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A Methodology for Identifying Time-Trend Patterns: An Application to the Advertising Expenditure of 28 European Countries in the 1994-2004 Period

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Abstract

The aim of our study is to reveal different time-trend patterns in the ratio of advertising expenditure to gross domestic product for 28 European countries in the 1994-2004 period. To fulfil the objective, we applied two multidimensional statistical approaches: cluster analysis and multidimensional scaling for time-varying data, followed by linear regression analysis of the time-series within the clusters. A proximity matrix was calculated using the dissimilarity between two time series, which takes into account the order of time points, the information on the fixed time points, and the weights. We identified four clusters of countries with similar trend patterns in the 1994-2004 period: awakening countries, stable countries, catching-up countries, and the leading cluster.

1 Introduction

The advertising industry is an important component of the economic activities of a certain country. Advertising expenditure at the country level includes the aggregate value of advertising expenditure in the press (newspapers and magazines), television, radio, outdoor and cinema. The data for advertising expenditure are presented in the local currency and in current prices and are not directly comparable over time and between countries. We therefore considered advertising expenditure on a relative scale, as the ratio of advertising expenditure to gross domestic product, which is an internationally recognised standard for measuring national economic activity. Thus, the variable under study is the ratio of advertising expenditure to gross domestic product for 28 European countries for the 1994-2004 period. Our main research questions are the following:

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- Are there different time-trend patterns for the variable under study?
- Which European countries have similar patterns over time?

2 Methodology and analysis

2.1 Data

We considered the data for advertising expenditure (AD) and gross domestic product (GDP). The derived variable, AD/GDP %, represents the percentage of AD in GDP. Its values range from 0.059% (Russia in 1994) to 2.42% (Cyprus in 2004), whereas the median is 0.759%. The number of countries (28) and the 11-year period correspond to the largest data matrix for which the data were available (Euromonitor, 2006). Hence, 28 time-series of length 11 were the input for the statistical analysis (see Appendix 1).

2.2 Dissimilarity

To meet our research objectives, we applied two multivariate statistical methodologies: cluster analysis and multivariate scaling for time-varying data. The first step for both approaches is the calculation of a proximity matrix, in our case a dissimilarity matrix between countries, with each being represented by one time series. Standard dissimilarity measures are not appropriate for time series and should be replaced by a measure that takes the time dimension and its ordering property into account. In Appendix 2 we present the rationale for the derivation of dissimilarity *D* between two time series (Košmelj and Batagelj, 1990). It takes into account the dissimilarities d_t at successive time points *t*, $t = 1,\ldots,T$, where *d* is a standard dissimilarity measure, and the corresponding weights k_t, which assess the impact of an important external characteristic at time points. The weights w_t express the relative importance of the dissimilarities d_t in the calculation of *D* and incorporate a strong time-ordering condition.

We used a squared Euclidean distance to measure the dissimilarity between time series *x* and *y* at time point *t*, $d_t = (x_t - y_t)^2$. In the definition of the weights w_t, we took into account information on the aggregate advertising expenditure for entire Europe, ADE. We defined k_t as the ratio of two successive values for ADE and expressed it in terms of its growth rate r_t:

$$k_t = \frac{ADE_{t-1}}{ADE_t} = \left(1 + \frac{r_t}{100}\right)^{-1}$$

The weights w_t were calculated from the k_t values using the formula given in Appendix 2.

2.3 Clustering and ordinal scaling

Several clustering methods and ordinal multidimensional scaling were used to identify different time patterns in AD/GDP % for the 28 countries under study. The analysis was done using the R 2.4 and SPSS 14.0 programmes.

3 Results

The growth rates for aggregate advertising expenditure for entire Europe (ADE) and the weights w_t are presented in Figure 1. The figure reveals the highest growth rates for ADE in 1997, 1999 and 2000 (around 10%) and a period of stagnation afterwards. The weights w_t reflect these phenomena, they increase from 1994 to 2001 and are nearly constant afterwards.

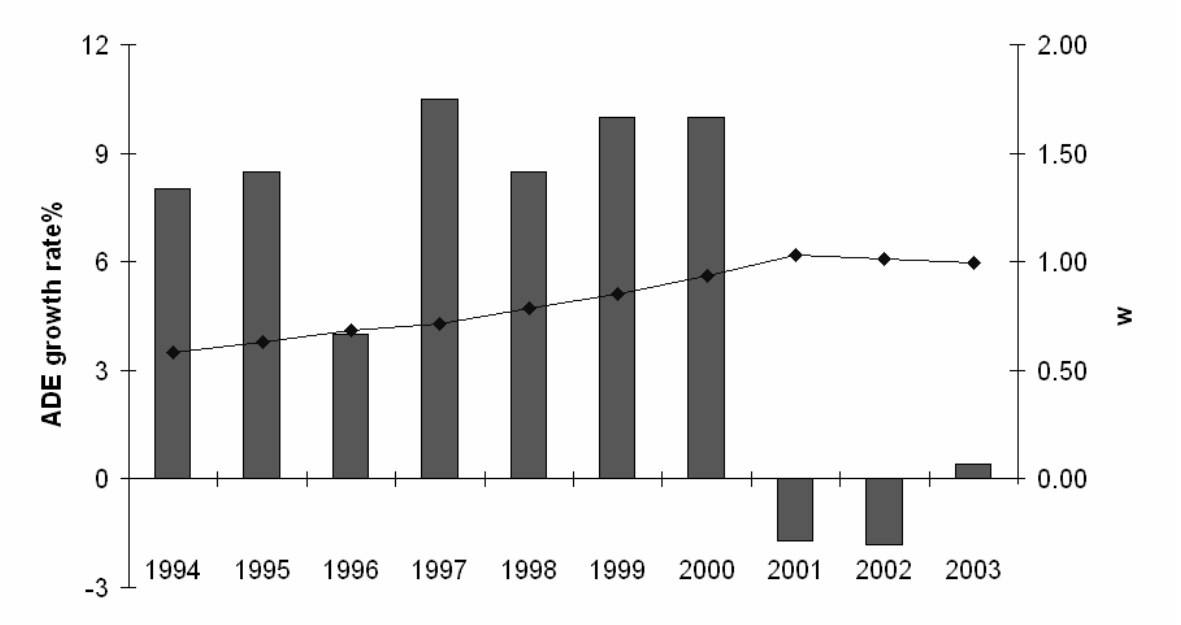


Figure 1: Annual growth rate for aggregate advertising expenditure for Europe (ADE) for the 1994-2003 period (bar chart, scale on the left y-axis) and weights w used in the calculation of dissimilarity D (line chart, scale on the right y-axis).

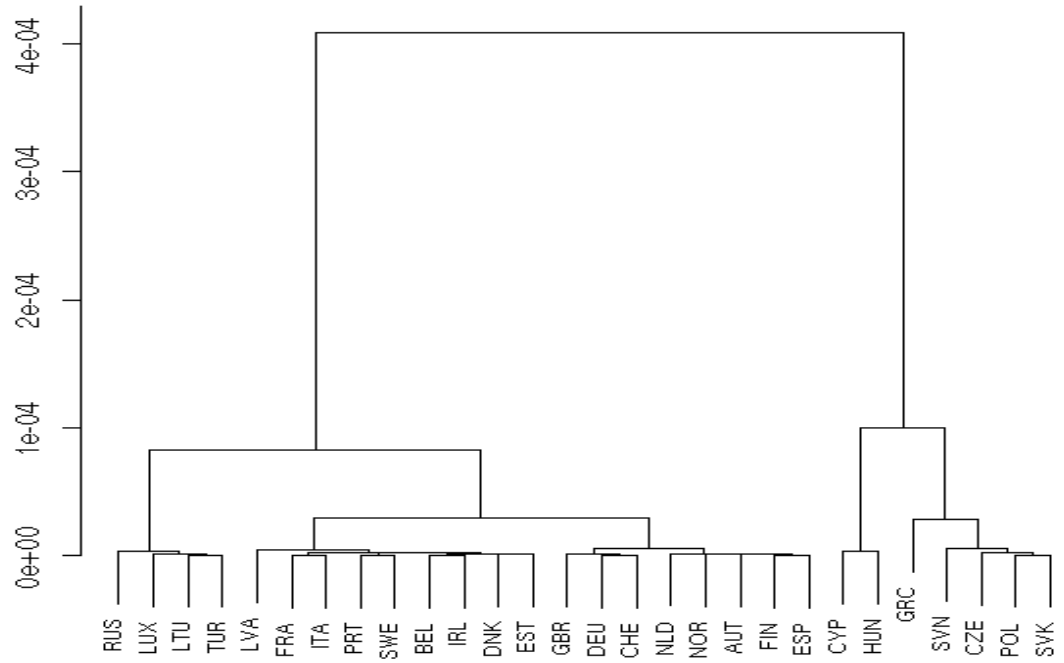


Figure 2: Dendrogram obtained by Ward's method.

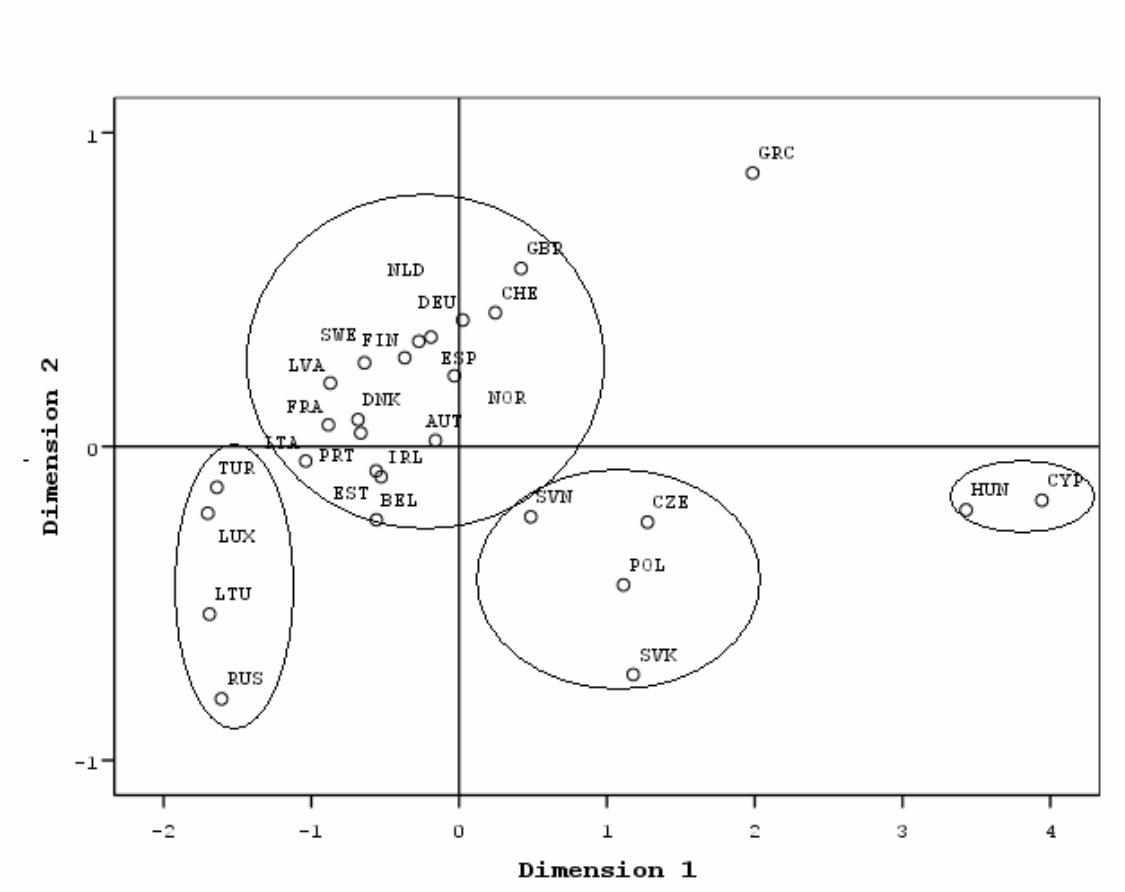


Figure 3: Two-dimensional scatterplot of countries obtained by ordinal multidimensional scaling.

Different clustering methods were used and Figure 2 presents the dendrogram obtained by Ward's method. It shows that, on the first level, 28 countries are clustered into two clusters: the first cluster contains Cyprus, Hungary, Greece, Slovenia, Czech Republic, Poland and Slovakia, while the remaining 21 countries are in the second cluster. On a lower level, there are four clusters, as presented in Table 1. The results for the different clustering methods are identical except for Greece, which joined either Cluster 3 or Cluster 4.

The results obtained by ordinal multidimensional scaling (ALSCAL in SPSS) show that a two-dimensional representation is satisfactory. We present 'the map' of the countries in Figure 3 to offer a deeper insight into the clustering results. The clusters are allocated along the *x*-axis, 'Cluster 1' is on the left, followed by 'Cluster 2' and 'Cluster 3', 'Cluster 4' on the right; however, Greece is allocated far-off.

To gain a deeper understanding of the results, we undertook a detailed analysis of the countries within each cluster. First we plotted the time series for each cluster (see Figures 4 and 5 in Appendix 3). The strange 'jumps' in some time series (see Latvia and Greece) can be explained by the change in definition of advertising spending (for example, data for advertising spending in Latvia in 1994-1997 included production costs) and we did not take these values into further analysis.

Table 1: Linear regression for the time series within each cluster obtained by Ward's method. The intercept presents the predicted value for AD/GDP % in 1994, while the slope indicates the average change per year.

Cluster	Members	Intercept	Slope	Comment
1	Lithuania, Luxembourg, Russia, Turkey	0.293***	0.024***	Very slow growth from a very low intercept.
2	Austria, Belgium, Denmark, Estonia, Finland, France, Germany, Ireland, Italy, Latvia[+], Netherlands, Norway, Portugal, Spain, Sweden, Switzerland, United Kingdom	0.745***	0.005	No growth from a medium intercept.
3	Czech Republic, Greece[++], Poland, Slovakia, Slovenia	0.515***	0.099***	Intensive growth from a low intercept.
4	Hungary, Cyprus	0.998***	0.122***	Very intensive growth from a high intercept.

**Legend: ***** $p<0.001$

[+] Data for Latvia for 1998-2004 [++] Data for Greece for 1996-2004

These plots show a linear trend in all four clusters and we therefore analysed the time series within each cluster using the linear regression model. The results are summarised in Table 1. The intercept presents the predicted value for 1994, whereas the slope indicates the average change per year in the 1994-2004 period. The intercept is significantly different from zero for all four clusters; the slope is positive and significant in all clusters except in 'Cluster 2'.

A deeper insight into time-trend patterns reveals several interesting issues. In 'Cluster 1' we observe a very low starting point (0.3%) and the ten-year growth of 0.2%; hence the percentage of AD in GDP increased from 0.3% in 1994 to 0.5% in 2004. The four countries (Lithuania, Luxembourg, Russia and Turkey) can be characterised by a slow change from a very low starting point. This cluster incorporates the '*awakening countries*'.

'Cluster 2' incorporates 17 countries where AD represents about 0.7% of GDP and is constant throughout the 1994-2004 period. The cluster members are the most developed European Union countries along with the two Baltic countries of Estonia and Latvia. This cluster consists of the '*stable countries*'. The two Baltic countries come out as a surprise, an explanation for Estonia can be found in Ilić, 2000.

In 'Cluster 3' we observe intensive growth from 0.5% in 1994 to 1.5% in 2004. The results show that Greece differs from the other four cluster members (Czech Republic, Poland, Slovakia, and Slovenia). These countries were candidates for the European Union in the period under study, Greece joined in 2001 while the others followed in 2004. The main characteristic of the cluster is intensive growth from a low starting point. This cluster consists of the '*catching-up countries*'.

Cluster 4 has the highest starting point (1%) and the highest growth in the ten-year period (1.2 %). The two countries, Cyprus and Hungary, were very propulsive and had very intensive growth from the highest starting point. This cluster is the '*leading cluster*'. According to Manrai et al. (2001), Hungary has the most developed advertising industry.

5 Conclusions

This study enquired into whether there are different time patterns of the ratio AD/GDP % for 28 European countries in the 1994-2004 period. The answer is affirmative. Further, we investigated which countries have similar patterns across time. Two multidimensional statistical approaches were used for this purpose: cluster analysis and multidimensional scaling on time-varying data. A proximity matrix was calculated using the dissimilarity between two time series. It takes into account the order of time points, the information on the fixed time points, and the weights which are arbitrary. Since information on advertising expenditure for the whole of Europe is very important, its growth rate was incorporated into the calculation of the weights.

The results show that dissimilarity holds great power when it comes to identifying different time patterns. We identified four clusters of countries with similar trend patterns in the 1994-2004 period:

- awakening countries (Russia, Luxembourg, Lithuania and Turkey);

- stable countries (Latvia, France, Italy, Portugal, Sweden, Belgium, Ireland, Denmark, Estonia, the United Kingdom, Germany, Switzerland, the Netherlands, Norway, Austria, Finland and Spain);
- catching-up countries (Greece, Slovenia, Czech Republic, Poland and Slovakia); and
- leading countries (Cyprus and Hungary).

To sum up, the new exploratory approach enables a deeper insight into time-trend patterns of advertising expenditure in the countries under study.

References

[1] Euromonitor (2006): World Marketing Data and Statistics. www.euromonitor.com/womdas

[2] Ilić, M. (2000): Čas velike rasti in čas umirjanja. *Marketing magazin*, **20**, 227, 18-19, Ljubljana.

[3] Košmelj, K. and Batagelj, V. (1990): Cross-sectional approach for clustering time varying data. *Journal of Classification* **7**, 99-109.

[4] Manrai, L.A., Manrai, A.K., and Lascu, D.-N. (2001): A country-cluster analysis of the distribution and promotion infrastructure in Central and Eastern Europe. *International Business Review*, **10**, 517-549.

Appendix 1

Table 2: Data for AD/GDP% for 28 European countries in the 1994-2004 period.

	1994	**1995**	**1996**	**1997**	**1998**	**1999**	**2000**	**2001**	**2002**	**2003**	**2004**
AUT	0.6843	0.6744	0.6824	0.7347	0.7857	0.8748	0.9164	0.8842	0.8523	0.8455	0.8418
BEL	0.5361	0.5526	0.5542	0.6009	0.6801	0.7123	0.7345	0.6950	0.7478	0.8031	0.8078
CYP	0.9009	0.9884	0.9768	1.1499	1.2339	1.6493	1.6200	1.8022	2.1820	2.3965	2.4239
CZE	0.6403	0.5526	0.6211	0.8225	1.0023	1.1849	1.3100	1.4173	1.3427	1.3512	1.3337
DNK	0.6723	0.7292	0.7267	0.7432	0.7540	0.6780	0.6556	0.6251	0.5768	0.7938	0.7958
EST	0.4048	0.6198	0.7415	0.8254	0.9063	0.7827	0.7280	0.7207	0.6965	0.7399	0.7339
FIN	0.7877	0.8109	0.8028	0.8177	0.8356	0.8543	0.8414	0.7780	0.7425	0.7523	0.7300
FRA	0.6126	0.6152	0.6166	0.6200	0.6422	0.6835	0.7219	0.6597	0.6248	0.6121	0.6178
DEU	0.8664	0.8824	0.8803	0.8925	0.9109	0.9352	0.9806	0.9070	0.8564	0.8555	0.8644
GRC	1.2645	1.5864	1.0211	1.0840	1.1515	1.3178	1.5002	1.4280	1.4537	1.4020	1.5461
HUN	0.8722	0.8581	1.0292	1.1987	1.4408	1.5183	1.7012	1.7965	1.9070	1.9939	2.3716
IRL	0.6710	0.6543	0.6576	0.6762	0.6513	0.6361	0.7559	0.7581	0.8102	0.7790	0.7595
ITA	0.5298	0.5174	0.5250	0.5517	0.5847	0.6341	0.6918	0.6405	0.5977	0.5982	0.6114
LVA	0.2448	0.5426	0.7802	1.0946	0.6405	0.6628	0.6402	0.6579	0.7204	0.6643	0.6455
LTU	0.2130	0.1916	0.2261	0.4368	0.4642	0.4682	0.4173	0.4093	0.4531	0.4824	0.5330
LUX	0.4693	0.4692	0.4953	0.4001	0.3704	0.3842	0.3669	0.3638	0.4912	0.4939	0.4873
NLD	0.7962	0.4622	0.8862	0.9089	0.9577	0.9613	0.9767	0.8811	0.8211	0.7385	0.7461
NOR	0.5473	0.8346	0.9056	0.9185	0.9615	0.9568	0.8867	0.8466	0.8674	0.8775	0.8330
POL	0.4616	0.4439	0.5786	0.7264	0.9190	1.0861	1.0989	1.2906	1.3175	1.3628	1.4492
PRT	0.7297	0.5367	0.6011	0.6796	0.7511	0.8053	0.8404	0.7387	0.6412	0.6493	0.6731
RUS	0.0593	0.0827	0.2678	0.3454	0.4801	0.2925	0.3180	0.4358	0.5822	0.6380	0.6658
SVK	0.4247	0.3998	0.3927	0.7514	0.9793	0.9937	0.9984	1.2521	1.3977	1.4878	1.5175
SVN	0.5625	0.5085	0.6416	0.6991	0.9214	1.0555	1.0564	1.0212	1.0439	1.1417	1.1815
ESP	0.8780	0.8075	0.7879	0.7866	0.8220	0.9038	0.9276	0.8365	0.7736	0.7468	0.7368
SWE	0.7399	0.7350	0.7212	0.7507	0.7978	0.7811	0.8413	0.7249	0.6717	0.6510	0.6521
CHE	0.8729	0.9370	0.9104	0.8952	0.9216	1.0045	1.0478	0.9873	0.8987	0.9202	0.9281
TUR	0.3650	0.3762	0.4004	0.5063	0.4615	0.5089	0.5368	0.3794	0.3918	0.4403	0.5151
GBR	0.9443	0.9744	0.9868	1.0234	1.0543	1.0647	1.1153	1.0194	0.9694	0.9358	0.9462

Appendix 2

The dissimilarity D between time series x and y is based on a *compound interest model*. D is obtained in a stepwise manner using the dissimilarities d_t and the weights k_t at time points t, $t = 1,\ldots,T$. The value of D at time point t is D_t , it is based on its previous value D_{t-1}, on k_t and d_t as follows:

$$
\begin{aligned}
&D_1 = d_1 \\
&D_2 = D_1 \cdot k_1 + d_2 = d_1 \cdot k_1 + d_2 \\
&D_3 = D_2 \cdot k_2 + d_3 = d_1 \cdot k_1 \cdot k_2 + d_2 \cdot k_2 + d_3 \\
&\ldots\ldots \\
&D_T = D_{T-1} \cdot k_{T-1} + d_T = d_1 \cdot k_1 \cdot k_2 \cdot \ldots \cdot k_{T-1} + d_2 \cdot k_2 \cdot \ldots \cdot k_{T-1} + \ldots + d_T
\end{aligned}
$$

In this scheme, d_t represents the *income*, k_t incorporates the information on the *interest rate* and D_t the *balance* at a particular time point *t*.

To summarise, D can be expressed as the weighted sum of d_t*:*

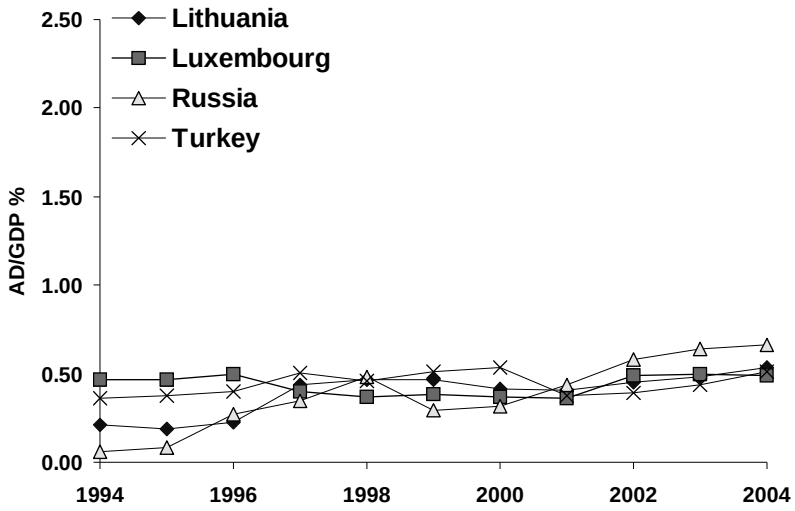
$$D = D_T = \sum_{t=1}^{T} w_t \cdot d_t$$

with the weights w_t which are the products of the weights k_t:

$$
\begin{aligned}
&w_t = \prod_{s=t}^{T-1} k_s, \quad t = 1,\ldots,T-1 \\
&w_T = 1.
\end{aligned}
$$

Appendix 3

Cluster 1



Cluster 2

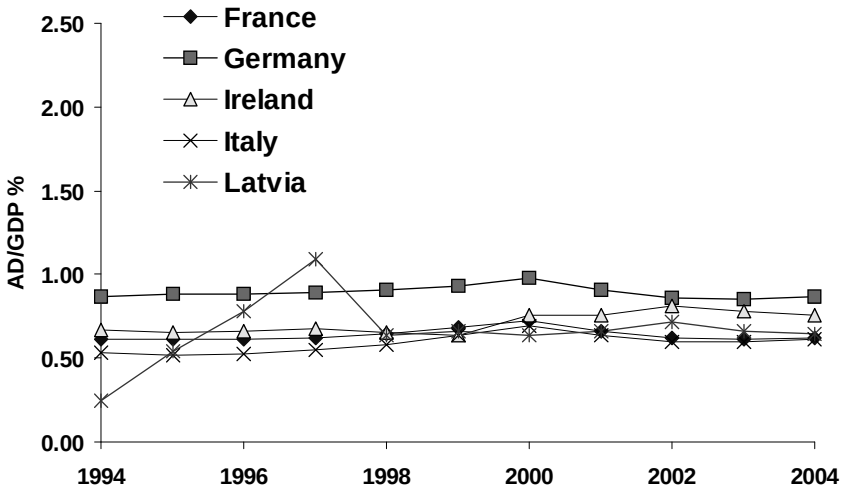
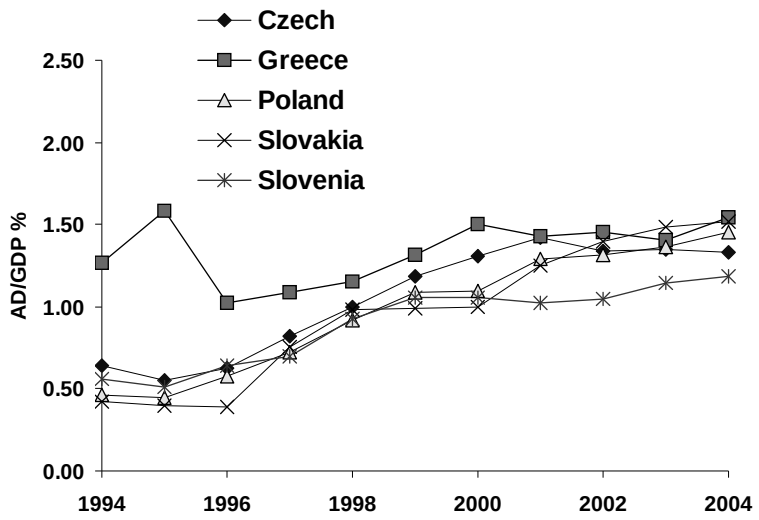


Figure 4: Time-series for the percentage of advertising expenditure in gross national product (AD/GDP %) for 'Cluster 1'and 'Cluster 2'. Note: for 'Cluster 2' only 5 out of 17 time-series are plotted.

Cluster 3



Cluster 4

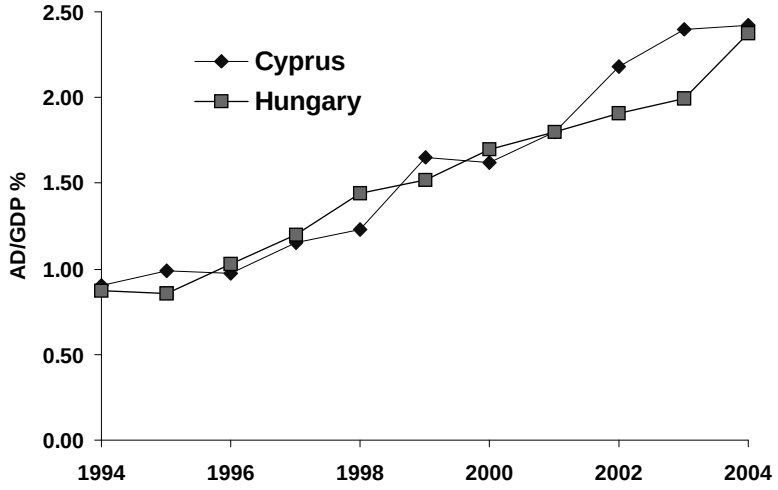


Figure 5: Time-series for the percentage of advertising expenditure in gross national product (AD/GDP %) for 'Cluster 3' and 'Cluster 4'.