

Nobody expects the Spanish Inquisition: The effect of events on Australian parliamentary discussion *

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Government policy is partly driven by the topics that are discussed in parliament. Conversely, those same topics can indicate a government's priorities. But major events—both expected, such as an election, and unexpected, such as a recession or terrorist attack—can affect the course of parliamentary debate. In this paper, we systematically analyse how parliamentary debate has changed in response to different types of events in Australian history. We compile a dataset of what was said in Australian state and federal parliaments from the mid-1800s through to 2017 based on available public records. We use a structural text model to reduce the dimensionality of the text and to impose prior knowledge such as correlation between days and changes over time. We then examine the effect of various events using a discrete choice model. We find that: 1) changes of government are associated with topic changes only when there is also a change of the party in power; and 2) economic events, such as financial crises, have significant and persistent effects. Our findings have implications for how we think about the longer-term trajectory of government policy as the media cycle becomes increasingly focused on short-term events.

Keywords: text analysis, politics, Australia

Introduction

New governments often go to some trouble to be different to the governments they replace. For instance, Kevin Rudd's apology to Indigenous Australians was not supported by his predecessor John Howard, and then one of Tony Abbott's first acts was to repeal his predecessor Kevin Rudd's carbon tax. Similarly, significant events such as the 9/11 attacks or the Great Recession have often altered the course of a government. However it is not so clear which events drive changes, for how long these changes persist, and what was given up due to the change.

In this paper we examine text records of what was said in Australian state and federal parliaments from the mid-1800s through to 2017. We use the Structural Topic Model (STM) of [Roberts, Stewart and Airoldi \(2016\)](#) for dimensionality reduction and to impose structure such as correlation between days and changes over time. We then use a discrete choice model to examine changes at various types of events, including: changes in government; changes in the political environment (as defined by polling or other results); changes in economic conditions; and other significant events (such as the 9/11 attacks or

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the Bali bombings).

We find [INSERT RESULTS].

Our paper applies a topic model to a dataset of larger-scale parliamentary text records from multiple Australian parliaments. Our use of a discrete choice model allows us construct a counterfactual. Our work fits into a growing literature that considers text as a input to more usual quantitative techniques, rather than requiring separate analysis. While using text as data has well-known shortcomings, it allows larger-scale analysis that would not be viable using less-automated approaches and so it can identify patterns that may otherwise be overlooked.

Data

Parliamentary text data

Following the example of the UK a daily text record called Hansard of what was said in Australian parliaments has been made available since their establishment.¹ Hansard records and their equivalents are an increasingly popular source of data as new methods and reduced computational costs make larger-scale analysis easier. For instance, the digitisation of the Canadian Hansard, [Beelen et al. \(2017\)](#), allowed [Whyte \(2017\)](#) to examine whether parliamentary disruptions in Canada increased between 1926 and 2015 and [Rheault and Cochrane \(2018\)](#) to examine ideology and party polarisation in Britain and Canada. In the UK, [Duthie, Budzynska and Reed \(2016\)](#) analysed Hansard records to examine which politicians made supportive or aggressive statements toward other politicians between 1979 and 1990 and [Peterson and Spirling \(2018\)](#) examined polarisation. In New Zealand, [Curran et al. \(2017\)](#) modelled the topics discussed between 2003 and 2016, and [Graham \(2016\)](#) examined unparliamentary language between 1890 and 1950. And in the US [Gentzkow, Shapiro and Taddy \(2018\)](#) examine congressional speech records from 1873 to 2016 to find that partisanship has risen in the past few decades.

Australian Hansard records have been analysed for various purposes. For instance, [Rasiah \(2010\)](#) examined Hansard records for the Australian House of Representatives to examine whether politicians attempted to evade questions about Iraq during February and March 2003. And [Gans and Leigh \(2012\)](#) examined Australian Hansard records to associate mentions by politicians of certain public intellectuals with neutral or positive sentiment.

Australian parliaments generally make their daily Hansard records available online as PDFs and these are considered the official release. There is a more limited set of XML records available in some cases.² There are 65,000 [UPDATE] Hansard records publicly

¹While Hansard is not necessarily verbatim, it is considered close enough for text-as-data purposes. For instance, [Mollin \(2008\)](#) found that in the case of the UK Hansard the differences would only affect specialised linguistic analysis. [Edwards \(2016\)](#) examined Australia, New Zealand and the UK, and found that changes were usually made by those responsible for creating the Hansard record, instead of the parliamentarians.

²Tim Sherratt makes these XML records available as a single download and also presents them in a website (<http://historichansard.net/>) that can be used to explore Commonwealth Hansard records from 1901 to 1980. Commonwealth XML records from 1998 to 2014 are available from Andrew Turpin's website, and from 2006 through today from Open Australia's website.

available across the state and federal parliaments (Table 1) [UPDATE NUMBERING]. As with any larger-scale data process, there are various issues with some of the PDFs and the known ones are detailed in the Appendix.

Parliament	House	Years used	Number of records
Commonwealth	House of Representatives	1901 - 2017	7,873
	Senate	1901 - 2017	[TBD]
Queensland	Legislative Assembly	1860 - 2017	9,699
	Legislative Council	1860 - 1922	4,156
New South Wales ³	Legislative Assembly	1856 - 2017	[TBD]
	Legislative Council	1856 - 2017	[TBD]
Victoria	Legislative Assembly	1856 - 2017	[TBD]
	Legislative Council	1851 - 2017	[TBD]
Tasmania ⁴	House of Assembly	1856 - 2017	[TBD]
	Legislative Council	1856 - 2017	[TBD]
South Australia ⁵	House of Assembly	1857 - 2017	[TBD]
	Legislative Council	1840 - 2017	[TBD]
Western Australia ⁶	Legislative Assembly	1890 - 2017	[TBD]
	Legislative Council	1832 - 2017	[TBD]

The formatting of the Hansard records changes between the different parliaments and over time. We use R scripts to convert the PDFs into daily text records.⁷ These scripts are primarily based on: the `PDFtools` package of Ooms (2018a); the `tidyverse` package of Wickham (2017); the `tm` package of Feinerer and Hornik (2018); the `lubridate` package of Grolemund and Wickham (2011); and the `stringi` package of Gagolewski (2018). The functions of those packages are supported by: the `furrr` package of Vaughan and Dancho (2018); and the `tictoc` package of Izrailev (2014). Some error is introduced at this stage because many of the records are in a two-column format that need to be separated, and the PDF parsing is not always accurate especially for older records. An example of the latter issue is that ‘the’ is often parsed as ‘thc’. These errors are fixed when they occur at scale and can be identified. The `hunspell` package of Ooms (2017) is also used to help find spelling issues.

[ADD PICTURE OF HANSARD RECORD AND THE SUBSEQUENT TEXT RECORD?]

These daily records are the main data used in this paper, however the daily records are also further divided into individual-level records. Sometimes these are just short interjections or notes that are not specific to any particular politician, such as ‘Honourable

³The NSW Legislative Council was established earlier than 1856, however the earlier Hansard records have not been through an independent OCR process and were not used in this paper. However, the Google Tesseract OCR engine as implemented by Ooms (2018b) provided useful data and these could be used in the future.

⁴[Update this, depending on final Tassie records].

⁵[Update this, depending on final SA records].

⁶[Update this, depending on final WA records].

⁷An example of the workflow and some reduced-detail scripts are provided in the Appendix. The full set of scripts are available on request.

members interjecting'. Interjections are interesting in their own right, for instance [Whyte \(2017\)](#) analysed them in a Canadian context for the period 1926 to 2015 to find that female MPs were more likely to be interrupted than male MPs, but do not usually contribute much to defining the topics being discussed.

Usually the disaggregation into individual-level records is done by identifying politicians' names in particular patterns. For instance, when the Hansard record is trying to indicate that a person is speaking, as opposed to being mentioned (for more on the political effect of being mentioned see [Alexander \(2018\)](#)), often the name is in upper case (e.g. 'Mr WHITLAM' or 'Mr MENZIES'); followed by a dash or colon; or are next to some title within brackets. There is substantial variation in how the person making a statement is identified. Again some error is introduced at this stage because of inconsistencies over time and between the parliaments, as well as the errors introduced during the PDF parsing stage. There is considerable variance but on average each daily record had 250 [UPDATE] individual-level records, resulting in roughly 15 million rows [UPDATE] across the state and federal parliaments.

Text usually needs to be pre-processed before topic models can be used. The specific steps that we take are to remove numbers and punctuation and to change all the words to lower case. Then the sentences are deconstructed and each word considered individually. In addition to the packages already mentioned, in this step the R scripts to do this use the `tidytext` R package of [Silge and Robinson \(2016\)](#).

Additional information

Data from other sources are useful to complement the parliamentary text data. For instance, although the name, party, and division represented are contained in Hansard records they are inconsistent. Also non-Hansard information about the politicians can inform the analysis. This includes: date of birth and date of death; sex; date of entry to parliament and exit from parliament; some aspects of their pre- and post-parliamentary career; some aspects of their parliamentary career, such as ministry appointments; and electoral information such as primary and two-party-preferred results.

The main sources for this additional supplementary information are the handbooks supplied by the various parliaments. However these had many errors and were supplemented by data from the Australian Dictionary of Biography and Wikipedia.⁸

Model

The main models that we use in this paper are the Structural Topic Model (STM) as implemented by the `stm` R package of [Roberts, Stewart and Tingley \(2018\)](#), and a discrete choice model as implemented by the `XXXX` R package of [XYZ](#). In theory we could have directly used the text as an input to the discrete choice model, but this is intractable due to computer memory and storage constraints. Instead, in a similar way to [Mueller and Rauh \(2018\)](#), we use the topics that the text is about as an input to another model, which in our case is a discrete choice model.

⁸An example of the additional information is provided in the Appendix. The datasets are available on request.

The basis of the STM is the Latent Dirichlet Allocation (LDA) model of [Blei, Ng and Jordan \(2003\)](#). In this section we provide a brief overview of both the LDA model and the STM. we consider the outputs of the topic model as reduced dimension inputs. In our case they are inputs to a discrete choice model, and so we then discuss that model.

Latent Dirichlet Allocation

Although more- or less-fine levels of analysis are possible, but here we are primarily interested in considering a day's topics. This means that each day's Hansard record needs to be classified by its topics. Sometimes Hansard records includes titles that make the topic clear. But not every statement has a title and the titles do not always define topics in a well-defined and consistent way, especially over longer time periods. One way to get consistent estimates of the topics discussed in Hansard is to use the LDA method of [Blei, Ng and Jordan \(2003\)](#), for instance as implemented by the R package 'topicmodels' by [Grün and Hornik \(2011\)](#).

The key assumption behind the LDA method is that each day's text, 'a document', in Hansard is made by speakers who decide the topics they would like to talk about in that document, and then choose words, 'terms', that are appropriate to those topics. A topic could be thought of as a collection of terms, and a document as a collection of topics, where these collections are defined by probability distributions. The topics are not specified *ex ante*; they are an outcome of the method. In this sense, this approach can be considered unsupervised statistical learning. Terms are not necessarily unique to a particular topic, and a document could be about more than one topic. This provides more flexibility than other approaches such as a strict word count method. The goal is to have the words found in each day's Hansard group themselves to define topics.

As applied to Hansard, the LDA method considers each statement to be a result of a process where a politician first chooses the topics they want to speak about. After choosing the topics, the speaker then chooses appropriate words to use for each of those topics. More generally, the LDA topic model works by considering each document as having been generated by some probability distribution over topics. For instance, if there were five topics and two documents, then the first document may be comprised mostly of the first few topics; the other document may be mostly about the final few topics (Figure 1).

Similarly, each topic could be considered a probability distribution over terms. To choose the terms used in each document the speaker picks terms from each topic in the appropriate proportion. For instance, if there were ten terms, then one topic could be defined by giving more weight to terms related to immigration; and some other topic may give more weight to terms related to the economy (Figure 2).

Following [Blei and Lafferty \(2009\)](#), [Blei \(2012\)](#) and [Griffiths and Steyvers \(2004\)](#), the process by which a document is generated is more formally considered to be:

1. There are $1, 2, \dots, k, \dots, K$ topics and the vocabulary consists of $1, 2, \dots, V$ terms. For each topic, decide the terms that the topic uses by randomly drawing distributions over the terms. The distribution over the terms for the k th topic is β_k . Typically a topic would be a small number of terms and so the Dirichlet distribution with

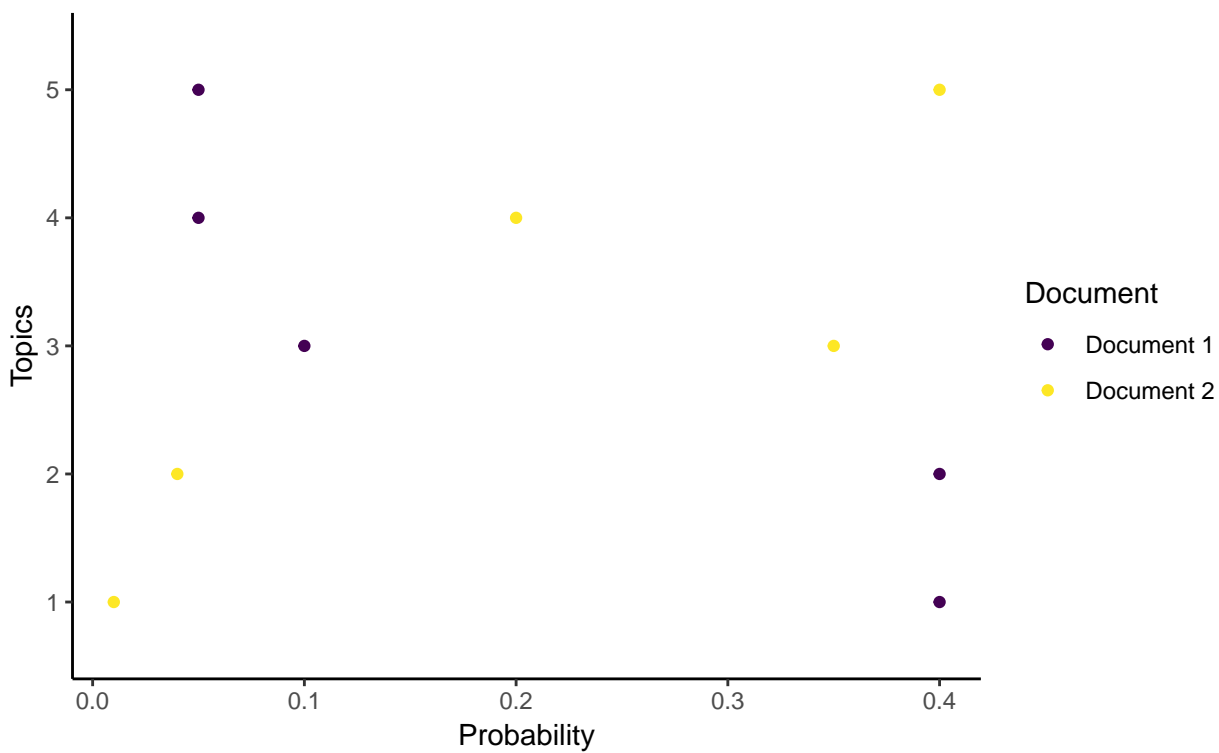


Figure 1: Probability distributions over topics for two documents

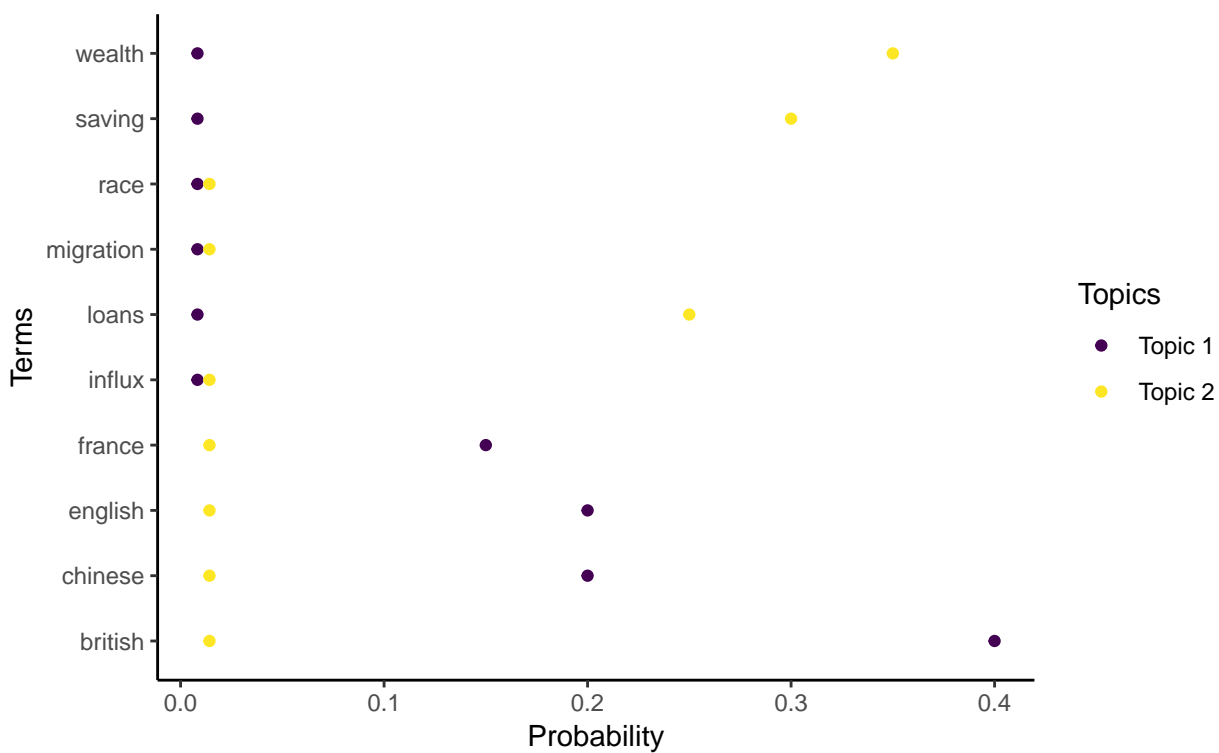


Figure 2: Probability distributions over terms

hyperparameter $0 < \eta < 1$ is used: $\beta_k \sim \text{Dirichlet}(\eta)$.⁹ Strictly, η is actually a vector of hyperparameters, one for each K , but in practice they all tend to be the same value.

2. Decide the topics that each document will cover by randomly drawing distributions over the K topics for each of the $1, 2, \dots, d, \dots, D$ documents. The topic distributions for the d th document are θ_d , and $\theta_{d,k}$ is the topic distribution for topic k in document d . Again, the Dirichlet distribution with the hyperparameter $0 < \alpha < 1$ is used here because usually a document would only cover a handful of topics: $\theta_d \sim \text{Dirichlet}(\alpha)$. Again, strictly α is vector of length K of hyperparameters, but in practice each is usually the same value.
3. If there are $1, 2, \dots, n, \dots, N$ terms in the d th document, then to choose the n th term, $w_{d,n}$:
 - a. Randomly choose a topic for that term n , in that document d , $z_{d,n}$, from the multinomial distribution over topics in that document, $z_{d,n} \sim \text{Multinomial}(\theta_d)$.
 - b. Randomly choose a term from the relevant multinomial distribution over the terms for that topic, $w_{d,n} \sim \text{Multinomial}(\beta_{z_{d,n}})$.

Given this set-up, the joint distribution for the variables is (Blei (2012), p.6):

$$p(\beta_{1:K}, \theta_{1:D}, z_{1:D,1:N}, w_{1:D,1:N}) = \prod_{i=1}^K p(\beta_i) \prod_{d=1}^D p(\theta_d) \left(\prod_{n=1}^N p(z_{d,n} | \theta_d) p(w_{d,n} | \beta_{z_{d,n}}) \right).$$

Based on this document generation process the analysis problem, discussed next, is to compute a posterior over $\beta_{1:K}$ and $\theta_{1:D}$, given $w_{1:D,1:N}$. This is intractable directly, but can be approximated (Griffiths and Steyvers (2004) and Blei (2012)).

After the documents are created, they are all that we have to analyse. The term usage in each document, $w_{1:D,1:N}$, is observed, but the topics are hidden, or ‘latent’. We do not know the topics of each document, nor how terms defined the topics. That is, we do not know the probability distributions of Figures 1 or 2. In a sense we are trying to reverse the document generation process – we have the terms and we would like to discover the topics.

If the earlier process around how the documents were generated is assumed and we observe the terms in each document, then we can obtain estimates of the topics (Steyvers and Griffiths (2006)). The outcomes of the LDA process are probability distributions and these define the topics. Each term will be given a probability of being a member of a particular topic, and each document will be given a probability of being about a particular topic. That is, we are trying to calculate the posterior distribution of the topics given the terms observed in each document (Blei (2012), p. 7):

$$p(\beta_{1:K}, \theta_{1:D}, z_{1:D,1:N} | w_{1:D,1:N}) = \frac{p(\beta_{1:K}, \theta_{1:D}, z_{1:D,1:N}, w_{1:D,1:N})}{p(w_{1:D,1:N})}.$$

⁹The Dirichlet distribution is a variation of the beta distribution that is commonly used as a prior for categorical and multinomial variables. If there are just two categories, then the Dirichlet and the beta distributions are the same. In the special case of a symmetric Dirichlet distribution, $\eta = 1$, it is equivalent to a uniform distribution. If $\eta < 1$, then the distribution is sparse and concentrated on a smaller number of the values, and this number decreases as η decreases. A hyperparameter is a parameter of a prior distribution.

The initial practical step when implementing LDA given a collection of documents is to remove ‘stop words’. These are words that are common, but that don’t typically help to define topics. There is a common list of stop words such as: “a”; “an”; and “and”. However the exact list used depends on research of focus. In the case of Australian Hansard, these are words such as: “australia”; “australian”; and “bill”. Punctuation and capitalisation is also typically removed. The documents then need to then be transformed into a document-term-matrix. This is essentially a table with a column of the number of times each term appears in each document.

After the dataset is ready, the R `topicmodels` package of [Grün and Hornik \(2011\)](#) can be used to implement LDA and approximate the posterior. It can do this using Gibbs sampling or the variational expectation-maximization algorithm. Following [Steyvers and Griffiths \(2006\)](#) and [Darling \(2011\)](#), the Gibbs sampling process attempts to find a topic for a particular term in a particular document, given the topics of all other terms for all other documents. Broadly, it does this by first assigning every term in every document to a random topic, specified by Dirichlet priors with $\alpha = \frac{50}{K}$ and $\eta = 0.1$ ([Steyvers and Griffiths \(2006\)](#) recommends $\eta = 0.01$), where α refers to the distribution over topics and η refers to the distribution over terms ([Grün and Hornik \(2011\)](#), p. 7). It then selects a particular term in a particular document and assigns it to a new topic based on the conditional distribution where the topics for all other terms in all documents are taken as given ([Grün and Hornik \(2011\)](#), p. 6):

$$p(z_{d,n} = k | w_{1:D,1:N}, z'_{d,n}) \propto \frac{\lambda'_{n \rightarrow k} + \eta}{\lambda'_{\cdot \rightarrow k} + V\eta} \frac{\lambda'^{(d)}_{n \rightarrow k} + \alpha}{\lambda'^{(d)}_{-i} + K\alpha}$$

where $z'_{d,n}$ refers to all other topic assignments; $\lambda'_{n \rightarrow k}$ is a count of how many other times that term has been assigned to topic k ; $\lambda'_{\cdot \rightarrow k}$ is a count of how many other times that any term has been assigned to topic k ; $\lambda'^{(d)}_{n \rightarrow k}$ is a count of how many other times that term has been assigned to topic k in that particular document; and $\lambda'^{(d)}_{-i}$ is a count of how many other times that term has been assigned in that document. Once $z_{d,n}$ has been estimated, then estimates for the distribution of words into topics and topics into documents can be backed out.

This conditional distribution assigns topics depending on how often a term has been assigned to that topic previously, and how common the topic is in that document ([Steyvers and Griffiths \(2006\)](#)). The initial random allocation of topics means that the results of early passes through the corpus of document are poor, but given enough time the algorithm converges to an appropriate estimate.

The choice of the number of topics, k , affects the results, and must be specified *a priori*. If there is a strong reason for a particular number, then this can be used. Otherwise, one way to choose an appropriate number is to use a test and training set process. Essentially, this means running the process on a variety of possible values for k and then picking an appropriate value that performs well.

One weakness of the LDA method is that it considers a ‘bag of words’ where the order of those words does not matter ([Blei \(2012\)](#)). It is possible to extend the model to reduce the impact of the bag-of-words assumption and add conditionality to word order.

Additionally, alternatives to the Dirichlet distribution can be used to extend the model to allow for correlation. For instance, in Hansard topics related the army may be expected to be more commonly found with topics related to the navy, but less commonly with topics related to banking. This motivates the use of the Structural Topic Model, described in the next section.

Structural Topic Model

The distinguishing aspect of the Structural Topic Model (STM) of [Roberts, Stewart and Airoldi \(2016\)](#) is that it includes additional information about documents. For instance, in general we usually have some information about the author and date of a document. In the case of Hansard, we know who was speaking and the date. STM allows this additional information to affect the construction of topics, though influencing either topical prevalence or topical content. That said, the assumption that there is some document generation process is the same as the LDA method, it is just that this process now includes metadata.

The STM is set-up to most easily include metadata to do with prevalence and content. Prevalence relates to the topic proportions in each document. For instance, we expect that topics related to the reasons for Federation such as tariffs and trade should be more prevalent in those earlier years than later. Similarly, we may expect topics to do with terrorism to be more prevalent in recent years than in earlier ones. Content relates to the words that make up each topic. For instance, there are changes in the use of language over the period for which we have data, and it would be better for these to not be responsible for defining different topics rather than being part of the same topic.

The document generation process of [Blei, Ng and Jordan \(2003\)](#) discussed earlier is modified slightly by [Roberts, Stewart and Airoldi \(2016\)](#):

1. The proportion of a document dedicated to a topic is drawn “from a logistic-normal generalised linear model based on a vector of document covariates X_d ”:

$$\theta_d | X_d \gamma \sigma \sim \text{logisticnormal}(\mu = X_d \gamma, \sigma)$$

“where X_d is a 1-by- p vector, γ is a p -by- $K - 1$ matrix of coefficients and σ is $K-1$ by $K-1$ covariance matrix.” **THIS IS ALL QUOTES. NEED TO REWRITE.**

2. Given a document-level content covariate

HERE

Following [Blei and Lafferty \(2009\)](#), [Blei \(2012\)](#) and [Griffiths and Steyvers \(2004\)](#), the process by which a document is generated is more formally considered to be:

1. There are For each topic, decide the terms that the topic uses by randomly drawing distributions over the terms. The distribution over the terms for the k th topic is β_k . Typically a topic would be a small number of terms and so the Dirichlet distribution

with hyperparameter $0 < \eta < 1$ is used: $\beta_k \sim \text{Dirichlet}(\eta)$.¹⁰ Strictly, η is actually a vector of hyperparameters, one for each K , but in practice they all tend to be the same value.

STM can be implemented using the `stm` R package of [Roberts, Stewart and Tingley \(2018\)](#).

Note that each of the states and the Commonwealth are treated independently here. Future work could expand the model to better understand, and allow, for correlation between them.

Considering events

[TBD]

Results

Political events

When you change the government, you change the country. Paul Keating.

Change of government.

Polling events

The only poll that matters is the one on election day. John Howard.

[TBD]

Economic events

Major economic changes.

[TBD]

External events

Events, dear boy, events. Attributed to Harold Macmillan.

Major event such as 9/11 attacks, or economic change.

¹⁰The Dirichlet distribution is a variation of the beta distribution that is commonly used as a prior for categorical and multinomial variables. If there are just two categories, then the Dirichlet and the beta distributions are the same. In the special case of a symmetric Dirichlet distribution, $\eta = 1$, it is equivalent to a uniform distribution. If $\eta < 1$, then the distribution is sparse and concentrated on a smaller number of the values, and this number decreases as η decreases. A hyperparameter is a parameter of a prior distribution.

Summary and conclusions

In this paper we examined

What could happen if we had longer terms. Eg GST needed multiple generations of politicians but carbon tax couldn't because it was one generation.

Text analysis has well-known biases and weaknesses and is a complement to more detailed analysis such as qualitative methods and case studies. We consider the results presented in this paper, as well as many of those results of the larger text-as-data research program, as fitting within findings based on other methods.

Future work - examine how it changed during Federation

Appendix

Document sources

Where from?

Which years are being used (not non-OCRd)

Dataset issues

Which PDFs are missing or have no content, etc.

I have this number yearin Reprs	They say this number in Senate	They say this number in Reprs	Difference in Reprs	Comment	Source
1902106	93	107	1	Positive means I am missing some	https://www.aph.gov.au/Parliamentary_Business/Statistics/Senate_StatsNet/General/sittingdaysyear
190893	84	91	-2	Negative means I have too many	
190997	71	98	1		
191887	68	86	-1		
1920113	76	114	1		
192192	79	93	1		
19346	22	35	-1		
19354	37	55	1		
19424	36	45	1		
19489	39	90	1		
195155	40	56	1		
19553	36	52	-1		
19744	64	62	-2		
19855	74	66	1		
199166	83	67	1		
199260	76	44	-16		
199347	53	46	-1		
19949	80	68	-1		
199571	78	70	-1		
19979	82	76	-3		
199856	57	54	-2		
200071	71	73	2		

	I have this number yearin Repts	They say this number in Senate	They say this number in Repts	Difference in Reps	Comment	Source
	200268	60	69	1		
	200374	64	75	1		
	200458	49	59	1		
	201263	57	67	4		

Example workflow

Example of the workflow from PDF to text

PDF to CSV issues

Insert graph of stop words over time.

Selection of number of topics

Robustness of results

Here we change the number of sitting days considered either side of an event. The results in the main section of the paper are for the nearest ten days either side of an event. Here are show that the results are essentially the same if the nearest one, two, five, and twenty days either side of an event.

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