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# Determinants of tourism industry in selected European countries: a smooth partial least squares approach

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## ABSTRACT

Various events, such as the global economic crisis, have seriously hampered long-term stable tourism processes with a particular relevance to international visits. In this study, we use the smooth paths of partial least squares (PLS; more specifically its PLS-SVD algorithm) and principal component analysis (PCA) dependent on a time parameter to descriptively examine the multivariate connections of tourism and economic growth during the periods close to the crisis. A novel approach regarding the paths of leading singular values and corresponding singular vectors and describing the maximum covariance strength reveals many practical outputs as time lags and mutual connections between sets of data. From the base of Central European countries analysed here, only Switzerland shows a significant tourism lagged situation, where the results provide relative perceptive conditions to non-residents with stable conditions for domestic tourism. Our findings show great evidence of similar behaviour in the Austria, Slovenia and Poland group as well as the Czech Republic and Slovakia group. Also the Czech Republic and Slovakia are potentially very sensitive to non-resident visits. Germany reveals its strong interconnection to the European economy. On the other hand, in the case of Hungary, simultaneous changes in income and consumer prices form ideal conditions for tourism.

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C32; C38; L83

## 1. Introduction

Tourism and tourism-related activities are regarded as one of the most important sectors of economic growth in the world. It is estimated that the tourism sector stimulates investment, and due to increased competition, leads to the greater efficiency of local companies. This, in turn, decreases production costs in many cases. Tourism increases foreign exchange earnings and decreases unemployment because of its close connection with human capital (Antonakakis, Dragouni, & Filis, 2013; Zolfani, Sedaghat, Maknoon, & Zavadskas, 2015). Government revenues and industries such as construction, agriculture and handicrafts are also closely connected to tourism. As a dynamic economic sector, tourism is influenced by

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the various and often changing conditions offered by individual countries with consequent per-capita tourism expenditures, travel decisions and corresponding length-of-stay decisions. Considering the potential of tourism for poverty alleviation and economic growth (World Economic Forum, 2009), the decrease of tourism demand during the 2008–2009 economic crisis<sup>1</sup> has had a serious impact on vulnerable groups of people and businesses connected to tourism, with a particular impact in developing countries. The crisis peaked in 2009, marking a decline in international tourist arrivals of 4% at the global level and a 6% decrease in tourism receipts. In March 2009, arrivals were at their minimum and accounted for a 12% decrease in international tourist arrivals. International tourism was also affected by the worldwide outbreak of influenza A (H<sub>1</sub>N<sub>1</sub>) at the beginning of spring 2009. The crisis witnessed great changes in travel habits as tourists booked at the last moment due to the lack of job stability and thus the inability to plan for the future. Tourists were able to profit from last-minute purchases and also because of the under-utilised capacities of customer services (Smeral, 2010). Therefore, tourism became more price sensitive, a trend which survived the crisis period and aggravated necessary investment. In many cases, the crisis also led to a worsening of service quality. Considering a global context, where tourism demand is influenced by natural disasters, economic crises, terrorism, crime, ethnic conflicts and political instability, the studying of mutual relations between tourism and the relevant economic parameters is crucial to setting effective management plans during, as well as after, the considered period.

Europe is the leading tourist destination in the world with over 563.4 million (51.8%) international tourist arrivals in 2013, an increase of 5.4% over 2012, and double the region's average growth for the period 2005–2012 (United Nations World Tourism Organization, 2014). This increase is forecasted to continue by 3–4% for Europe and the Americas, with even stronger prospects for Asia and the Pacific as well as for Africa. Asia and the Pacific demonstrated the largest increase of international tourism receipts in 2013, followed by the Americas and Europe (4% for Europe; local currencies; constant prices) compared to 2012. Africa recorded flat results in receipts while the Middle East fell. The global economic crisis and the eurozone debt crisis of 2010 induced a serious decrease in international tourism for Europe; the sector evinced long-term annual growth. Presently, the rapid recovery in global tourism despite changing economic conditions proves the sector's resilience and its role as a key driver of growth and employment.

Current tourism-related statistical methods dealing with modelling and forecasting can be roughly divided into the time series approach, econometric modelling and some new statistical models, such as artificial intelligence techniques being independent on distribution and other probability information of data studied (Song & Li, 2008). Time series models often assume higher frequency data than the annual scale. Since time series models try to determine future tourism processes according to past behaviours, their informative abilities are rather limited in the currently changing world. Periods of crises are linked with changes in consumption behaviour, which must be incorporated into new models to describe incoming demands. The great advantage of econometric techniques over the time series approach is the ability to interpret causal relations between tourism demand and the multivariate influencing factors (economic variables), as they can act as a guide for policymakers and subsequent leading processes. Recently, the econometric model has been using spillover indexes in a vector autoregression technique, which also enables the study of relations over time (Antonakakis, Dragouni, & Filis, 2013). However, the application of such a technique

reveals the great extent of the time varying relationship between tourism-led economic growth and the economic-driven tourism growth examined in the 10 European countries.

Along with confirmation of the significant share of tourism in national and worldwide economy accounts, a vast amount of literature was focused on connections between tourism and the wide range of economic parameters. Publications dealing with tourism demand and the economy are currently oriented to two promising areas – the various alternatives of co-integration and vector autoregression techniques. Mello-Sampayo and Sousa-Vale (2012) confirm the tourism-led growth theory using the likelihood-based panel co-integration technique, although they detect a higher impact of tourism on GDP in North- than in South-European countries. However, they also prove a much stronger effect of total trade volume on long-run economic growth, thus in some sense, a smaller effect of tourism on the economy in the long horizon. Through the other panel co-integration technique, Dritsakis (2012) finds connection between tourism development and GDP in the case of seven Mediterranean countries, together with a strong influence from the real exchange rate. Previously, Dritsakis (2004) discovered bi-directional causality in economic-driven tourism growth as well as tourism-led economic growth in the case of the Greek economy. Savas, Beskaya, and Samiloglu (2010) use the autoregressive distributed lag approach to co-integration and the error correction model to reveal long-run unidirectional causality beginning with tourism expenditures, tourism arrivals and real exchange rates on economic growth in Turkey, thus supporting the tourism-led growth hypothesis. Ivanov and Webster (2013) find the relation of tourism and the average per capita economic growth contribution for the years 2000–2010 worldwide. Also the socio-economic environment can affect the tourism sector in a contrary way (Payne & Mervar, 2010), given by resources availability, developed infrastructure and political stability.

Delayed relations between tourism time series data are often studied using the autoregressive distributed lag model with the preferably implied error correction model. In this way, numerical realisations are completed by an ordinary least squares approach. The autoregressive distributed lag model was used to study the relations between Hong Kong international tourism arrivals and a set of economic indicators with a single (annual) lag considered (Song, Wong, & Chon, 2003). The most important factors identified favouring travel were the cost of tourism, the income level in the origin countries or regions, the cost of tourism in the competing destinations and the word-of-mouth effect. A forecast of international tourism arrivals for the period 2001–2008 is also included in their work. Song and Fei (2007) proved very similar influencing factors contributing to tourism demand in mainland China. In the study of Nanthakumar, Ibrahim, and Harun (2008), which is inconsistent with the preceding ones, they use the vector autoregressive estimation, Johansen's and Juselius' co-integration analysis and Granger-causality results to find economic-driven tourism growth in Malaysia with subsequent notes on policies and strategies to increase tourist arrivals. Eugenio-Martin, Morales, and Scarpa (2004) publish the fact that the tourism sector is contributing to economic growth in medium- and low-income Latin American countries. This is a very important task in the sense of studying whether the relations between tourism and economic growth differ in developed and developing countries. In detail, the literature indicates a larger influence of tourism on economic growth in smaller developing countries than in developed ones (Dritsakis, 2012). This is very important as many developing countries have invested heavily in tourism as part of their strategy for development (Brohman, 1996).

Brida and Giuliani (2013) study time series data from 1980 to 2009 of local real GDP, the number of international tourists visiting the region, and the relative price index between the European regions of South Tyrol, Trentino and Tyrol to confirm the tourism-led growth hypothesis. Using the co-integration technique, the unidirectional causality between international tourism and the growth of local economies was proven. The exception was Tyrol, where the tourism-led economic growth hypothesis was not validated between tourism demand and the regional GDP, probably due to the fact that the economy in Tyrol is more complex, diverse and less dependent on tourism than the others. This fact also stipulates the question of whether the tourism-led growth hypothesis is valid for economies that are not heavily dependent on the tourism sector.

Another substantial part of tourism and the economy relations deals with analysing the synchronisation between tourism demand and business cycles, studied by Guizzardi and Mazzocchi (2010) and Gouveia and Rodriguez (2005). Guizzardi and Mazzocchi (2010) analysed the cyclical movements in tourism demand, expressed as quarterly data, on nights spent in hotels between 1985 and 2004 explained by the delay of the economic cycle by using the latent cycle component and explicit modelling of cycles through explanatory variables in Italy. They consider GDP, industrial production, consumer price indices, the aggregate price index and the US dollar exchange rate vs euro as the explanatory economic parameters. After extracting cyclical components and purging seasonal and trend components, they study the economic determinants of the nights spent and confirm the hypothesis of delayed effects of the overall business cycle through the stepwise dynamic regression approach. The key lagged pattern for domestic tourism is the fourth quarters, possibly due to the word-of-mouth process and a substantial seasonality of demand. On the other hand, the lag in international tourism is likely dependent on the printing time of the advertising brochures, being approximately two or three quarters in advance of the holiday period. Gouveia and Rodriguez (2005) use the non-parametric method of Harding and Pagan (2003) and the Hodrick-Prescott filter on stays in Algarve hotels to find a time lag and cycle synchronisation between foreign tourism stays and the industrial production index of origin countries. On the basis of cycle indicators for the UK, Germany, the Netherlands and Portugal, they found that the synchronisation is represented to a greater extent by tourism demand than from economic cycles, and using the recursive correlation coefficient, that the degree of synchronisation is also increased over years. Gouveia, Guerreiro, and Rodriguez (2013) extend previous work (Gouveia & Rodriguez, 2005) to analyse tourism exports cycles for all regions of the world with the cycle of the EU-27. Among others, on the basis of the concordance index, they found positive growth of synchronisation for developing countries with increasing tourism contrary to currently synchronised countries of North and Central America, North Africa, Middle East and Asia. This difference in synchronisation may be caused by the decrease in European markets and a favouring of competing destinations.

The majority of studies consider regions where tourism is one of the main contributors to the national economies. But there is a great extent of recommendations to analyse economies where tourism does not serve as the main factor for growth (Brida & Giuliani, 2013). In this study, Central European tourism is considered as being typical of this case. Central Europe is studied on a country by country basis in the broader sense and divided into a western part, covering Austria, Germany, Liechtenstein, Slovenia and Switzerland, and an eastern part, comprising the Czech Republic, Hungary, Poland and Slovakia. While the eastern part is based solely on the Visegrád Group countries following narrow definition, the western

part embraces the rest of them, i.e., the German-speaking countries as well as Slovenia. The sample period is vastly informative and case-specific as including global economic crisis time series data. The main aim of this study is twofold. Firstly, time lags are investigated between sets of economic parameters and tourism given by maximum relations. Then, we find the structure of relationships between and within the sets in the points of such maxima. The relations, excluding the time-lag pattern in time series data, are studied in accordance with the work (Malec, Pavlíček, & Poživil, 2014). Contrariwise, theory on functional relation considering the analytical paths extension of such approach dependent on a parameter in the convex combination of constraints was published and can be derived similarly with (Malec, 2015). The smooth processes of multivariate partial least squares (PLS) and principal component analysis (PCA) methods and their application by a moving window process of tourism data (window sliding along the data) depending on a time parameter is discussed by set economic conditions in a constant interval of time. We use the singular value decomposition theory in data processing rather than spectral decomposition due to its generality, and because of straightforward theory, we concentrate our attention mainly on the leading singular value. The paths of singular values and corresponding singular vectors of between and within sets correlation matrices are expressed as smooth functions of the annual data processed by a piecewise polynomial form of the cubic spline interpolant. To the best of our knowledge, Malec (2014) has published the only one descriptive application of smooth PLS on real data. However, the approaches can also be termed as moving window PLS and moving window PCA. Excluding the chemical disciplines such as analytical chemistry, although the various techniques of a moving window have been used intensively in quality control (De Ketelaere, Hubert, & Schmidt, 2013), seldom can publications be seen in the field economics, with no publications from the area of tourism.

The rest of this study is organised as follows: Section 2 contains a description of the data used and the empirical and algebraic background of the applied methods. Section 3 reveals the connections between the economic and tourism parameters through a practical example of selected countries. Section 4 concludes by emphasising the most important outcomes.

## 2. Experimental

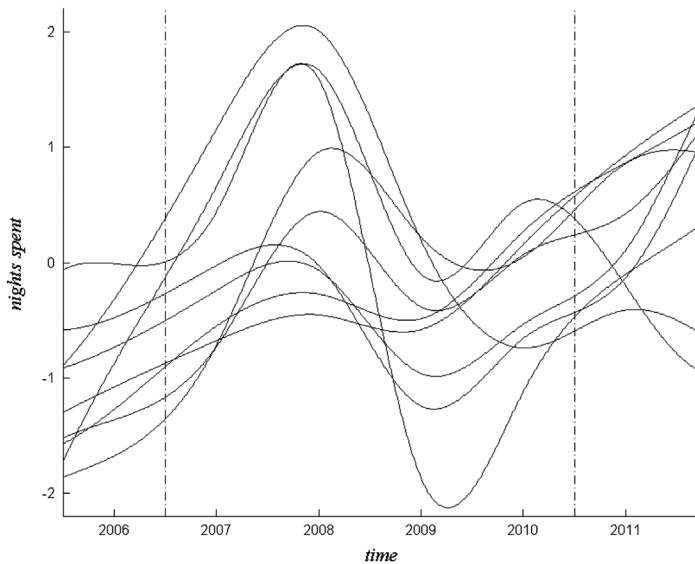
### 2.1 Data studied

In light of the globalised world, it is suitable to investigate the relations between economic parameters and tourism on the basis of more than one country for mutual comparison of individual findings. Due to the wider sense, the western part of Central Europe (consisting of Austria, Germany, Liechtenstein, Slovenia and Switzerland), and the eastern part of Central Europe (comprising the Czech Republic, Hungary, Poland and Slovakia), are examined in this study. For the consequent analyses, the 2005–2013 (resp. 2005–2012 in case of no release) annual time series data were split into a higher frequency scale. The economic parameters for 2007–2010, describing some of the pre-crisis, the global economic crisis as well as the eurozone debt crisis data are compared with moving window tourism conditions over time. The parameters (variables) used throughout this study are from those often considered in tourism demand functions as introduced above for the proper data mining approach and are presented in Table 1. The European Statistical Office (Eurostat database, 2014) was used to gather the required data. A lack of data on the economy is detected

**Table 1.** Economic and tourism parameters.

Parameter	Abbreviation	Description
Gross domestic product	GDP	Gross domestic product at current prices; in euro
Exchange rates*	EXR	Exchange rates on average
Income	INC	Gross disposable income; non-financial transactions; households, non-profit institutions serving households; in euro
Consumer prices	CPR	Harmonised indices on consumer prices; all items; annual average index
Unemployment	UNP	Unemployment rate in total; 15 years or over
Nights spent	NGT	Hotels and similar accommodation establishments; total number of nights spent
Non-residents' and residents' ratio	NRR	Ratio of number of nights spent by non-residents and residents; hotels and similar accommodation establishments
Arrivals	ARR	Hotels and similar accommodation establishments; total number of arrivals

\*In case of countries involved to eurozone, the US dollar exchange rate vs euro is used. The euro exchange rates vs national currencies are employed in cases of the Czech koruna, Hungarian forint, Polish zloty and Swiss franc. Source: authors.

**Figure 1.** Standardised nights spent data. Source: authors.

in Liechtenstein, but particularly due to comparability and the relatively low analogy of methodical approaches, the corresponding parameters are regarded as missing.

The literature notes vary with respect to using arrivals or nights spent data (Alegre & Pou, 2006). Bakkal (1991) provides reasons to prefer nights spent in modelling tourism demand, as it considers the length of stay being more related to expenditures and consequent economy accounts. It is important to note that the travel decision, and thus generally the arrival, is a binary variable based on the threshold levels of the actual economic situation and some other conditions. We emphasise tourism nights spent data in this study. Figure 1 shows such data processed by a cubic spline interpolant providing the second derivative continuous.<sup>2</sup> The vertical lines restrict the area of the selected economy window. The graphical representation, inter alia, demonstrates the great significance of the period considered

because the nights spent data fell sharply during the global economic crisis. The pre-crisis data are an important part of the time window because they represent the magnitude of the decrease in the indicators in the course of the following crisis period. Many EU countries have experienced a great economic downturn since 2009 inclusive.

## 2.2 Methods

The new approach is applied to examine the empirical consensus of the relationship between the tourism and economic parameters in the multivariate model. We study the relations on original variables processed by a piecewise polynomial form of the cubic spline interpolant, and examine the similarity of profiles in a descriptive way. The processes (paths) of eigenvalues known from natural sciences, with particular attention paid to theoretical physics, are used in this study as a suitable way to describing time processes of the relations between and within sets. Zovko and Farmer (2007) published notes about the magnitude of eigenvalues considering finite and infinite time series data. Only a limited number of publications on paths of eigenvalues are applied in the financial time series (Fricke, 2012; Plerou, Gopikrishnan, Rosenow, Amaral, & Stanley, 2001) considering one set. Fricke (2012) uses the evolution of the few largest eigenvalues to detect significant clustering in trading strategies in the overnight money market of the Italian interbank trading system with a focus on the leading eigenvalue and corresponding eigenvector. On the other hand, Plerou et al. (2001) study the collective behaviour of stock price movements by applying the conceptual framework of the random matrix theory. On the basis of the leading eigenvalue, they confirm the crash when all stocks in the market lost value at the same time, which means a more synchronous movement of stocks than usual. Kauermann and Wegener (2011) introduce the successful application of one type of the smooth PCA.

In this study, PLS and PCA approaches are used. Considering the huge amount of PLS models, we use and describe one of them – abbreviated as PLS-SVD and called robust canonical analysis, canonical covariance or intercorrelations analysis – which has a straightforward theory leading to its smooth parameter processes. Although the probability description of PCA exists, such a report is missing for many of the PLS variants. The PLS method studies the covariance relations between two sets of data through linear combinations of original variables. Those combinations form latent variables (also factors or components). The reason to apply this method is the significant collinearity within sets causing the disruption of input assumptions of other regression methods, e.g., of the canonical correlation analysis being algebraically very similar to PLS-SVD (see Wegelin, 2000). Krzanowski (2000, p. 436) discusses in detail the properties and assumptions of the canonical correlation analysis. Standard PCA describes the relations within one data-set using maximisation of variance of principal components (also called latent variables) – linear combinations of original variables (Krzanowski, 2000, p. 60). We standardise the variables in order to assign equal weights to all data used.

The presence of significant relations in the economy and other sciences cannot be generally interpreted as causal. On the other hand, the importance of the variables considered in this study is testified by the vast amount of literature dealing with relations between the tourism industry and economic parameters. The literature evidence is that the economic conditions form the environment for the countries' specific tourism industry potential. On the other hand, tourism has an impact on the economy, and in many cases it is the initiator



of economic growth. From the theoretical background, it is evident that the approaches used herein are perceptive to the evidence of threshold in the economic parameters from which tourism is requested to a greater extent. In comparison to the methods, such as co-integration or vector autoregressive technique, they are very sensitive to the distance of a given value of a variable from the mean, a situation specific to the interpretation of results. It follows that the approaches used in this study form the potential of the other way to analyse data additional to standard time series models.

The algebraic extension of both static methods to the smooth processes of mutual relations is demonstrated in the next sub-section using a time parameter. The leading eigenvalues (resp. singular values) are examined within the main text of this study and applied in the practical tourism example. The theory considering the whole spectra is introduced in the Appendix. All the programmes are written by the author using MATLAB 7.1 (Mathworks, Natick, MA, USA) software platform. We use a number of built-in functions, especially those from linear algebra as singular value matrix decomposition.

**Smooth partial least squares and principal component analysis**

*Notation.* The discrete values of vector functions  $(x_1(t), x_2(t), \dots, x_p(t))$ , resp.

$(y_1(t), y_2(t), \dots, y_q(t))$  are sorted to matrices  $X = \begin{pmatrix} x_1(t_1) & \dots & x_p(t_1) \\ \vdots & & \vdots \\ x_1(t_k) & \dots & x_p(t_k) \end{pmatrix}$  of type  $(k, p)$ ,  
 resp.  $Y(\delta) = \begin{pmatrix} y_1(t_1 + \delta) & \dots & y_q(t_1 + \delta) \\ \vdots & & \vdots \\ y_1(t_k + \delta) & \dots & y_q(t_k + \delta) \end{pmatrix}$  of type  $(k, q)$  whose elements are smooth

functions (having at least class  $C^{(1)}$ ) of parameter  $\delta \in \langle \delta_0, \delta_1 \rangle$ . The individual times  $t_i$ ,  $i = 1, 2, \dots, k$  are chosen within the interval  $\langle t_1 + \delta_0, t_k + \delta_1 \rangle$  equidistantly. We consider  $k \geq \max(p, q)$ ,  $rank(X) = p$  and  $rank(Y(\delta)) = q$ . The matrices  $X$ , resp.  $Y(\delta)$  are standardised by columns (variables) to form the symmetric and positive-definite sample correlation matrices  $XX$ , resp.  $Y(\delta)Y(\delta)$ . Greek letters are used for eigenvalues, singular values, resp. parameters. The reversed notation of data matrix  $X$  due to the parameter  $\delta$  in PCA is given by standard convention. Vectors are introduced in bold.

Our task is solved by the PLS (PLS-SVD) method in the process dependent on a time parameter by leading eigenvalue paths (and corresponding eigenvectors), resp. leading singular value paths (and corresponding singular vectors). In our approach, we consider  $0 \in \langle \delta_0, \delta_1 \rangle$ , where the case  $\delta = 0$  corresponds exactly to PLS on stationary data (see for example, De Bie, Cristianini, & Rosipal, 2005; Wegelin, 2000).

In the smooth process we solve the optimisation task

$$\max_{\mathbf{u}(\delta), \mathbf{v}(\delta) \neq \mathbf{0}} \frac{\mathbf{u}'(\delta)X'Y(\delta)\mathbf{v}(\delta)}{\sqrt{\mathbf{u}'(\delta)\mathbf{u}(\delta)}\sqrt{\mathbf{v}'(\delta)\mathbf{v}(\delta)}}, \tag{1}$$

being a homogenous function in both  $\mathbf{u}(\delta) \in R^p$  and  $\mathbf{v}(\delta) \in R^q$  (coefficients of linear combinations) for  $\delta \in \langle \delta_0, \delta_1 \rangle$ .

The algebraic solution of task (1) is determined by the eigenvalue  $\lambda(\delta)$  and corresponding eigenvectors,<sup>3</sup> thus by triplet

$$(\lambda(\delta), \mathbf{u}(\delta), \mathbf{v}(\delta)). \quad (2)$$

The numerical realisation applies the Kuhn-Tucker theorem (Kuhn & Tucker, 1951) in the way of stationary points of Lagrangian. The resulting system is based on symmetric matrices

$$\begin{aligned} X'Y(\delta)Y'(\delta)X\mathbf{u}(\delta) &= \lambda(\delta)\mathbf{u}(\delta) \\ Y'(\delta)XX'Y(\delta)\mathbf{v}(\delta) &= \lambda(\delta)\mathbf{v}(\delta). \end{aligned} \quad (3)$$

Note that we can express the latent variables covariance using eigenvalue. The latent variables are often employed for dimension reduction as well as for the graphical display of results.

The vector (2) can be solved by finding the singular value  $\sigma(\delta)$  and corresponding singular vectors of matrix  $XY(\delta)$  (Golub & Van Loan, 1996, p. 70). In our system, the eigenvalues are the squares of corresponding singular values, i.e.,  $\lambda(\delta) = \sigma^2(\delta)$ . The elements of eigenvectors are numerically equal to elements of singular vectors.

If the leading eigenvalue  $\lambda(\delta)$  of task (3) is simple (of multiplicity 1) within the interval  $\langle \delta_0, \delta_1 \rangle$ , then the solution exists  $(\lambda(\delta), \mathbf{u}(\delta), \mathbf{v}(\delta))$  of (3) and (1), which is smooth on such interval. If in the following we require that the solution of (3) for any  $\bar{\delta} \in \langle \delta_0, \delta_1 \rangle$  gains the selected values  $(\lambda(\bar{\delta}), \mathbf{u}(\bar{\delta}), \mathbf{v}(\bar{\delta}))$ , i.e., if interpolates the initial condition, then the solution is unique. This statement is the corollary of (Harville, 1997, theorem 21.15.1, p. 564) by differentiation of eigenvalues and corresponding eigenvectors of symmetric matrices.

The PCA dependent on a time parameter is a special case of the preceding where we have the discrete values of vector function  $(x_1(t), x_2(t), \dots, x_p(t))$  to form a matrix

$$X(\delta) = \begin{pmatrix} x_1(t_1 + \delta) & \cdots & x_p(t_1 + \delta) \\ \vdots & & \vdots \\ x_1(t_k + \delta) & \cdots & x_p(t_k + \delta) \end{pmatrix} \text{ of type } (k, p), \delta \in \langle \delta_0, \delta_1 \rangle.$$

The smooth process is solved by optimisation task

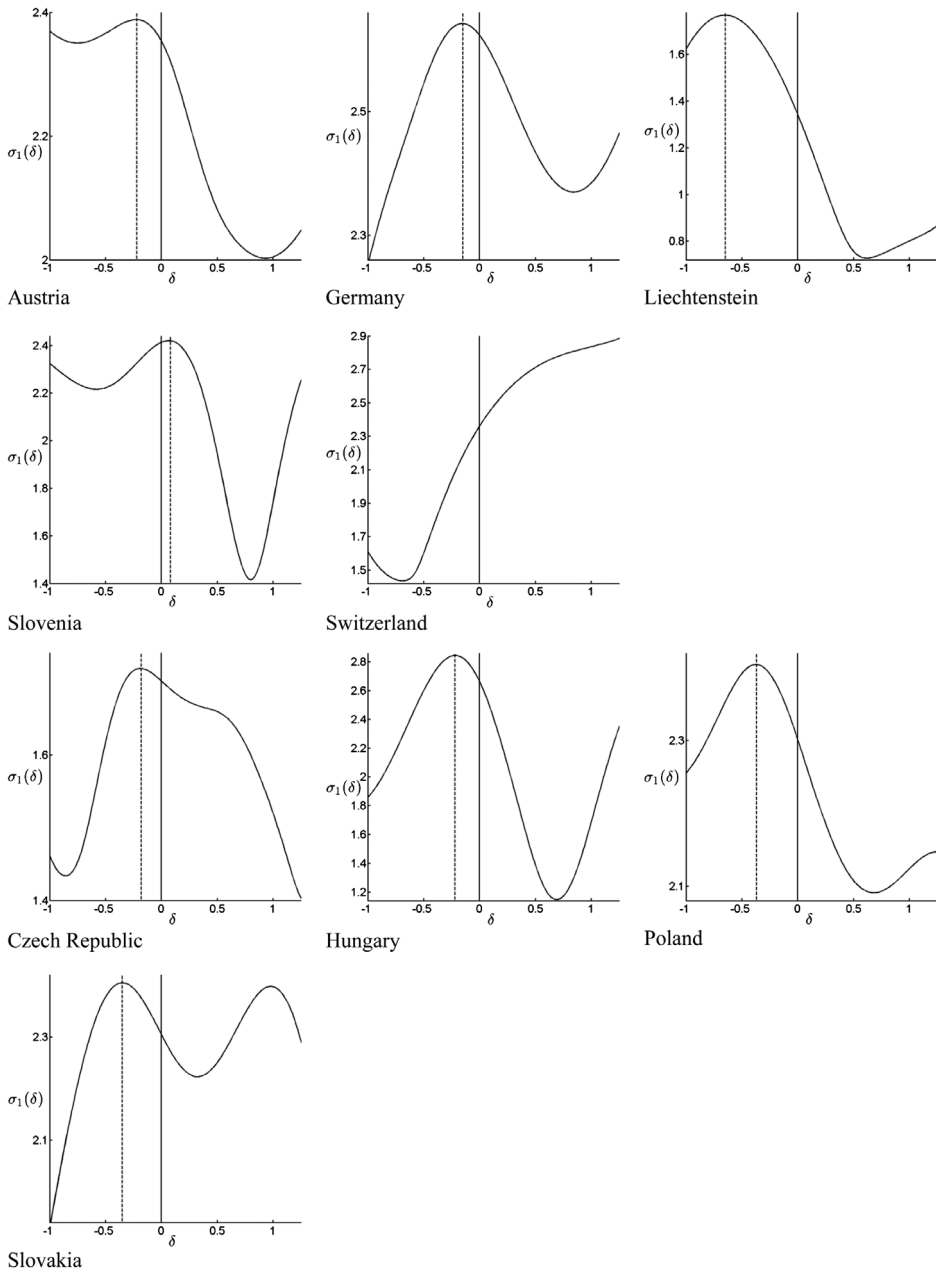
$$\max_{\mathbf{u}(\delta) \neq \mathbf{0}} \frac{\mathbf{u}'(\delta)X'(\delta)X(\delta)\mathbf{u}(\delta)}{\mathbf{u}'(\delta)\mathbf{u}(\delta)}, \quad (4)$$

where this function is homogenous in  $\mathbf{u}(\delta) \in R^p$  (coefficients of linear combination). According to the Kuhn-Tucker theorem (Kuhn & Tucker, 1951) the numerical solution of task (4) is given by the leading eigenvalue  $\lambda(\delta)$  and corresponding eigenvector  $\mathbf{u}(\delta)$  of matrix  $X'(\delta)X(\delta)$  arranged to vector  $(\lambda(\delta), \mathbf{u}(\delta))$ . This problem can be solved directly by using the singular value decomposition of standardised matrix  $X(\delta)$ .

Provided that  $\lambda(\delta)$  is simple within the interval  $\langle \delta_0, \delta_1 \rangle$ , then the solution is a smooth function of the parameter, and if it interpolates the initial condition, then such a solution is also unique (Harville, 1997, theorem 21.15.1, p. 564).

### 3. Results and discussion

The results of the empirical studies in many examples suggest that the causality between tourism and economic growth is bi-directional with a relative direct conclusion of tourism



**Figure 2.** Path of singular values. Source: authors.

supporting economic growth, see, e.g., (Antonakakis, Dragouni, & Filis, 2013; Dritsakis, 2004; Lee & Chien, 2008). Using the PLS moving window process of tourism data depending on a time parameter and setting the economic period constant for the global economic crisis and other close events, we start the analysis with the economy lag and then through the contemporaneous effect (no lag) pass over a study of the tourism lagged situation. Tourism lag can be perceived as the lag in economy impact considering unidirectional

**Table 2.** Smooth PLS results.

	Austria		Germany		Liechtenstein	
<i>Western part</i>						
$\delta$	0	-0.22	0	-0.15	0	-0.65
$\sigma_1(\delta)$	2.354	2.388	2.623	2.642	1.342	1.768
Sh.*	62.89	66.32	82.77	81.47	82.84	94.43
GDP	0.559	0.534	0.507	0.511	-0.596	-0.622
EXR	0.022	-0.006	0.251	0.168	-0.803	-0.783
INC	0.580	0.594	0.543	0.541		
CPR	0.586	0.600	0.430	0.445		
UNP	-0.087	-0.047	-0.448	-0.469		
NGT	0.564	0.548	0.649	0.660	0.735	0.604
NRR	-0.443	-0.470	0.401	0.363	0.258	0.442
ARR	0.697	0.692	0.647	0.658	0.627	0.663
	Slovenia		Switzerland			
$\delta$	0	0.08	0	1.25		
$\sigma_1(\delta)$	2.413	2.420	2.360	2.884		
Sh.*	70.18	71.17	72.47	79.93		
GDP	0.534	0.557	0.475	0.489		
EXR	-0.349	-0.370	-0.502	-0.483		
INC	0.571	0.554	0.492	0.491		
CPR	0.511	0.492	0.250	0.394		
UNP	0.079	0.051	0.467	0.363		
NGT	0.631	0.626	-0.350	-0.572		
NRR	-0.420	-0.430	-0.761	-0.689		
ARR	0.653	0.651	0.546	0.445		
	Czech Republic		Hungary		Poland	
<i>Eastern part</i>						
$\delta$	0	-0.18	0	-0.22	0	-0.37
$\sigma_1(\delta)$	1.702	1.719	2.662	2.843	2.301	2.404
Sh.*	63.60	59.31	84.81	83.06	79.91	79.11
GDP	0.156	0.037	0.495	0.472	0.491	0.485
EXR	-0.180	-0.077	-0.500	-0.487	0.214	0.217
INC	0.460	0.377	0.518	0.493	0.530	0.525
CPR	0.572	0.498	-0.301	-0.339	0.657	0.644
UNP	0.637	0.776	-0.382	-0.427	-0.029	-0.166
NGT	-0.485	-0.516	0.710	0.694	0.568	0.604
NRR	-0.818	-0.772	0.302	0.456	-0.582	-0.527
ARR	-0.309	-0.372	0.637	0.557	0.582	0.597
	Slovakia					
$\delta$	0	-0.35				
$\sigma_1(\delta)$	2.305	2.405				
Sh.*	75.86	72.33				
GDP	0.321	0.242				
EXR	0.372	0.514				
INC	0.494	0.395				
CPR	0.467	0.357				
UNP	0.544	0.627				
NGT	-0.545	-0.570				
NRR	-0.693	-0.652				
ARR	-0.472	-0.500				

\*Percent share of  $\sigma_1(\delta)$  on relations is given by  $\sigma_1(\delta) / \sum_i \sigma_i(\delta)$ . Source: authors.

causality. The tourism parameters are then studied deeply by the smooth evolution of the PCA. Examining the leading singular values, we describe the proportion of the direction of main relations (resp. variance) over time. On the other hand, corresponding singular vectors give information on how much a particular original parameter affects the latent variable. For better clarity, we descriptively set the elements of singular vectors  $> 0.3$  as significant. It is important to note that the leading singular values in all cases are simple,

**Table 3.** Smooth PCA results.

	Austria		Germany		Liechtenstein	
<i>Western part</i>						
$\delta$	0	-0.22	0	-0.15	0	-0.65
$\sigma_1(\delta)$	2.012	2.086	2.636	2.530	2.598	2.316
Sh.*	67.06	69.54	87.87	84.32	86.59	77.18
NGT	0.528	0.555	0.603	0.613	0.582	0.575
NRR	-0.482	-0.467	0.530	0.508	0.533	0.494
ARR	0.699	0.688	0.597	0.606	0.614	0.652
	Slovenia		Switzerland			
$\delta$	0	0.08	0	1.25		
$\sigma_1(\delta)$	2.331	2.296	1.789	2.089		
Sh.*	77.71	76.53	59.63	69.65		
NGT	0.621	0.626	0.732	0.606		
NRR	-0.452	-0.438	0.657	0.690		
ARR	0.641	0.646	0.179	-0.396		
	Czech Republic		Hungary		Poland	
<i>Eastern part</i>						
$\delta$	0	-0.18	0	-0.22	0	-0.37
$\sigma_1(\delta)$	2.632	2.553	2.284	2.161	2.689	2.778
Sh.*	87.72	85.09	76.14	72.03	89.62	92.59
NGT	0.608	0.617	0.647	0.676	0.584	0.578
NRR	0.535	0.520	0.481	0.451	-0.543	-0.557
ARR	0.587	0.592	0.591	0.584	0.603	0.596
	Slovakia					
$\delta$	0	-0.35				
$\sigma_1(\delta)$	2.677	2.592				
Sh.*	89.23	86.41				
NGT	0.605	0.615				
NRR	0.540	0.527				
ARR	0.585	0.588				

\*Percent share of  $\sigma_1(\delta)$  on variance is given by  $\sigma_1(\delta) / \sum_i \sigma_i(\delta)$ . Source: authors.

which is often not case regarding higher-order analyses. Considering the results of empirical studies, the lagged demand of economic parameters is often set at four quarters in annual data using the various autoregressive lag models, see, e.g., (Song, Lin, Zhang, & Gao, 2010). The 2005–2013 (resp. 2005–2012) annual time series data were processed in this study with results instable over time appearing to be largely affected by the crisis. In all cases, zero-lag outputs are selected for interpretation of results, as well as in the vast majority of cases those consisting of maxima in a concave process of function with the zero lag. Based on the graphical results, a maximum four-quarter lag for economy delayed data and five-quarter lagged tourism conditions were selected in our case. The constant time window 2007–2010 for the economic parameters as well as the direction and extent of both lags is evident from Figure 1.

Figure 2 examines the time process of leading singular values considering the selected countries. It can be seen that Austria, Germany and Liechtenstein from the western part of Central Europe, as well as all countries from the eastern part, reveal significant negative lag considering the economy delayed case. In the case of Slovenia, the lag was positive, but relatively low. On the other hand, Switzerland reveals a high positive lag in tourism parameters. A well-resolved local maximum is identified in Germany, Hungary and Poland. Also the range of singular values considering the graphical representations is important to

assess the significance of such maxima. This means the countries of Liechtenstein, Slovenia, Switzerland and Hungary, in particular, are considered significant cases.

The relations of individual variables given by coefficients of PLS first latent variables are introduced in Table 2. The time lags, magnitudes of individual singular values at a specified time lag, and shares on total covariance are also stated. We must note that the relations are case-specific and differ between individual countries. Considering the western part of Central Europe, in the case of Austria the no-lag as well as lagged data show similar patterns of relationships. There, the GDP, the income and corresponding consumer prices positively relate to the nights spent, share of residents and arrival parameters. In such an arrangement, the increase in the GDP and income causes the growth for arrivals, nights spent, and share of residents. On the other hand, the rise in consumer prices suppresses the share of non-residents. Germany in no-lag and lagged data demonstrates a similarly positive relationship of GDP, income and corresponding consumer prices with nights spent, share of non-residents and arrivals, opposite to the unemployment rate. In such a case, the GDP, the income and consumer prices increase nights spent and arrivals with a lower, although significant, relation to the share of non-residents and residents. The positive relation of non-residents favouring ratio is probably due to the direct interconnection of the German economy to the others, particularly with respect to European countries. Also, the unemployment rate is negatively dependent on nights spent, arrivals, and the share of non-residents as well. In Liechtenstein, due to a lack of Eurostat data, the only two economic parameters are incorporated into the analyses. Apparently, because of the fact that Liechtenstein is currently not a significant market for US tourists, the relations of the exchange rate with nights spent and arrivals are reversed. At the lagged data, it seems that the past growth of the share of non-residents mainly influences the falling GDP at the increasing euro. Considering no-lag as well as lagged data for Slovenia, the GDP, income and corresponding consumer prices positively relate to nights spent, share of residents and arrivals contrary to the exchange rate. In this case, at the increasing GDP and income, the nights spent, arrivals and share of residents grow. On the other hand, the increase in consumer prices acts contrary to the share of non-residents. The increase of the euro against the US dollar leads to fewer foreign tourists and consequently less revenue in the target country. Switzerland, in no-lag data, reveals the GDP, the income and the unemployment rate as positively related to the share of residents and arrivals contrary to the exchange rate and nights spent. In this case, the exchange rate mainly favours the share of non-residents and nights spent at simultaneous decreasing arrivals. Also, as the GDP and income increase, the share of residents as well as arrivals increase, but the number of nights spent falls. This situation seems to be very sensitive to non-residents where stable conditions for domestic tourism are characterised by a lower number of nights spent. The unemployment rate is also negatively related to the share of non-residents and nights spent parameters. For tourism lagged data, the economic conditions are more pronounced and impact foreign tourists more. There, the consumer prices seem to be more significant and negatively related to the number of nights spent and the share of non-residents. It should be noted that tourism delayed data consider a maximum lag of 1.25 years, limited by the time interval examined in this study due to the empirical background of tourism processes. But the real delay in Swiss tourism data is considered later, approximately at 1.83 years, given by the maxima of the singular value path. We support this choice by the fact that the covariance relations in both the lagged points give almost identical results.

The Central European situation including east part is in some sense different to the preceding one. Generally, the amount of significant coefficients is larger at individual countries, particularly considering Hungary and Slovakia. In the Czech Republic, with no-lag data, a positive relation was revealed at income, consumer prices and the unemployment rate with the share of residents, contrary to nights spent and arrivals. There, the increase in consumer prices decreases the share of non-residents, the number of nights spent and arrivals parameters. On the other hand, with the rising income, the share of residents grows-up. Also, a significant parameter is the unemployment rate being inversely related to the share of non-residents, nights spent as well as arrivals. In lagged data, the situation is quite similar, with a more significant unemployment rate consisting of the same relations. This seems to indicate that Czech tourism depends more on foreign visitors, due to the opposite relation of income with nights spent and arrivals. No connection to the GDP was revealed. In Hungary with no-lag data, GDP and income are positively related with nights spent, arrivals and the share of non-residents contrary to the exchange rate, consumer prices and unemployment. In this case, increasing the GDP and income with a simultaneous reduction in consumer prices forms ideal conditions for tourism and leads to a growing number of nights spent and arrivals. Because both income and consumer prices act conversely for the non-residents' and residents' nights spent ratio, this parameter gains a rather low value. In this case, the exchange rate acts in a contrary way in some sense. At lagged data, the pattern of relations is quite similar, with only one exception, as the share of non-residents is more significant. For Poland, considering both no-lag and lagged data, the positive relation is evident at the GDP, income, consumer prices, nights spent, share of residents and arrivals. Like Austria and Slovenia, growth in the GDP and income causes an increase in nights spent, share of residents and arrivals. On the other hand, the rise in consumer prices causes a decrease in the share of non-residents. Considering no-lag data for Slovakia, a positive relation was revealed at income, consumer prices, unemployment, GDP and the exchange rate with the share of residents, contrary to nights spent and arrivals. The situation is similar to the Czech Republic where growing income caused an increase in the share of residents and a decrease in nights spent and arrivals. Also the GDP is significantly positively related to the share of residents in Slovakia. On the other hand, growth in consumer prices decreases the non-residents' and residents' ratio parameter, the number of nights spent and arrivals. Moreover, significant parameters are the exchange rate and unemployment, being inversely related to the share of non-residents. In the lagged situation, the relations demonstrate a similar pattern, particularly with the exchange rate being more significant than in data with no delay. This situation of Slovakia is also case-specific, being heavily dependent on foreign visitors.

The results of PLS give the approximate pattern of relations within groups. For exact conclusions, we process the tourism data by PCA (see Table 3) for points specified as zero lag, and in almost all cases considering the maximum singular value specified in the preceding analysis. This gives us very important information such as nights spent or total arrivals are more positively related to the share of non-residents (resp. residents). It can be seen that Austria, Slovenia and Poland nights spent and total arrivals are related to the share of residents. This is especially important in cases of high numbers of visits, because the ratio in the tourism sector favours residents for those countries. However, in Germany, Liechtenstein, the Czech Republic, Hungary and Slovakia, the share of non-residents is favoured at increasing nights spent and total arrivals. Switzerland is the exception as at

zero lag the relation between nights spent and total arrivals is weak, and at lagged data the pattern is even the opposite, where in both cases the nights spent favour the share of non-residents. The different relations of Switzerland within sets are visible in contrast to the other countries as well as at the results of PLS.

#### 4. Conclusion

The tourism sector's potential lies in its significance for ameliorating economic growth with particular attention on developing countries and also the least developed countries. Tourism expenditures are an alternative form of exports, improving the balance of payments owing to foreign exchange earnings in many countries. Thus, the breakpoints corresponding to important economic, political, natural or other events can seriously hamper the relations regarding tourism and related activities. The impact of the 2008–2009 global economic crisis and the subsequent European sovereign debt crisis is examined. It is proven and demonstrated that the smooth paths of parameters of both PLS and PCA considering the first-order approaches serve well in practical tourism time series data processing situations. We investigate the time lag covering selected tourism parameters which react to changed economic conditions and reveal the relations in such a point given by a time parameter  $\delta$ . This improvement of standard outcomes makes the methods used more powerful for descriptive purposes with the possibility to generalise the approaches to the other multivariate methods as well. Graphical representation of latent variables dependent on a time parameter in future studies also forms the potential to reveal the time evolution of observations by covariance, variance, or possibly other followed properties. Moreover, all the selected economic indicators prove their relevance in the model. Tourism Satellite Account data and employment in tourism are the other parameters forming possible inputs to the methods discussed. Based on the results of this study, appropriate policy recommendations can be derived in order to try to mitigate the repercussions of future crisis situations. A deeper insight into the outcomes is demonstrated within the main body of this study, but the basic results can be summarised as follows:

- The majority of the Central European countries demonstrate an economy lagged situation, with the exceptions of Slovenia and Switzerland. Thus the vast amount of selected countries are very sensitive to worldwide and various local events with preliminary changes in the tourism sector. The significant tourism lag in Switzerland reveals its strong resilience to changed economic parameters during and long after the crisis period. On the other hand, only Swiss tourism has significantly reacted to changing economic conditions after the crisis period, and not vice versa.
- Considering the PLS results, some similar general patterns were revealed. Austria, Slovenia and Poland behave similarly, as is expressed by a relatively clear positive relation of GDP and income with nights spent, the share of residents and arrivals. At the same time, an inverse relation of consumer prices and the share of non-residents was revealed. The Czech Republic and Slovakia also demonstrate similar behaviour, expressed by positive relations of income, consumer prices and the unemployment rate with the share of residents, being negatively dependent on nights spent and arrivals. Both countries seem to be perceptive to non-residents' visits.



- Furthermore, Germany reveals its close connection to the European economy, indicated by the positive relations of GDP, income and corresponding consumer prices with the share of non-residents. Also, the positive relation between nights spent and arrivals contrary to unemployment were revealed. For Hungary, the increase in GDP and income parameters with a simultaneous decrease in consumer prices both form ideal conditions for tourism. The converse sense of income and consumer prices produce a less pronounced ratio of non-residents and residents.
- Different relations to the others were detected in Switzerland, which form a relative stable environment for tourism without fast interconnections close to the crisis period. There, the GDP, income and the unemployment rate positively depend on the share of residents and arrivals with an inverse relation to the exchange rate and nights spent. Such a situation is sensitive to the share of non-residents at stable conditions of domestic tourism preferring shorter stays. This is confirmed by the results of the PCA using the smooth parameter processes.
- The difference in no-lag and lagged data interpretation is of particular interest in this study. In Liechtenstein, the negative relation of the past share of non-residents on the GDP was revealed. In the case of Switzerland tourism lag, the consumer prices are negatively related mainly to the number of nights spent and also the share of non-residents. For the Czech Republic, the unemployment rate is more significant in delayed data. In Hungary, the share of non-residents is more pronounced, and in the case of Slovakia, the exchange rate demonstrates increased significance in economy lagged data.

## Notes

1. In this study, the global economic crisis is introduced specifically in the horizon of sense most influencing the tourism sector.
2. All the data were also treated by a piecewise cubic Hermite interpolating polynomial with similar time processes and almost identical results of multivariate approaches.
3. According to Harville (1997, p. 555), this can be solved by spectral or singular decomposition theories.

## Disclosure statement

No potential conflict of interest was reported by the authors.

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## Appendix

In the following, the whole spectra of PLS and PCA is considered. For PLS method all positive eigenvalues (and corresponding eigenvectors) of (3) are employed given by symmetric, positive-semidefinite matrices, resp. all non-zero singular values (and corresponding singular vectors) of the matrix  $X'Y(\delta)$ . The higher-order latent variables are defined identically as in expression (1), taking the additional restriction into account, i.e., the latent variable of order  $l$ , with  $1 < l \leq \min(p, q)$ , is orthogonal to all the lower-order latent variables of the other set.

The solution of the optimisation task in dependency on parameter  $\delta \in \langle \delta_0, \delta_1 \rangle$  is given by vectors

$$(\lambda_i(\delta), \mathbf{u}_i(\delta), \mathbf{v}_i(\delta)), \quad (5)$$

where  $\lambda_i(\delta)$  is the non-growing sequence of the eigenvalues where every eigenvector  $\mathbf{u}_i(\delta)$  (resp.  $\mathbf{v}_i(\delta)$ ) is always and for all  $\delta$  orthogonal to all preceding vectors  $\mathbf{u}_j(\delta)$  (resp.  $\mathbf{v}_j(\delta)$ ),  $j = 1, 2, \dots, i - 1$  (Seber, 2004; theorem 5.9; De Bie et al., 2005).

We assume all the positive eigenvalues of (3) simple (of multiplicity 1) within the interval  $\langle \delta_0, \delta_1 \rangle$ . Then  $\lambda_i(\delta)$ ,  $i = 1, 2, \dots, r$  in (3) form a decreasing sequence, where generally  $r = \text{rank}(XY(\delta))$ , being independent on the parameter  $\delta$ . If for the vectors  $\mathbf{u}_i(\delta)$  (resp.  $\mathbf{v}_i(\delta)$ ) we choose the initial condition as corresponding own subspaces have a dimension 1, then the functions in (5) are unique and smooth within  $\langle \delta_0, \delta_1 \rangle$ . Anew, this is the corollary of (Harville, 1997, theorem 21.15.1, p. 564) by differentiation of eigenvalues and corresponding eigenvectors of symmetric matrices.

Using the singular value decomposition theory, if matrix  $XY(\delta)$  is a full-rank with simple singular values within interval  $\langle \delta_0, \delta_1 \rangle$ , then at the chosen initial condition for vectors  $\mathbf{u}_i(\delta)$  (resp.  $\mathbf{v}_i(\delta)$ ), the solution is unique in the form of singular values and singular vectors, where also the corresponding functions are smooth (Bunse-Gerstner, Byers, Mehrmann, & Nichols, 1991, theorem 2).

The solution of PCA by the whole spectra employing all positive eigenvalues (and corresponding eigenvectors) of matrix  $X(\delta)X(\delta)$  is completely analogous to the preceding one.