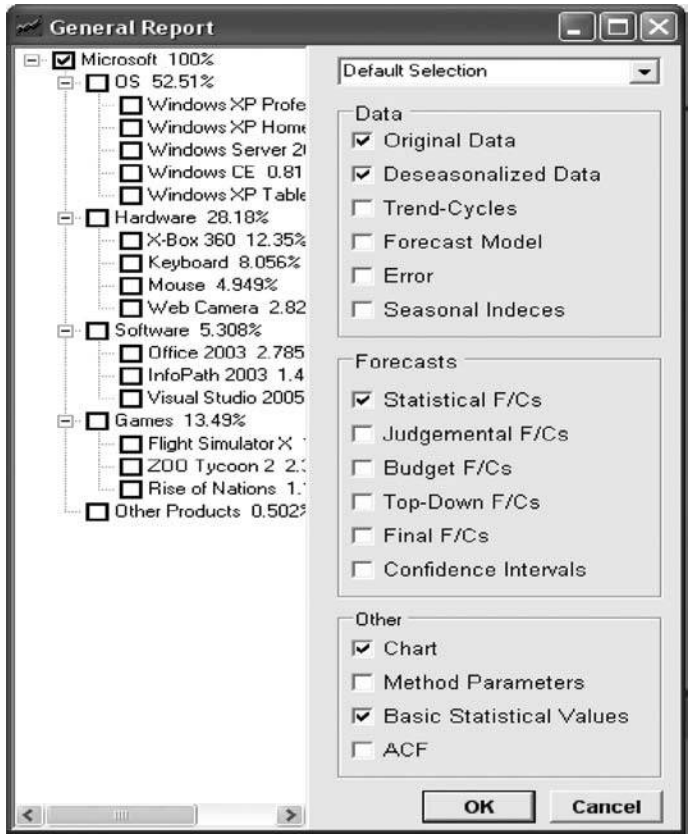


Figure 19.
General report

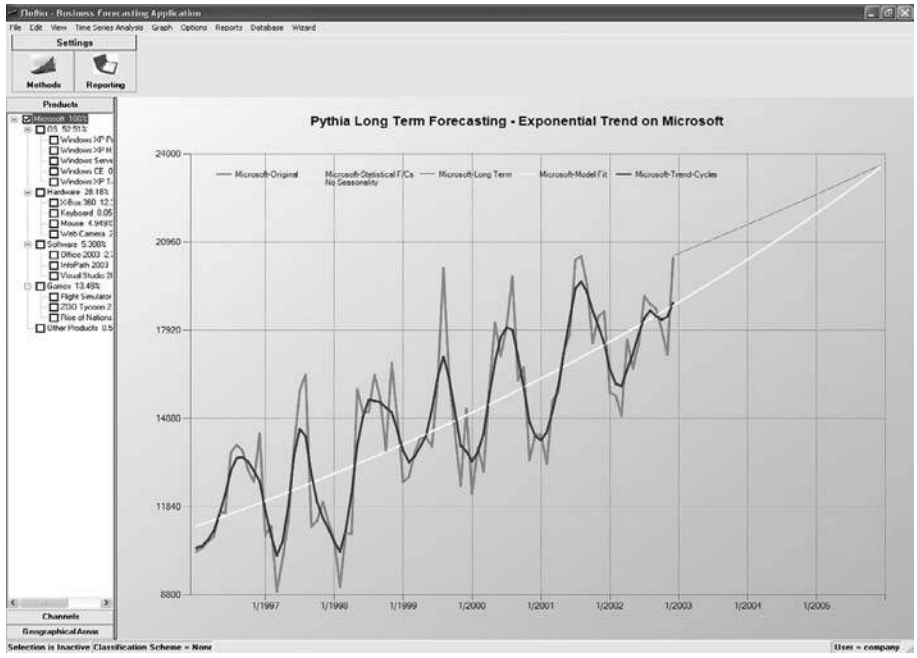
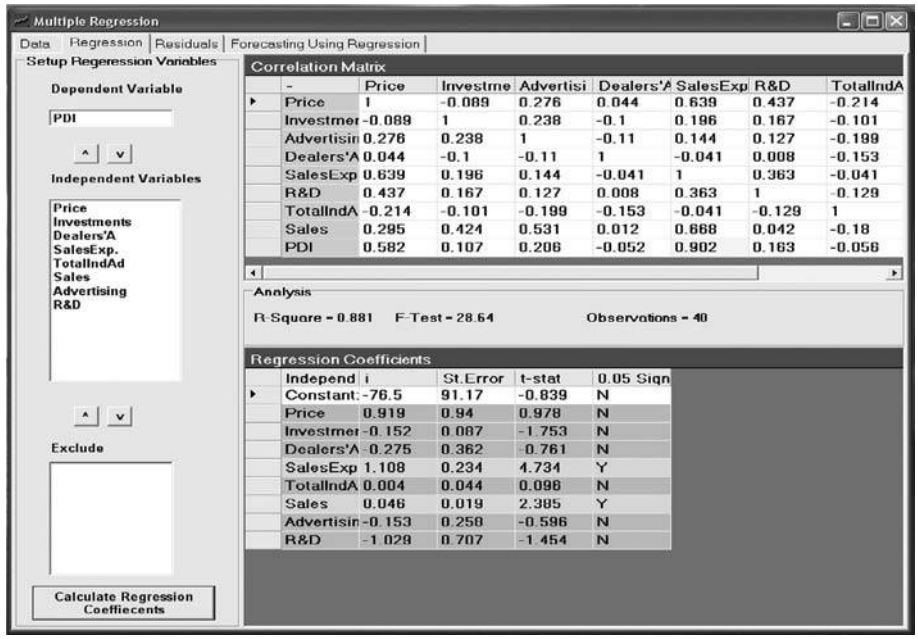


Figure 20.
Long-term forecasts



-	Price	Investme	Advertisi	Dealers'A	SalesExp	R&D	TotalIndA
Price	1	-0.089	0.276	0.044	0.639	0.437	-0.214
Investmer	-0.089	1	0.238	-0.1	0.196	0.167	-0.101
Advertisin	0.276	0.238	1	-0.11	0.144	0.127	-0.199
Dealers'A	0.044	-0.1	-0.11	1	-0.041	0.008	-0.153
SalesExp	0.639	0.196	0.144	-0.041	1	0.363	-0.041
R&D	0.437	0.167	0.127	0.008	0.363	1	-0.129
TotalIndA	-0.214	-0.101	-0.199	-0.153	-0.041	-0.129	1
Sales	0.295	0.424	0.531	0.012	0.668	0.042	-0.18
PDI	0.582	0.107	0.206	-0.052	0.902	0.163	-0.058

Independ	i	St.Error	t-stat	0.05 Sign
Constant:	-76.5	91.17	-0.839	N
Price	0.919	0.94	0.978	N
Investmer	-0.152	0.087	-1.753	N
Dealers'A	-0.275	0.362	-0.761	N
SalesExp	1.108	0.234	4.734	Y
TotalIndA	0.004	0.044	0.098	N
Sales	0.046	0.019	2.385	Y
Advertisin	-0.153	0.258	-0.596	N
R&D	-1.029	0.707	-1.454	N

Figure 21.
Regression

- *Model 1*. All buyers – average loan prices in UK.
- *Model 2*. First-time buyers – average loan prices in UK.
- *Model 3*. Home-movers – average loan prices in UK.

Here, we present in detail the case of "Model 1: all buyers – average loan prices in UK", which includes the graphs and the statistics produced by each of the four forecast methods we mentioned above. The process and results are similar for the other Models too, but for the sake of space are not presented here. However, we include a table with forecasting errors of each method applied on each time-series, in order to evaluate the performance of the methods. All three time-series with historical data (www.cml.org.uk/cml/statistics) are included in the Appendix of the paper.

In the following forecasts, PYTHIA automatically hides a number of observations in order to test the performance of the methods by comparing forecasts with historical data. The forecast horizon is again automatically chosen by PYTHIA and is 11 points in the future, but we could have also chosen another number of forecasts. Each forecast point corresponds to a quarter and so the actual forecasts we obtain are for the second, third and fourth quarter of 2007 and for all quarters in the years 2008 and 2009. In the graphs that follow, the red line represents the original time series, the blue line the trend-cycle series, the black line the statistical forecasts and the grey one the confidence intervals.

4.4 Model 1: all buyers – average loan prices in UK

In following, we present the results of each forecasting method applied in Model 1 (Figures 22-25, Tables I-IV).

4.5 Results

Other statistics that PYTHIA produces for Model 1 are shown in Table V. PYTHIA also computes four seasonal indices, one for each quarter of the time-series that are presented in Table VI.

The same procedure was followed for the rest time series too. The next table presents the mean absolute percentage errors (MAPE) of each forecasting method when applied to each Model of time series. The forecasting errors are major indicators of a good forecast and except from MAPE we could use mean square error, mean absolute error, Symmetric MAPE, etc. in order to compare the forecasting methods (Table VII).

From the table we can see that the best forecasts according to MAPE are produced by WINTERS and this is maybe due to the fact that there is seasonality in the data. The Theta method comes next in the row and generally produces good forecasts with small MAPE. In order to tell with grater certainty which method produces the most accurate forecasts we could compare the rest error statistics provided by PYTHIA too.

4.6 Adjustments useful to the bank

After the production of the statistical forecasts of the average mortgage loan values, the manager at the Bank can do adjustments if he thinks that the future values may

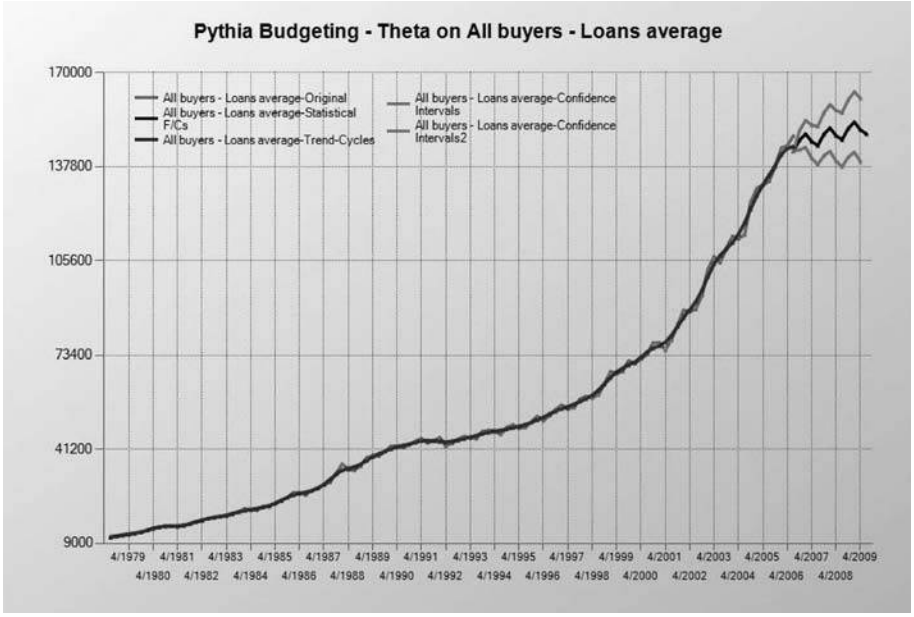


Figure 22.
Graph of historical data and forecasts data using Theta method

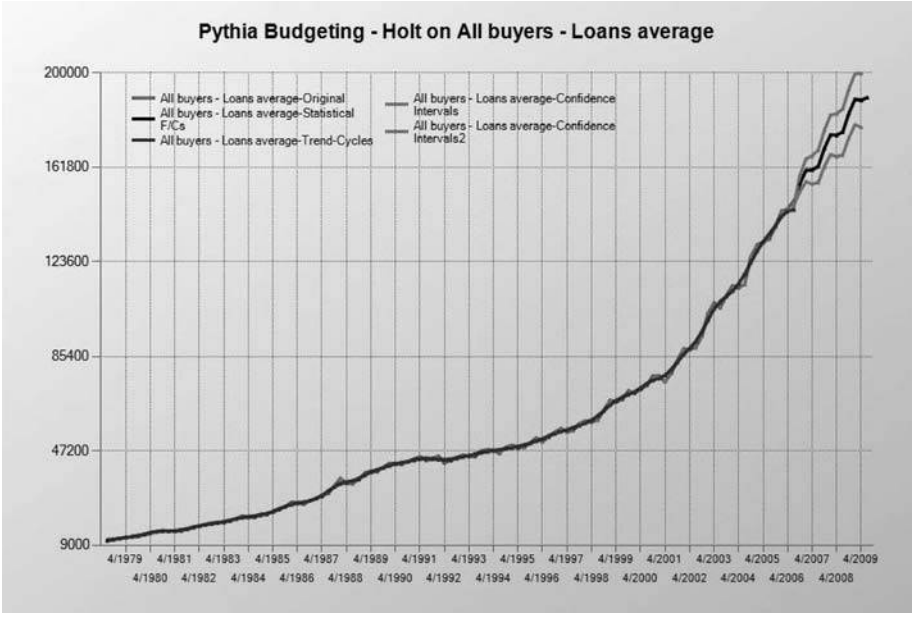


Figure 23.
Graph of historical data and forecasts data using HOLT method

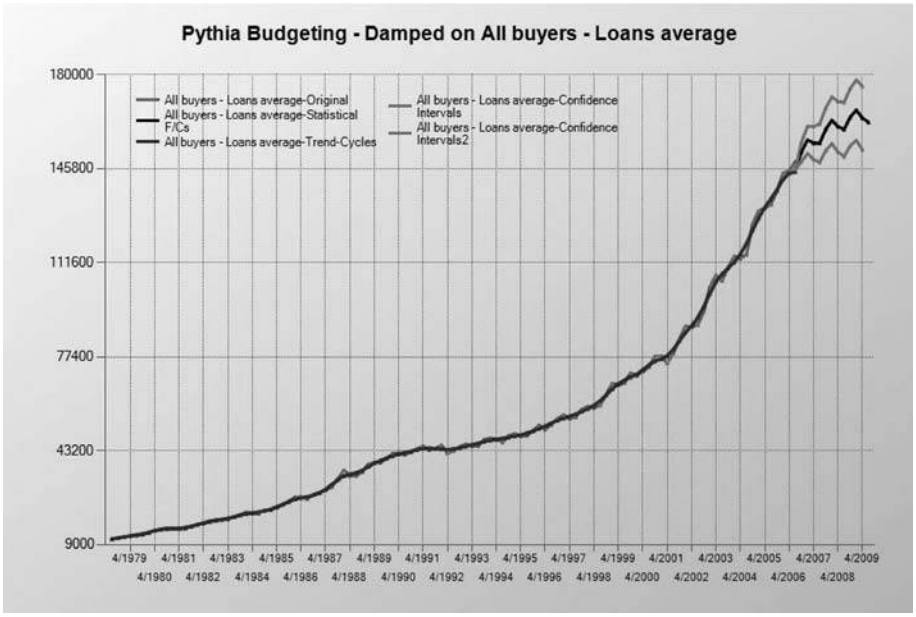


Figure 24.
Graph of historical data and forecasts data using DAMPED method

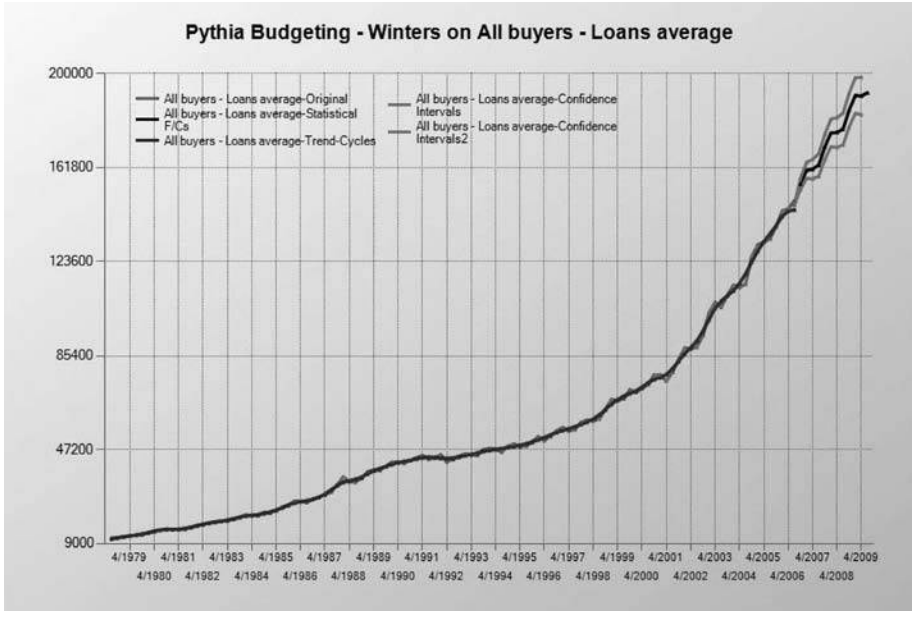


Figure 25.
Graph of historical data and forecasts data using WINTERS method

differ from the forecasts. So, he is able to interfere and change the forecasts manually on the graph, thus producing judgmental forecasts. He can also alter the forecasts to a positive or negative percent, which provides budget forecasts. Then he can choose which of the above methods he wants to combine in order to produce the final forecasts.

Table I. Statistical errors using Theta method

Mean absolute error	Mean square error	Mean absolute percentage error
1,235	3,957,513	2.107

Table II. Statistical errors using HOLT method

Mean absolute error	Mean square error	Mean absolute percentage error
1,106	3,970,614	3.819

Table III. Statistical errors using DAMPED method

Mean absolute error	Mean square error	Mean absolute percentage error
1,203	4,471,608	3.832

Table IV. Statistical errors using WINTERS method

Mean absolute error	Mean square error	Mean absolute percentage error
890.5	1,933,250	1.769

Table V. Time-series statistics of Model 1

Mean	Min value	Max value	R^2	MAD
52,310	10,999.15	148,332.32	0.871	27,204

Table VI. Seasonal indices of Model 1

Seasonal index 1 (percent)	Seasonal index 2 (percent)	Seasonal index 3 (percent)	Seasonal index 4 (percent)
98.3	100.5	101.7	99.5

Table VII. Competition of forecasting methods

	Mean average percentage errors		
	Model 1 All buyers – average loan prices in UK (percent)	Model 2 First-time buyers – average loan prices in UK (percent)	Model 3 Home-movers – average loan prices in UK (percent)
Theta	2.107	2.358	2.252
HOLT	3.819	3.93	4.003
DAMPED	3.832	3.915	3.817
WINTERS	1.769	2.148	1.982

Another useful functionality for the Bank is the bottom-up and top-down analysis that PYTHIA provides. PYTHIA lets the manager to make bottom-up predictions by adding the forecasts up to any desired level of aggregation. A top manager can then allocate the forecasts to each subcategory or division. In the case that the manager's decision is affected by the desired growth rate of the Bank or division, he can see through PYTHIA various growth rates related to the forecasts and change the forecasts accordingly. As the two forecasts (bottom-up and top-down) may differ, the top manager can reconcile the difference and allocate it appropriately to the various sub-aggregation levels.

PYTHIA can also identify SEA when an unexpected change in the level of data is observed in the time-series. A SEA for our case study could be a raise or a decline of interest rates, which affects loans and buyers. The manager can confirm an identified SEA, change the impact of a SEA in the selected period or change the period that happened. In another case, if the Bank wanted to forecast number of loans or sales of other products and services, it would probably find useful to adjust the working days or calculate the Bank Holidays in UK, which is also provided by PYTHIA.

5. Comparing PYTHIA with Theta Forecaster

The PYTHIA forecasting platform offers many more functionalities to the user than Theta Forecaster (Assimakopoulos and Nikolopoulos, 2001; Pagourtzi *et al.*, 2007, 2006). The main differences between the two forecasting tools are presented in following:

- New modules are incorporated in PYTHIA, which are those of "Budget", "Production/inventory", "Long term", "Estimating relationships", "Monitoring" and "Wizard".
- In addition, the modules of "Data Analysis and Adjustments" and "Reporting" that we also find in Theta Forecaster, have more features and better functionality in PYTHIA.
- PYTHIA gives the capability to the user to deal with missing values, zero values, working days and SEA.
- PYTHIA provides the user with more statistical information about the time series, such as many types of error statistics.
- In PYTHIA the user can choose to see more statistical lines in the main chart than in Theta Forecaster, e.g. the trend/cycle line.
- Theta Forecaster allows the combination of more forecasting methods than PYTHIA does, but PYTHIA allows the user to adjust the proportion that each method has in the averaging.
- PYTHIA allows the user to adjust the smoothing parameters of the forecasting methods. Moreover, PYTHIA automatically applies the appropriate forecasting method to the time-series inserted by the user.
- Theta Forecaster produces only statistical forecasts, whereas PYTHIA can also produce judgmental and budget forecasts. The user can then combine them to produce the final forecasts.
- PYTHIA lets the user to make bottom-up predictions by adding the forecasts up to any desired level of aggregation.

- Additionally, in PYTHIA after the person in charge produces the final forecasts he is able to allocate them to each category or division bellow. This can happen by reconciling the difference and allocating it appropriately to the various sub-aggregation levels.
- While Theta Forecaster can be used only for time-series forecasting, PYTHIA provides multiple regression too, through the module "Estimating Relationships".
- Finally, PYTHIA aims rather more to professionals than simple users and is more suitable for use in a business environment than Theta Forecaster.

6. Perspectives

For the years 2007 and 2008, mortgage and housing markets will probably remain resilient. With the wider economy continuing to provide a sound backdrop, the level of property sales in 2007 is expected to be broadly similar to 2006. But affordability will remain stretched. Asking prices for homes continue to be challenging for many first-time buyers, and movers will find it increasingly difficult to trade up as price differences between properties widen.

With interest rates rising in 2006, payment difficulties are likely to increase over the next year. Prospects for employment and income are positive, but higher interest rates look set to result in a temporary rise in short-term arrears later in 2007. Most borrowers will be able to resolve these problems by speaking with their lender early if they are in difficulty. The number of possessions is expected to be broadly stable over the years 2007 and 2008.

7. Conclusions

In this paper, we show how the PYTHIA forecasting platform can be used by the managers of a Bank to forecast mortgage loan values. In fact, PYTHIA can provide the forecasts required by practically all business situations demanding accurate predictions. It is designed and developed with the purpose of making the task of managerial forecasting straightforward, user-friendly and practical. It incorporates a lot of knowledge and experience in the field of forecasting while fully utilizing new capabilities of computers and software. PYTHIA gives more capabilities to the user than Theta Forecaster and can be used by professionals that need a flexible tool to forecast, analyze and organize their data.

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Appendix

Table AI (on the next page) contains the time series we used to produce the forecasts. In PYTHIA, each time series was inserted separately in Excel format, but here for convenience we present them as a whole. All prices are given in English pounds (£).

Name		Average loan prices		
Periods per year		4		
Seasonality		4		
		Data		
Quarter	Year	All buyers	First-time buyers	Home-movers
1	1979	10.999	10.566	11.385
2	1979	11.504	10.995	11.894
3	1979	11.951	11.776	12.094
4	1979	12.256	11.975	12.492
1	1980	12.473	12.221	12.683
2	1980	12.789	12.534	12.996
3	1980	13.472	13.013	13.777
4	1980	14.298	13.843	14.649
1	1981	14.650	14.196	14.993
2	1981	15.088	14.475	15.530
3	1981	14.958	14.328	15.449
4	1981	14.787	14.016	15.543
1	1982	14.987	14.121	16.018
2	1982	15.731	14.708	16.863
3	1982	16.461	15.349	17.552
4	1982	16.906	15.440	18.255
1	1983	17.535	15.722	19.272
2	1983	18.035	16.412	19.637
3	1983	18.241	16.469	19.913
4	1983	18.419	16.950	19.837
1	1984	19.074	17.518	20.762
2	1984	19.878	18.419	21.238
3	1984	20.794	19.278	22.094
4	1984	20.489	19.045	21.906
1	1985	20.481	18.946	22.332
2	1985	21.634	20.123	23.263
3	1985	21.711	20.300	23.202
4	1985	22.653	21.268	24.119
1	1986	23.583	21.933	25.281
2	1986	24.769	23.147	26.342
3	1986	26.345	24.326	28.113
4	1986	26.364	24.465	28.197
1	1987	25.815	23.843	27.917
2	1987	27.097	25.045	29.026
3	1987	27.931	25.994	29.596
4	1987	28.971	26.886	30.900
1	1988	30.109	27.641	32.527
2	1988	32.948	30.015	35.477
3	1988	36.165	33.020	38.440
4	1988	34.223	30.613	37.592
1	1989	34.181	29.556	39.429
2	1989	35.649	32.143	39.340
3	1989	38.286	34.036	42.529
4	1989	39.084	35.865	42.620
1	1990	39.009	34.580	44.305
2	1990	40.483	36.697	44.638
3	1990	42.212	39.019	45.632

Table AI.

(*continued*)

Name		Average loan prices		
Periods per year		4		
Seasonality		4		
		Data		
Quarter	Year	All buyers	First-time buyers	Home-movers
4	1990	42.325	38.882	46.047
1	1991	41.900	37.924	45.883
2	1991	42.905	38.726	46.910
3	1991	43.966	39.381	47.566
4	1991	44.888	39.352	49.493
1	1992	43.587	39.198	48.099
2	1992	44.047	39.218	48.317
3	1992	45.253	40.226	50.116
4	1992	42.447	36.936	48.917
1	1993	43.322	37.976	49.530
2	1993	44.658	39.837	50.239
3	1993	45.675	39.618	52.213
4	1993	45.139	39.114	51.547
1	1994	45.063	38.325	53.211
2	1994	47.271	40.493	55.059
3	1994	47.762	40.432	56.195
4	1994	47.568	40.903	55.363
1	1995	46.460	40.557	54.077
2	1995	48.668	42.072	56.270
3	1995	49.564	41.333	57.726
4	1995	48.515	41.602	55.535
1	1996	48.796	41.069	57.541
2	1996	50.583	43.900	56.411
3	1996	52.539	44.795	59.243
4	1996	51.149	43.866	58.437
1	1997	52.840	43.870	60.396
2	1997	54.841	46.024	61.862
3	1997	56.292	47.862	63.589
4	1997	55.076	47.283	62.057
1	1998	55.580	47.754	62.899
2	1998	58.318	51.123	65.459
3	1998	59.406	53.007	65.330
4	1998	58.968	51.271	65.920
1	1999	59.911	52.699	66.711
2	1999	63.736	57.695	68.987
3	1999	67.751	59.070	74.966
4	1999	67.246	58.956	74.314
1	2000	68.079	59.104	76.088
2	2000	71.565	61.516	79.444
3	2000	70.669	60.084	78.789
4	2000	72.193	60.854	80.418
1	2001	73.783	63.157	81.821
2	2001	77.667	66.091	85.911
3	2001	77.760	68.175	86.650
4	2001	75.294	69.711	82.021
1	2002	78.803	74.168	83.633

(*continued*)

Table AI.

Name		Average loan prices		
Periods per year		4		
Seasonality		4		
		Data		
Quarter	Year	All buyers	First-time buyers	Home-movers
2	2002	83.889	79.054	88.149
3	2002	88.574	84.482	92.469
4	2002	88.336	85.075	91.237
1	2003	89.136	83.913	90.624
2	2003	93.856	85.390	96.079
3	2003	102.676	91.050	105.836
4	2003	106.974	95.205	110.090
1	2004	105.089	93.467	109.355
2	2004	109.840	101.217	113.115
3	2004	113.897	105.365	117.541
4	2004	113.164	105.039	117.438
1	2005	114.533	106.559	118.879
2	2005	125.690	108.053	136.588
3	2005	130.399	111.016	141.890
4	2005	131.514	113.096	142.689
1	2006	132.854	114.321	144.325
2	2006	137.855	119.789	148.008
3	2006	144.108	123.736	155.226
4	2006	145.033	125.792	155.268
1	2007	148.332	127.395	160.035

Table AI.

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