

# Formulas and Decision-Making: the Case of the States General of the Dutch Republic

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## Abstract

Formulaic expressions are commonly used in administrative texts, and may reflect standardisation of the decision-making process or its recording process. In this paper we investigate whether the use of formulas in the Resolutions of the Dutch States General (1576-1796) reveal an increase in standardisation. We use stylometric analysis and measures of textual repetition to identify shifts in the use of formulas, and study how the fraction of paragraphs that is covered by formulas changes over time to identify templates consisting of frequent combinations of formulas. Our findings are that there are stylistically clearly distinguishable periods, and that the use of formulas and templates increases between subsequent periods.

## Keywords

formulaic expressions, information extraction, political history

## 1. Introduction

Formulaic expressions have been used in legal procedures and decision-making processes for millennia [40, 33, 27]. Often, the correct usage and exact phrasing of formulas established their validity [40]. Formulas could also make recording more efficient, by lowering the cognitive load to think of a phrasing that correctly expresses what was decided. Similarly, it could make organising and finding back information easier [23]. Formulas could also reflect a standardisation of the decision-making process itself.

In this paper, we investigate whether the development of formulaic expressions in the resolutions (decisions) of the States General of the Dutch Republic in the period 1576-1796 reflects changes in the decision-making process and its recording. The archive of resolutions contains all decisions registered during daily meetings for a 220 year period [32, 20, 37]. The resolutions are bundled chronologically, in one or more volumes per year.

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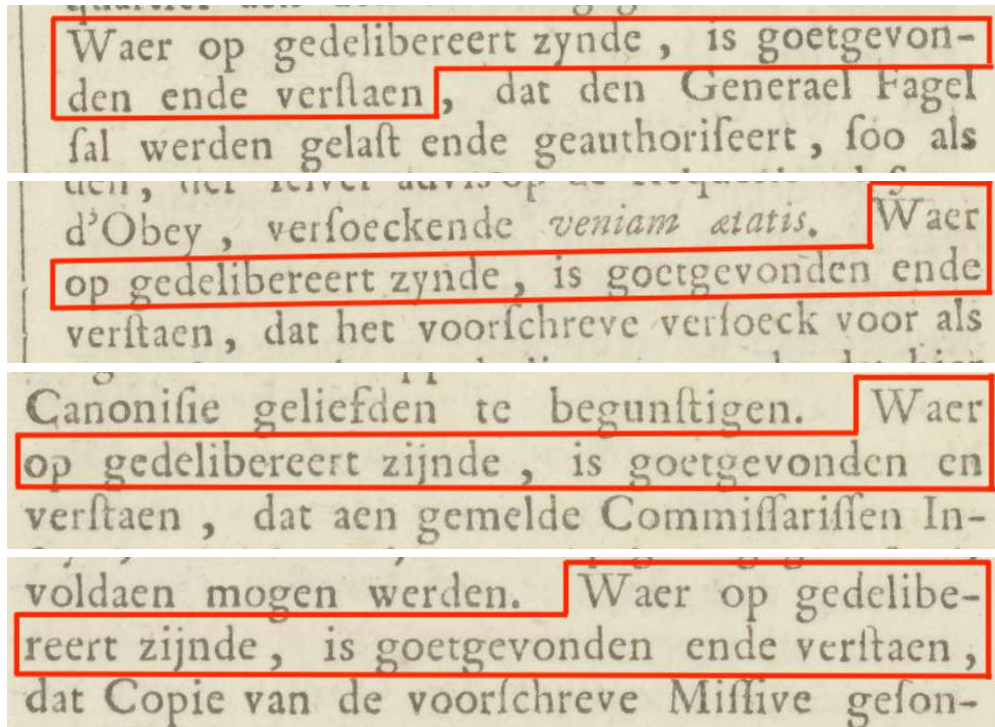
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**Figure 1:** The formulaic expression ‘Waer op gedelibereert zijnde, is goetgevonden ende verstaen’ used in four resolutions taken from a single meeting on the 22nd of November 1709 to introduce the start of the decision paragraph. Images courtesy of the Nationaal Archief.

The digitised archive contains almost 500,000 pages of handwritten and printed resolutions in over 600 volumes.<sup>1</sup> Textual representations of these pages were made through HTR, after which the text has been segmented into paragraphs and individual decisions.<sup>2</sup> The archive consists of almost 1 million decisions and 150 million words.

The resolutions of the States General (SG) have a stable structure, consisting of two parts: a proposition and a decision. The proposition describes what was proposed or requested and by whom, and the decision paragraph details whether the proposition has been accepted, and if so, under what conditions and what actions are to be taken next. Earlier research has shown that the resolutions contain many text structuring formulas [29, 21], including formulas to introduce the proposition and decision paragraphs (Figure 1).

So far, it is not clear whether these formulas were used throughout the entire period, and whether they changed over time, and, if so, how emergence, change and disappearance of formulas was related to changes in the meeting procedures, the way the decisions were recorded or who recorded them.

In this paper, we focus on a diachronic analysis of the resolutions and how changes in the use of formulas is potentially related to standardisation, both of phrasing and of procedure.

<sup>1</sup>See <https://www.nationaalarchief.nl/onderzoeken/archief/1.01.02>.

<sup>2</sup>See <https://republic.huygens.knaw.nl/index.php/en/republic-english/>.

Our analysis consists of three parts. We start with a stylometric analysis to investigate if volumes written closer to each other in time are also stylistically more similar, and if there are periods of stable language use. Next, we compare the periods in terms of vocabulary growth of individual words and word n-grams to analyse how textual repetition changed over time. Finally, we zoom in on resolutions that consist mostly of commonly co-occurring words to identify whether they reveal signals of standardisation of decision making or recording.

We report a number of findings. First, clusters of stylistically similar volumes form contiguous periods, which in the 17th century correspond with changes between the greffiers who were in charge of the creation and organisation of the resolutions. Second, the different periods have a similarly sized vocabulary of frequently used individual words, but later periods have a larger vocabulary of frequently repeated multi-word phrases, suggesting an increase in formulaic expressions. Third, the resolutions show an increase in the use of template structures for specific types of propositions and decisions, that consist almost entirely of formulas in which only names, locations and dates varied.

Our findings suggest that the resolutions show an increasing standardisation, of either the decision-making process, the recording process, or both. We end with a discussion of the implications of our analysis and suggestions on how to link specific characteristics of the corpus to these two processes.

## **2. Background**

Our work builds on different strands of research: research related to the nature of administrative and legal discourse and the role of formulaic expressions; the study of the linguistic characteristics of formulaic expressions and textual repetition; and study of the decision-making and recording processes related to the creation of the archive of resolutions. The latter is discussed in Section 3.

### **2.1. Administrative Texts and Formulaic Language**

According to Gotti, textual standardisation is particularly strong in legal genres, as texts are often adaptations of earlier texts, and because their precise formulation determines their legal force. Frade noted that the operative clauses in contracts remain stable as part of an attempt to “unify and harmonise legal rules” [13, pp.49-50].

Formulaic expressions are commonly used in administrative documents to signal important aspects of a document [25, 26, 21]. Medieval charters contain opening and closing formulas to signal that the document is a charter and what type of charter it is [5, 9]. Notarial deeds contain formulas based on notary manuals to make sure the transaction they confirm is unambiguous and follows protocol [42, 28, 30].

Gustafsson estimated that legal texts have higher repetition of multi-word phrases than texts in other genres. This finding was corroborated by Koolen and Hoekstra who found that administrative texts have more textual repetition of especially phrases of 3 or more words, than other genres.

## 2.2. Identifying formulaic expressions

The identification of formulas in text corpora is studied, a.o., in the field of computational phraseology [31]. Several algorithms exist to automatically extract repeated phrases [41, 38], although most of these studies focus on modern languages. Closer to our aims is research by Kopaczyk, who studied the use of formulaic expressions in Medieval Scottish legal texts, by identifying frequently used long phrases [24, 25, 26]. Kopaczyk focuses on the relationship between standardisation in the legal texts and the standardisation of the Scottish language. In earlier work we identified formulas in the resolutions of the Dutch States General to segment and structure the text into individual resolutions, but did not look at changes in the use of formulas Koolen and Hoekstra.

## 3. The Corpus of Resolutions

The resolutions are the written record of the decisions taken at the meetings of the assembly in The Hague on weekdays and sometimes even on Sundays from 1593 until 1796.

They have been studied extensively [32, 36, 37, 6], including the institutional context of the daily meetings and the recording of the resolutions by the *greffier* and his department of clerks.

### 3.1. The recording of resolutions of the States General

Knowledge about the procedures during and after the meeting relating to the decision-making and its recording in the form of the written resolutions is relevant for our analysis (for more details see Appendix A).

**Greffier transitions** Over the 220 year period, 13 different people held the position of greffier.

Each greffier may have introduced his own preferences for spelling and vocabulary, and may have changed the existing formulas as well as introduced new formulas. It is plausible that formulas introduced by one greffier were adopted by the next greffier. If so, we would expect the amount of formulas used to gradually increase over time and not decrease.

**Reduced spelling variation** During the 17th and 18th centuries, Dutch spelling was not yet fixed resulting in spelling *variation* (multiple spellings of the same word within a single volume) as well as spelling *change* over time. However, the progressive tendency toward standardisation of spelling, also affected standardisation of the surface form of formulaic phrasing. Furthermore, from 1705 the resolutions were printed, and have a lower character error rate in text recognition. The Character Error Rate (CER) for handwritten material is 2 – 3% and for printed material 0.5 – 1.0%. This affects surface forms of expressions, so more variation is expected in the handwritten material due to recognition errors.

**Increased time pressure** Throughout the 17th century the daily number of decisions grew, resulting in increasing pressure to efficiently minute and extend resolutions for approval the next day [37, Ch.4]. This may have led the greffier to introduce standard phrasings for the most repetitive elements of the resolutions.

**Procedural standardisation** To improve the production, organisation and approval of resolutions, the SG introduced various changes to the procedure [37, pp. 436-437]:

**Introduction of resumption (1637)** The greffier read aloud all recorded resolutions for approval by the SG. From 1637, this was moved from the end of the meeting to the start of the next meeting, giving the greffier more time to draft the resolution [37, p.437].

**Preparation by committees (1651)** From 1651, committees of the SG increasingly prepared its administrative, organisational and ceremonial tasks to such an extent that discussing them in the meeting was reduced to a formality [36, p.162].

**Extending by the commies (1680)** Until 1680, the greffier extended the minutes into full resolutions himself. After 1680, this was taken over by the so-called *commies* [32]. Strict protocols ensured that the resolutions reflected what was decided at the meeting. A modest manual comparison between minute and neat resolutions corroborates that there were indeed minimal deviations in word choice and word order, although there were individual differences in spelling.

The corpus of resolutions that we used covers the period 1597-1796, minus the years 1651, 1703 and 1704, and consists of two parts. The handwritten resolutions of 1597-1702 come in the form of individual paragraphs (no resolutions boundaries have been detected yet). The printed resolutions of 1705-1796 are segmented at the level of resolutions (consisting of one or more paragraphs). For uniformity, we analyse both the handwritten and printed resolutions at the level of paragraphs.

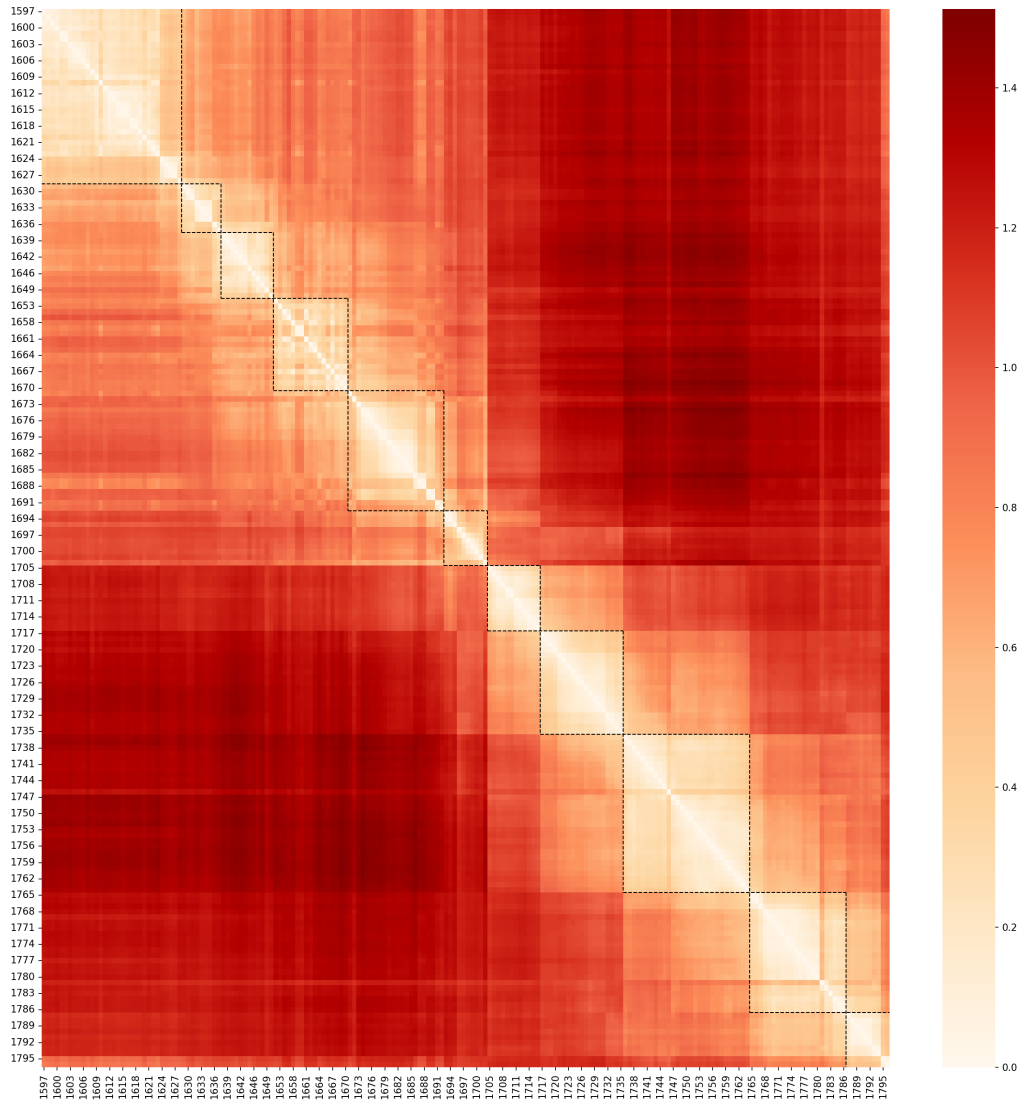
A more extensive description of the selection of resolutions is given in Appendix A.1. The corpus for analysis consists of just over 1.5 million paragraphs and 125 million words.

## 4. Stylometric Analysis

One way to study the extent of language stability or change is through stylometric analysis [8]. Quantitative aspects of writing style that are indicative of authorship include high-frequency words and phrases [7]. We use stylometry to identify sudden shifts in the style between two periods that could signal a change in spelling (from 'ae' to 'aa'), in author (greffier, commies or clerks), but also a change in recording the decisions (through introducing stable expressions for recurring aspects of decisions) or in procedural changes (the requirements of submitting proposals in written form in 1625, the introduction of resumptions in 1637, or the increased preparation by committees from 1651).

Burrows' Delta [7] is one of the most robust measures of textual distance and authorship attribution [19, 12]. Jannidis, Pielström, Schöch, and Vitt found that the Cosine metric [35] is a more effective distance measure than Manhattan distance [7] and Euclidian distance [1] for corpora of fiction novels in three different languages.

We compute Cosine distances based on the top 1000 most frequent word 3-grams, for the resolutions of individual years. That is, we combined the text of all resolutions of one year, and compare the style of resolutions between years. The reason to use word 3-grams is that we want to identify transitions in the use of multi-word phrases. A heatmap of the cosine



**Figure 2:** A heatmap showing the Burrows' Delta cosine distances between 1-year periods of resolutions, based on the 1000 most frequent word 3-grams. The dashed lines indicate the cluster boundaries of hierarchical clustering.

distances between all years is shown in Figure 2. The periods are ordered from 1597 to 1796 on the X- and Y-axis. Larger distances are darker red. The distances are lowest along the diagonal, which indicates that the resolutions written close to each other in time are more similar in style than resolutions written further apart in time.

Given that we do not know who the authors of the specific resolutions are, we have no ground truth to evaluate how effectively Burrows' delta can cluster resolutions by author. What we can do is make hierarchical clusters and analyse: 1) how books of resolutions cluster

temporally (e.g. do the books in the same cluster form a continuous period, or are books from different periods grouped together?), and 2) whether clusters overlap with periods of different greffiers or periods of the same spelling preferences, or periods with the same formulas.

For the hierarchical clustering of the yearly resolutions we use SciPy's hierarchy linkage<sup>3</sup> based on the Ward method [39]. Of the many available linkage algorithms, stylometric evaluations in literary studies has found Ward to be one of the best performing methods [18, 11]. We are not aware of any similar studies for administrative texts, therefore, use the findings in literary studies as the best available evidence.

Ideally, we would end up with clusters that group contiguous years, that is, the years in a cluster form one continuous period. For purposes of comparison, we want clusters that are neither very small (only 1 or 2 years) nor very big (grouping an entire century). We use SciPy's `fcluster` function with `distance` as metric and range over the cut threshold  $t$  to find a suitable number of clusters.

The clusters show strong temporal groupings at any level of the clustering. With 200 years of resolutions, the details of the dendrogram with 200 leaves are hard to read, but it clearly shows there are two main clusters. The left cluster in Figure 3 contains all the years with handwritten volumes (1597-1702), and the right cluster all the printed volumes (1705-1796) (see Appendix B for the full dendrogram). It seems plausible that the additional step of typesetting the resolutions had an influence on spelling and style. The vertical dashed line shows the threshold  $t = 71$  at which we cut the hierarchical clustering and flatten the sub-clusters within each cluster at that level. All clusters except one are contiguous. At lower thresholds, the number of clusters with non-contiguous periods increases. The one non-contiguous cluster has a contiguous part from 1671 until 1692, and one extra year, 1702. In the dendrogram, this cluster is next to the contiguous cluster 1693-1701, so the discontinuity is still stylistically close to the intermediate period.

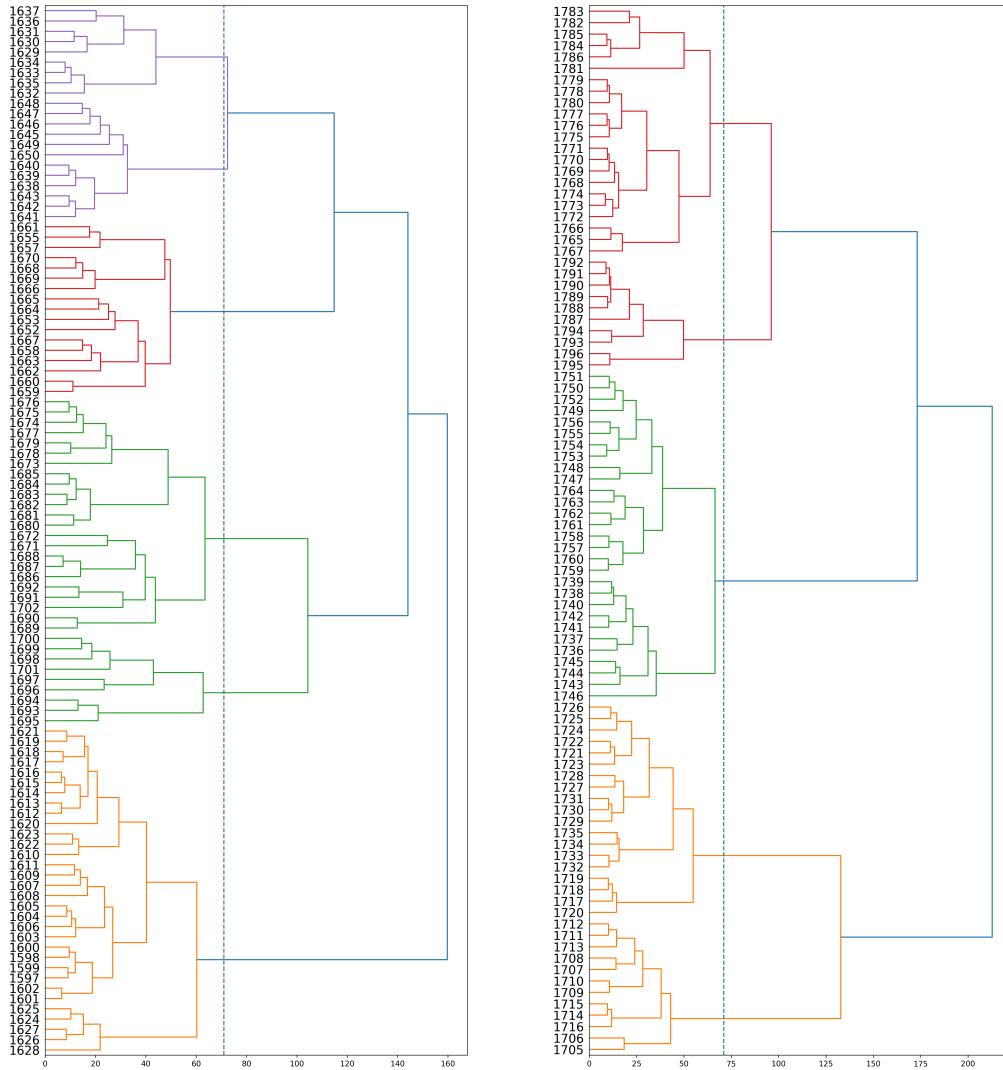
For easier analysis, we use the contiguous parts of the clusters and move the year 1702 to its neighbouring cluster 1693-1701, so that it forms one contiguous period as well. The resulting cluster boundaries are shown as dashed lines in Figure 9

There are 11 clusters, covering periods ranging between 9 and 32 years (Table 1). Some clusters overlap with the periods of one or more greffiers, e.g. the cluster 1597-1628 overlaps with the greffiers Cornelis van Aerssen en Johan van Goch. The next two clusters, 1629-1637 and 1638-1651 overlap with greffier Cornelis Musch (1628-1650), and the change in the resumption procedure (1637) as well as the requirement that propositions of anyone outside the SG were submitted in writing and signed by the proposer (1628).<sup>4</sup> In the 18th century, the cluster boundaries seem more related to changes in spelling than to transitions of greffiers.

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<sup>3</sup>See <https://docs.scipy.org/doc/scipy/reference/cluster.hierarchy.html#module-scipy.cluster.hierarchy>

<sup>4</sup>This was in fact already instructed by the SG in 1623, but was reiterated in 1628 and again in 1646, when the then greffier Cornelis Musch, known at the time for his corruption, turned out to still handle many requests in person [37, p.461].



**Figure 3:** A hierarchical clustering of 5-year periods of resolutions, based on Burrows' Delta cosine distances using the 1000 most frequent word 3-grams.



**Table 1**

The periods of the style-based clustering and the greffiers that started in each period, as well as the main changes in terms of procedure and spelling.

<b>Cluster period</b>	<b>Greffiers</b>	<b>Procedural and spelling changes</b>
1597-1628	Cornelis van Aerssen (1584-1623) Johan van Goch (1623-1628)	propositions must be written and signed (1623/1628)
1629-1637	Cornelis Musch (1628-1650)	introduction of resumption (1637)
1638-1650	Cornelis Musch (1628-1650) Nicolaas Coenraadsz Ruijsch (1650-1670)	increased preparation by committees (1651)
1652-1670	Nicolaas Coenraadsz Ruijsch (1650-1670)	permanent committees on recurrent topics (1650s)
1671-1692	Gaspar Fagel (1670-1672) Hendrik Fagel de Oudste (1672-1690)	commies extends minutes (1680)
1693-1702	François Fagel (1690-1744)	
1705-1716		resolutions are printed
1717-1735		spelling shift 'ae' → 'aa' (1717)
1736-1764	Hendrik Fagel de Oude (1744-1790)	spelling shift 'ey' → 'ei' (1750)
1765-1786		spelling shift 'ck' → 'k' (1765), spelling shift 'gh' → 'g' (1765)
1787-1796	Hendrik Fagel de Jonge (1790-1795) Willem Quarles van Ufford (1795-1796)	Batavian Republic (1795)

## 5. Textual Repetition and Vocabulary Growth

With the 11 style-based periods, we investigate changes in the use of formulaic expressions. We start with analysing vocabulary growth and repetition. [21] used vocabulary repetition ratios to show that administrative texts, and especially the resolutions of the SG, contain more frequently repeated phrases than other document genres.

We start from the same premise that textual repetition is a signal for the amount of formulas being used, and analyse if the amount of textual repetition decreases or increases over time, and if so, whether these changes correspond in time with any of the changes in greffiers, meeting procedures or spelling, as identified in Table 1.

Instead of using repetition ratios, we use vocabulary growth curves [2, 3]. These curves show how the size of the vocabulary  $V$  grows as the number of term tokens  $N$  increases. The vocabulary  $V(N)$  contains all terms in the analysed text, but growth curves can be computed for different threshold frequencies. E.g.  $V_1(N)$  is the growth of the vocabulary of terms that occur at least once after observing  $N$  tokens, while  $V_5(N)$  shows the growth for terms that occur at least five times.

To create the growth curves for a given period, we put the paragraphs of that period in a random order and count term frequencies. For a curve for  $V_x(N)$ , after every 10,000 terms, we record the number of terms with a frequency  $f(w) \geq x$ .

From a frequency-based definition of formulas, we expect a change in the use of formulas to be reflected by a change in vocabulary growth, with higher usage of formulas leading to faster growth of high-frequency terms.

Terms can be individual words, but also word n-grams. Formulaic expressions are multi-word phrases, therefore, like [21], we expect differences in the use of formulas to be especially reflected by differences in growth curves of multi-word terms.

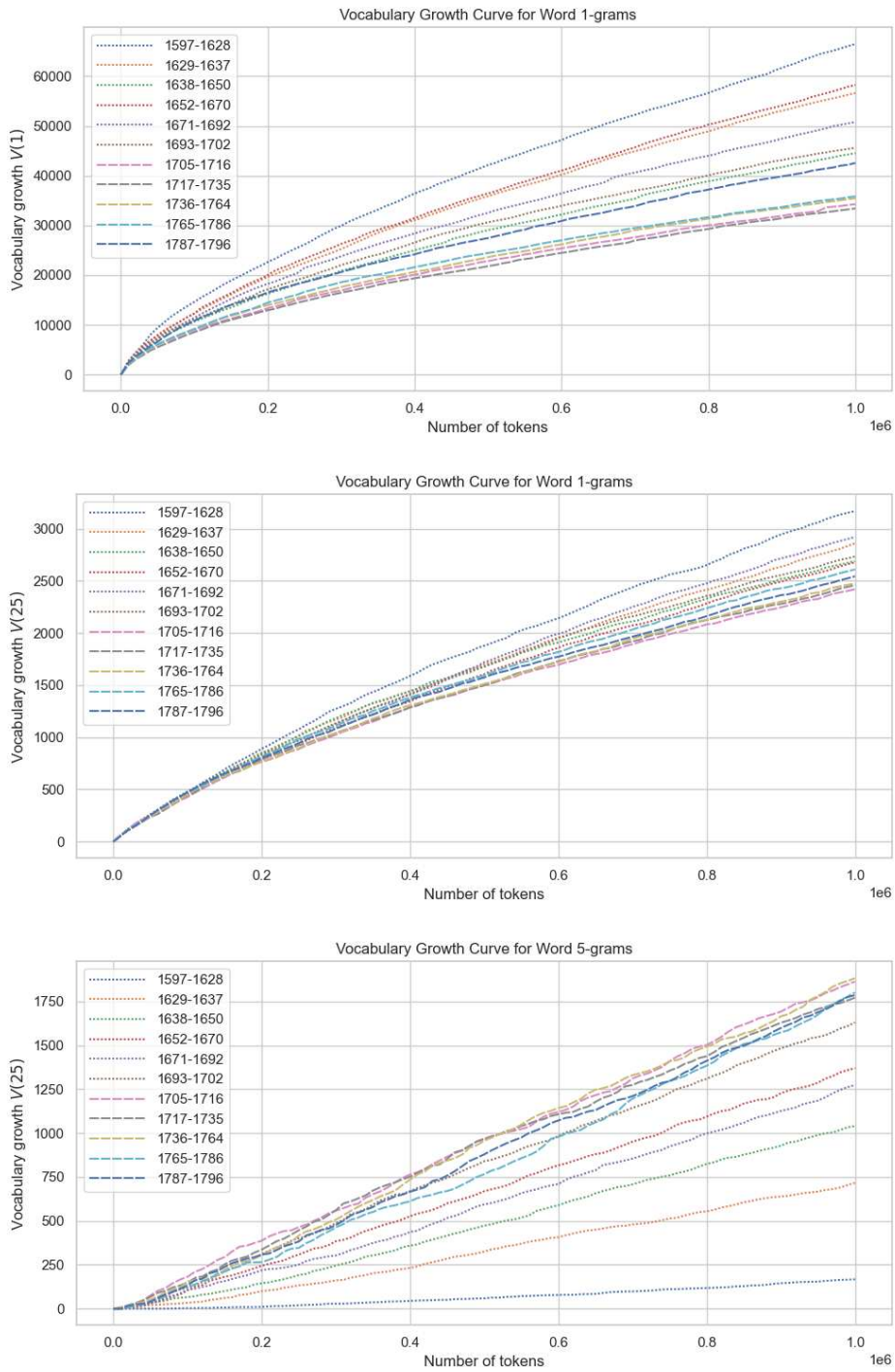
The curves for the 11 style-clustered periods are shown in Figure 4 for up to 1 million words per period.<sup>5</sup> The top plot shows  $V_1(N)$  for word 1-grams, while the middle and bottom plots show  $V_{25}(N)$  for, respectively, word 1-grams and word 5-grams. In the top plot, it is clear that the different periods have different vocabulary sizes, with the 18th century periods having smaller vocabularies than 17th century periods. Among the 17th century periods, there is no linear relationship between period and vocabulary growth. For the earliest period resolutions (1597-1628), the vocabulary growths fastest – perhaps reflecting the highest amount of spelling variation – but for the following period (1638-1650) the vocabulary growths slower than for all other periods of handwritten resolutions.

The middle plot shows that among the more frequent words, the differences between the periods are smaller. This shows that across all periods, there is a similarly sized vocabulary of common words.

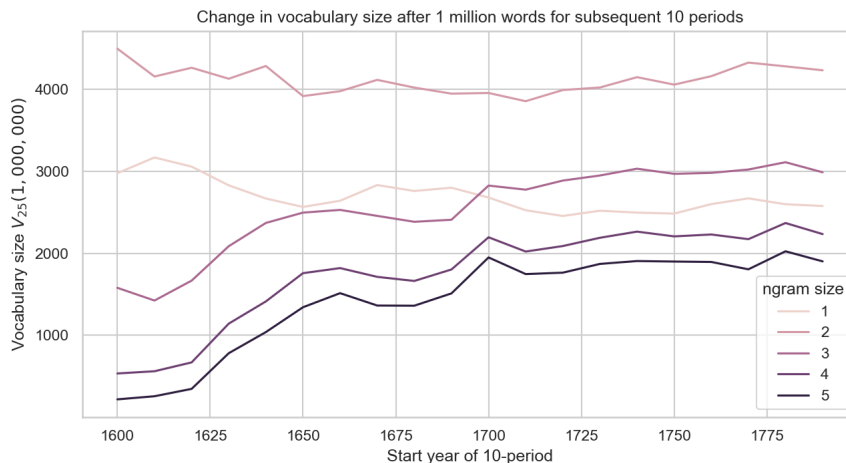
Finally, the bottom plot shows how many different 5-word phrases occur at least 25 times. Here, the differences are clear. The earliest period has very few repeated 5-grams, while the periods of the printed editions in the 18th century have well over 1750 5-grams after observing 1 million words. We note that some of these 5-grams are partially overlapping, because they are part of a single, longer formulaic expression. It is possible that textual repetition increases because the number of formulaic expressions increases, but also because formulas are getting longer. There is a large gap between the earliest period 1597-1628 and the next period 1629-1637, possibly indicating that the earliest period has few frequent formulas. Throughout the 17th century, the number of frequent 5-grams increases. The last period of handwritten resolutions, 1693-1702, is close to the printed resolutions in terms of 5-gram repetition. It seems

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<sup>5</sup>The periods differ in the number of resolutions and the amount of text, but all have at least a few million words. For each period, the first 1 million ngram tokens from randomly ordered paragraphs is thus semi-random sample.



**Figure 4:** Vocabulary growth curves for the 11 style-clustered periods between 1597 and 1796. The top plot shows vocabulary  $V_1(N)$  for word 1-grams up to 1 million words. The middle and bottom plots show vocabulary  $V_{25}(N)$  up to 1 million words for, respectively, word 1-grams and word 5-grams.



**Figure 5:** Vocabulary size after 1 million words for 10-year periods.

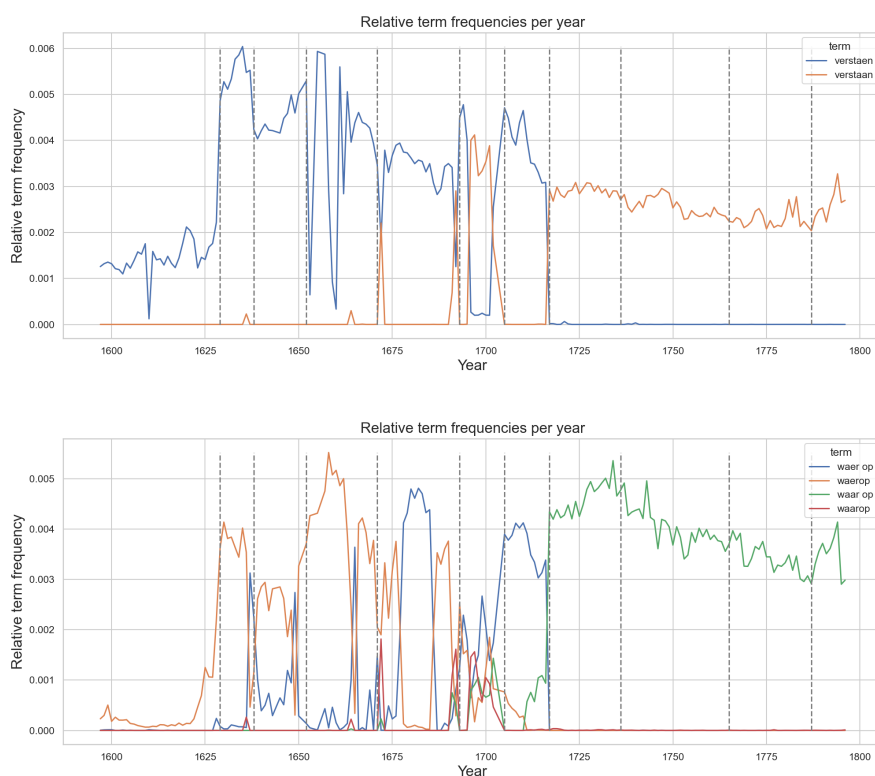
that from 1693, the number of frequent 5-grams per 1 million words stabilises.

The changes in vocabulary repetition can also be viewed by taking a single data point per period, e.g. the vocabulary size at 1 million words. This is shown in Figure 5, where the vocabulary size  $V_{25}(1,000,000)$  is shown for 1-5 word n-grams for the 11 periods. The vocabulary of word 1-grams and 2-grams does not change much over 200 years, indicating that, despite differences in the amount of spelling variation, each period has a similarly large vocabulary that is used in frequent expressions. For larger n-grams, the differences in vocabulary size become more pronounced. Between 1600 and 1700, the amount of repetition steadily grows, and remains stable in the 18th century. These results make it unlikely that the reduction in spelling variation is the only cause for the increase in the use of long repetitive phrases.

### 5.1. Vocabulary and spelling variation

Spelling stabilised throughout the 17th and 18th century, but there were also consistent changes, e.g. from ‘ae’ to ‘aa’ for long a-vowels as in *verstaen* vs. *verstaan* (EN: ‘understand’) and *waerop* and *waarop* (EN: ‘on which’). This is visible in the yearly relative term frequencies of variants of these terms, shown in Figure 6. The variants of *verstaan* are shown at the top, and those of *waarop* at the bottom.

The first notable change in both plots in Figure 6 is around 1628, when Cornelis Musch becomes greffier, until 1650. Both *verstaen* and *waerop* are suddenly used much more frequently. This corresponds to a growth in the amount of textual repetition during this period (see Figure 4). These words are part of the central decision formula *waerop gedelibereert sijnde is goetgevonden ende verstaen dat* (EN: ‘which, after deliberation, it has been accepted and understood that’, see Figure 1), that is introduced in the resolutions around the time when Musch takes over the role of greffier. The variant *verstaen* is more or less the only variant until briefly in 1670-1672, when there are two transitions of greffiers, once in 1670 and again in 1672. With Gaspar Fagel as greffier in 1670-1672, both *verstaen* and *verstaan* were used. With the next greffier,



**Figure 6:** Yearly relative frequency of variants of terms *verstaan* (top) and *waar op* (bottom). The dotted lines are years of greffier transitions.

Hendrik Fagel de Oudste, *verstaen* is used exclusively. Then, in 1690, when François Fagel takes over, *verstaan* is used more frequently than *verstaen*. Their order swaps again around 1700 until 1717, when the use of *ae* is discarded and *verstaan* is used exclusively. For variants of *waarop*, swaps in their relative frequency occur at the same moments in time, suggesting that these spelling changes have the same underlying causes (perhaps change of greffier or commies). For *waarop* there is another source of variation, which is the segmentation of function words. The term *waarop* can also be spelled as two words *waar op*. For these variants, there is one period between 1690 and 1705, where all four variants occur. Again, from 1717, only a single variant is used. For many key terms in the resolutions, the distributions show similar shifts from almost exclusive use of one variant to almost exclusive use of another. This suggests that spelling variation of key terms was minimal, which is further evidence that the increasing repetition of long phrases is not only due to increasing spelling standardisation.

## 6. Template structures in resolutions

If the recording of resolutions standardised over time, we would expect to see resolutions to increasingly consist of frequent formulas or phrases. To identify *candidate formulas*, we used a

frequency threshold to extract sequences of commonly co-occurring words [21]. We use these sequences to analyse what fraction of a resolution consists of such *candidate formulas*.

The eleven periods identified in Section 4 have different amounts of text. To make a fair comparison across these periods, we use frequency thresholds that are relative to the amount of text in each period. For the minimum co-occurrence frequency of word pairs, we use a threshold of once per 100,000 word tokens. That is, a continuous sequence of words is considered a *candidate formula* if each pair of words in the sequence co-occurs at least once per 100,000 words. This threshold was chosen on practical grounds. Per period, this corresponds to a minimum term frequency between 45 (for period 1629-1637 with 4.5 millions words) and 172 (for 1736-1764 with 17.2 million words). This means all low-frequency terms (including most terms with recognition errors) are removed, while retaining a large enough vocabulary to identify formulas containing mid-frequency terms, if they mostly occur in the same context.

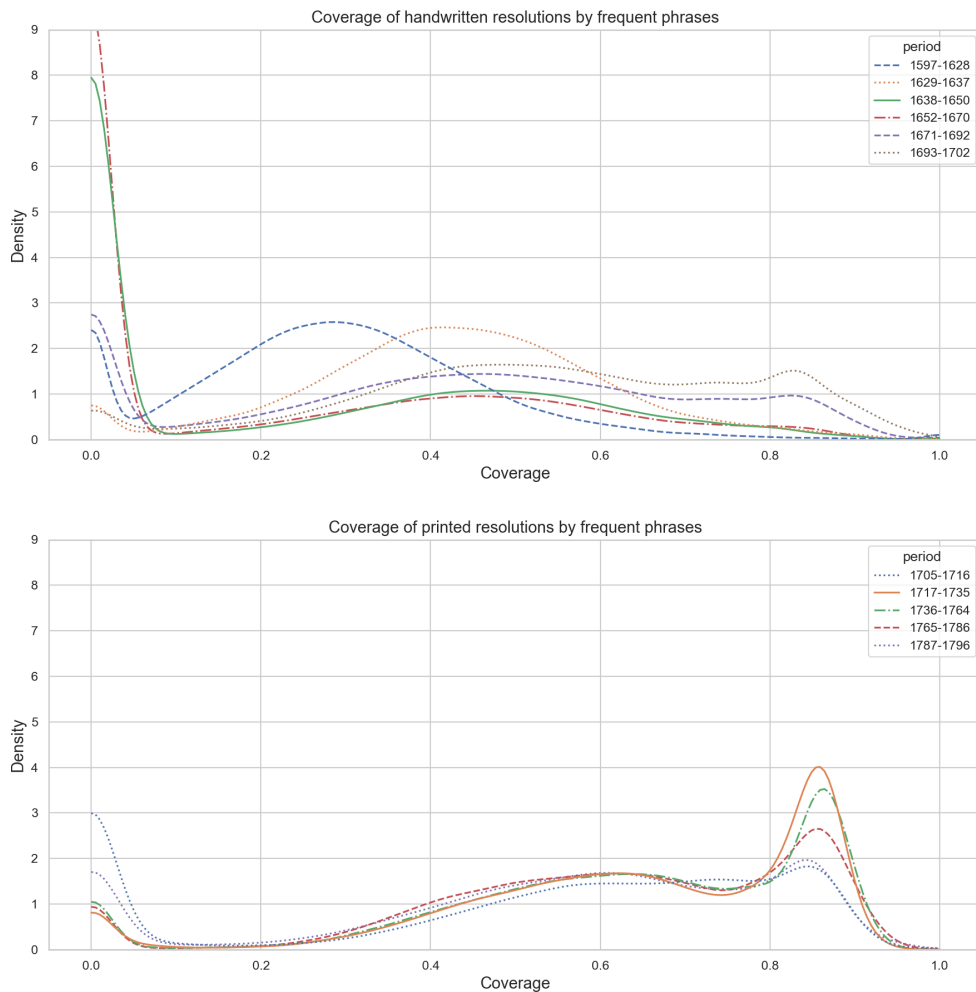
Next, we compute the fraction of words in each paragraph that are part of *candidate formulas*. For a paragraph of 100 words with five candidate formulas of ten words each, the *coverage* of a paragraph by candidate formulas is 50% of the text. With this definition of *coverage*, we look at its distribution for the eleven periods (see Figure 7), for both the handwritten and printed resolutions (top and bottom plot respectively). There are clear differences between periods. For the earliest period, the bulk of the paragraphs have a coverage below 0.4. For later periods, the bulk is shifted to the right, with the exception of 1638-1650 and 1652-1670. These two periods have a high number of paragraphs with zero coverage by candidate formulas. These are mostly very short paragraphs of a few words due to incorrectly inserted paragraph boundaries. In the printed resolutions, the paragraph coverage by candidate formulas is higher, with the bulk having a coverage between 0.6 and 0.9, and a peak around 0.9. Throughout the 18th century, the peak at 0.9 gets higher, with the exception of the last period 1787-1796. Note that the last period of handwritten resolutions (1693-1702) has a distribution similar in shape to those of the printed resolutions, but with a less pronounced peak.

These results suggest that over time, an increasing part of paragraphs became formulaic. This prompts several questions. For instance, what is the nature of paragraphs that consist almost exclusively of candidate formulas? And does the gradual increase of candidate formulas correspond to increasingly standardised resolutions?

## 6.1. Template Resolutions

We zoom in on the paragraphs with high *coverage*, for four of the eleven periods, to see how the nature of these paragraphs changes.

First, we analyse whether high-coverage paragraphs are different from other paragraphs by identifying *key phrases*. We turn each candidate formula into word 5-grams and count their frequencies. Then we compare their frequencies in high-coverage paragraphs against their frequencies in all paragraphs in a given period. For *keyness* we compute the log likelihood ratio [10] and percentage difference [15, 14] and select 5-grams with  $G^2 > 10.83$  (which corresponds to a p-value  $p < 0.001$ ) and a percentage difference above  $\%Diff > 20\%$ . These threshold values are somewhat arbitrary, but were chosen empirically. The number of *key phrases* per period are shown in Figure 8. In the early periods, there are few phrases that are statistically significantly more likely to appear in high-coverage paragraphs than in other paragraphs. From the 18th

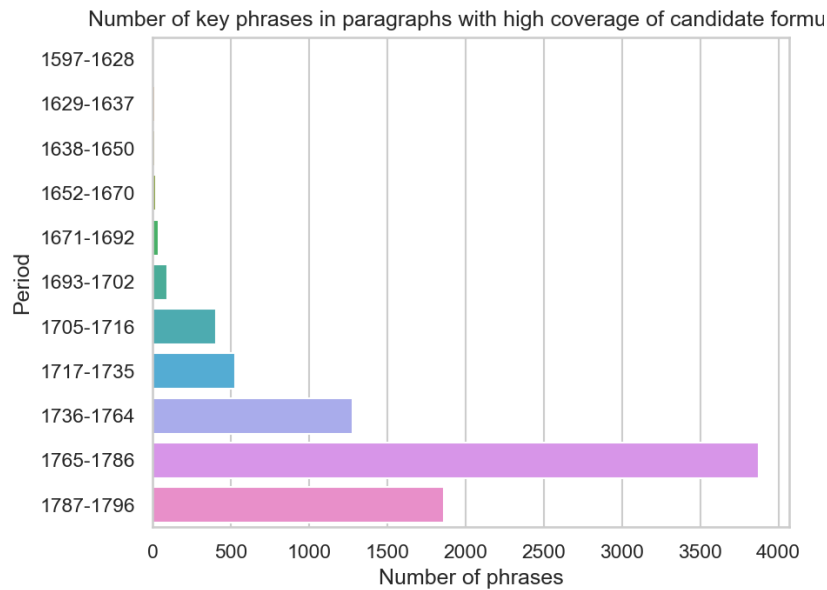


**Figure 7:** The fraction of resolutions that is covered by frequent phrases, for different periods in the handwritten resolutions (top) and printed resolutions (bottom).

century onward, the number of phrases increases rapidly. It seems that the nature of candidate formulas and of high-coverage paragraphs changes over time.

To find out what changes, we zoom in further, and select paragraphs where the *key phrases* cover at least 30% of paragraphs. We then make TF-IDF representations of these paragraphs and cluster them using K-means, with  $K = 20$ . The reason to cluster paragraphs is to find out if there are specific types of paragraphs with specific functions and consisting of relatively fixed sets of formulas. The *Elbow* and *Silhouette* measures both indicate that  $K = 3$  gives the optimal clustering, but we find that higher values of  $K$  result in a better separation of different resolution templates. But they also lead to multiple clusters with the same formulas and functions (which are merged with  $K = 3$ ).

The clustering was done for each of four periods 1597-1628, 1671-1692, 1717-1735 and 1765-



**Figure 8:** The number of key phrases in paragraphs with high coverage by candidate formulas.

1786. Based on manual inspection of the results, we created sets of regular expressions for each identified template and classified the resolutions in each of the clusters. Most clusters are highly homogeneous and consist of paragraphs with a single stable template, while some clusters are mixtures of multiple templates and of paragraphs that do not seem to follow a template structure.

With  $K = 20$ , many of the clusters contain paragraphs with small variations of the same template (which are grouped into a single cluster when we choose  $K = 3$ ), that has the following main form:

Ontfangen een Missive van <PERSON>, geschreven te <LOCATION> den <DATE>, houdende advertentie, Waar op geen resolutie is gevallen. (EN: Received a Missive of <PERSON>, written in <LOCATION> on <DATE>, containing intelligence, on which no resolution was made.)

Another large and stable group consists of so-called resumption paragraphs, which appear at the start of each session to indicate that the written versions of the resolutions of the previous day have been read and approved:

DE Relolutien gisteren genomen, zyn geleesen en geresumeert, gelijk ook geresumeert en gearresteert zyn de Depeches daar uit resulterende. (EN: The resolutions made yesterday are read and summarised, as well as the depeches that follow from them.



**Table 2**

Distribution of high-coverage paragraphs over 6 different templates.

Template function	1597-1628	1671-1692	1717-1735	1765-1786
No resolution	0	190	19,311	16,081
Extract from resolution register	0	5	380	949
Resolutions summarised and confirmed	0	7	1	5,368
Request Province for vote/opinion	0	0	0	599
Province read resolution for Insertion	0	0	9	1,306
Send bill to Chamber of Finance	0	0	0	959
Unknown	4	16	0	1,664
Total	4	218	19,701	26,926

The distribution of paragraphs over the different template structures is given for each of the four periods in Table 2.<sup>6</sup>

In the earliest period, the clusters identify no templates, but later periods have increasing number of paragraphs that follow a template structure and phrasing, and have increasingly many types of templates. In the *unknown group* there may be more types of templates that we did not yet identify. So far we looked at the paragraph level, but it is possible that there are smaller templates and associated formulas within larger paragraphs that also contain other, less formulaic text.

These results form at least part of the explanation of increased textual repetition seen in Figure 5. Starting from the middle of the 17th century, the greffiers and clerks of the SG introduced template structures and associated formulas for recording common propositions and decisions.

## 7. Conclusions

With this paper, we aim to shed light on the use of formulaic expressions and templates to standardise the decision-making process of the States General of the Dutch Republic, and of the recording of the decisions resulting from it.

The 200 years of recorded decisions of daily meetings form an invaluable resource to study these processes, but come with many challenges as well. Over this long period, many aspects of both processes changed, and it is difficult to establish how these changes are reflected in or have influenced the creation of the written resolutions.

Our stylometric analysis suggests that the resolutions went through several stylistic changes that align in the 17<sup>th</sup> century with transitions between greffiers who were in charge of recording and organising the resolutions, and in the 18<sup>th</sup> century by changes in spelling conventions.

The analysis of vocabulary growth of individual words and word 5-grams shows that over time, the amount of textual repetition of multi-word phrases increases, suggesting an increasing use of formulaic expressions.

<sup>6</sup>See Appendix C for examples of each type.

Finally, our analysis of paragraphs that consist almost entirely of frequent multi-word phrases reveal a set of template paragraphs, and show that both the number of template types and the frequency of their usage increased over time.

Our findings do not directly identify to what extent this standardisation is a reflection of the decision-making process, or of its recording, or of both. It is possible that changes in one of the processes influenced the other. It is also possible that, with what written record has survived/been handed down (resolutions or otherwise), it is impossible to separate these two and identify more precise causal factors.

Our findings prompt further questions in this direction. For instance, to what extent can the introduction of specific formulas or templates be attributed to individual greffiers? Can we distinguish the influences of the greffier and other people/clerks involved by comparing in more detail the minutes and neat resolutions, and the different series of copies that have been archived?

Our findings only partially align with earlier analysis by Riemsdijk and Thomassen, Thomassen, who disagree with each other on whether the commies took over the extending of minutes to full resolutions from the greffier in 1680 [32], or also the taking of the minutes themselves [37]. Our stylometric analysis suggests that certain transitions between greffiers correspond to transitions in spelling, word choice and formulaic expressions, but it is as yet unclear what the influences of greffier, commies and clerks were on the text of the extended and approved resolutions. Further analyses of the handwriting of the resolutions and comparison between extended resolutions and minutes could reveal more insight on this matter.

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## A. The process of recording the Resolutions of the States General of the Dutch Republic

Although representatives of the regions that made up the Netherlands had been meeting since 1464 to provide advice and money to the sovereign, the States General only really became a political factor of importance in the context of the Dutch Revolt against the Spanish king Philip II. The States General developed into a political body in which the rebellious provinces—first including the southern, but from 1585 only the northern regions that became the Republic of the Seven United Netherlands—negotiated and decided upon their common interests, such as foreign policy, defence, and religious matters. The resolution registers are the written record of the decisions taken at the meetings of the assembly, which resided in The Hague from 1588 onwards, and met practically on all weekdays and sometimes even on Sundays from 1593 until 1796.

In the course of the period under study, various administrative customs developed which are important for the analysis of the resolutions. The greffier attended the meetings and had to record the decisions taken. He first noted the conclusion and ‘extended’ it, until 1637 still during the meeting, into a resolution by preceding it with the proposition. He was not allowed to include the intermediate discussion unless a conflict ran high and one of the provinces explicitly wished their position to be recorded. The greffier read the resolutions, or just the ‘disposition’ (the decision), thus drafted for approval by the assembly. After 1637, the reading and approval (the ‘resumption’) was moved to the beginning of the next meeting, usually the following day. As a result, more attention was paid to the drafting of resolutions, leading to more standardisation. The procedure of drafting resolutions involved other officials, who gradually took on a more important role as the administrative burden increased. The extension of some resolutions was done by a clerk after 1637, under the supervision of the greffier. In 1637, the States General appointed a *commies*, in some periods called *second greffier*, who replaced the greffier in his absence. From 1680 the commies/second greffier took over the extension of the ordinary resolutions entirely from the greffier, sometimes with the help of a clerk. After 1744, the extension was left entirely to a clerk. Of importance for the analysis of the ordinary resolutions is also that in our project we do not use the minutes of the resolutions, but the written neat copies until 1703, and thereafter the printed copies. The reason for using the printed copies

where available, is that automatic text recognition gives the better results for printed than for handwritten text. The neat copies were written by clerks. A small-scale manual comparison between the minute and neat resolutions revealed that the latter are a very faithful copy of the minutes, but the spelling of individual words sometimes differs.

Obviously, the involvement of different officials in the drafting of the resolutions, and the fact that the neat copies were written by clerks, has implications for our analysis. After all, the clerks form an additional layer between what the greffier and commiezen drafted and the neat copies we used. Nevertheless, our analysis does show a correlation between variations in the resolutions and the periods when different clerks were in office when it comes to word usage and spelling. Future research could also include the minute-resolutions in the analysis and possibly distinguish between the different handwritings of greffiers, commiezen and clerks.

In addition to the ordinary resolutions, there was also a series of secret resolutions in which the greffier noted down resolutions that were too sensitive to be included in the *ordinaris* register. Unlike the ordinary resolutions, the greffier continued to extend these himself throughout the period, obviously keeping them as secret as possible. Nor were these resolutions printed like the *ordinaris* resolutions from 1703 onwards. As we do not currently have a proper paragraph separation for the secret resolutions, these could not yet be included in the analysis.

### A.1. Text Selection and Representation

The full corpus of resolutions consists of 220 years of decisions recorded in over 600 volumes of handwritten and printed text. As with any large archive that was created over centuries, its creation process was complex and went through many changes.

Initially, there was only one series of minute resolutions, which consisted of the draft resolutions with additions or amendments ordered by the assembly. From 1578 onwards, these ‘messy’ minutes were copied in a neat register, creating a second series of ordinary resolutions, or the first series of *neat* resolutions. The introduction of the resumption in 1637 created a third series. The greffier’s draft resolutions served as the basis of the resumption. Once this draft-with amendments-was approved by the assembly, it was copied as the second series of *neat* resolutions. In the mean time, the custom of having another neat copy produced remained. From 1671, there was even a fourth series produced. For our analysis, we use the first set of neat resolutions up to 1637, and from there the second set of neat resolutions.

We were able to obtain the digital textual representations, transformed from lines of text on physical pages into running paragraphs where word-breaks have been resolved, for the 200 year period 1597-1796, with the exclusion of 1651, 1703 and 1704. For these years, the HTR process generated no usable output (yet).

The individual resolutions have been identified in the printed volumes—covering the period 1705-1796<sup>7</sup>—by [22]. This corpus has 286,340 resolutions. The handwritten volumes we obtained, have not been segmented into individual resolutions, but first into individual sessions<sup>8</sup>, and into individual paragraphs. To have a more uniform corpus for our analysis, we removed

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<sup>7</sup>There are printed copies of earlier volumes of resolutions, by they are archived separately, and have not gone through the OCR pipeline yet.

<sup>8</sup>The resolutions were record chronologically, with the resolutions of each day preceded by the date and a list of attendants of the meeting.

the date and attendance lists of the handwritten resolutions and cut the 18<sup>th</sup> century resolutions into individual paragraphs as well. The total corpus has just over 125 million words.

## A.2. Spelling normalisation

We attempted algorithmic spelling normalisation, using a combination of FastText word embeddings [4] to find spelling variants that occur in similar contexts, context-sensitive rewrite rules to normalise variation in vowel and consonant sequences, and word splitting and merging to identify variation in word segmentation. The goal was to bring the different periods closer together in spelling, or at least in amount of spelling variation. Although this worked well for the later periods, we found that it captured only a small fraction of the variation for the earliest periods. Given these findings, we perform the rest of the analyses in this paper without spelling normalisation.

We experimented with a combination of techniques to normalise spelling, for two reasons. First, to study how spelling variation affects the frequency of multi-word phrases, and second, to bring the different periods closer together in spelling, or at least in amount of spelling variation.

We use FastText word embeddings [4] to find spelling variants that occur in similar contexts. Some spelling changes and variations are sudden and happen with whole groups of words. We use a list of character ngram pairs and a list of context-sensitive rewrite rules to find spelling variants. We compute word 2-gram frequencies per 5-year period and check if the merger of each word 2-gram is more frequent in different periods. This results in a list of unigram and bigram pairs that can be algorithmically normalised (e.g. always use the unigram or bigram, or always use the most frequent of the two). All these term pair lists were manually curated to remove errors.

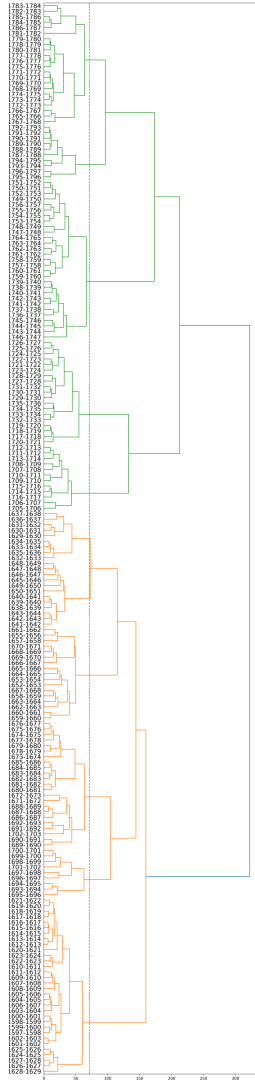
Although this worked well for the later periods, we found that it captured only a small fraction of the variation for the earliest periods. Given these findings, we perform all the analyses in this paper without spelling normalisation.

## B. Hierarchical clustering and periodisation

The threshold value for cutting the hierarchical clustering and flatten the sub-clusters was set to  $t = 71$  for two reasons. First, at that level, the clusters are relatively close to each other in size in number of years per cluster (between 9 and 30 years) and the number of clusters (11) is small enough to make manual comparison feasible.

Using more conventional criteria like silhouette [34] would have resulted in two clusters, one for the handwritten resolutions of 1597-1702 and one for the printed resolutions of 1705-1796. This is by far the strongest division. The threshold  $t$  where a single cluster splits into two clusters is  $t = 323$ , and the threshold between a two cluster and a three cluster split is  $t = 213$ .

The second reason is that we want the number of non-contiguous clusters to be minimal. At  $t = 71$ , all but one of the clusters represent contiguous periods, and there is only a single year (1702) that is grouped with a contiguous period (1671-1692). The closest cluster to that one in terms of cosine distance is the intermediate period (1693-1701). All lower (integer)  $t$  values result in multiple temporal discontinuities in the clusters.



**Figure 9:** A hierarchical clustering of 5-year periods of resolutions, based on Burrows' Delta cosine distances using the 1000 most frequent word 3-grams.

The full dendrogram is shown in Figure 9.



## C. Examples of templated paragraphs

Below are example paragraphs for each of the template types. The formula combinations are underlined. Variable slots that require a named entity of a specific type are indicated with <VAR>.

**Template type:** No resolution.

ONtfangen een Missive van <PERSON>, geschreeven <LOCATION> den <DATE>, houdende advertentie. WAAR op geen resolutie is gevallen.

ONtfangen een Missive van <PERSON>, geschreeven te <LOCATION> den <DATE>, geadresseert aan den Griffier Fagel, houdende advertentie. WAAR op geen resolutie is gevallen.

ONtfangen een Missive van <PERSON>, geschreeven te <LOCATION> den <DATE>, houdende advertentie. WAAR op geen resolutie is gevallen.

ONtfangen een Missive van <PERSON>, geschreeven te <LOCATION> den <DATE>, houdende advertentie. WAAR op geen resolutie is gevallen.

**Template type:** The resolutions taken yesterday have been read and approved.

DE Relolutien gisteren genomen, zyn geleesen en geresumeert, gelijk ook geresumeert en gearresteert zyn de Depeches daar uit resulterende.

DE Resolutien gisteren genoomen, zyn geleesen en geresumeert, gelijk ook geresumeert en gearresteert zyn de Depeches daar uit resulterende.

DE Resolutien gisteren ge. nomen, zyn geleesen en geresumeert, gelijk ook geresumeert en gearresteert zyn de Depeches daar uit resulterende.

DE Resolustien gisteren genoomen, zyn geleesen en geresumeert, gelijk ook geresumeert en gearresteert zyn de Depeches daar uit resulterende.

**Template type:** requesting the SG to send a bill to the Generaliteits Reekenkamer (EN: *Chamber of Finance*):

IS ter Vergaderinge geleesen de Requeste van <PERSON>, presenterende daar nevens aan haar Hoog Mogende sijne Declaratie van Daggelden en Verschotten <PERIOD>; versoekende dat haar Hoog Mog. deselve ten fine van examinatie en liquidatie gelieven te senden aan den Raad van Staate en de Generaliteits Reekenkamer.

IS ter Vergaderinge geleesen de Requeste van <PERSON>, presenterende daar nevens aan haar Hoog Mog. sijne Declaratie van Tractementen en Verschotten, welke aan hem in voorschreeve qualiteit nog waren competeerende, <PERIOD>; versoekende derhalven, dat haar Hoog Mog. deselve ten fine van examinatie en liquidatie gelieven te senden aan den Raad van Staate en de Generaliteits Reekenkamer.

IS ter Vergaderinge geleesen de Requeste van <PERSON>, presenterende daar nevens aan haar Hoog Mog. sijne Declaratie van Taactementen, Daggelden en Verschotten, <PERIOD>; versoekende dat haar Hoog Mog. deselve ten fine van examinatie en liquidatie, gelieven te senden aan den Raad van Staate en de Generaliteits Reekenkamer.

**Template type:** acceptance to send a bill to the Generaliteits Reekenkamer (EN: *Chamber of Finance*).

WAAR op gedelibereert zynde, is goedgevonden en verstaan, dat de Declaratie nevens de voorsz <DOCUMENT> gevoegt, gesonden sal worden aan den Raad van Staate en de Generaliteits Reekenkamer, om te visiteeren, examineeren en liquideeren, volgens en in conformiteit van de ordres van het Land.

WAAR op gedelibereert zynde, is goelgevonden en verstaan, dat de Declaratie, neevens de voorschreeve <DOCUMENT> gevoegt, gesonden sal worden aan den Raad van Staate en de Generaliteits Reekenkamer, om te visiteeren, examineeren en liquideeren, volgens en in conformiteit van de ordres van het Land.

WAAR op gedelibereert zynde, is goedgevonden en verstaan, dat de Declaratie nevens de voorsz <DOCUMENT> gevoegt, gesonden sal worden aan den Raad van Staate en de Generaliteits Reekenkamer, om te visiteeren, examineeren en liquideeren, volgens en in conformiteit van de ordres van het Land.

*Template type:* Request Province for vote/opinion.

WAAR op gedelibereert zynde, is goedgevonden en verstaan, mits deesen te versoeken de Heeren Gedeputeerden van de Provincien, welke sig op het voorsz subject nog niet hebben verkl art, hun daar toe meede te willen bekwamen.

WAAR op gedelibereert zynde, is goedgevonden en verstaan, mits deesen te versoeken de Heeren Gedeputeerden van de Provincien van <PROVINCE> en <PROVINCE>, welke sig op het voorschreeve subject nog net hebben verklaart, hun daar toe meede te willen bequamen.

WAAR op gedelibereert zynde, is goedgevonden en verstaan, mits deesen te versoeken de Heeren Gedeputeerden van de Provincie van <PROVINCE>, welke sig op het voorschreeve subject nog niet hebben verklaart, hun daar toe meede te willen bequamen.

**Template type:** Deputies of province read resolution that is inserted.

DE Heeren Gedeputeerden van de Provincie van <PROVINCE>, hebben ter Vergaderinge ingebracht en laten leesen de Resolutie van de Heeren Staaten van hooggemelde Provincie hunne Principaalen, waar by hoogstdeselve de gemelde

Heeren hunne Gedeputeerden autoriseeren, om met gevog van de andere Provincien te consenteeren in den voorslag vervat in de Missive van den Raad van Staate, den 27 April deeses jaars alhier ter Vergaderinge ingekomen, en tenderende om een douceur te geeven van ses honderd guldens, aan de vyftien oude Compagnien Artilleristen; volgende de voorsz Resolutie hier na geinsereert.

DE Heeren Gedeputeerden van de Provincie van <PROVINCE>, hebben ter Vergaderinge ingebracht en laten leesen de Resolutie van de Heeren Staaten van hooggemelde Provincie hunne Principaalen, waar by hoogstdeselve consenteeren in de door het Collegie ter Admiraliteit in Westvriesland en het Noorder Quartier versogte tweede Negociatie van 60coco guldens ter voldoening hunner agterstallen; volgende de voorsz Resolutie hier na geinsereert.

DE Heeren Gedeputeerden van de Provincie van <PROVINCE>, hebben ter Vergaderinge ingebracht en laten leesen de Resolutie van de Heeren Staaten van hooggemelde Provincie hunne Principaalen, waar by hoogstdeselve alsnog deelaereeren, het Corys van den Rhyngrove van Salm met den 7 Mey laatstleeden, te houden voor afgedankt, soo nogtans, dat aan het selve nog zullen worden betaald twee maanden Soldye, ingaande met den 7 Mey en 18 Junv; volgende de voorschreeve Resolutie hier na geinsereert.

DE Heeren Gedeputeerden van de Provincien van <PROVINCE> en van <PROVINCE>, hebben ter Vergaderinge ingebracht en laten leesen de Resolutien van de Heeren Staaten van hooggemelde Provincien hunne Principaalen, waar by hoogstdeselve sig conformeeten met het Rapport den 24 Augusty laatstleeden alhier ter Vergaderinge uitgebragt, over het getal der Leeden, dewelke souden dienen te worden benoemt in de bekende saak der niet geexccuteerde Expeditie na Brest; volgende de voorschreeve Resolutie hier na geinsereert.

**Template type:** Extract from resolution register.

Extract uyt het Register der Resolutien van Ridderschap en Steeden de Staaten van <PROVINCE>.

Extract uit het Register der Resolutien van Ridderschap en Steeden de Staaten van <PROVINCE>.

Extract uyt het Register der Resolutien van Ridderschap en Steeden de Staaten van <PROVINCE>.

Extract uit het Register van de Resolutien der Heeren Staaten van <PROVINCE>.