Modelling responsiveness and willingness to negotiate using sentiment: a textual analysis of the FARC-Colombia peace talks

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Abstract

This paper considers factors during the peace process that contribute to the success of peace talks, and, of ultimately peace agreements. The FARC-Colombia talks from 2012-2016 sought to end an intractable half-century-long conflict with a negotiated settlement. Using a new dataset of separate statements from the government and FARC (Fuerzas Armadas Revolucionarias de Colombia) and joint statements from the negotiators, I use sentiment analysis and hidden Markov models to estimate each actor's willingness to negotiate as a function of their textual sentiment. I find some support for the hypothesis that willingness to negotiate predicts the sentiment of joint statements. I use a Markov process to estimate sentiment responsiveness, and, contrary to my predictions, I find that actors are unlikely to respond to each other with the same levels of sentiment. These results suggest that using sentiment analysis to measure the

progress of peace talks is a promising new tool for research on why talks are successful or fall apart and, ultimately, what makes peace agreements durable.

1 Introduction

Why do some peace negotiations succeed but not others, and what accounts for the durability of peace or the resumption of fighting? Understanding the factors behind successful conflict termination is of great academic and real-world importance. Much of the existing analysis of peace processes and outcomes has tended to use game theoretical or case specific approaches, and empirical research has focused on violence during negotiations and implementation of agreements.

For instance, many scholars have modelled peace negotiations, for either interstate or intrastate wars, as a bargaining process or game (Powell 2002; Fey and Ramsay 2011; Pillar 2014). Building upon these themes, a major strand in the theoretical literature explains peace process failure as a commitment problem driven by uncertainty. Beliefs about guarantees for implementing agreements determine whether combatants choose to resume fighting or commit to peace (Walter 2002). Accordingly, postconflict research has examined the effect of peacekeeping operations and other third-party guarantees intended to resolve the commitment problem (Fortna 2004, 2008). Looking at transitions to peace more generally, scholars have used hand-coded texts of peace agreements to better understand whether provisions such as political representation for rebels in postconflict governments or territorial autonomy predict peace survival (Hartzell et al. 2001). Other work has examined institutions such as power-sharing (Hartzell and Hoddie 2003; Mukherjee 2006).

Regarding ongoing negotiations, researchers have posited theories to explain the variable effect of violent attacks on derailing talks (Kydd and Walter 2002) and the relationship between government concessions and the level of terrorist activity (De Mesquita 2005). Other research has looked for peace process spoilers within the cacophony of factions in state

and nonstate actors, with some scholars arguing that internal contestation and excluded or disgruntled parties thwart peace (Stedman 1997; Pearlman 2009). However, other findings suggest that including all factions is less important than originally thought (Nilsson 2008).

In short, a broad body of empirical and theoretical literature has discussed many features of peace negotiations and their outcomes. Understanding the negotiations process is a key to explaining the dynamics of bargaining, the provisions that end up in agreements, and whether these settlements bring about peace. However, to my knowledge there is no empirical research that estimates the status of peace talks over time—e.g whether they are deadlocked, near an agreement, or about to fall apart—or uses texts from the peace process other than the final agreement itself. Nor has sentiment analysis previously been used to study peace talks.

To fill this gap, this paper makes several original contributions. I collect a new dataset of texts from the Colombian government and FARC, in addition to joint statements issued by the peace negotiators, from an ongoing conflict/negotiation period (2012-2016). I use text analysis methods from psychology and natural language processing to measure the sentiment of these documents. Although it is difficult to draw causal conclusions from this kind of observational data, these texts are a promising and heretofore unutilized source of information about the status of a peace process. I use the textual sentiment in hidden Markov models to estimate each actor's willingness to negotiate. To validate the model's results, I test predictions about the relationship between willingness and the sentiment and issuance of joint statements. These findings offer potential explanations to questions such as why negotiations continue despite episodes of violence, and how the sentiment of each actor's statements affects the output from the peace negotiators—and perhaps ultimately, the peace treaty.

I use Markov processes to model the responsiveness of sentiment—e.g. whether FARC is more likely to respond to a positive government statement with a positive statement of its own rather than a negative one, in a "tit-for-tat" strategy—and whether sentiment is "sticky." Results about the persistence of sentiment may help explain the effect of shocks

such as extremist attacks, and the findings about responsiveness can yield insights about the mechanics of the bargaining process.

2 Background

FARC (Revolutionary Armed Forces of Colombia) was founded in 1964, in the aftermath of the ten-year period of civil war known as La Violencia.[1] Originally a Marxist insurgency seeking to overthrow the government, FARC's supporters were mainly communists and rural peasants (Renwick 2016). FARC's current circumstances can be traced to the 1980s and 1990s, when it began to tax cocaine producers, soon becoming involved in cocaine production itself (Otis 2014). This sparked the formation of right-wing paramilitary groups, such as the Autodefensas Unidas de Colombia (AUC; United Self-Defense Forces of Colombia), who battled FARC about, inter alia, control over drug trafficking (Otis 2014). FARC's tactics have included murder, kidnappings for ransom, disappearances of civilians and security personnel, and extortion; less widely known abroad is their use of landmines, which have killed or maimed thousands, and their kidnapping and forced conscription of child soldiers. The paramilitaries used many of the same tactics; AUC was also labelled a terrorist organization and was also involved in drug trafficking prior to being disbanded in the mid-2000s (Trent 2012). FARC, the paramilitaries, and the government have all been accused of human rights abuses in the brutal violence, which has claimed the lives of more than 200,000 civilians and displaced millions (BBC News 2016).[2] During the '80s, FARC also co-founded a political party, the Patriotic Union, which had declined into nonexistence by the '90s after thousands of its members, politicians, and candidates were murdered (Schemo 1997).

During the tenure of president (now senator) Álvaro Uribe from 2002-2010, the gov-

[1]The group's rarely used, official name is Fuerzas Armadas Revolucionarias de Colombia–Ejército del Pueblo (People's Army), or FARC-EP.

[2]The Ejército de Liberación Nacional (ELN; National Liberation Army), a separate, smaller, Marxist group, was founded around the same time and has also engaged in murder, kidnappings, extortion, and other violence (Renwick 2016). ELN began pursuing cooperation with FARC and peace talks with the government as FARC's peace process came underway over the last several years.

ernment cracked down on Marxist groups and drug traffickers, significantly reducing the strength of FARC (Renwick 2016). FARC's willingness to negotiate is generally attributed in part to this crackdown. Peace talks, brokered by Cuba and Norway, commenced in the fall of 2012 in Havana and have been championed by president Juan Manuel Santos. The talks were limited to an agenda of six topics: agrarian reform/land development; political participation; ending of the conflict (i.e. ceasefire, post-conflict justice, disarmament, and reintegration); illegal drugs; victims; and implementation. Over the course of the talks, negotiators came to preliminary agreements for these topics, to be incorporated in the final deal. Despite this progress, Santos's approval ratings have plummeted, because of public skepticism/pessimism and the vociferous opposition of right-wing politicians such as Uribe and some members of the military who oppose provisions which, in their view, give the former rebels political representation and amnesty instead of prosecution for crimes committed (Casey 2016; Isaacson 2015).

With many of its leaders and founders killed in the years leading up to the negotiations, FARC is currently led by a rebel known as Timochenko. Despite the high-ranking participation of numerous Secretariat members and top members from key Fronts (regional subdivisions) in the negotiating team, and FARC's declaration of several unilateral ceasefires during the negotiations period, attacks have continued during the peace talks, ranging from the killings of rural policemen to the kidnapping of a high-ranking general and the bombing of oil pipelines. Throughout (and prior to) the talks, FARC released statements on their website and created an additional website about the peace process, which features blogs of the negotiators.[3]

This project examines texts from the peace process up until May 31, 2016; however, it should be noted that president Santos and Timochenko signed a bilateral ceasefire agreement on June 22, 2016, and announced that they had reached a final deal on August 24, 2016, which will subsequently face a popular referendum (Brodzinsky and Watts 2016).

[3]See, for instance, http://pazfarc-ep.org/index.php/ivan-marquez

3 Theory and hypotheses

3.0.1 Theoretical and empirical research on peace processes

Many researchers model negotiations as a bargaining game (Pillar 2014; Filson and Werner 2002; Powell 2002). Specific to intrastate conflict termination, scholars have argued that commitment problems cause the bargaining failures that lead to the failure of talks or the recurrence of war (Walter 2002). Thus, such research argues, the key to durable peace is designing "credible guarantees," such as third-party intervention, to convince combatants that their adversaries are committed (Walter 2002). In research on arms control treaties, other studies of negotiations processes as games have found that actors respond to each other's previous move in a modified "tit-for-tat" strategy (Druckman and Harris 1990).

Another segment of the conflict resolution literature argues that conflicts are resolved at "ripe" moments—moments of opportunity when belligerents find themselves painfully deadlocked (Zartman 2008). Other scholars suggest that the "willingness" of participants is more important than the "ripeness" of situations (Kleiboer 1994). The former concept has been little studied; nevertheless, central to both the "ripeness" and "willingness" theories are the ideas that negotiations are dynamic and that actors' willingness to make a deal is time variant. Also related is "seriousness," which is essential to initiating talks. An actor might convincingly demonstrate seriousness with "credible and costly signals ... such as unilateral disarmament" (Walter 1999), but those actions leave them vulnerable and reduce their bargaining leverage. To take FARC-Colombia as our example, "seriousness" is significant to the government because of the political cost of continuing to negotiate and the still heavier cost of a failure (prior to the announcement of the peace deal, a common observation was that Santos "has staked his legacy on the deal" (Miroff 2016)), and because of uncertainty about whether avowedly Marxist-Leninist revolutionaries who have not disarmed are serious about a deal that will stipulate disarmament but not a Marxist-Leninist political-economic system. To this end, the Santos government held out on the bilateral ceasefire,

arguably FARC's most coveted concession, until just weeks before the final deal was reached.[4] FARC, for its part, is wary of disarming or giving up its fighters' locations as a "good faith" gesture if the government is not serious about negotiating and decides to settle the conflict on the battlefield. How, then, did either party determine whether the other was serious/willing, if they left the door open to the possibility of more war?

As the threat of a return to violence casts a long shadow over negotiations, unsurprisingly the focus of much empirical research is on violence during the peace process. For instance, one theory argues that violence is a reaction to events in the negotiations: when the government grants concessions, moderates leave the organization in the hands of extremists, who perpetrate more attacks (De Mesquita 2005). On the other hand, Kydd and Walter argue that extremist violence during peace negotiations reveals information about the rebel group's inability or unwillingness to control extremist factions, and will derail talks if trust is low (Kydd and Walter 2002). A basic premise underlying this theory is that the government cannot discern whether the rebels are sincere based on their words alone. (Similar reasoning underlies one rationalist explanation for war, which is based on the incentives of both parties to misrepresent their resolve to go to war and their military power (Fearon 1995).) Yet the FARC-Colombia negotiations ran concurrently with violence, as is often the case, but neither regular low-intensity violence nor shocks permanently derailed the FARC talks (although they were temporarily suspended several times).

3.0.2 Postconflict outcomes

Third-party intervention, such as United Nations peacekeeping operations, is intended to resolve the commitment problem and has been found to contribute to peace (Fortna 2004; Collier et al. 2008). Other empirical research on postconflict transitions has found that peace survival can be predicted by the circumstances of the just-ended conflict (e.g. its

[4]Security analysts interpreted the government's decision as a safeguard thwarting a "long con" being played by FARC—i.e., continued military operations would prevent FARC from using the negotiations to stall as they increase their military strength (Battaglino and Lodola 2013).

intensity and the nature of the previous regime), as well as peace agreement provisions such as territorial autonomy and assurances of security made by third-party states or organizations (Hartzell et al. 2001). Specific postconflict institutions, such as power-sharing among former combatants, are also associated with a higher likelihood of peace durability (Hartzell and Hoddie 2003).

This paper does not present results directly related to postconflict transitions or peace survival, because the peace agreement occurred outside of the sample of data; however, I mention this literature briefly to illustrate that if the content of peace agreements predicts or facilitates peace survival, understanding the process that generates those agreements can provide valuable insight. Much as we might look at the draft bills and amendments that precede a piece of final legislation, we should look at the other output from peace talks if we want to understand what causes the outcomes of durable peace or failed negotiations.

3.0.3 Sentiment analysis of extremist texts

The final part of this literature review discusses text analysis of extremist texts ("text" being any form of written or transcribed statement), which originated with Pennebaker and coauthors in the field of psychology (Tausczik and Pennebaker 2010). Pennebaker developed the Linguistic Inquiry and Word Count (LIWC) for text analysis to divine the emotional and psychological states of individuals from their word usage (Pennebaker et al. 2001, 2007). The LIWC measures are very simple: words belonging to specific categories—parts of speech (e.g. "articles," "pronouns"), or types of emotion ("positive" and "negative," within which are subcategories such as "optimism" and "anxiety or fear")—are counted, and their share of the total words in the document is calculated as a percentage. Using LIWC, Pennebaker and Chung "examine[d] people's social and psychological states by analyzing their use of function and emotion words," the former being words such articles or pronouns that are relatively devoid of content, and found associations between frequency of particular word categories and emotional, cognitive, and social attributes of the authors (Pennebaker and

Chung 2008). Additionally, LIWC analysis of texts from American Nazi and militant animal rights organizations found that "third-person plural pronouns are the single best predictor of extremism... suggest[ing] that the group is defining itself to a large degree by the existence of an oppositional group, " and a finding supported by another study of texts issued by al-Qaeda leaders Osama bin Laden and Ayman al-Zawahiri (Pennebaker and Chung 2008). Other analyses of extremist texts have tended to utilize large corpora of online postings, with a focus on the emotional affect of posts on extremist Internet forums (Abbasi and Chen 2008), network analysis of the authors of extremist blogs (Chau and Xu 2007), and content analysis of extremist documents (Smith et al. 2008).

The data in previous LIWC studies differs in several significant ways from the data in this paper: for instance, the al-Qaeda texts were translated, authored by specific individuals,[5] and originally oral rather than printed texts. Nevertheless, Pennebaker et al.'s findings are the starting point for this paper's sentiment measures and theoretical assumptions about sentiment. I use the Spanish LIWC, which was translated and augmented (e.g. additional Spanish synonyms for words translated from the English) by Ramírez-Esparza, Pennebaker, García, and Suriá Martínez (Ramírez-Esparza et al. 2007).

3.0.4 Hypotheses

To estimate the concept of "seriousness" or "willingness" of negotiants, as discussed by Walter and Kleiboer, respectively (Walter 1999; Kleiboer 1994), I present a regime-switching hidden Markov model that uses LIWC measures of negative and positive sentiment to estimate an actor's willingness to negotiate. This method is novel in that it uses "talk" rather than actions or violence. The results will be most useful if they predict documents issued from the negotiating table, although unfortunately this does not include the final peace agreement.

[5]Some of the FARC statements are signed by specific individuals, but in this paper the author is simply "FARC." There is significant heterogeneity in the nature of government statements, some of which are transcripts of speeches delivered by president Santos, but the author is "government"; and indeed, the question of whether presidents themselves have actually authored texts has been explored in the literature (Sigelman 2002).

Consequently, I hypothesize that greater willingness to negotiate is positively associated with (1) positive joint statements and (2) issuance of joint statements, and I test these hypotheses with regressions.[6] In other words, when FARC and/or the government are estimated to be in conciliatory rather than hardline states, I predict that joint statements are more likely to occur and that their positive sentiment is higher and negative sentiment is lower.

In the second part of the paper, I model sentiment responsiveness with another Markov process. Drawing broadly from research on responsiveness in negotiations (Druckman and Harris 1990), I hypothesize (3) that an actor is more likely to respond with the same level of sentiment as the most recent statement from the other actor. For example, if FARC issues a statement with high (positive) sentiment, the following government statement is more likely to respond with high sentiment, and vice versa.

Substantively, I predict that, in line with the theory that high levels of trust explain cases of peace talks not being derailed by violence (Kydd and Walter 2002), (a) major episodes of violence coincide with FARC being highly willing to negotiate, and (b) persistence of negative sentiment is weak.

4 Data

This paper uses an original dataset of (1) communiqués issued by FARC, (2) statements from the government, and (3) joint communiqués issued by the peace negotiators. The statements in the original Spanish were scraped and parsed in Python, thus avoiding the pitfalls of inter-translator variance, loss of nuance through translation, etc. The data was collected from September 1, 2012, the month in which formal peace talks were announced, through May 31, 2016, the beginning of this project. Unfortunately, this excludes the weeks leading up to the announcement of the final agreement in August 2016.

[6]Since joint statements can announce agreements on policy, progress reports, or the next steps in the negotiating schedule, their occurrence may be a rough metric for how much is being accomplished.

4.0.1 Sources

FARC-authored documents were scraped from the "Comunicados" (Communiqués) section of the official FARC website (Las Fuerzas Armadas Revolucionarias de Colombia - Ejército del Pueblo 2016).

Table 1: Summary statistics of documents

	FARC	Government	Joint
No. documents	101	318	70
Word count	696.05 (620.86)	1116.97 (1269.80)	391.17 (501.85)
% Negative emotion	1.37 (1.92)	5.37 (6.34)	1.97 (3.68)
% Positive emotion	5.21 (5.33)	6.25 (8.23)	14.61 (20.40)

Reported values are the means with SD in parentheses.

Joint statements were scraped from the official website of the peace negotiators (Mesa de Conversaciones 2016). I exclude reports published by the negotiators, which have a different purpose, format, and audience than the statements.

Finally, government statements were scraped from the "Sala de Prensa" (Press Room) section of the president's website (Presidencia de la República 2012-2015, 2016). The same president, Santos, has been in office during the peace talks, conveniently obviating variance that might result from different administrations. Because the government issues statements on all manner of topics besides FARC, documents were initially screened with a simple keyword search for "FARC" and "peace."[7] Altogether, the preliminary government dataset consisted of 509 documents, ranging from press releases to news bulletins to transcripts of the president's speeches. Additional human screening was necessary to remove statements that

[7]The implementation of this search differed slightly for 2012-2015 and 2016 because of differences in the structures of the current and archived presidential websites. All press releases from 2012-15 were scraped, and kept if "las Farc" and "paz" appeared in the text of the document. This was executed with a basic search script in Python during the scraping. A new website for the president's press releases in 2016 did not allow batch downloading of press releases by date; a search for the terms "farc" and "paz" using the website's search tool was performed and all results of that search were scraped.

Table 2: Sample of FARC Statements with Extreme Sentiment Measures

Text	Translation	Neg.	Pos.
... No somos los guerreristas que han querido pintar algunos medios de comunicación, venimos a la mesa con propuestas y proyectos para alcanzar la paz definitiva, una paz que implique una profunda desmilitarización del Estado y reformas socioeconómicas radicales que funden la democracia, la justicia y la libertad verdaderas. ...	... We are not the warmongers that they depict in the media, we come to the table with proposals and projects to achieve definitive peace, a peace that implies a profound demilitarization of the state and radical socioeconomic reforms that merge true democracy, justice, and liberty. ...	4.99	32.06
... las FARC-EP guardamos la sincera aspiración de que el régimen no intenta repetir la misma trama del pasado. Pensamos simplemente que están en evidencia las enormes dificultades que tendrá que afrontar este empeño. ...	... The FARC has the sincere hope that the regime does not intend to repeat the same plot that has occurred. We think simply that there is evidence of enormous difficulties that will face this endeavour. ...	3.46	20.10
... Nuestra resistencia armada, es la expresión de inconformidad, rebeldía y cambio de los herederos de Jorge Eliécer Gaitán, de los desterrados por la violencia de los años cuarenta, cincuenta y de cada década siguiente en que los de abajo tuvieron que levantarse, con armas o sin ellas...	... Our armed resistance, is an expression of nonconformity, rebellion and change of the Jorge Eliécer Gaitán's heirs, of those exiled by the violence of the '40s, '50s, and each decade that followed when the downtrodden had to rise up, with or without arms ...	2.75	19.85
... Pedían que en vez de balas y bombas, en lugar de tropas y aviones, el gobierno de Colombia les suministrara apoyo, carreteras, créditos, escuelas, puestos de salud, garantías para hacer política. No se trataba de sumas escandalosas de dinero, ni de derechos que no estuvieran reconocidos en la Constitución y las leyes. Pero primó la voz de quienes los llamaban bandidos y exigían su exterminio, acusándolos de haber construido una República Independiente. ...	... They asked that instead of bullets and bombs, in place of soldiers and planes, the Colombian government provide support, roads, loans, schools, hospitals, and guarantees to participate in politics. Not scandalous sums of money nor rights not recognized in the Constitution or by law. But the voices that called them bandits and called for their extermination prevailed, accusing them of having made an independent republic. ...	10.18	4.92
... Contrario a lo publicitado por el Presidente Santos, fueron la movilización por la paz y la lucha guerrillera las que obligaron a la oligarquía colombiana a explorar nuevamente la vía del dialogo e inaugurar la Mesa de La Habana. ...	... Contrary to what President Santos publicized, they were a movement for peace and a guerrilla struggle that compelled the Colombian oligarghy to explore anew the path for dialogue and to inaugurate the [Negotiating Table] in Havana. ...	7.89	2.67
... El carácter antidemocrático y violento del régimen colombiano ha impedido el desarrollo del trabajo político, en el grado requerido para que la movilización popular pueda estremecer sus cimientos. Esa ha sido la razón fundamental de nuestra apelación a las armas. ...	... The antidemocratic and violent nature of the Colombian regime has impeded political work to develop to the degree necessary for a popular movement to shake its foundations. This was the fundamental reason for our call to arms. ...	7.12	9.14

contained the keywords but were (a) not relevant to the peace talks or (b) not reasonably attributable to the government.[8] I removed documents if the peace talks were mentioned in passing or in a laundry list of policy issues, if a minor proportion of the document was spent discussing FARC/peace talks, or if the statement simply noted support for the peace process from NGOs or third-party countries.

Using the Spanish LIWC dictionary, I obtained measures of positive and negative emotion

[8]For example, a statement from May 27, 2013, was titled "Frases del Vicepresidente Joe Biden" ("Quotes from Joe Biden"), in which the vice president expressed U.S. support for the peace process.

Table 3: Sample of Government Statements with Extreme Sentiment Measures

Text	Translation	Neg.	Pos.
... Y lo que acordamos en 23 de septiembre fue precisamente es como es que se va aplicar la justicia para que no haya impunidad, para que las víctimas digan: aquí hay un mínimo de justicia.Porque muchas veces unas víctimas reclaman justicia, otras reclaman solamente verdad. ...	... And what we agreed on September 23 was precisely how we will apply justice so that there is no impunity, so that the victims say, here's a minimum of justice. Because often some victims seek justice, others only seek truth. ...	30.22	45.28
Quiero primero que todo celebrar este foro, la convocatoria de este conversatorio 'Dividendos de la paz'. Es muy oportuno y muy importante. Y voy a explicarles por qué creo que es tan oportuno y tan importante. ...	First of all, I want to celebrate this forum, the convocation of the discussion "Dividends of peace." It is very timely and very important. And I will explain why I think it is so timely and so important. ...	5.18	38.50
... Estamos hace ya más de un año en los dos puntos más difíciles–siempre se deja lo más difícil para lo último–que son los puntos referentes al tema de las víctimas y sus derechos–y ahí entra la justicia transicional–y el punto del fin del conflicto, lo que llaman los ingleses el DDR: el desarme, la desmovilización y la reincorporación a la vida civil. ...	... For more than a year we have been on the two most difficult points–we always leave the hardest for the end–that are the two points referring to the theme of victims and their rights–and there transitional justice fits in–and the point of the end of the conflict, which in English is called DDR: disarmament, demobilization, and reintegration into civil society. ...	16.91	36.08
... No es muy difícil. Nosotros hemos reintegrado más de 53 mil combatientes entre paramilitares y guerrilleros, hoy en día no hay más de 8 mil hombres en armas en las Farc. Entonces reintegrar 8 mil no es un desafío demasiado grande. ...	... It isn't very hard. We have reintegrated more than 53,000 combatants among the paramilitaries and guerrillas, today there aren't more than 8,000 fighters in FARC. Then, reintegrating 8,000 is not too big a challenge. ...	30.22	45.28
... Medio siglo de conflicto, al comienzo las víctimas eran totalmente ignoradas, no existían; luego durante mucho tiempo las escuchaban pero no las atendían. Y en ese propósito de construir un país en paz, desde el primer día también identifiqué como prioridad en esa nave que nos va a llevar a ese puerto de destino a las víctimas como prioridad. ...	... Half a century conflict, from the start the victims were totally ignored–they did not exist; then after a long time they were heard but no one paid attention to them. And in our goal to build a peaceful country, from the first day I also identified that the priority which we must carry on the ship that will take us to our destiny is that victims are the priority. ...	28.02	25.83
... El fin del conflicto, que es el tema que falta. Ahí estamos discutiendo el cese al fuego. La guerrilla pregunta o pide, y ha pedido desde hace cinco años cese al fuego. Hemos dicho que no, no cese al fuego, al principio porque teníamos una experiencia terrible con la guerrilla en materia de cese al fuego. Siempre nos habían puesto conejo. Siempre nos habían engañado. ...	The end of the conflict, that is the issue we lack. There we are discussing the ceasefire. The guerrilla asks or calls for, and has asked for a ceasefire the last five years. We said no, no ceasefire, from the start because we have had a terrible experience with the guerrillas in ceasefire. We were always the rabbit. We were always tricked. ...	40.65	40.44

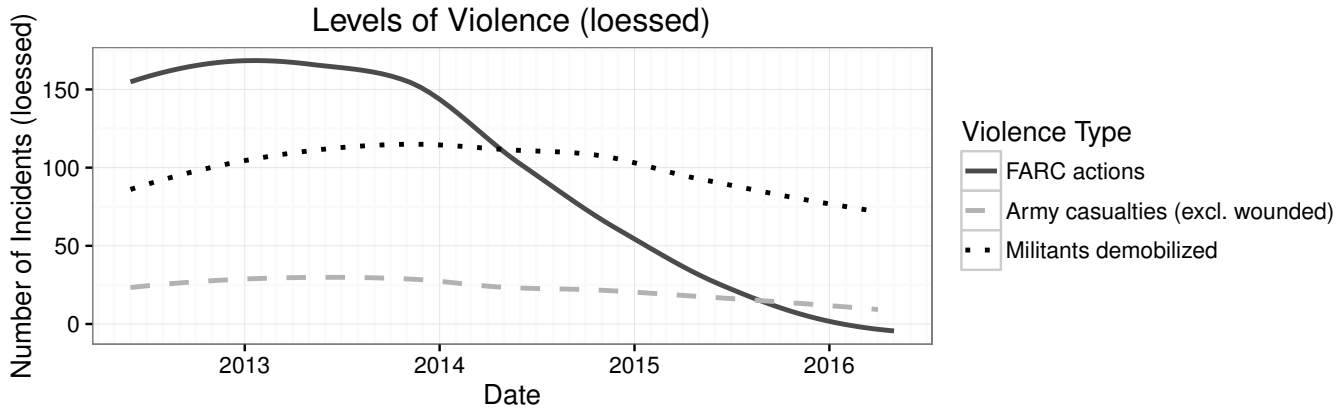
for each text and smoothed the estimates with loess.[9] Tables 2 and 3 show snippets of FARC and government statements with extreme sentiment. (Additional plots of sentiment measures per actor over time are in the Appendix, as well as graphs showing the optimal structural breaks identified with the strucchange R package (Zeileis et al. 2001).) The LIWC measures are imperfect: the statistics are simple word counts; the dictionary is not tailored for political

[9]Although I initially planned to also use the category of third-person plural pronouns, which have been found to be used at higher rates by extremist groups (Pennebaker and Chung 2008), as it turns out the government uses them more frequently than FARC on average, and they are highly correlated with both positive and negative emotion.

science purposes; and their intended use is analysis of individual personality traits. However, methods such as Principal Component Analysis (PCA) and traditional time-series analysis proved to be unsuitable owing to the high variance in the length of documents and the highly irregular issuance of statements, respectively.

4.0.2 Violence

Statistics on ongoing violence were gathered from several sources. The number of FARC attacks per month were collected from two Colombian conflict analysis groups, the Fundación Paz y Reconciliación (PARES) and the Centro de Recursos para el Análisis de Conflictos (CERAC). Data for 2012-2014 was from PARES (Fundación Paz y Reconciliación 2013, 2015) while data for 2015-2016 was from CERAC because PARES data was not available (Centro de Recursos para el Análisis de Conflictos 2016a,b). PARES and CERAC define attacks as "armed actions" and "offensive actions," respectively.



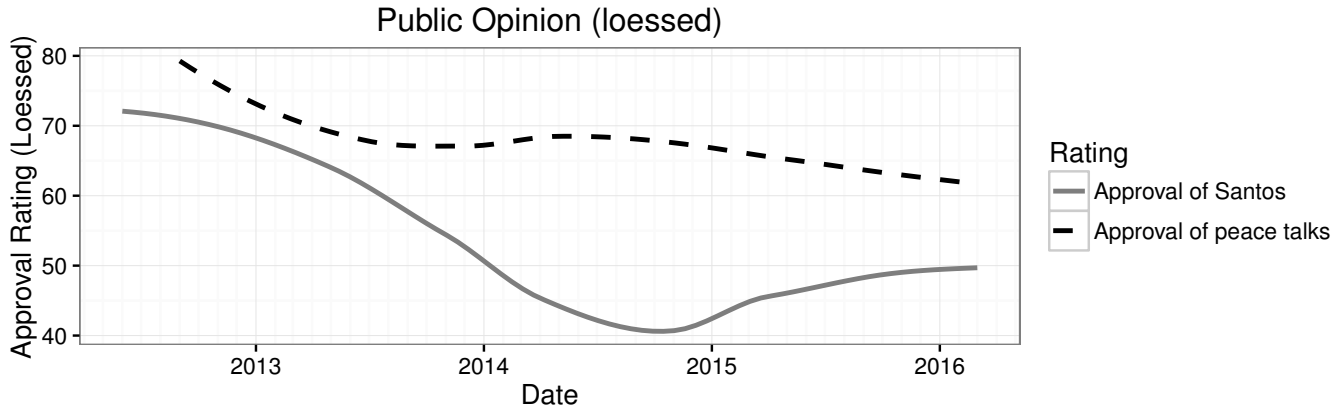
Service personnel killed per month and demobilized militants per month were collected from PARES[10] and the Defense Ministry (Fundación Paz y Reconciliación 2015; Ministerio de Defensa, Colombia, Viceministerio para las Políticas y Asuntos Internacionales 2016); however, violence with ELN or bacrim (criminal gangs) contributes to these figures. Consequently, in the estimation I use the log transformed FARC actions because it is the most specific.[11]

[10]PARES cites the Defense Ministry as the source for its figures.

[11]The graph of loessed rather than log transformed data is shown to give an idea of the general shape of the data, but obviously negative values are not possible.

4.0.3 Public opinion

Monthly public opinion data was collected from the Centro Nacional De Consultoría, a Colombian consultancy (Centro Nacional de Consultoría 2016, 2012, 2013b,a). Responses to the questions, "Do you have a positive or negative image of President Juan Manuel Santos?" and "Do you approve of the decision of President Santos to open peace talks with the guerrillas?",[12] were recorded as approval ratings for the president and for the peace process, respectively. Because other factors influence the president's approval rating, I use the log transformed peace talks approval rating in the estimation.



5 Estimation method

5.1 Modelling hidden states

The first estimation task is to use the positive and negative sentiment in a sequence of texts to model a Markov regime-switching model, in which the hidden regimes are discrete states that represent whether government or FARC is in a "hardline" versus "conciliatory" state. In other words, we are interested in the random variable that represents FARC's (or the government's) willingness to negotiate, which is directly unobservable. Instead, we observe the stream of positive and negative sentiment of the FARC documents, which emanate from

[12] Author's translation.

the latent state that FARC is in at the time. To simplify this discussion, I assume a state space with two possible states, but the model can theoretically be generalized to any number of states.

This regime-switching or hidden Markov model (HMM) is a special case of a first-order Markov process. The sequence of states is a Markov chain: the probabilities of being in a hardline or conciliatory state, S_H and S_C, respectively, exhibit the Markov property, i.e. $Pr(S_t = S_H)$ or $Pr(S_t = S_C)$ depends only on the realization of the state S_H or S_C at time $t-1$. Thus, the realization of S_{t-1} captures all information about what occurred prior to $t-1$. I assume that the process is stationary, i.e. the probability of moving from state i to state j does not depend on how long the process has been in state i.

At each time t the process is in a hidden state and we observe the emissions, or symbols, O_t. The probability of an observed emission O_t depends only on the state S at t (Jurafsky and Martin 2014). Thus, we can compute the probability of a stream of observations $O_1, ..., O_T$ by using a shortcut called the forward-backward algorithmn to sum over all of the hidden state sequences that could have generated that stream of observations (Rabiner 1989). In this case, the observed sequence of emissions is a stream of loessed sentiment measures; the percent of negative emotion words in FARC statements might look like $(0.01, 0.12, 0.04, 0.01)$. We are interested in the corresponding sequence of hidden states which generated the sequence of emissions, for example (S_H, S_H, S_C, S_H). We are also interested in the transition probabilities, which represent probability of moving from $S_t = S_i$ to $S_{t+1} = S_j$. These probabilities are represented in transition matrix P below:

$$\begin{array}{c} \\ S_H \\ S_C \end{array} \begin{array}{c} \begin{array}{cc} S_H & S_C \end{array} \\ \begin{pmatrix} P_{HH} & P_{HC} \\ P_{CH} & P_{CC} \end{pmatrix} \end{array}$$

Each entry $P_{ij} = Pr(S_{t+1} = state_j | S_t = state_i)$. Thus, P_{HH} is the probability of transitioning from a hardline state to a hardline state, P_{HC} is the probability of moving from a

hardline to a concessions state, and so on.

5.1.1 Optimizing the number of states

This discussion has used a discrete state space with two possible states. In some cases substantive/theoretical grounds may define an appropriate number of latent states for a HMM; however, because the spectrum from "hardline" to "conciliatory" can reasonably be split in different ways, I adopt an agnostic approach. I identify the best-fitting number of HMM states using the Bayesian information criterion (BIC) and the Akaike information criterion (AIC) values.[13] To keep interpretation across the FARC and government models comparable, I specify the same number of latent states. The substantive interpretation of the model accommodates small numbers of latent states—for instance, two latent states would correspond to a dichotomy between "hardline" and "conciliatory" regimesm while three latent states might represent low, moderate, and high levels of willingness to negotiate, respectively—but as the number of states increases, the substantive interpretation of transition probabilities across these states becomes more challenging, and fitting the model becomes difficult because transitions between any two given states may be rare or nonexistent.

5.1.2 Labelling the states

Because HMM estimation does not attach substantive labels to the states, such labelling must be done post-estimation. I explore two possible methods. First, I rank the unlabelled states in order of willingness to negotiate based on mean emotion. For example, the state with the highest positive emotion and lowest negative emotion would correspond to high willingness (i.e. "conciliatory"), and the state with the lowest positive emotion and the highest negative emotion should be the "low" willingness ("hardline"). I also use a multi-choice decision matrix

[13] In other applications of hidden Markov models, the number of states is not mathematically optimized because it and the labels attached to the states tend to determined by substantive criteria: e.g. in medical examples, values for various indicators of health that fall within certain ranges correspond to pre-set states, and in economic examples, "bull" and "bear" markets are modelled with two states that clearly correspond with economic indicators. This paper uses a more agnostic approach.

to optimize the ranking of states based on mean sentiment.

5.2 Modelling sentiment responsiveness

The second part of this paper uses a Markov process to model how sentiment responds to sentiment. I assume that the sequence of time-ordered statements represents a single Markov chain, like a back-and-forth debate in which each text responds to the document immediately preceding it. The irregularity of the data presents challenges, as the time-ordered sequence of FARC and government texts has stretches where little alternation occurs. This is partly owing to the fact that there are roughly roughly three times as many government statements as FARC statements, and that both actors sometimes release multiple statements on the same day. This means that a FARC document could "respond" to a previous FARC document.

To categorize overall sentiment of a text as "high" or "low," I constructed an indicator defined by LIWC-based research that found that positive emotion words occur twice as frequently as negative emotion words in normal usage (Pennebaker and Chung 2008). The indicator takes on the value "high" if the loessed proportion of positive words in a statement is at least twice the loessed proportion of negative words, and "low" otherwise. I used this indicator to construct a categorical variable representing the four possible states: "FARC/low," "FARC/high," "government/low," and "government/high."

As before, the probabilities of transitioning from state to state are represented in a Markov transition matrix. I estimate the transition probabilities using a multinomial logit with maximum likelihood estimation.

$$
\begin{array}{c} \\ F_L \\ F_H \\ G_L \\ G_H \end{array}
\begin{array}{c}
\begin{array}{cccc} F_L & F_H & G_L & GH \end{array} \\
\begin{pmatrix}
P_{F_L,F_L} & P_{F_L,F_H} & P_{F_L,G_L} & P_{F_L,G_H} \\
P_{F_H,F_L} & P_{F_H,F_H} & P_{F_H,G_L} & P_{F_H,G_H} \\
P_{G_L,F_L} & P_{G_L,F_H} & P_{G_L,G_L} & P_{G_L,G_H} \\
P_{G_H,F_L} & P_{G_H,F_H} & P_{G_H,G_L} & P_{G_H,G_H}
\end{pmatrix}
\end{array}
$$

Like before, $P_{i,j} = Pr(S_{t+1} = state_j | S_t = state_i)$. We are most interested the diagonal, which reflects state persistence, and the entries $P_{F_H,G_H}, P_{F_L,G_L}, P_{G_H,F_H}$, and P_{G_L,F_L}, which represent the probabilities that an actor will respond with the same level of sentiment that the other actor used in its previous statement.

6 Results and discussion

6.1 Hidden Markov model

6.1.1 Optimizing and labelling the states

A hidden Markov model was fitted for each actor using the depmixS4 R package (Visser and Speekenbrink 2010). (For a note on how this implementation of the expectation-maximization algorithm affects the results, see the Appendix.) First, however, I optimized the number of latent states. Table 4 shows the BIC and AIC values for HMMs fitted separately for FARC and the government with $n = 1 : 5$ latent states. I tested models with and without covariates for violence (log number of FARC actions that month) and public opinion (log monthly approval rating for peace talks).

Table 4: Comparison of Hidden Markov Models

	FARC				Government			
	(1)		Covariates added (2)		(3)		Covariates added (4)	
States	BIC	AIC	BIC	AIC	BIC	AIC	BIC	AIC
1	1059.57	1049.11	1059.57	1049.11	4341.76	4326.72	4341.76	4326.72
2	965.47	936.70	831.40	802.63	3565.09	3523.70	3565.09	3523.70
3	813.98	751.00	813.98	761.68	3497.88	3456.36	3531.60	3422.63
4	**811.60**	**730.53**	**811.60**	755.02	3478.84	3375.17	3500.37	3362.22
5	859.32	738.23	833.41	718.35	**3423.81**	**3346.13**	**3481.55**	**3258.28**

Note: Models (1) and (2) are estimated with negative and positive emotion. Covariates for the log transformed number of FARC actions and the log transformed peace talks approval rating are added to Models (3) and (4).

Comparing Model (1) vs. (2) and Model (3) vs. (4) shows that the inclusion of violence and public opinion covariates does little to improve fit. Going from $n = 1$ to $n = 2$, the improvement in BIC and AIC values demonstrates that a mixture is a better fit for the data than a single state. For the FARC models with and without covariates, the BIC values suggest that $n = 3$ optimizes the number of latent states; although $n = 4$ has a slightly better BIC value than $n = 3$ in both models, the improvement is marginal and is weighed against the consideration that the fewest possible number of latent states should be used. For the same reason, although the AIC values across the board favor a specification with $n = 5$, these improvements in fit must be balanced against the tradeoff in the interpretability of results (e.g. what is the substantive meaning of a "transition from 1/5 to 2/5 hardline"?) and the difficulty of substantively labelling a large number of states. Consequently, the following analysis will proceed with $n = 3$ latent states, without the covariates.

As discussed earlier, the HMM estimation does not attach substantive labels to numbered states, nor does it order the states by magnitude.[14] For instance, state 1 may correspond with "high willingness," state 2 with "low," and state 3 with "moderate." I first use the mean and median sentiment measures for each unlabelled state to rank the states as "high," "medium," and "low" willingness to negotiate. For instance, the state with the lowest negative and highest positive sentiment should be "high" willingness, while the state with the highest negative and lowest positive sentiment would be hardline/"low" willingness.

Table 5: Mean Sentiment Scores for Latent States: FARC

	Neg. emotion			Pos. emotion		
State	Mean (SD)	Median	Predicted label	Mean (SD)	Median	Predicted label
1	0.50 (0.30)	0.49	High	2.86 (1.75)	2.54	Low
2	5.50 (3.42)	6.74	Low	3.46 (2.94)	3.02	Moderate
3	2.01 (1.08)	1.73	Moderate	12.10 (6.39)	9.92	High

[14]It is readily apparent that with $n > 2$ states, labelling becomes increasingly complex.

Table 6: Mean Sentiment Scores for Latent States: Government

	Neg. emotion			Pos. emotion		
State	Mean (SD)	Median	Predicted label	Mean (SD)	Median	Predicted label
1	1.65 (1.13)	1.44	High	2.06 (1.21)	2.03	Low
2	14.71 (7.37)	13.86	Low	18.29 (10.46)	17.41	High
3	4.92 (2.59)	4.98	Moderate	4.51 (2.84)	4.33	Moderate

Although negative sentiment produces the same rankings for both actors, positive sentiment produces conflicting results. Because of these contradictions, I use a multi-choice decision matrix, implemented in the MCDM R package, to identify the optimal ranking based on different methods for computing multi-criteria decisions (Martin 2015). The ranking maximizes negative sentiment and minimizes positive sentiment: the state ranked first is low willingness and the state ranked third is high willingness. When using either the mean or median sentiment, the overall decision matrix maps states $1, 2, 3$ to "moderate," "low" (hardline), and "high" (conciliatory).

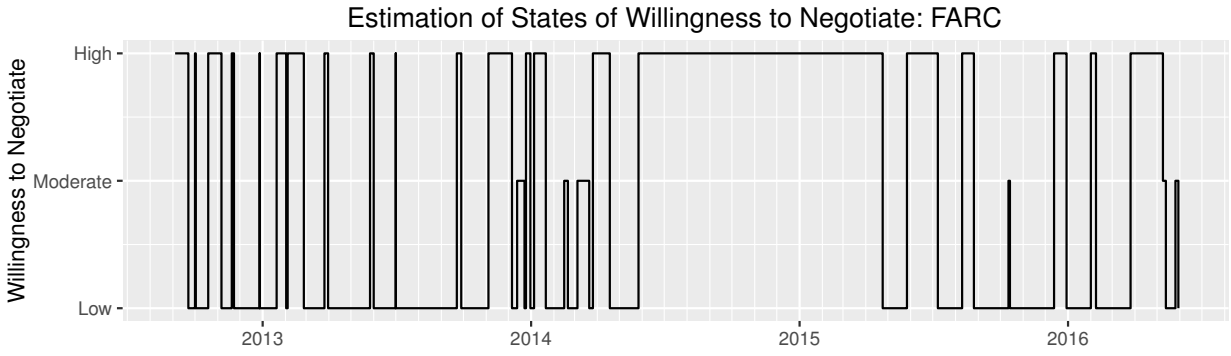
6.1.2 HMM results

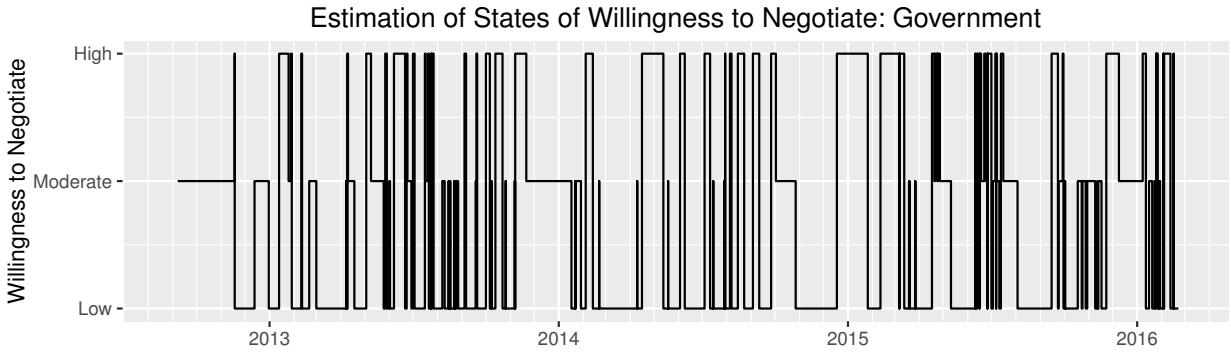
The Markov transition matrices below represent the probabilities of regime switching for FARC and the government, estimated using the loessed negative and positive emotion measures and labeled according to the decision matrix.

Table 7: Transition matrices

	(a) FARC			(b) Government		
		to			*to*	
	Low	Moderate	High	Low	Moderate	High
from						
Low	0.90	0.10	0.00	0.18	0.55	0.27
Moderate	0.00	0.79	0.21	0.24	0.48	0.28
High	0.00	0.52	0.48	0.23	0.37	0.40

What do the transition probabilities reveal about the persistence of willingness? Hardline or moderate states for FARC have very high rates of stickiness. For the government, on the other hand, the transition probabilities in each row are more evenly dispersed. These probabilities suggest that if FARC experiences a shock that causes negative sentiment, it will be difficult to transition out of that state, while the government's sentiment is both more resilient and more volatile because it can transition from any state to any state.





We can further discuss these results in light of the line graphs above, which show the estimated states of FARC and the government over the peace talks. Although FARC is predicted to never transition directly from low to high and vice versa, and to never transition from moderate to low, perhaps because of rounding, these transitions do occur. Interestingly, although both FARC and the government have fairly high probabilities of transitioning to moderate willingness from any state, each spends very little time in the moderate state. This suggests that a simpler model with two latent states might have been preferable for ease of

interpretation.

Overall, the government's willingness to negotiate is more volatile, with frequent regime switching from low to high throughout the time interval. The irregularity and frequency of data accounts for some of this volatility: the government issued many more statements more frequently than FARC. However, the government's lower probabilities of state persistence are consistent with the volatility of transitions. A potential explanation is that the government's statements address many different audiences: toward FARC, the government must be a tough negotiator; for domestic critics, the government must appease hawks' objections about issues such as seats in the legislature for ex-guerrillas or amnesty from prosecution; for the military, the government must reassure their concerns regarding potential prosecution of military personnel for acts committed during the war; for the international community, the government pledges its commitment to peace as it possibly seeks regional or UN assistance with implementation; and for the public, the government must assure survivors that the voices of victims of the conflict have been heard, and encourage optimism so that people will vote for the deal in the referendum. Moreover, regardless of the "truth" about FARC's seriousness or willingness, popular impressions (e.g. "FARC is stalling" or "the government isn't driving a hard enough bargain") affect the government's bargaining behavior and demands in public and in private, its level of military operations, and certainly its rhetoric. The government has to answer to public opinion, political opponents and, eventually, the next cycle of elections; thus, the political toll of failing to address one of its constituencies is very high.

FARC, on the other hand, has fewer audiences and interests to address: its rank and file fighters who need to be persuaded to demobilize; its bargaining adversary, the government; and occasionally the nation. Unlike the government, FARC's decision to negotiate is not being constantly and publicly questioned, and it does not face elections or serious leadership challenges. Thus, FARC has fewer disparate constituencies and is arguably less motivated to address them.

Regarding the theories about "ripeness," "seriousness," and "willingness," the HMM results suggest that these moments of opportunity are fleeting but frequent, especially for the government. Generally, this supports a theory that progress in negotiations is made in a piecemeal fashion when conditions are right.

6.1.3 Validation

The HMM results are most useful if they can predict the content of output from the joint negotiations, such as (but not in this case) the final ageement. To evaluate this predicted relationship, I regress joint statement sentiment on the estimated FARC/government willingness on the day that the statement was issued, with linear interaction terms, to test hypothesis (1) that both actors' willingness to negotiate is positively associated with positive sentiment of joint statements and negatively associated with negative sentiment. I use a logistic regression to test hypothesis (2) that high willingness to negotiate is positively associated with the issuance of joint statements.

Table 8: Does Willingness to Negotiate Predict Joint Sentiment?

	Negative	Positive
FARC low willingness	0.39 (3.51)	5.47 (21.49)
FARC high willingness	1.23 (3.71)	15.53 (22.69)
Government low willingness	10.30** (4.79)	72.37** (29.29)
Government high willingness	1.45 (1.78)	-3.48 (10.90)
Interactions		
FARC low x Govt. low	-8.77* (4.92)	-66.57** (30.14)
FARC low x Govt. high	1.29 (2.28)	19.46 (13.95)
FARC high x Govt. low	-10.60** (5.08)	-77.70** (31.07)
Constant	0.23 (3.38)	3.95 (20.71)
Observations	88	88
R-squared	0.14	0.14

Notes: *p<0.1; **p<0.05; ***p<0.01
FARC high x Govt. high term omitted because of collinearity.

Regarding hypothesis (1), the interaction terms indicate that the effect of each actor's willingness on joint sentiment depends on the other actor's willingness. When the government is hardline and FARC is either conciliatory/hardline, this is associated with much lower levels of positive sentiment and slightly lower levels of negative sentiment, relative to the moderate willingness state. The statistical power of these results is hampered by the small number of joint statements; we are unable to draw the same conclusions about FARC. Thus, there is limited support for hypothesis (1), insofar as a hardline government is associated with less positive joint statements but we cannot conclude that high levels of willingness are associated with more positive sentiment.

To test hypothesis (2), i.e. whether the states estimated by the HMM can predict joint statement issuance, I created date/state indicator variables for FARC and the government for each day in the negotiations period, and a dummy variable for joint statement issuance. I use a logistic regression with linear interaction terms. However, none of the results are statistically significant, and hypothesis (2) does not find support. (Table in Appendix.)

What accounts for these hypotheses not being fully supported? One problem is the paucity of data; joint statements are relatively rare. Additionally, although a relationship between actor willingness and joint statements may exist, but there may be lag between productive willingness and the resulting joint statements/action. Of course, it is possible that sentiment of joint statements is not the ideal metric for progress in talks, and that a content-based (perhaps hand-coded) measure is more appropriate.

Finally, we may also consider FARC/government willingness in the context of major events, in order to discuss the theory that high trust prevents talks from being derailed (Kydd and Walter 2002). Beginning in June 2015, FARC launched a series of attacks on infrastructure, bombing oil pipelines in Norte de Santander, Putumayo, and Nariño, resulting in an oil spill that caused severe environmental damage and contaminated the water supply of thousands; and bombing power stations that supplied electricity to Buenaventura and Tumaco (Brodzinsky 2015; Fortino 2015; Washington Office on Latin America 2015; Telesur

2016). In response, the government suspended talks. This time period coincides with an episode of volatile regime-switching for the government, but it coincides with a period of high FARC willingness to negotiate. Although bombings and conciliatory sentiment seem contradictory, FARC's high willingness to negotiate during this period may explain why peace talks, though temporarily suspended, ultimately continued. Hardline sentiment backed by violent attacks might have caused the government to update its beliefs to conclude that FARC planned to walk away from talks, but FARC's willingness to negotiate might have contributed to the eventual resumption of talks. Why, then, did FARC launch these attacks if it was willing to negotiate? Reminding the government and the public of the damage that they are capable of could be a bargaining tactic to gain leverage.

Following FARC's kidnapping of a general in November 2014, the government is prected to be in a hardline state, consistent with its suspension of talks[15] on November 16; they were resumed on December 9 after the general was released (Washington Office on Latin America 2015; Telesur 2016). This episode, too, falls within FARC's long spell of "high" willingness to negotiate. As with the bombings, FARC's conciliatory sentiment (combined with the safe return of the general) may help explain why the peace talks recovered from this crisis. Although these examples are anecdotal, they are generally consistent with the concepts of willingness or seriousness.

6.2 Sentiment responsiveness results

In the second part of this paper, I estimate the responsiveness of sentiment to sentiment, in the form of a Markov transition matrix. The probabilities in this matrix are calculated using a multinomial logit with maximum likelihood estimation. I test four models: The first is a simple MNL of $State_{t+1}$ as a function of $State_t$. Model (2) adds year indicators to control for year effects, because of potential associations between sentiment and time (e.g.

[15] Although threatening to suspend or suspending talks ("walking away from the table") may seem like a common bluffing maneuver, the government carried out this threat very rarely during these negotiations: in fact, only on these two occasions. FARC suspended talks on one occasion in 2013, over objections about the government's plan to hold a referendum (Washington Office on Latin America 2015).

Table 9: Results of Multinomial Logit Models

	Dependent variable: State at t+1			
	(1)	(2)	(3)	(4)
S_{t+1}=F_{low}				
| S_t = F_{high}	−3.11** (1.22)	−3.03** (1.23)	−2.61 (1.60)	−2.34 (1.62)
| S_t = G_{low}	−5.79*** (1.33)	−5.48*** (1.34)	−4.37*** (1.58)	−4.09** (1.60)
| S_t = G_{high}	−4.82*** (1.51)	−5.12*** (1.57)	−3.39* (1.77)	−2.96* (1.78)
| 2013		15.39 (3643.44)		15.56 (3722.61)
| 2014		15.07 (3643.44)		15.92 (3722.61)
| 2015		14.23 (3643.44)		13.64 (3722.61)
| 2016		34.82 (4975.47)		16.69 (6697.52)
|Log violence			0.02 (0.46)	−0.42 (0.63)
|Log approval rtg.			2.11 (5.11)	1.04 (7.67)
S_{t+1}=F_{high}				
| S_t = F_{high}	−1.57 (1.11)	−1.88* (1.13)	−1.08 (1.19)	−1.61 (1.21)
| S_t = G_{low}	−3.46*** (1.10)	−3.28*** (1.11)	−2.80** (1.18)	−2.90** (1.19)
| S_t = G_{high}	−2.45** (1.12)	−3.11*** (1.16)	−2.00* (1.21)	−2.68** (1.23)
| 2013		−1.92*** (0.63)		−1.81** (0.72)
| 2014		−2.46*** (0.68)		−2.47*** (0.73)
| 2015		−2.27*** (0.66)		−3.04*** (0.92)
| 2016		17.73 (3388.32)		16.67 (3942.61)
| Log FARC actions			−0.19** (0.07)	−0.26 (0.18)
| Log approval rtg.			1.93 (1.56)	−2.08 (2.43)
S_{t+1}=G_{high}				
| S_t = F_{high}	−0.34 (1.44)	−0.64 (1.49)	−0.54 (1.47)	−1.29 (1.49)
| S_t = G_{low}	−1.80 (1.43)	−1.44 (1.48)	−1.90 (1.46)	−2.17 (1.46)
| S_t = G_{high}	0.39 (1.43)	−0.60 (1.49)	−0.14 (1.47)	−1.35 (1.49)
| 2013		−1.85*** (0.66)		−1.65** (0.73)
| 2014		−2.73*** (0.76)		−2.75*** (0.82)
| 2015		−1.71** (0.67)		−1.22 (0.96)
| 2016		18.87 (3388.32)		19.73 (3942.61)
| Log FARC actions			−0.35*** (0.07)	−0.05 (0.18)
| Log approval rtg.			1.22 (1.54)	1.93 (2.52)
Obs.	418	418	401	401
Log Likelihood	−400.97	−358.52	−362.11	−329.88
LR Test	117.52***	202.42***	118.46***	182.91***
	(df = 12)	(df = 24)	(df = 18)	(df = 30)
AIC	1.98	1.83	1.90	1.80
BIC	−1648.47	−1660.95	−1571.46	−1563.99

Notes: *p<0.1; **p<0.05; ***p<0.01

Models (2), (4) include year indicators. Models (3), (4) include covariates for violence and approval of the peace process. The referent level is S_{t+1}=G_{low}, the most common state. No. of obs. in (3), (4) is reduced because of missing covariate data. Log odds coefficients are reported.

one might argue that we should expect sentiment in later years to be higher simply because of the survival of the talks). Model (3) adds covariates for log number of FARC actions and log peace approval ratings for that month to the base model. Model (4) includes the year, violence, public opinion covariates. Thus, Model (1) is nested in each of the others, and Models (2) and (3) are nested in Model (4), the full model. I use pairwise likelihood ratio tests to compare each model with the model(s) in which it is nested. The results in Table 9 suggest that Model (4), with year, violence, and public opinion coefficients, is the best fit. The rest of the results proceed using that model. (See Table 9 for the AIC, BIC, and log likelihood values for each models; these are included for reference, although our interest is in the transition probabilities.)

Table 10: Likelihood Ratio Test Comparison of Nested Models

	Likelihood Ratio χ^2			
	Comparison with "full" model			
	(1)	(2)	(3)	(4)
Nested model				
(1)	–	84.90***	77.71***	142.17***
(2)	–	–	–	57.27***
(3)	–	–	–	64.46***
Notes:	*p<0.1; **p<0.05; ***p<0.01			

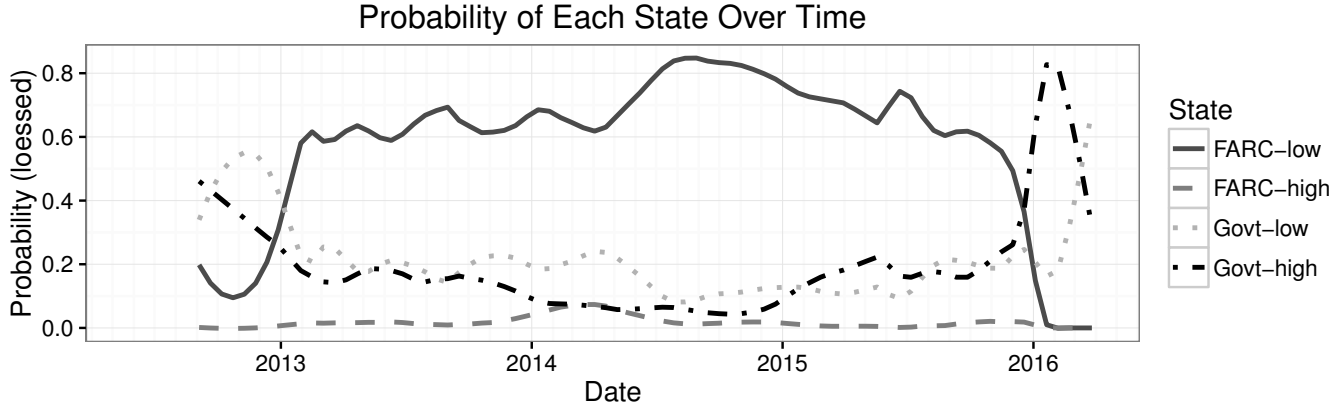
Is sentiment is "sticky"? Low government sentiment has a high probability (0.62) of continuing in subsequent time periods, but it was also the most commonly occurring state; thus, low government sentiment is also likely to follow high government sentiment. Persistence of FARC's sentiment is less frequent, with 0.10 and 0.33 for low and high sentiment. Overall, these results suggest that dire pronouncements from either negotiant do not necessarily spell doom for a peace process. If sentiment has a degree of resilience to shocks such as attacks, this suggests an alternate explanation for why violence did not derail talks. However, these results do not support the prediction that low persistence of negative government sentiment

in particular accounts for the talks not being derailed; negative government sentiment is quite persistent and also quite likely in general. This suggests there may not be an association between sentiment and "trust" if trust does indeed account for the resilience of talks to attacks (Kydd and Walter 2002).

Table 11: Transition Matrix of Sentiment Response

	$State_{t+1}$			
$State_t$	FARC-low	FARC-high	Govt-low	Govt-high
FARC-low	0.10	0.51**	0.13	0.26
FARC-high	0.03	0.33***	0.40***	0.24***
Govt-low	0.01	0.17***	0.62***	0.20***
Govt-high	0.02	0.16***	0.52***	0.30***
Note:		*p<0.1; **p<0.05; ***p<0.01		

Looking at patterns of statement issuance, another interesting result is that the statement most likely to follow a government statement is another statement from the government. Reasons for repetitive statements may be related to signalling or the audiences that statements are addressed to. For instance, the government might make a series of public denunciations to signal to the political opposition or the public that it is being tough on FARC. This theory fits in with the explanation for government regime volatility given in the HMM section.



Interestingly, we do not observe the same repetitions with FARC: although the statement following a low-sentiment FARC statement is most likely to be another FARC statement, a

high-sentiment FARC statement is most likely to be followed by a government statement. This may be because FARC has relatively fewer statements so it is more likely that a government statement occurs in between.

Do actors respond to sentiment with the same level of sentiment, similar to a "tit-for-tat" strategy? Our ability to answer this question is limited by statistical power. Contrary to hypothesis (3), when a high FARC statement is followed by a government statement, the latter is more likely to be low rather than high. We cannot conclude with statistical significance that the government is more likely to respond to low FARC statements with high or low sentiment, nor can we draw statistically significant conclusions about FARC's strategy. Again, this is partly due to paucity of data, because there are more cases where an actor "responds" to its own previous statement rather than to a statement from the other actor, owing to "bursts" of multiple statements from a single actor that occur in the Markov chain. However, in general, the transition probabilities suggest that high-sentiment responses are more likely across the board, whether or not the other party previously issued a high or low statement, and that low government sentiment is common.

6.2.1 Summary of findings

The levels of willingness estimated in the HMM indicate high persistence of sentiment for FARC and volatile regime-switching for the government, which may be explained by theories about audiences and divisions within politics/society. Conciliatory statements and the resilience of sentiment potentially explain why talks did not fall apart after episodes of violence. Although an association between "willingness" or "seriousness" and the volume of activity from the negotiators was not found, the actors' willingness is partly associated with the sentiment of joint statements. Although statistically significant support for tit-for-tat strategies of sentiment responsiveness was not found, bursts of statements from just one actor can provide insight into the persistence of sentiment and how statements may address different audiences.

7 Conclusion

This paper is a first attempt at applying sentiment analysis methods to the study of conflict negotiation. Estimating the state of a negotiation process can contribute to research on what causes peace durability and on bargaining and violence during talks.

The results from the HMM model indicate different trends of persistence and volatility for the FARC and government, respectively. These findings are consistent with the theory that the government uses statements to address different audiences that have different concerns, such as the public, the military, and FARC, and suggests that further research might focus on why the behavior of state and nonstate actors differs. Although it is not a causal explanation, the regime-switching model also suggests a potential theory for how the peace process survived crises such as FARC's kidnapping of a general and the infrastructure bombings. These findings indicate that empirical research into "seriousness" or "willingness" can potentially change our understanding of negotiations processes. Further investigation, however, is needed to explore the relationship between the actors' willingness and the output of the peace process—namely, the final peace accord.

In the sentiment responsiveness model, the only statistically significant results suggest that the government is more likely to respond with low sentiment to a high-sentiment FARC statement, rather than a tit-for-tat exchange where actors mirror each other's sentiment. These findings have interesting implications for theories about bargaining and about how public signalling, such as statements, relates to negotiations. Also interesting are the patterns of persistence within actors. A theoretical explanation for repetitive issuances of statements is consistent with the theory that governments address statements to many different audiences, some of which demand more attention. These bursts of texts from one actor may be as worthwhile to investigate than the back-and-forth between the two adversaries.

Regarding the effect of violence on talks, this paper's results suggest several interesting theories worth a more rigorous investigation. The first is that a nonstate actor might pair violence with sentiment that indicates high willingness to negotiate in order to gain leverage

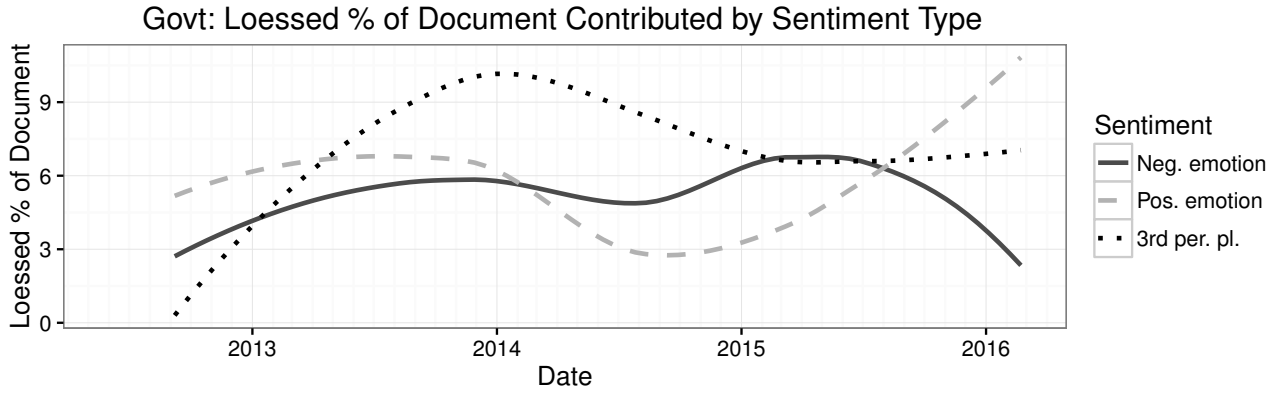
at the negotiating table, and that a total collapse of peace talks is averted by the conciliatory sentiment. If this is the case, in other peace processes we should expect that hardline sentiment coupled with violent attacks will derail the process. The other is that the state actor's sentiment is both volatile and resilient: though it is sensitive to events such as attacks, the high frequency of regime-switching enables the peace process to recover rather than being permanently derailed.

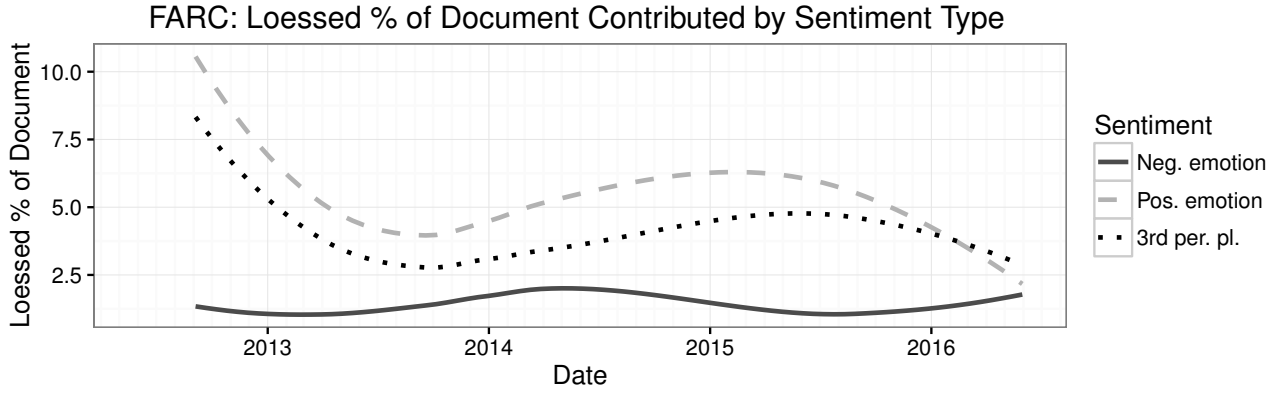
On some technical notes, further research might test alternative measures of sentiment. Using a general dictionary such as LIWC and using very general categories such as "positive" and "negative" have the advantages of being extendable to other conflicts or to non-conflict applications, but a dictionary with political science- or conflict-specific terms (e.g. terms that might refer to a specific leaders, locations, events, etc.) may be the way forward for more refined analysis and more specific results, although custom dictionaries require extensive background knowledge and time. Additionally, my use of a three-state HMM was guided by considerations of model fit, but the results suggest that a simpler model with a hardline/conciliatory dichotomy may be preferable. Surprising, too, were the findings that a sentiment-only model was as good of a fit as a model that included covariates for levels of public opinion and violence. Future HMM estimation could thus be considerably simpler than it was in this paper. With that said, substantive labelling of latent states is essentially a classification problem that could be optimized with machine learning algorithms.

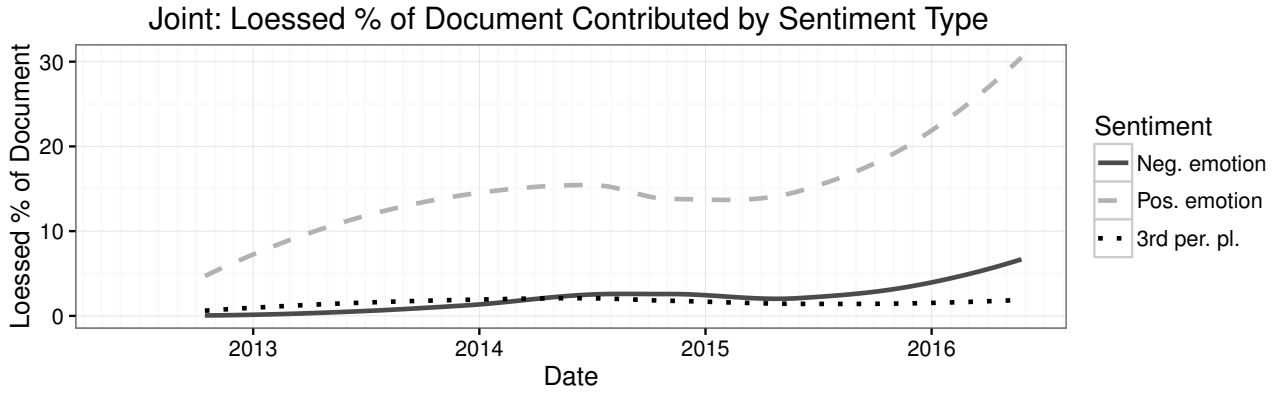
This case study could be extended to the outcome of the negotiations by updating the data to include statements leading up to the August 2016 peace agreement announcement and the (future) referendum. Examining the relationship between the sentiment of texts from the peace process and the final agreement may enable us to predict peace survival from negotiations sentiment. Another interesting area of future inquiry is the Colombian government's imminent negotiations with the ELN, which could be a step toward extending these results to other conflicts and to multidyad contexts.

8 Appendix

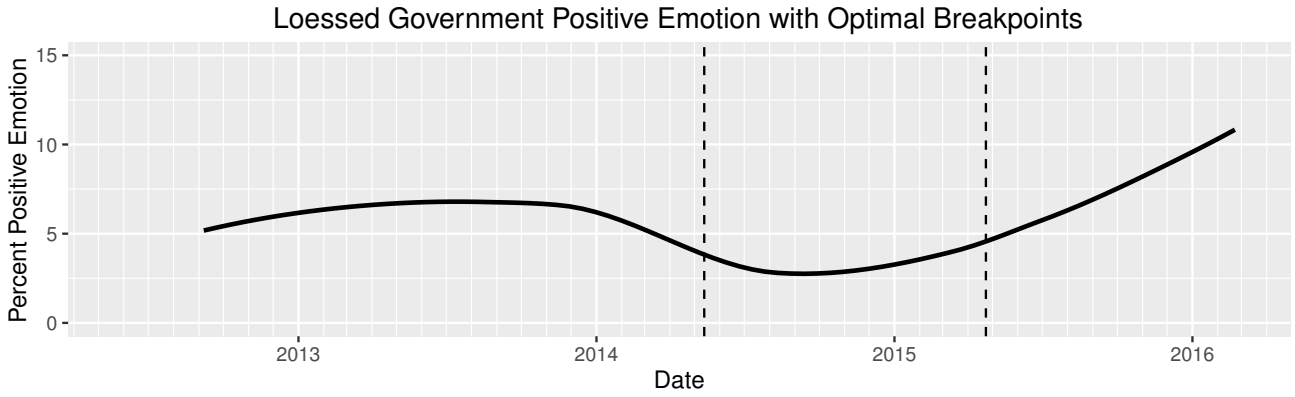
8.0.1 Data: Graphs of loessed sentiment measures

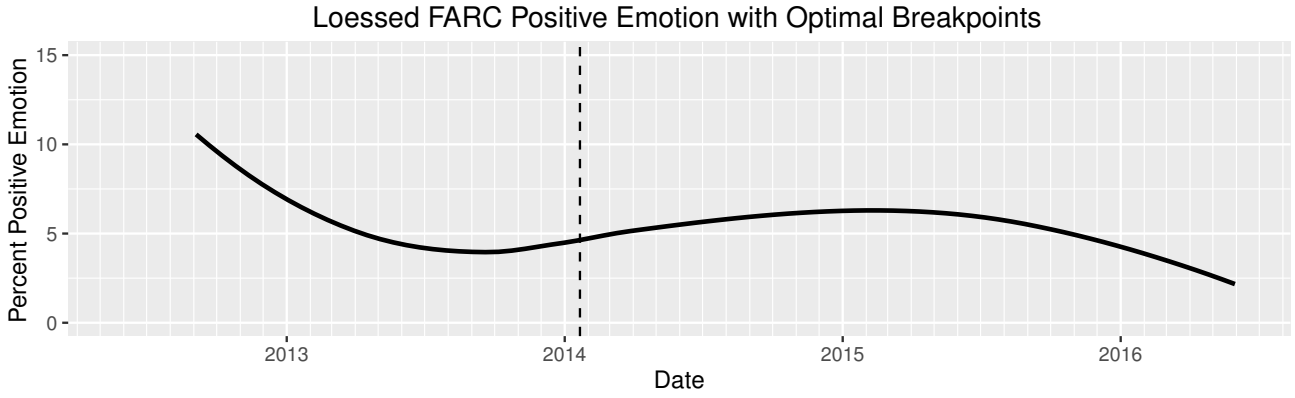


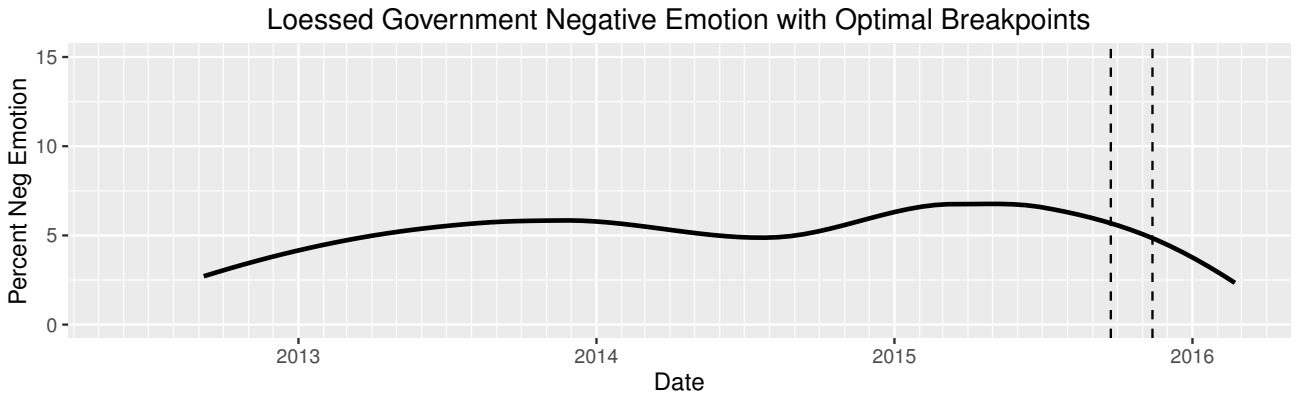


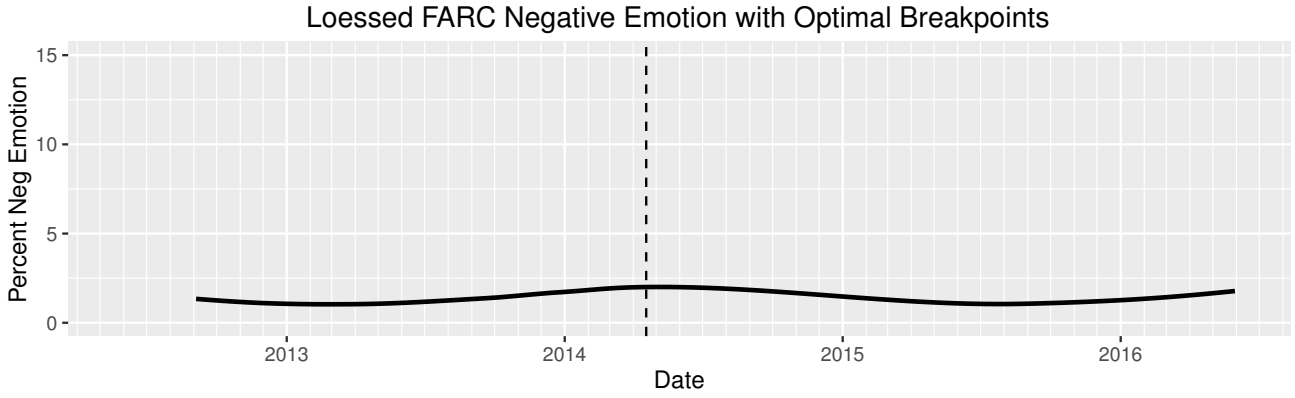


8.0.2 Data: Structural breaks in sentiment









8.0.3 Estimation: A note on fitting hidden Markov models using depmixS4

The expectation-maximization algorithm used in fitting hidden Markov models to data, implemented in the depmixS4 R package, randomly generates start values by generating random uniform values for the parameter $\gamma_t(j) = P(S_t = j|O_{1:T}, z_{1:T}, \theta')$, where $O_{1:T}$ are the observations, $z_{1:T}$ are covariates, and θ' is the set of initial model parameters.Visser and Speekenbrink (2010) Even when the seed is set to a fixed value, the EM algorithm does not always produce the same results because it randomly assigns the initial state, meaning that it does not generate the same transition matrix every single time. It does, however, reliably generate a limited number of transition matrices: three different matrices for FARC, and four for the government. (The rows of these matrices may be arranged in different orders, but they are equivalent because substantive labelling of the states i.e. rows occurs subsequently. The "same" matrices usually had identical values, but in a few cases differed by 0.001, or rarely by 0.01, because of rounding during fitting.) I fitted the model 1,000 times for FARC and the government separately, and used the most frequently occurring models (the selected FARC model occurred 596/1000 times, while the government model occurred 916/1000).

8.0.4 Validation of HMM: Logit of joint statement issuance on estimated states of willingness

Table 12: Does Willingness to Negotiate Predict Issuance of Joint Statements?

	Joint statement issuance
FARC low willingness	0.60
	(0.653)
FARC high willingness	0.40
	(0.461)
Government low willingness	0.37
	(0.534)
Government high willingness	2.36
	(1.272)
Interactions	
FARC low x Govt. low	3.64
	(5.45)
FARC low x Govt. high	0.59
	(0.41)
FARC high x Govt. low	4.39
	(6.78)
Observations	1,464
Pseudo R2	0.0067
chi2	1464

Note: *p<0.1; **p<0.05; ***p<0.01

Odds ratios are reported. The referent level is moderate willingness to negotiate.

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