Frequency structure of New Year’s presidential speeches in Czech.
The authorship analysis

Radek Čech

1. Introduction

New Year’s presidential speeches represent a very specific genre. They mix both political and festive aspects and, contrary to common political speeches, they usually do not have persuasive character. The New Year’s speeches can be viewed as a very homogeneous genre because of their a) aim, b) form, and c) tradition. As for the aim (a), the goal of the speech is usually to summarize main events of the past year, mention perspectives of a near future, and express best wishes to the inhabitants of the state. The speeches have a very steady form (b), they are prepared in advance and read by the president. The tradition (c) of this kind of speeches is very long in Czech Republic (former Czechoslovakia) – it has started since 1949 and continued up to now (except of 1993 when no president was in office). Obviously, the strong homogeneity of the genre facilitates the authorship analysis because a host of boundary conditions is eliminated.

One can expect two contradictory “powers” which should have the greatest impact on the frequency structure of presidential speeches. On the one hand, the official and ceremonial character of this event should lead to the high uniformity of texts and, consequently, to the high similarity of frequency structures. On the other hand, presidents are usually persons with a strong individuality; as politicians, they have to be able to express their uniqueness and specificity, so, one can expect great differences among them.

For the measurement of frequency characteristics two methods were used: 1) the lambda measurement proposed by Popescu et al. (2010, 2011) and 2) the vocabulary richness index $R_I$ (Popescu et al. 2009); both methods are presented in the next section.

2. Methodology

The lambda-indicator expresses one aspect of frequency structure of text. In short, it takes into account both the frequency of words and the relationships among individual frequencies. It can be viewed as an indicator of frequency technique used by an author. One of the biggest advantage of this measurement is
the independence of lambda-indicator on the text length (cf. Popescu et al. 2011, pp. 10-12). It is defined as

\[ \Lambda = \frac{L(\log_{10} N)}{N} \]  

where \( L \) is the arc length between the ranked frequencies defined as

\[ L = \sum_{r=1}^{V-1} [(f_r - f_{r+1})^2 + 1]^{1/2} \]  

where \( N \) is the text size (in tokens), \( f_r \) is the frequency at rank \( r \) and \( V \) is the highest rank. The variance of \( \Lambda \) is a complex formula and it is presented in detail in Popescu et al. (2010, 2011).

The vocabulary richness index \( R_1 \) is defined as

\[ R_1 = 1 - \left[ F(h) - \frac{h^2}{2N} \right] \]  

where \( h \) is the \( h \)-point (Popescu, Altmann 2006) and \( F(h) \) is the cumulative relative frequency up to the \( h \)-point. \( H \)-point is defined as

\[ h = \begin{cases} 
  r, & \text{if there is an } r = f(r) \\
  \frac{f(i)r_j - f(j)r_i}{r_j - r_i + f(i) - f(j)}, & \text{if there is no } r = f(r)
\end{cases} \]  

i.e. that point at which \( r = f(r) \), or, if there is no such point, it is computed by means of the second part of formula (4).

The variance of \( R_1 \) are computed as follows

\[ \text{Var}(R_1) = \frac{F(h)[1 - F(h)]}{N} \]  

Let us illustrate the procedure of comparison of authors in the case of three presidents, namely Gottwald, Novotný, and Klaus, by using lambda-indicator. First, from Table 7 in Appendix both the mean lambdas and variances of means are computed, see Table 1.
Table 1.
Mean lambdas and variances of lambdas of New Year’s presidential speeches.
Presidents are ordered according to the magnitude of mean lambda.

<table>
<thead>
<tr>
<th>President</th>
<th>year</th>
<th>n</th>
<th>mean(\Lambda)</th>
<th>\sigma^2(\Lambda)</th>
<th>\sigma^2 (\Lambda)/n</th>
</tr>
</thead>
<tbody>
<tr>
<td>Klaus</td>
<td>2004-2011</td>
<td>8</td>
<td>1.9292</td>
<td>0.003834</td>
<td>0.000479</td>
</tr>
<tr>
<td>Husák</td>
<td>1975-1989</td>
<td>15</td>
<td>1.9211</td>
<td>0.008357</td>
<td>0.000557</td>
</tr>
<tr>
<td>Havel</td>
<td>1990-2003</td>
<td>13</td>
<td>1.8882</td>
<td>0.004031</td>
<td>0.000310</td>
</tr>
<tr>
<td>Zápotocký</td>
<td>1954-1957</td>
<td>4</td>
<td>1.8818</td>
<td>0.001945</td>
<td>0.000486</td>
</tr>
<tr>
<td>Svoboda</td>
<td>1968-1974</td>
<td>6</td>
<td>1.8769</td>
<td>0.005683</td>
<td>0.00026</td>
</tr>
<tr>
<td>Gottwald</td>
<td>1979-1953</td>
<td>5</td>
<td>1.8714</td>
<td>0.005268</td>
<td>0.001054</td>
</tr>
<tr>
<td>Novotný</td>
<td>1958-1968</td>
<td>11</td>
<td>1.7564</td>
<td>0.004349</td>
<td>0.000395</td>
</tr>
</tbody>
</table>

As can be seen in Table 1, Klaus has the highest mean lambda, while Gottwald and Novotný obtain the lowest lambda values. The first task is to observe, whether the differences of mean lambdas are significant. Because the texts of the same genre in the same language are analyzed, we use the asymptotic $u$-test

$$u = \frac{A_1 - A_2}{\sqrt{\frac{s_1^2}{n_1} + \frac{s_2^2}{n_2}}}.$$

Specifically, for the comparison of Gottwald and Novotný we obtain

$$u = \frac{1.8714 - 1.7564}{\sqrt{0.001054 + 0.000395}} = 3.02$$

which expresses a significant difference. So, we can state that the frequency structure, expressed by mean lambda, of Gottwald’s speeches is significantly different from those of Novotný. Analogously, if we compare Klaus and Novotný, we obtain $u = 5.85$ which is significant too, however, for Gottwald and Klaus we obtain a non-significant $u = 1.48$. The results reveal that Novotný’s speeches have significantly different frequency structure in comparison with both Gottwald and Klaus, while the frequency structures of Gottwald’s and Klaus’ speeches express similarities.
3. The lambda structure of presidential speeches

Following the procedure presented in the previous section, we obtain the results presented in Table 2.

Table 2
Comparison of mean lambdas in New Year’s presidential speeches of Czech or Czechoslovak Presidents (two-sided \( t \)-test). Bold values express significant differences (significance level \( t \leq 1.96 \)).

<table>
<thead>
<tr>
<th>President</th>
<th>Gottwald</th>
<th>Zápotocký</th>
<th>Novotný</th>
<th>Svoboda</th>
<th>Husák</th>
<th>Havel</th>
<th>Klaus</th>
</tr>
</thead>
<tbody>
<tr>
<td>( \bar{\lambda} )</td>
<td>1.8714</td>
<td>1.8818</td>
<td>1.7564</td>
<td>1.8769</td>
<td>1.9211</td>
<td>1.8882</td>
<td>1.929</td>
</tr>
<tr>
<td>( s^2(\bar{\lambda}) )</td>
<td>0.001054</td>
<td>0.000486</td>
<td>0.000395</td>
<td>0.000026</td>
<td>0.000557</td>
<td>0.000310</td>
<td>0.000479</td>
</tr>
<tr>
<td>Gottwald</td>
<td>x</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Zápotocký</td>
<td>0.27</td>
<td>x</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Novotný</td>
<td>3.02</td>
<td>4.22</td>
<td>x</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Svoboda</td>
<td>0.17</td>
<td>0.22</td>
<td>5.87</td>
<td>x</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Husák</td>
<td>1.24</td>
<td>1.22</td>
<td>5.34</td>
<td>1.83</td>
<td>x</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Havel</td>
<td>0.45</td>
<td>0.23</td>
<td>4.96</td>
<td>0.62</td>
<td>1.12</td>
<td>x</td>
<td></td>
</tr>
<tr>
<td>Klaus</td>
<td>1.48</td>
<td>1.53</td>
<td>5.85</td>
<td>2.33</td>
<td>0.25</td>
<td>1.46</td>
<td>x</td>
</tr>
</tbody>
</table>

For the sake of better lucidity, the relationships among the presidents can be expressed graphically. Figure 1 represents a small network based on Table 2 in which two presidents are connected, if there is non-significant difference between their mean lambdas (i.e., \( t \geq 1.96 \)). Presidents with the same number of similarities are put at the same level – for Havel, Gottwald, Husák, and Zápotocký, each obtains five similarities, Klaus and Svoboda four, and Novotný has zero.

At a first sight, the extraordinary position of Novotný is evident – there are no similarities between Novotný’s mean lambda value and any other president. Further, Klaus and Svoboda can be seen as counterparts because their frequency structures differ significantly, while they both are connected to the same other presidents. Havel, Husák, Zápotocký, and Gottwald represents the most uniform cluster of this genre with regard to lambda.
For more detailed comparison it is possible to measure a weighted $u_w$ differences among presidents

(7) \[ u_{wi} = \frac{\sum u_i}{\sqrt{k}} \]

where $k$ is a number of comparisons. The results based on the formula (7) are presented in Table 3.

Again, the extraordinary position of Novotný is even more obvious. A comparison of weighted differences $u_w$ and mean lambdas reveals that Novotný’s position is given by the simplest frequency structure of his speeches, as is illustrated in Figure 2. The values of $u_w$ of the other presidents are located within a relatively small interval $<2.70, 5.26>$ which indicates high homogeneity of this genre with regard the frequency structure expressed by lambda-indicator.
Table 3
The weighted differences $u_w$ of presidents

<table>
<thead>
<tr>
<th>President</th>
<th>$\lambda$</th>
<th>$u_w$</th>
</tr>
</thead>
<tbody>
<tr>
<td>Gottwald</td>
<td>1.8714</td>
<td>2.70</td>
</tr>
<tr>
<td>Zápotocký</td>
<td>1.8818</td>
<td>3.13</td>
</tr>
<tr>
<td>Havel</td>
<td>1.8882</td>
<td>3.61</td>
</tr>
<tr>
<td>Husák</td>
<td>1.9211</td>
<td>4.49</td>
</tr>
<tr>
<td>Svoboda</td>
<td>1.8769</td>
<td>4.52</td>
</tr>
<tr>
<td>Klaus</td>
<td>1.929</td>
<td>5.26</td>
</tr>
<tr>
<td>Novotný</td>
<td>1.7564</td>
<td>11.95</td>
</tr>
</tbody>
</table>

Figure 2. The weighted differences $u_w$ of presidents

4. The vocabulary richness $R_1$

The computation of vocabulary richness $R_1$ reveals different ranking of presidents, and very small differences among them – all mean values of $R_1$ are in the interval <0.8546, 0.8770>, see Table 4.
Table 4
Mean vocabulary richness $R_1$ and variances of $R_1$ of New Year’s presidential speeches. Presidents are ordered according to the magnitude of mean $R_1$.

<table>
<thead>
<tr>
<th>President</th>
<th>year</th>
<th>n</th>
<th>mean($R_1$)</th>
<th>$s^2(R_1)$</th>
<th>$s^2(R_1)/n$</th>
</tr>
</thead>
<tbody>
<tr>
<td>Svoboda</td>
<td>1969-1974</td>
<td>6</td>
<td>0.8770</td>
<td>0.000556</td>
<td>0.000094</td>
</tr>
<tr>
<td>Klaus</td>
<td>2004-2011</td>
<td>8</td>
<td>0.8727</td>
<td>0.000125</td>
<td>0.000016</td>
</tr>
<tr>
<td>Husák</td>
<td>1975-1989</td>
<td>15</td>
<td>0.8724</td>
<td>0.000207</td>
<td>0.000014</td>
</tr>
<tr>
<td>Havel</td>
<td>1990-2003</td>
<td>13</td>
<td>0.8607</td>
<td>0.000311</td>
<td>0.000024</td>
</tr>
<tr>
<td>Zápotocký</td>
<td>1954-1957</td>
<td>4</td>
<td>0.8555</td>
<td>0.000052</td>
<td>0.000013</td>
</tr>
<tr>
<td>Novotný</td>
<td>1958-1968</td>
<td>11</td>
<td>0.8552</td>
<td>0.000079</td>
<td>0.000007</td>
</tr>
<tr>
<td>Gottwald</td>
<td>1949-1953</td>
<td>5</td>
<td>0.8546</td>
<td>0.000548</td>
<td>0.000110</td>
</tr>
</tbody>
</table>

Performing $u$-tests among all presidents we obtain the results presented in Table 5 and graphically expressed differences in Figure 3.

Table 5
Comparison of vocabulary richness $R_1$ in New Year’s presidential speeches of Czech or Czechoslovak Presidents (two-sided $u$-test).

<table>
<thead>
<tr>
<th>President</th>
<th>Gottwald</th>
<th>Zápotocký</th>
<th>Novotný</th>
<th>Svoboda</th>
<th>Husák</th>
<th>Havel</th>
<th>Klaus</th>
</tr>
</thead>
<tbody>
<tr>
<td>$\bar{R}_1$</td>
<td>0.8546</td>
<td>0.8555</td>
<td>0.8552</td>
<td>0.877</td>
<td>0.8724</td>
<td>0.8607</td>
<td>0.8727</td>
</tr>
<tr>
<td>$s^2(\bar{R}_1)$</td>
<td>0.00011</td>
<td>0.000013</td>
<td>0.000007</td>
<td>0.000094</td>
<td>0.000014</td>
<td>0.000024</td>
<td>0.000016</td>
</tr>
<tr>
<td>Gottwald</td>
<td>x</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Zápotocký</td>
<td>0.08</td>
<td>x</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Novotný</td>
<td>0.06</td>
<td>0.07</td>
<td>x</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Svoboda</td>
<td>1.57</td>
<td>2.08</td>
<td>2.17</td>
<td>x</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Husák</td>
<td>1.60</td>
<td>3.25</td>
<td>3.75</td>
<td>0.44</td>
<td>x</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Havel</td>
<td>0.53</td>
<td>0.85</td>
<td>0.99</td>
<td>1.50</td>
<td>1.90</td>
<td>x</td>
<td></td>
</tr>
<tr>
<td>Klaus</td>
<td>1.61</td>
<td>3.19</td>
<td>3.65</td>
<td>0.41</td>
<td>0.05</td>
<td>1.90</td>
<td>x</td>
</tr>
</tbody>
</table>
Figure 3. The network in which two presidents are connected, if there is non-significant difference between their mean $R_I$ (i.e., $u \leq |1.96|$

Analogously to Figure 1, presidents with an equal number of links are put at the same level and, further, presidents who connect the same other presidents are clustered. As is seen in Figure 3, Novotný is again the president with the lowest similarities (with Zápotocký). Contrary to lambda-measurement, Klaus and Svoboda have non-significant difference of $R_I$, so, their speeches differ because of frequency technique they used. Finally, Havel and Gottwald are connected to all presidents which means that they are the most conformal authors with regard to vocabulary richness (the author’s conformity is analysed in more detail in Section 5

The computation of weighted $u_w$ differences of $R_I$ reveals very small differences among presidents, cf. Table 6 and Figure 4.

<table>
<thead>
<tr>
<th>President</th>
<th>$R_I$</th>
<th>$u_w$</th>
</tr>
</thead>
<tbody>
<tr>
<td>Gottwald</td>
<td>0.8546</td>
<td>2.22</td>
</tr>
<tr>
<td>Havel</td>
<td>0.8607</td>
<td>3.13</td>
</tr>
<tr>
<td>Svoboda</td>
<td>0.8770</td>
<td>3.34</td>
</tr>
<tr>
<td>Zápotocký</td>
<td>0.8555</td>
<td>3.89</td>
</tr>
<tr>
<td>Novotný</td>
<td>0.8552</td>
<td>4.36</td>
</tr>
<tr>
<td>Klaus</td>
<td>0.8727</td>
<td>4.41</td>
</tr>
<tr>
<td>Husák</td>
<td>0.8724</td>
<td>4.49</td>
</tr>
</tbody>
</table>
Figure 4. The weighted differences $u_w$ of presidents

The small interval in which all weighted differences $u_w$ lie reflects a high similarity of vocabulary richness. So, the authorship’s differences of presidents are caused mainly by the different frequency techniques (i.e., expressed by lambda) which particular presidents used, as is clearly seen in Figure 5.

Figure 5. Comparison of lambda-values and $R_1$. 
In Figure 5, all presidents lay in almost horizontal line which means high similarities of $R_j$. The authorship differences are caused by dissimilar frequency techniques which is indicated by lambda-differences.

5. The measurement of author’s conformity within the genre

The properties of graphs (see Figure 1 and 3) enable to propose a conformity indicator. It is given by the relative degree of node representing the author, i.e. by the relative number of its links

\[
(7) \quad d_{i(\text{rel})} = \frac{\sum l_i}{l_{i(\text{max})}}
\]

where $l_i$ is an observed number of links of the node and $l_{i(\text{max})}$ is the maximum number of links which can the node obtain

\[
(8) \quad l_{i(\text{max})} = (n-1)x
\]

where $n$ is a number of nodes in the network and $x$ is the number of particular networks used for measurement. For illustration, for Havel (based on graphs in Figure 5 and 3, i.e. $x = 2$) we obtain

\[
d_{\text{Havel(\text{rel})}} = \frac{11}{(7-1)2} = 0.92.
\]

The conformity indicator of all presidents is shown in Table 6

<table>
<thead>
<tr>
<th>Presidents</th>
<th>$d_{\text{rel}}$</th>
</tr>
</thead>
<tbody>
<tr>
<td>Gottwald, Havel</td>
<td>0.92</td>
</tr>
<tr>
<td>Husák</td>
<td>0.75</td>
</tr>
<tr>
<td>Klaus, Svoboda, Zápotocký</td>
<td>0.67</td>
</tr>
<tr>
<td>Novotný</td>
<td>0.25</td>
</tr>
</tbody>
</table>
Novotný is evidently the most original author among presidents, with regard to both lambda-structure and vocabulary richness. On the other hand, Gottwald and Havel are the most conformal ones. As for Havel, this result is a little surprise – one could expect that Havel, as the world-famous dramatist, should strive for the greatest language originality. However, if Havel’s frequency technique appears to be conformal also in the other genres, it should mean that frequency conformability can be taken as a characteristic feature of his language usage. Of course, the conformability or frequency technique itself has nothing to do with a content and literary quality of his texts. Contrariwise, the same frequency technique can be used for extremely different purposes, as our results clearly manifest – it is striking that the most conformal authors (i.e., Gottwald, Havel) are persons which can be viewed as political and personal counterparts: Gottwald was a professional politician, leader of communist coup, dictator, while Havel has been a writer, long-term leader of democratic opposition in communist Czechoslovakia, democrat, humanist.

6. Conclusion

The analysis of lambda-structure and vocabulary richness of presidential speeches reveals surprisingly high number of similarities among presidents. This indicates that the tendency to uniformity prevails the need to express individuality of particular persons. Moreover, both measurements do not unveil the impact of period (the speeches do not reflect the changes in sixty years of language development) or political regime (Gottwald, Zápotocký, Novotný, Svoboda, and Husák are representatives of communist totality, while Havel and Klaus represent democracy).

Acknowledgement

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References


Table 7
New Year’s presidential speeches.

<table>
<thead>
<tr>
<th>President</th>
<th>year</th>
<th>N</th>
<th>V</th>
<th>h</th>
<th>L</th>
<th>(\Lambda)</th>
<th>(\text{var}(\Lambda))</th>
<th>R1</th>
<th>(\text{var}(R1))</th>
</tr>
</thead>
<tbody>
<tr>
<td>Gottwald</td>
<td>1949</td>
<td>1413</td>
<td>828</td>
<td>10</td>
<td>881.4247</td>
<td>1.9650</td>
<td>0.000395</td>
<td>0.8882</td>
<td>0.000089</td>
</tr>
<tr>
<td>Gottwald</td>
<td>1950</td>
<td>2205</td>
<td>1115</td>
<td>15</td>
<td>1188.516</td>
<td>1.8021</td>
<td>0.000377</td>
<td>0.8342</td>
<td>0.000077</td>
</tr>
<tr>
<td>Gottwald</td>
<td>1951</td>
<td>2211</td>
<td>1121</td>
<td>13.5</td>
<td>1186.033</td>
<td>1.7941</td>
<td>0.000352</td>
<td>0.8359</td>
<td>0.000074</td>
</tr>
<tr>
<td>Gottwald</td>
<td>1952</td>
<td>1817</td>
<td>971</td>
<td>11.67</td>
<td>1053.653</td>
<td>1.8901</td>
<td>0.000240</td>
<td>0.8454</td>
<td>0.000085</td>
</tr>
<tr>
<td>Gottwald</td>
<td>1953</td>
<td>1651</td>
<td>911</td>
<td>11.5</td>
<td>977.842</td>
<td>1.9058</td>
<td>0.000399</td>
<td>0.8692</td>
<td>0.000086</td>
</tr>
<tr>
<td>Zápotocký</td>
<td>1954</td>
<td>2590</td>
<td>1272</td>
<td>14</td>
<td>1387.437</td>
<td>1.8285</td>
<td>0.000316</td>
<td>0.8502</td>
<td>0.000059</td>
</tr>
<tr>
<td>Zápotocký</td>
<td>1955</td>
<td>1570</td>
<td>846</td>
<td>9</td>
<td>931.7357</td>
<td>1.8966</td>
<td>0.000200</td>
<td>0.8627</td>
<td>0.000087</td>
</tr>
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