Divided Switzerland

Yadolah Dodge[1], Gérard Geiser[2], and Valentin Rousson[3]

[1] Statistical Institute, University of Neuchâtel
Pierre-à-Mazel 7, 2000 Neuchâtel, Switzerland, *yadolah.dodge@unine.ch*
[2] Neuchâtel Cantonal Statistical Office
Le Château, 2001 Neuchâtel, Switzerland, *gerard.geiser@ne.ch*
[3] Department of Biostatistics, University of Zürich
Hirschengraben 84, 8001 Zürich, Switzerland, *rousson@ifspm.uzh.ch*

Abstract. On the 6th of December, 1992, the Swiss population voted against the "Adhesion of Switzerland to the European Economic Area". Swiss German cantons, except Basel-Stadt and Basel-Land, voted against, and all French speaking cantons voted in favour of adhesion. Shocked by this outcome, the media, the politicians, and the population itself took this date as the beginning of the divided Switzerland. The purpose of this article is to show that what happened on that day was not a new phenomenon but was in line with more than a century of votations.

1 Introduction

Switzerland is a small but diverse country. Although it has an area of only about 41'000 km^2 and a little more than 7 million inhabitants, four very different official languages are spoken and Catholics and Protestants are present with similar proportions. Its geographical situation is particular too. Switzerland lies at the heart of Europe between countries with influential cultures such as France, Germany, Austria and Italy. Consequently, it is a country containing many different mentalities and it is divided in 26 cantons (or half-cantons).

Swiss direct democracy gives the people (and its government) various ways of expressing their opinions. The most frequent procedure used is the compulsory referendum which concerns mainly constitutional amendments. Another one is the popular initiative. For the acceptance of a referendum or a popular initiative, the majority of the people and the majority of the cantons must stand behind. Thus, all the cantons have equal weight (importance) in the final decision, regardless of their population sizes. For example, a canton like Zürich which in 1990 had more than one million inhabitants has the same weight as Glarus with less than 40'000. According to the constitution, this ensures representation of the minorities (small cantons).

A major problem with such a federal system of voting is cultural differences such as language, mentality and traditions. In particular there are only 6 French cantons whereas there are 16 Swiss-German ones (13 cantons and 6 half-cantons). If these two groups of cantons do not agree about an object, there is no doubt about the final result. The only Italian speaking canton is

still more minoritary. The famous vote of the 6th of December, 1992, about the "Adhesion of Switzerland to the European Economic Area" is a typical example of such a situation. A real linguistic cleavage was observed on this occasion, and the media, the politicians and the population believed this to be a new phenomenon.

The primary aim of this study is to show how official statistics can be useful in the analysis of some cultural phenomena in a given country. The official statistics are rarely used for decision making purposes. They are usually summarized in tables, percentages or graphical displays such as pies and bar charts to be presented to the general public. In fact official statistics are one of the best sources of information to understand the political, social, economical or cultural behaviors of a nation when combined with some simple statistical techniques. More importantly, an attempt has been made to "picture the mass of data" in a constructive way. The secondary aim of the article is to show that the linguistic cleavage has always existed in Switzerland. To achieve this, we took into consideration all the voting results from 1866 to 1998 and used a simple multivariate statistical method, namely principal components analysis.

This article is organized as follows. The data are presented in Section 2. In Section 3, the main aspects of principal component analysis are recalled. The analyses of the data for the three periods considered are given in Section 4. In Section 5, an attempt is made to compare the voting results with other variables that describe Switzerland. Finally, some conclusions are drawn in Section 6.

2 The data

The results of all federal votes from 1866 to 1998 are the basis of our study (Bundesblatt, 1866, 1872, 1874–1876, 1878–1880, 1882, 1884-1885, 1887, 1889-1898, 1900, 1902–1903, 1905–1908, 1912–1915, 1918–1935, 1937–1939, 1941–1942, 1944–1998). These include the compulsory referendums, the popular initiatives, as well as the optional referendums (although the latter do not need the double majority to be accepted). The total number of topics voted on is 405. For each votation and each canton, the percentage of "yes" has been recorded. The blank and the nonvalid bulletins have been excluded since they were in negligible quantities. A few examples of the data are given in Table 1. We have divided the votes in three periods, and this for several reasons. First, we wanted to observe if the voting behavior has changed with time. Second, we had to consider the creation of the canton Jura in 1978, and third, we wanted to see if the results of the votes since the 6th of December, 1992, were different. The three periods are:

1. From 1866 to 1978 (256 votations),
2. From 1979 (date of the entry of the canton of Jura into the Confederation) to December 6, 1992 (96 votations),

	14.01.1866	14.01.1866	...	25.10.1908	...	14.03.1948	...	06.12.1992	...
	vote #1	vote #2		vote #67		vote #143		vote #352	
Cantons	% of yes	% of yes		% of yes		% of yes		% of yes	
Zürich (ZH)	92.71	92.94		93.63		33.66		48.48	
Bern (BE)	38.59	37.19		83.21		40.55		47.59	
Luzern (LU)	21.76	19.20		92.79		32.74		39.31	
Uri (UR)	10.76	16.22		58.33		25.18		25.13	
Schwyz (SZ)	23.06	25.20		59.62		31.79		26.69	
Obwalden (OW)	73.74	71.37		79.97		37.83		28.20	
Nidwalden (NW)	20.64	15.68		77.08		37.42		33.86	
Glarus (GL)	78.66	65.48		89.23		31.88		31.95	
Zug (ZG)	12.27	14.09	...	85.97	...	33.80	...	43.83	...
Fribourg (FR)	21.27	46.50		83.76		54.41		64.89	
Solothurn (SO)	71.58	71.46		90.72		31.21		42.59	
Basel-Stadt (BS)	53.02	53.97		97.66		18.36		55.43	
Basel-Land (BL)	58.45	58.82		85.45		30.40		53.18	
Shaffhausen (SH)	48.20	47.00		92.42		47.58		38.51	
Appenzell-AR (AR)	41.51	40.38		82.92		18.12		36.73	
Appenzell-IR (AI)	4.79	1.59		47.78		29.80		29.05	
St.Gallen (SG)	26.32	20.22		75.43		32.36		38.44	
Graubünden (GR)	11.05	8.12	...	72.48	...	43.80	...	32.44	...
Aargau (AG)	57.39	56.15		78.76		33.34		39.94	
Thurgau (TG)	77.27	77.73		81.70		43.14		35.96	
Ticino (TI)	66.87	78.45		73.61		43.99		38.46	
Vaud (VD)	14.19	10.90		90.09		40.93		78.31	
Valais (VS)	14.91	13.30		79.87		42.30		55.84	
Neuchâtel (NE)	83.44	80.76		89.92		23.06		79.96	
Genève (GE)	75.71	69.05		98.65		51.03		78.14	
Jura (JU)							...	77.15	...

Table 1. A subset of the Swiss votation data used in our study (source: Bundesblatt, 1866–1998).

3. From 1993 to June 7, 1998 (53 votations).

The 26 cantons are the units of the present analysis. One might think that a large canton is too heterogeneous to serve as an interesting unit. However, according to Joye (1987) if one wishes to observe extensive cultural divisions like the linguistic, a canton is a good unit because it is most of the time a geographical area well recognized by its inhabitants. Other analyses based on smaller units such as the communities within cantons are certainly possible and will be the subject of further investigation.

3 Principal Components Analysis (PCA)

This well-known methodology was originally proposed by K. Pearson in 1901 as a means of fitting planes by orthogonal least squares, and was developed

by Hotelling in 1933 for the particular purpose of analyzing correlation structures.

A sample of p measurements $\mathbf{X}_1, \cdots, \mathbf{X}_p$ taken on n individuals can be represented by a matrix $\mathbf{X}$ of n rows and p columns (an x_{ij} element of this matrix being the j^{th} measurement on the i^{th} individual) or by a cloud of n points in a p-dimensional space, which is hard to visualize if p is greater than 2 or 3. It is therefore difficult to summarize such a sample using elementary descriptive statistics techniques and to get a global idea of what the data contain. Principal components analysis allows to deal with this difficulty by representing a p-dimensional cloud of points in a well chosen subspace of dimension smaller than p, for example in a 2-dimensional subspace. The idea is to project the n individuals in a subspace in which the distances between the (projected) individuals are the largest possible. The optimal 2-dimensional subspace hence obtained is called the principal plane of the sample in question, and the axes that generate it are the first two principal components. The procedure for a principal components analysis is as follows:

1. Standardize the p variables $\mathbf{X}_j$, i.e. replace the initial data matrix $\mathbf{X}$ by the matrix $\mathbf{Y}$ with elements y_{ij} such that $y_{ij} = (x_{ij} - \overline{x}_j)/s_j$, where $\overline{x}_j$ and s_j are the estimated mean and standard deviation of the variable $\mathbf{X}_j$ (for $j = 1, \cdots, p$).
2. Compute $\mathbf{C} = \mathbf{Y}'\mathbf{Y}/(n-1)$. This is the estimated correlation matrix of the variables $\mathbf{X}_1, \cdots, \mathbf{X}_p$.
3. Find the eigenvalues $\lambda_1, \cdots, \lambda_p$ and the associated eigenvectors $e_1, \cdots, e_p$ of $\mathbf{C}$. Order them so that λ_1 is the largest eigenvalue and λ_p the smallest one (they are all positive). Retain the first two eigenvectors e_1 and e_2.
4. Calculate the variables $\mathbf{Z}_1$ and $\mathbf{Z}_2$ as follows:

$$\mathbf{Z}_1 = e_{11}\mathbf{Y}_{1+}e_{21}\mathbf{Y}_2 + \cdots + e_{p1}\mathbf{Y}_p$$

$$\mathbf{Z}_2 = e_{12}\mathbf{Y}_{1+}e_{22}\mathbf{Y}_2 + \cdots + e_{p2}\mathbf{Y}_p$$

where e_{ij} is the i^{th} coordinate of the j^{th} eigenvector. These linear combinations of the p initial variables are the first two principal components that we are searching for.

Thus, one has reduced the number of dimensions from p ($\mathbf{X}_1, \mathbf{X}_2, \cdots, \mathbf{X}_p$) to 2 ($\mathbf{Z}_1$ and $\mathbf{Z}_2$), and one can now visualize the n individuals in the principal plane generated by $\mathbf{Z}_1$ and $\mathbf{Z}_2$. If one desires to add a third dimsnsion, one can consider the third principal component, i.e. the linear combination of the original variables defined by the third eigenvector e_3, and similarly for further dimensions. Recall also that the eigenvalue λ_i associated with the principal component $\mathbf{Z}_i$ is the variance of the n individuals projected on $\mathbf{Z}_i$, while the ratio λ_i/p is the percentage of total variance of the n individuals represented (preserved) by the principal component $\mathbf{Z}_i$. For more details, see for example chapters in the books of Diday et al. (1982), Manly (1986) or Jolliffe (2002).

4 Data analysis

We performed a principal components analysis for each period. The Swiss cantons are the n individuals (or units), and the voting results (the percentages of "yes") are the p variables. For the first period we have 25 individuals in a 256-dimensional space, for the second period we have 26 individuals (with the new canton of Jura) in a 95-dimensional space, and for the third period we have 26 individuals in a 53-dimensional space. Actually, as there are more variables than individuals, the real dimension of the cloud of points is $(n-1)$ (that is 24 or 25 according to the period) in the same way that 2 points in a 3-dimensional space lie on a line (a one-dimensional subspace).

As explained in Section 3, PCA gives an approximate display in two dimensions of a cloud of points situated in a 24- or in a 25-dimensional space. Figures given in next section represent the Swiss cantons in principal planes. The horizontal axis represents the first principal component, and the vertical axis the second one.

These principal planes give us an idea of voting similarities among the different cantons. If two cantons are close to each other in such a plane, it means that they voted similarly, and if they are distant from each other, they voted differently (at least if the principal plane gives a good approximation of the real situation, that is if λ_1 and λ_2 are high). Note also that cantons situated near the origin of the graph were generally close to the Swiss mean (their opinions were often in line with the majority).

4.1 Analysis of the period 1866-1978

Figure 1 represents the Swiss cantons in the principal plane for the period 1866-1978 (the abbreviations for the cantons are given in Table 1). The first axis accounted for 36% of the total variance and the second axis for 17%. This graph provides us with a summary picture of more than a century of votations. Observe for example that the cantons of Basel-Stadt (at the extreme top right of the graph) and Appenzell-IR (at the opposite side) voted very differently from each other, while cantons like Zug or Graubünden were the closest to the Swiss mean.

On the left side of Figure 1 we found the small and rural cantons like Appenzell-IR, Obwalden, Nidwalden, Uri and Schwyz, while at the opposite side, we found cantons with big cities like Basel-Stadt, Zürich and Genève. Not surprisingly, cantons with small population densities voted in a different way than those with higher population densities. Another factor correlated with the first axis was religion. Cantons on the right side of the graph were rather protestant, cantons on the left side were rather catholic and cantons in the middle of the graph were often semi-protestant and semi-catholic. The role played by religion in the voting results may for example explain the surprising distance found between Appenzell-IR and Appenzell-AR. However, this remark did not hold true for the non Swiss-German cantons. Genève

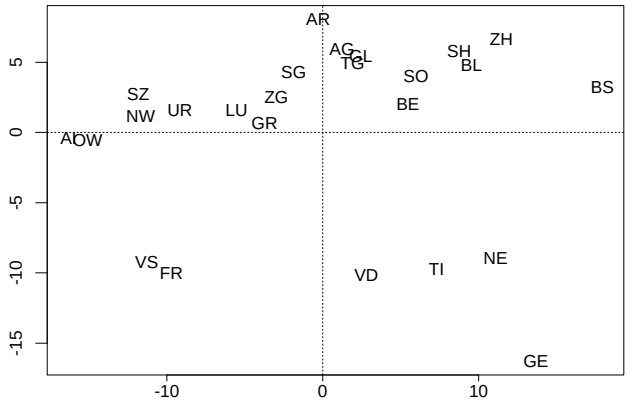

Fig. 1. First two principal components of 112 years of federal votation from 1866 to 1978.

and Ticino, with catholic majorities were close to Neuchâtel and Vaud, with protestant majorities. For a canton like Genève, this was not too much surprising given its history.

Interpretation of the second axis was more straightforward. All Swiss-German cantons were clearly situated in the top part of the graph whereas the French cantons and Ticino were in the bottom part. From all French cantons, the bilingual Valais and Fribourg were also the closest to the Swiss-German ones. From this analysis one can conclude that the difference in voting results between the German and the French cantons is a more deeply rooted phenomenon than the December 6, 1992 voting result.

4.2 Analysis of the period 1979-1992

Figure 2 represents the Swiss cantons in the principal plane for the period 1979-1992. The first axis accounted for 37% of the total variance and the second one for 29%.

Just entered into the Helvetic Confederation, the canton of Jura adopted a very special position, lying at the very right bottom part of the graph, still more extreme than Genève. All French cantons had actually quite special positions, each one being somewhat isolated in the plane. This was also the case of Ticino. Fribourg was a bit closer to the other French cantons (especially Vaud) than in Figure 1. The case of the Swiss-German cantons was quite different. With the exception of the two Basels, Zürich and Appenzell-IR, they were remarkably concentrated together.

Note that religion seems to have lost some of its influence. For example, the protestant cantons Bern and Schaffhausen were found in the neighbor-

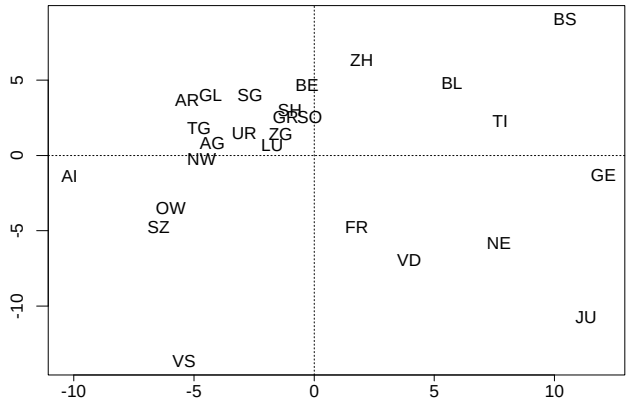

Fig. 2. First two principal components of votation results from 1979 to 1992.

hood of the catholic cantons Luzern and Uri. This was actually not really surprising since religion is nowadays less important in citizens' lives than in the past.

4.3 Analysis of the period 1992-1998

Figure 3 represents the Swiss cantons in the principal plane for the period 1993-1998. The first axis accounted for 39% of the total variance and the second one for 27%.

The linguistic separation between cantons was again pronounced, even more than for the previous periods, since the distinction was made here on the first axis, not on the second one. The French cantons stood on the right side of the graph whereas the Swiss-German cantons stood on the left side. Ticino had an intermediary position between the two groups. The homogeneity among French cantons was here comparable to the homogeneity among Swiss-German cantons. Valais was closer to French cantons than to Swiss-German ones, even if still a bit extreme. Among Swiss-Germans, Basel-Stadt and Basel-Land were the closest to the French cantons.

The linguistic factor seemed to play an important role among the Swiss-Germans cantons themselves! Swiss-German cantons where the percentage of German speaking people was particularly high (like Uri with 93.2%) were generally found more on the left side of the graph than Swiss German cantons where this percentage was smaller (like Basel-Stadt with 78.6%). Similarly, among the French cantons, the bilingual Fribourg and Valais remained the closest to the Swiss-German cantons. The correlation coefficient between the percentage of German speaking people and the coordinates on the first axis

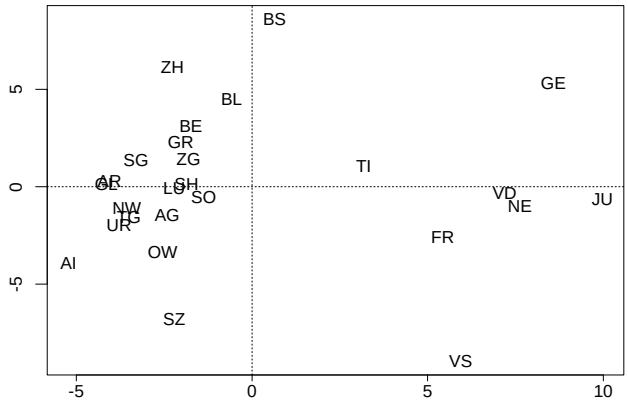

Fig. 3. First two principal components of votation results from 1993 to 1998.

was −0.95! Thus the spoken language was very much related to Swiss citizens' opinions.

5 Other description of Switzerland

In this section, we investigated how the Swiss cantons differ from each other according to other characteristics than votations. We performed a PCA using the 20 variables of general interest listed in Table 2 describing Switzerland in 1990. These data were published by OFS (1990, 1991-1994). The principal plane obtained is plotted in Figure 4. The first axis accounted for 32% of the total variance and the second one for 22%. Interestingly enough, the position of the Swiss cantons were very similar like in the principal plane of Figure 1 (if we ignore the canton of Jura not present in Figure 1). As in Figure 1, French cantons were found in the bottom part of the graph, with Genève at the right extremity, and with Fribourg and Valais nearly close to the Swiss-German cantons. The latter were covering the entire top part of the graph with Basel-Stadt and Appenzell-IR at both extremities and with big cities more on the right. The correlations between the canton's coordinates on Figure 1 and canton's coordinates on Figure 4 (if we ignore Jura) were of 0.87 for the first axis and of 0.85 for the second one! Thus, the picture of Switzerland was quite similar by considering more than one century of votations or by considering variables of general interest describing the Swiss cantons.

1. % of total population	11. % of 20 to 64 years old people
2. Population density (per km^2)	12. % of unemployment
3. % of German speaking people	13. % of married people
4. % of French speaking people	14. % of women
5. % of Protestant	15. % of women in cantonal parliament
6. % of Catholics	16. Infantile mortality
7. % of foreigners	17. % of road accidents
8. % of Swiss from another canton	18. Inhabitant income
9. % of students in gymnasium	19. Fiscal charge
10. % of students in university	20. % of pure agriculture exploitation

Table 2. Twenty variables describing Switzerland.

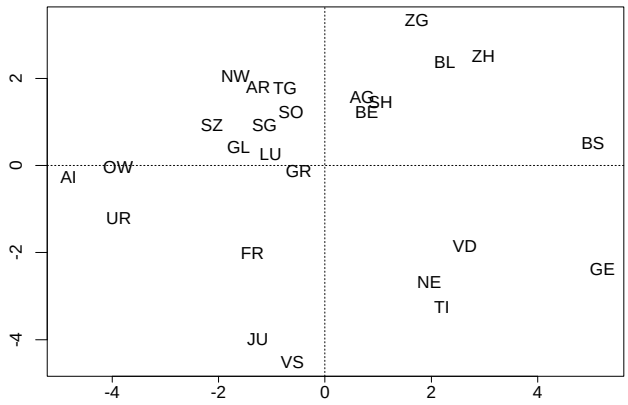

Fig. 4. First two principal components of 20 variables characterizing Switzerland.

6 Conclusion

An attempt has been made to answer the important question following the federal vote of the 6th of December, 1992, whether this date has to be interpreted as the beginning of a divided Switzerland. Using official statistics (the results of federal votations from 1866 to 1998) and a simple statistical technique (principal components analysis), we came to the conclusion that this division is not a new phenomenon. The fact that voting results have always been related to linguistic factors appears clearly in this analysis, even if other cleavages are also important. One should admit that Switzerland has faced such differences without too much difficulties during more than a century.

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