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Three Essays on the Political Economy of Speeches

Hugo Subtil

► **To cite this version:**

Hugo Subtil. Three Essays on the Political Economy of Speeches. Economics and Finance. Université Paris sciences et lettres, 2023. English. NNT : 2023UPSLM084 . tel-04839398

HAL Id: tel-04839398

<https://pastel.hal.science/tel-04839398v1>

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THÈSE DE DOCTORAT
DE L'UNIVERSITÉ PSL

Préparée à Mines Paris.

Three Essays on the Political Economy of Speeches
Trois essais en économie politique des discours

Soutenue par

Hugo SUBTIL

Le 13 décembre 2023

École doctorale n°543

**Sciences de la décision,
des organisations, de la
société et de l'échange.**

Spécialité

Économie

Préparée au

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Three Essays on the Political Economy of Speeches

Hugo SUBTIL

*Dissertation submitted in partial fulfillment of the
requirements for the degree of Doctor of Philosophy.*

École des Mines Paris Tech – PSL Research University

in collaboration with

École Polytechnique

under the joint supervision of

Pr. Pierre FLECKINGER and Pr. Alessandro RIBONI

Remerciements

Je tiens à exprimer ma reconnaissance envers mes deux directeurs de thèse, Alessandro Riboni et Pierre Fleckinger. Ils m'ont initié à la recherche, et je suis profondément heureux qu'ils soient devenus mes directeurs de thèse. Je suis honoré qu'Alessandro, après avoir supervisé mes premiers travaux sur les finances publiques chinoises et été le rapporteur de mon mémoire de master, ait pu encadrer mon travail doctoral pour le questionner, le faire progresser et le consolider. Mes connaissances en économie politique lui doivent beaucoup. *Alessandro, grazie infinite. Questa tesi sa quanto ti debba.* Un grand merci à Pierre Fleckinger pour m'avoir initié à la rigueur de la théorie. Ses encouragements à pousser toujours plus loin la modélisation et ses interprétations, ainsi que sa bienveillance envers Guillaume Dupéret et moi ont été inestimables. Merci d'avoir guidé mes premiers pas hésitants pour me faire avancer sur le chemin de la rigueur et de la connaissance, et de me permettre d'effectuer les derniers en confiance. Merci à vous deux d'avoir cru en moi et de m'avoir chaleureusement soutenu.

Cette thèse n'aurait pas vu le jour sans la rencontre de Guillaume Dupéret, qui m'a embarqué avec lui dans les arcanes du Libor. Sa rigueur et sa curiosité m'ont permis d'atteindre des moments rares de joie intellectuelle que je souhaite vivement perpétuer. Au-delà du privilège qu'il m'a offert en me permettant de travailler au côté de sa vive intelligence, j'ai pu découvrir l'homme pour y trouver, désormais, un ami. Merci à lui et à Marion de m'avoir ainsi donné une nouvelle (et bien meilleure) raison de leur rendre visite à Bordeaux, Achille.

Je suis très reconnaissant aujourd'hui qu'Arnault Dellis, Caroline Le Pennec, Francesco Sobbrío, Gloria Gennaro et Yves Le Yaouanq aient bien voulu accepter de composer mon Jury de thèse. La lecture de leurs travaux respectifs m'a accompagné et façonné pendant ma formation doctorale ; les avoir comme jury m'honore et je les en remercie chaleureusement. *In particular, I would like to warmly thank Arnaud Dellis and Francesco*

for accepting to be my referees. I highly appreciate your thorough reviewing and precious feedbacks.

Je voudrais remercier particulièrement Arnaud Dellis qui m'a permis de faire l'expérience, un semestre durant, du froid montréalais dans les meilleures conditions qui soient. Grâce à son accueil, la superbe ville universitaire de Montréal ne m'est plus étrangère. Merci à lui de m'avoir poussé à participer à un grand nombre de conférences québécoises. Au même titre, je voudrais également remercier Jean-Philippe Bonardi qui m'a accueilli durant un autre semestre sur les bords du Léman. Merci pour ses retours et ses encouragements. Grâce à lui, je sais que la vie académique helvétique est douce et stimulante. Ces deux séjours m'ont permis de plus amplement me réaliser dans mon travail doctoral.

C'est sur une autre topographie, le plateau de Saclay, que j'ai initialement découvert ce qu'est la recherche en économie, avec le Master MIE. Je suis très satisfait d'avoir pu continuer mon doctorat dans le cadre sympathique et stimulant qu'offre le CREST. Parmi tous les professeurs qui ont pris le temps de discuter de mes travaux, je tiens à remercier tout particulièrement Jean-Baptiste Michau d'avoir cru en moi, puis si bien exposé la critique de Lucas. Il s'en est fallu de peu pour que je signe en *macro*, mais c'était sans compter avec le cours d'économie politique de Pierre Boyer et d'Alessandro Riboni. Je dois beaucoup à Pierre pour sa vision de la recherche, à Matias Nunez pour ses conseils liboriens, et enfin à Yves Le Yaouanq pour ses conseils pour la suite.

Je tiens également à remercier tous mes camarades doctorants, en particulier mes co-bureaux avec qui j'aurais dû passer plus de temps. Merci à Mario, Pauline et Claire. Également au groupe des doctorants d'Alessandro pour avoir bien voulu prêter attention à mon travail et le critiquer avec intérêt. Et bien sûr, un immense merci aux quatre désormais docteurs avec qui j'ai partagé mon parcours au MIE : Eddy qui m'impressionne depuis la prépa ; Tang à qui je souhaite le meilleur ; Germain à qui cette thèse doit bien plus qu'il n'imagine, et Pierre-Edouard à qui je souhaite de croire à sa bonne étoile. Un grand merci à la super docteure en devenir qu'est Héloïse, elle m'inspire beaucoup. Je ne saurais quitter le CREST sans exprimer ma reconnaissance à Vincent Verger. Sa passion, son énergie et sa curiosité sans limites m'ont aidé à traverser les moments les plus difficiles de mon travail. Sans lui, ce manuscrit n'aurait pas été le même. Les deux premiers chapitres lui doivent beaucoup. Son nom ne figure

pas sur cette thèse, mais je sais que nous aurons l'occasion d'y remédier. À tous, que leur vie académique les mène aussi loin que l'inspiration qu'ils m'ont donnée.

Aux membres de mon autre maison, le CERNA, merci de m'avoir accueilli en plein troisième confinement et laissé être l'un des vôtres. Merci à Barbara d'avoir fluidifié tout cela, à Simon, Victor, Félix et Rémi d'avoir été mes collègues avant l'heure et à Tiphaine et Guillaume d'avoir pris la relève. Merci à Mathieu et François pour leurs discussions autour de la machine à café et à Sven et Denis pour leur bureau.

Je dois beaucoup à un autre groupe de doctorants, celui de Dauphine. Merci à Amanda, Théophile, Maria, Dianzhuo, Rami, Isaac et Lucas pour de longs moments de partage. Parmi eux, je salue affectueusement Diego, avec qui j'ai souvent eu mal aux doigts.

En parlant de Dauphine, merci à Bruno de m'avoir initié au traitement de données et à la gestion de projet. À Antoine pour notre collaboration avortée mais non moins agréable. À Marie-Hélène pour son soutien (pas seulement administratif) et sa sympathie. Son aide dévouée, au côté de Delphine, et sa disponibilité en toutes circonstances m'ont permis de mieux me concentrer sur mes recherches.

En dehors des différents laboratoires dans lesquels j'ai pu travailler, j'ai croisé la route de personnes que je souhaite ici remercier. J'ai fait mes premiers pas dans le monde de la recherche avec Rosanne, à qui je dois beaucoup. Merci à Léa pour son excellente relecture. Je la vois victorieuse dans tous les combats, si elle continue à en mener rien ne pourra lui résister. Luisa, *Gracie Mille por todo, hope we keep chatting on parliament and gender influences*. Laurent pour son incroyable disponibilité et m'avoir initié aux joies insoupçonnées de Python. Merci à Benjamin de m'avoir guidé de loin dans mes premiers pas de chercheur. J'espère pouvoir te rejoindre, dans ta ville et ta discipline (intellectuelle). Et enfin, à Jessica pour ses mois de stage à mes côtés. Je suis heureux que cela lui ait donné le goût de la science économique.

Sur une note européenne, merci à Mathilde de m'avoir introduit dans le monde du Parlement européen en répondant toujours présente à mes incessantes sollicitations. Merci également à tous les députés qui ont bien voulu répondre à mon sondage, et encore davantage à ceux qui ont pris le temps de me téléphoner. Merci particulièrement au service de la Présidence de l'Union européenne pour avoir bien voulu m'envoyer les différents registres d'assignation des sièges et de présence des députés durant les

séances plénières. Nos échanges ont contribué à me faire comprendre de nombreux aspects de cette Assemblée.

Sur une note pluraliste, merci à Stéphane Horel, la plus rigoureuse des journalistes. Merci de rendre le monde moins mauvais. Merci à Sylvain Laurens pour nos discussions sur les lobbyistes européens et nous faire savoir ce que sont vraiment les courtiers. Merci également à tous les sociologues et politologues qui ont bien voulu partager un café en m'expliquant leurs propres recherches.

Ce manuscrit doit beaucoup aux relectures méthodiques de Claude Améline, dans la forme mais aussi sur le fond, grâce à nos innombrables discussions qui n'ont cessé de façonner ma manière d'appréhender le monde depuis une décennie déjà. Venue par surcroît, notre amitié aura transformé un stimulant compagnonnage intellectuel en une exceptionnelle aventure humaine. Je considère notre rencontre comme un privilège.

Enfin, ce manuscrit doit énormément à mes proches. En particulier, merci aux *Couz* pour sans cesse me rappeler à ce que je suis, au *Komintern* pour sa fidélité et aux *Pékinois* pour leur audace intellectuelle et nocturne. La complémentarité de chacune de ces amitiés m'apporte beaucoup. À ceux qui n'appartiennent à aucun de ces cercles, je ne vous oublie pas. Merci à Sarah d'avoir toujours cru en moi (mais tout autant pour m'avoir fait rencontrer Ben). Merci à Linus pour son compagnonnage et ses fulgurances. Merci à Lucie pour nos échanges. Notre amitié a été essentielle à la réussite de cette thèse, et au reste de ma vie.

Ma mère et mon père m'ont constamment soutenu et encouragé tout au long de mes vingt-six (!) années d'études. Ils ont toujours respecté et soutenu mes choix académiques et personnels, et m'ont donné ce goût de la curiosité. Ils m'ont également assuré un espace de clôtüre et de stase si nécessaire au travail intellectuel. Pour tout cela et bien plus encore, je les remercie. La moue dubitative (et sarcastique) de mes frères, Timothée et Lucas, sur mes recherches m'a toujours poussé à chercher la clarté plutôt qu'à tomber dans des travers ésotériques. Je les salue en éternels complices.

J'aimerais remercier Louise pour son soutien inestimable dans la poursuite quotidienne de mon travail, malgré, entre autres, mon obsession des courriels administratifs intempestifs. L'écriture de ce manuscrit n'a fait que renforcer mes penchants égoïstes, et je suis profondément désolé que tu aies autant souffert. Elle seule sait tout ce que cette thèse lui doit. Vivement la suite.

Résumé

Cette thèse de doctorat en économie politique se compose de trois chapitres indépendants. Les deux premiers portent sur le comportement verbal des membres du Parlement européen, tandis que le dernier aborde un problème d'optimisation appliqué au scandale du Libor dans un cadre bayésien. L'originalité de ce travail réside notamment dans la création d'une nouvelle base de données textuelles regroupant tous les discours prononcés au Parlement européen de juillet 1999 à novembre 2022. Cette base permet en effet d'utiliser des techniques de traitement du langage naturel issues de l'apprentissage machine, en vue de mesurer les évolutions qui ont pu se produire au cours de ces vingt-trois années.

Le premier chapitre met en lumière pour première fois des convergences entre les discours prononcés à l'intérieur de chaque "groupe politique européen". On constate que chacun de ces groupes y a gagné en cohérence idéologique interne, notamment aux deux extrémités du spectre politique (à droite, le "Parti populaire européen" ; à gauche, "l'Alliance progressiste des socialistes et des démocrates"). Logiquement, cette homogénéité croissante du langage à l'intérieur d'un même groupe a fait que les groupes se sont davantage distingués les uns des autres. Par ailleurs, l'Europe de l'ouest et l'Europe de l'est ont convergé dans leurs façons de parler, mais la première conserve (notamment entre les États du nord) deux fois plus d'homogénéité que la seconde, dont les États membres se sont peu rapprochés depuis leur adhésion à l'Union. Enfin, lors des crises des migrants et du Brexit, les positions nationales l'ont emporté à nouveau au sein des différents groupes politiques européens. En conclusion, je soutiens qu'il importe de saisir les convergences des élus européens dans leurs discours pour évaluer les perspectives d'une UE plus politiquement intégrée.

Le deuxième chapitre examine l'influence des interactions sociales entre les membres du Parlement européen : dans cette assemblée où les sièges sont affectés de façon quasi-aléatoire, le fait, pour deux députés, d'être assis côte à côte rapproche-t-il leurs manières de parler ? On constate que la similarité de leurs langages augmente de 7 % si ces députés voisins appartiennent au même groupe politique, et encore de 4 % s'ils sont de groupes différents. Au sein d'un même groupe politique, ces rapprochements entre voisins portent davantage sur le choix des sujets que sur les expressions employées pour en parler. Entre voisins de groupes différents, la convergence porte uniquement sur les formulations qu'ils utilisent. Par ailleurs, ces effets de pairs sont nettement plus forts entre deux femmes siégeant côte à côte, et entre des nouveaux députés issus du même État membre. Mais le Parlement européen se réunit soit à Strasbourg, soit à Bruxelles, avec des affectations de sièges différentes. Qu'en est-il alors ? On constate que les effets de pairs subsistent : les députés qui ont siégé côte à côte dans l'un des deux hémicycles parlent toujours de manière plus similaire quand ils ne sont pas voisins dans l'autre. Dans une enquête auprès des députés actuels, la plupart des répondants m'ont exprimé leur scepticisme quant à l'influence possible d'une telle proximité physique, tout en reconnaissant qu'ils ont des relations étroites avec leurs propres voisins, en particulier s'ils sont des nouveaux arrivants. Dans l'ensemble, ces résultats mettent en lumière l'importance des interactions sociales entre les députés siégeant côte à côte. Cela suggère qu'un tel système de localisation aléatoire peut aider à réduire les divisions politiques dans une assemblée d'élus ; voire, peut-être, atténuer les polarisations croissantes dans la politique contemporaine.

Le troisième chapitre étudie les dynamiques de la manipulation du Libor au moyen d'un modèle bayésien, dans lequel un agent apprend peu à peu l'intensité de la surveillance à laquelle il est soumis. Le superviseur peut être actif ou inactif, et l'agent choisit l'intensité de sa manipulation à chaque période qui génère un gain immédiat. Alors qu'un superviseur inactif permet à l'agent de tricher indéfiniment, un superviseur actif peut découvrir la manipulation – et il est plus susceptible de la détecter à mesure que l'ampleur de la manipulation augmente. Si la manipulation est découverte, l'agent est sanctionné et le jeu prend fin. Dans un tel cadre, plus l'agent est patient, plus l'incitation à l'apprentissage le pousse à manipuler pour découvrir son environnement. Cette valeur expérimentale implique qu'une suite d'agents myopes

observant les actions de leurs prédécesseurs génère moins de manipulation qu'un seul agent vivant un nombre infini de périodes. Nous caractérisons ainsi la stratégie optimale de l'agent, les probabilités d'arrêt et les gains dans un ensemble de conditions assez générales, et discutons de l'affaire du Libor à la lumière de ces résultats.

Abstract

This PhD dissertation in political economy consists of independent chapters. The first two document the speaking behaviour of members of the European Parliament (MEPs), while the last one is an optimization problem studying the Libor scandal within a Bayesian framework. The originality of this work lies in particular in the creation of a new textual database that gathers all the speeches made in the European Parliament from July 1999 to November 2022, allowing to use natural language processing approaches as outcome measures.

Chapter one focuses on the speeches given by members of the European Parliament and present the first evidence of convergence within European political groups. The baseline analysis shows the development of increasingly cohesive ideological blocs in the Parliament, particularly among the more radical ideologies. Yet, this increasing unity within groups has come at the expense of proximity between them. Even though the East and West parts of the European Union have converged in their ways of speaking, western Europe is still twice more internally cohesive, especially in the north, than eastern members, which have barely done so since they joined the Union. I also show that in times of crises, national preferences take precedence, as evidenced by increased polarization between the EU member states during the migrants crisis and Brexit. I argue that understanding the convergence of MEPs' preferences in speeches is crucial to assess the prospects for a more politically integrated EU.

Chapter two investigates the influence of social interactions among members of the European Parliament on the similarity of language they speak. Using the quasi-random allocation of seats in the European Parliament, I find that sitting adjacently increases language similarity among MEPs by 7% within the same group and by 4% between different groups. Within-group peer effects are equally influenced by convergence in

the topics discussed and, in the phrases, used to address them. In contrast, between-group convergence is driven solely by a more similar manner of addressing topics. Peer effects are markedly stronger among women sitting side by side, new members and desk neighbours from the same member state. Using seating variation in the European Parliament's venues (Strasbourg or Brussels), I find persistent peer effects: MEPs who have previously sat together speak more similarly, even once they do not seat adjacently anymore. In a survey of current MEPs, most respondents expressed skepticism regarding the potential impact of peer influence, despite acknowledging close relationships with their desk neighbours, particularly when freshmen. Overall, these results highlight the importance of social interactions among legislators, suggesting that fostering connections can help bridging political divides and possibly mitigate the growing polarization in contemporary politics.

Chapter three studies the dynamics of Libor manipulation through the lens of a Bayesian model in which an agent learns the intensity of the supervision they is subject to. The supervisor can be active or inactive, and the agent chooses a manipulation intensity in each period that yields a short-term payoff. While an inactive supervisor lets the agent cheat indefinitely, an active supervisor can discover the manipulation, they is more likely to detect it as the extent of the manipulation increases. If the manipulation is discovered, the agent is sanctioned and the game ends. In such a framework, the more patient the agent is, the more the learning incentive pushes them to manipulate to discover their environment. This experimentation value implies that a sequence of myopic agents observing the actions of their predecessors generates less manipulation than a single agent living an infinite number of periods. We characterise the agent's optimal strategy, stopping probabilities and payoffs under a set of fairly general conditions, and discuss the Libor scandal in light of these results.

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1 United in Diversity?

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1.1 Introduction

Uniting people from diverse cultures was a founding principle for many nation-states.¹ It is also the core ambition that drove successive European endeavours after World War II, to promote peace and stability in the 'old continent'. The European Union (EU), whose motto is *United in Diversity*, has achieved a remarkable level of economic integration, marked by the free movement of goods, persons, services and capital, the creation of the eurozone and the implementation of common economic policies. As the world's largest single market with over 445 million consumers, the EU represents around 16% of global trade.

However, despite experiencing economic convergence and improved coordination of business cycles, the member states have not converged culturally or institutionally (Alesina et al. (2017)).² What about the political convergence, then? Are divisions between member states still the primary determinant in European political cleavages? Or, are European representatives becoming closer to their ideological counterparts in other member states as EU integrates?

¹For example, '*E pluribus unum*' in the United States, and '*L'union fait la force*' in Belgium, or '*Unity in Diversity*' in South Africa. History abounds with efforts to "make" national citizens (see, e.g., Duggan (2008) for Italy, and Bazzi et al. (2019) for Indonesia).

²They show that the degree of cultural heterogeneity, both within and between EU member states was similar to that in the United States, an allegedly efficient and well-functioning political and currency union. However, unlike in this analysis, their study only covered the EU15, excluding the eastern part of Europe.

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The European Parliament (EP), the only directly elected institution in the EU, has long been characterized by national divides rather than ideological ones (Hix (2008), Mair and Thomassen (2010)). Both on the side of political demand and supply, interests appear to be national. Strictly European themes account for only about one third of the campaign topics in European elections (Parliament (2020)). The majority of voters tend to base their choices on national representation criteria (Hix and Høyland (2013)) indicating that European citizens still prioritize their national identities and concerns over a collective European political identity (Hix and Hagemann (2008), Katz and Mair (2002)). Despite the European Commission's determination to continually increase EU integration, the member states' tendency to give priority to their national interests over possible common ones remains clear and seems to be growing, as shown by the UK's decision to leave the EU (Brexit). This tendency seems to be reflected in the rise of anti-EU parties within the European Union, which now gather more than 25% of all MEPs, as opposed to less than 5% before 2014 (Rooduijn (2019) and the corresponding [Popu-List.org](https://www.popu-list.org/)).

Against this background, the issue of European political groups (EPGs) speaking up in a more homogeneous manner becomes paramount, as it could contribute to balance the possible conflicting positions of member states.

This old idea, pushed by the most pro-European supporters for years is becoming more and more of a reality, as evidenced by the decision to introduce pan-European lists starting from the upcoming 2024 European elections.³ Is this the result of a phenomenon already at work within the European Parliament, or is it a completely *ex nihilo* intention emerging? As EU integrates, does the EP still consist of juxtaposed national parties, or have broader ideological groups already emerged?

A major issue in the analysis of ideology and political dynamics is measurement. Most commonly, research has so far focused on party affiliation through voting. However, this proves to be challenging when it is not a two-party system, and even more so when different levels of interests overlap, as is the case with national and political interests in

³In May 2022, the European Parliament adopted a [proposed legislation](#) to reform the European elections. Under this reform, voters will still cast their ballots for national candidates, but also elect 28 additional MEPs on pan-European lists, with the main candidates running for the presidency of the European Commission.

EU.⁴ I focus on ideology as a summary measure of political positions that can be used to evaluate polarization and partisanship. Following [Bénabou \(2008\)](#), ideologies can be defined as 'collectively sustained sets of beliefs' that most often manifest in patterns of ideas, primarily along a left-right scale, as noted by [Cochrane \(2015\)](#). However, some researchers have argued that measuring ideology through votes might be misleading, as politicians can mix issue positions from all the positions of the traditionally defined ideological spectrum ([Converse and Kapstein \(2006\)](#), [Donald and Nathan \(2017\)](#)). It is not clear how to position developments such as the recent surge in populist politics in relation to the left-right spectrum.⁵ This complexity also applies to specific multi-layer political systems like the EP. Studying actual speeches made by politicians, thanks to *natural language processing* techniques (NLP) such as 'party embeddings' have proven successful at capturing latent concepts like ideology ([Rheault and Cochrane \(2020\)](#)). It relies on artificial neural networks that consider a large number of complex interactions between words and political variables, making it naturally suitable for research focusing on latent properties of political discourse, such as ideology. This methodology goes beyond word counts, and provides a fresh look at research into political semantics.

To do so, I present the most comprehensive analysis to date of speeches in the EP plenary sessions, with a view to quantify the magnitude of partisan differences in speech. Firstly, I gathered new data on those speeches between 1999 and 2022, made by 2,500 different members of the EP (MEPs). Secondly, I classified speeches into 12 different topics (such as foreign affairs, monetary policy or human rights) using an unsupervised machine learning algorithm (LDA) to capture what the Parliament is really talking about. I present descriptive patterns that monitor changes in the composition of the Parliament over time, categorized by member state, EPGs, and national parties. This provides insights into the factors determining whether certain issues remain under national or pan-European jurisdiction. Thirdly, through the application of the vectorization

⁴In presidential systems, analyzing voting records is done through roll-call analysis (e.g., using DW-NOMINATE by [Poole and Rosenthal \(1985\)](#)). However, in parliamentary systems, due to high party discipline and government agenda control, voting patterns unsurprisingly reveal only a division between government and opposition parties ([Spirling and McLean \(2007\)](#) and [Hix and Noury \(2016\)](#)).

⁵As an example, recent research has proposed an extension of the left-right ideological model to encompass voters' identity ([Bonomi et al. \(2021\)](#)), a 'globalists' vs. 'nativists' dimension ([Gethin et al. \(2022\)](#)), or moral foundations ([Enke \(2018\)](#)).

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technique *party embedding*, I analyze the speeches of political groups to extract their underlying meaning. By assessing the semantic distances between political parties and member states I show how the content of speeches that reveals partisan positions has converged within EPGs but diverged between them. I demonstrate the variations in this pattern based on the political and national affiliations of MEPs, highlighting the extent to which the dynamics of speaking differs from that of voting. [Gentzkow et al. \(2019b\)](#) found disparities between speech dynamics and roll-call votes for the U.S. Congress, confirming my expectations. Analyzing speech can unveil aspects of the political landscape that may not be evident from examining roll-call votes alone, particularly in contexts characterized by high national party discipline ([Hix and Hagemann \(2008\)](#)).

My main result shows that a striking, gradual, long-term transformation in the structure of European political cleavages is emerging. Until the early 2010s, EU party systems were "national", in the sense that national parties were closer to their member states position than to their EPGs. These party systems have gradually evolved towards what I propose to call an "ideology-based" system, in which the national party identifies more with the EPG than with the country. This confirms the thesis of the emergence of large pan-European groups. Interestingly, this transformation has taken place without changing the cross-country disparities. This result can be further broken down as follows:

Firstly, even after decades of European integration ideological differences between member states remain. Overall, the ideological coherence has even decreased since 1999. The divergence mainly results from both the expansion into eastern Europe and the crisis from 2012 to 2016. Eastern member states did not draw closer to each other nor to the West. In addition, after Eastern Europe joined, the global variance of the ideological coherence increased significantly, confirming substantial heterogeneity in the newer countries. Although western member states have (barely) converged toward one another, differences remain with northern Europe that has constantly showed more coherence within and between its member states. While the South has a more back and forth approach, especially since 2014, when populist movements paved the way.

Secondly, European political groups tend to adopt a more unified ideology as the European Union integrates. While EPGs were heterogeneous groups in the early 2000s, they have become increasingly coherent internally, which has led them to drift apart

from each other. National parties now speak up more and more alike within their EPGs, creating broad and cohesive partisan coalitions. The ideological convergence within the European groups has been particularly more pronounced among the European Greens and the far right. It is worth noting that this phenomenon is more pronounced for the newly elected MEPs – who are more aligned with the positions of their EPG colleagues than their party's ideology at home.

Thirdly, even if all national parties are moving closer to their EPG, on average, they still speak more like their country. With the exception of the Green and the Left, whose national parties align more closely with their EPG ideology than with the ideology of their respective member states. During times of crises, such as the 2013-2016 European crises, MEPs tend to align their speech patterns more closely with their respective member states than their European colleagues. This demonstrate a stronger identification with their national identity.

If I expand the framework of the optimal political area proposed by [Alesina and Spolaore \(1997\)](#), between EPGs increasing distance, which can be interpreted as polarization, may not be a bad thing in this case. I argue that effective representation at European level, with the development of coherent European ideologies, is crucial for addressing major shocks affecting differently member states. In such situations, when national interests are fragmented, EPGs guided by unified ideologies are better platforms to discuss and reach EU-wide solutions.

Broadly, this article makes three notable contributions. Firstly, I have constructed the most comprehensive database to date of speeches in the European Parliament. My data not only greatly expands the year coverage of plenary speeches by previous scholars, but also provides valuable information such as the individual political affiliation and curriculum. Secondly, while there has been previous theoretical attention devoted to the role of economic convergence in Europe's organization and functioning, my findings fill a gap by providing empirical evidence on different political convergence dynamics in EU and discuss on how partisanship can affect the cohesive role of EPGs. They suggest that there has been an increasing convergence of the EU elites within their respective ideological groups, but a divergence between groups and between member states. By documenting which parties have converged, I highlight the potential role of EPGs in shaping European processes. Thirdly, and more generally,

this paper pushes forward the understanding of how partisanship affects political debates, with the use of NLP techniques, an important issue for parliamentary deliberation.

The remainder of this paper is organized as follows. Section 1.2 presents the related literature. Section 1.3 provides a primer on the European Parliament and introduces my new dataset on MEPs' speeches. Section 1.4 presents the party embedding model. Section 1.5 outlines my results. Section 1.6 discusses the implications of my findings. Section 1.7 concludes.

1.2 Literature

Firstly, this paper relates to the literature on the European Union as an optimal political area. This concept was initially introduced by [Alesina and Spolaore \(1997\)](#), considering that the optimal size of a political union arises balancing the advantages of integration, such as economies of scale and scope, against the drawbacks of expansion due to diversity in preferences. [Guiso et al. \(2016b\)](#) study historical data from the Eurobarometer surveys documenting that the considerable cross-country gaps in supporting the European Union have closed. [Guiso et al. \(2016a\)](#) stress cultural differences between northern and southern European member states and argue that future integration (with common enforcement) is needed to confront the "cultural clash". According to [Alesina et al. \(2017\)](#) what is striking in the EU is the high degree of within-country (rather than cross-country) heterogeneity in beliefs and trust. Applying simple variance decompositions on various cultural proxies from the *World Values Survey* during the period 1980–2007, they show that within-country variation dwarfs between-country variability, a pattern also found between U.S. states.⁶ They show that the degree of cultural heterogeneity both within and between EU countries was similar to that in the United States, an allegedly efficient and well-functioning political and currency union. Note that, unlike in my analyse, they do not take into account the inclusion of eastern European countries. According to them, what hinders better European integration is not the heterogeneity of cultures and values, but rather the divisions of national identities: "*The important question is the evolution of national versus European identities.*"

⁶They have an impressive result where preference heterogeneity and cultural diversity is about 10 times as large within each EU country than between them.

Secondly, this article directly relates to the growing literature on the sources of political change and the rise of “populism” in Western democracies. Recent studies conducted by [Algan et al. \(2017\)](#) and [Guiso et al. \(2017\)](#) have identified a prominent trend of populist politics in Europe, which seems to be linked to evolving economic circumstances. [Dustmann et al. \(2023\)](#) reach similar results showing that following the 2008 crisis, distrust in European institutions, primarily attributed to the economic challenges faced by Euro-area countries, is associated with the rise in populist voting. However, these populist trends are not necessarily symptomatic of ideological polarisation. For example, [Algan et al. \(2017\)](#) who study the political consequences of the Great Recession in Europe, detect no significant shift in political positioning along the left-right scale in their multi-country sample and pick up a decline in close party identification. According to [Guiso et al. \(2023b\)](#), economic insecurity does not directly impact the support for populist parties. Instead, it primarily leads to disillusion among the supporters of traditional parties from both the left and right. Then it can result in abstention and form a potential electoral foundation for a populist agenda. This leads to voter abstention and lays the groundwork for a potential populist political platform. [Guiso et al. \(2023a\)](#) delve deeper, conducting econometric analysis to determine that over one third of the rise in support for populist parties compared to other parties following economic security shocks is attributed to changes in voter turnout. On democratic politics and populism, recent examples include: [Acemoglu et al. \(2013\)](#), [Buisseret and Van Weelden \(2020\)](#), [Bursztyn et al. \(2020\)](#), [Guiso et al. \(2017\)](#) and [Rodrik \(2018\)](#). As discussed, my research provides insights into the potential long-term ideological foundations of these diverse political trends within the political elites.

Thirdly, there exists a substantial body of literature explicitly examining polarization and fractionalization along political, ethnic, and cultural dimensions. This body of work often centers on quantifying group structures within societies and analyzing their relationship with patterns of conflict. An indicative list includes: [Alesina and Spolaore \(2003\)](#), [Bossert et al. \(2011\)](#), [Caselli and Coleman \(2013\)](#), [Duclos et al. \(2004\)](#), [Canen et al. \(2020\)](#). Recent studies of relevance in this context include [Bertrand and Kamenica \(2018\)](#), who quantify ‘cultural distance’ between sub-groups of the population in the US and identify a consistent relationship across various outcomes and group divisions. They do, however, observe variations in social attitudes based on political ideology and income. [Desmet and Wacziarg \(2021\)](#) similarly explore cultural distance and report

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stability across most dimensions. The approach to identifying social sub-groups in a purely data-driven way has the potential to inform the emerging literature on identity politics (Atkin et al. (2021); Grossman and Helpman (2021); Shayo (2009)). This literature has recently focused on identity groups whose definition hinges on ex-ante characteristics (e.g., race, gender, income class). My methodology shows that there is scope to define latent political sub-groups based on observable positions other than vote.

Finally, there is a rapidly expanding body of literature that employs machine learning and natural language processing techniques to investigate aspects of ideology, policy-making, and political communication. This includes the previously mentioned studies by Gentzkow et al. (2019a) and Jensen et al. (2012), as well as other text-based research such as Ash et al. (2021), Hansen et al. (2018), Cage et al. (2020), and Jelveh et al. (2015). Another branch of this broader literature (Hill and Tausanovitch, 2015; Munro and Ng, 2020; Desmet et al., 2022) has also started to explore the application of unsupervised learning methods to analyze survey response data. To the best of my knowledge, my work is the first to employ the *Doc2Vec* technique for the examination of partisanship using EU speech data.

1.3 Background and data

1.3.1 The European Parliament

In short. Established in 1958 with the formation of the European Economic Community (EEC), its authority was limited at that time, and its composition comprised delegates appointed by member states' national parliaments. Since 1976, the EP's powers expanded to encompass amending, adopting, or rejecting Commission legislative proposals from the EU Commission, overseeing the EU budget, and supervising its execution. It exercised further oversight over EU institutions such as the European Commission and the Council of the European Union. Following the Maastricht Treaty (1992), the EP acquired the ability to approve or reject appointments for the European Commission's President. Subsequently, with the Lisbon Treaty (2009), the EP was

empowered not only to elect the Commission's President but also to approve or reject individual commissioner appointments.⁷

Day to day work. The European Parliament (EP) is the legislative chamber of the European Union. Since 1979, its members (MEPs) are elected in local or national elections in each EU member state. Once elected, MEPs join one of several trans-national European political groups (EPGs) according to their national political party.⁸⁹ Each EPG consists of MEPs from different member states and national parties. During the day-to-day work of the Parliament, EPGs carry out many of the functions performed by parties in national legislatures. In particular, they sit together during the Parliament's plenary sessions and also formulate a (non-binding) "party line" for many of the issues being voted on. The work of the Parliament is centered around the plenary sessions which are held once or twice a month in either Strasbourg or Brussels.¹⁰ These consist of several daily 'sittings' of debate and voting. They are organized by theme throughout the day and speaking is subject to strict rules: the order in which the authors of oral questions speak follows the chronological order, and speaking time is constrained, starting with the rapporteur speaking for six minutes and ending with a point of order of maximum one minute.¹¹

1.3.2 Data

Speeches and MEPs' characteristics dataset. This corpus was scraped from the European Parliament website (see Appendix 1.E.1). It comprises transcripts of 686,439 speeches pronounced between July 1999 (the beginning of EP's 5th legislature) and October 2022 (middle of the 9th legislature). It covers all plenary sessions, both

⁷For a more detailed on EP empowerment, refer to Appendix 1.F and [Aleh and Jessica \(2013\)](#).

⁸A small number of MEPs are not affiliated to any EPG (e.g. 43 at present, among the 705 MEPs).

⁹More precisely, national parties determine the European political group to which their MEPs will belong, the key committee positions and parliamentary commissions their MEPs will pursue, and which of their MEPs will be appointed to these positions.

¹⁰The Parliament's annual calendar includes 12 plenary sessions which take place over four days in Strasbourg (from 5 pm on Monday until Thursday evening). Since MEPs do not sit in August two sessions are organized during another month. Apart from the 12 annual plenary sessions, there are six mini-sessions per year which last two days and take place in Brussels. MEPs look into draft directives and regulations put forward by the European Commission. The parliamentary committees meet in Brussels two weeks per month.

¹¹More information [here](#).

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in Strasbourg and Brussels. The speeches were pronounced by 2,675 different MEPs discussing 5,870 draft laws.¹²

The scraped dataset encompasses meta-data associated with each speech. For instance the speaker's name, the title of the discussion, the nature of the discussion (debate, voting time, amendment, vote explanation, oral questions, etc.), the order of the section in the session agenda, the order of the speeches in the discussion and among all speeches in the day and the set of draft laws that are under MEPs' scrutiny in the discussion. This meta-data enables me to associate speeches with MEPs' individual characteristics and to match speeches to voting results. Note that I also have in this dataset speeches pronounced by people invited to the Parliament. This includes members of the European Commission and Council and, as the case may be, invited heads of state. I keep these speeches to train a robustness 'parliament embedding' model but discard them from my analysis.

I complement the dataset by incorporating MEPs' individual characteristics. I add information on the EPG, the national political party, the possible party leadership position, committee affiliation, committee chairmanship, gender, age and curriculum (Table 1.B.3). I use information from the [Parltrack website](#) to compile the individual-level data.

Table 1.B.4 summarizes the individual characteristics of all observed speakers in my dataset. I also observe the distribution of speeches between Strasbourg and Brussels as well as between legislatures. The differences in descriptive statistics between Tables 1.B.3 and 1.B.4 mean that some individual characteristics correlate with MEP's opportunity to take the floor (see Table 1.B.5).

The corpus pre-processing can be summarized as follows (see Appendix 1.E.2 for additional details). Each speech in the corpus is first segmented into sentences. Punctuation, capitalization, digits, and stop words (including names for countries, cities, months, politicians and procedural words) are removed. I drop words of less than 3 characters. To extract the most informative tokens, I tag parts of speech and take only nouns, adjectives, and verbs. These tokens are stemmed using the *snowball stemmer*. After filtering out rare stems (those occurring in less than 10 speeches), I have 350,152

¹²See Table 1.B.1 for the distribution of plenary sessions and sitting days across the legislatures in my dataset.

token types left in the vocabulary. Once I have pre-processed the corpus I can apply my *Doc2Vect* algorithm (see Section 1.4).

1.3.3 Key descriptive statistics

As this is the first article in the present thesis, let me briefly outline some important key descriptive statistics regarding the EU Parliament thanks to my database. To my knowledge, this is the only database that combines votes, speeches, and meta-information on the MEPs. While there exist databases for MEPs' meta-information, they are imperfect. The latest one, [Salvati \(2022\)](#), appears to have some encoding issues and discrepancies. I have verified and rectified them. Therefore, here is some valuable background information on all MEPs since 1979 that I was able to scrutinize. True, regarding the speeches data, some papers have focused on working with speeches in the plenary sessions of the EU. However, they have often encompassed an extensive time period and aggregated all the speeches from a single session. For example, [Sylvester et al. \(2023\)](#) gathered speeches only for specific countries, while [Schumacher et al. \(2016\)](#) focused solely on certain functions, specifically speeches made by heads of government from 10 member states, spanning from 2007 to 2015. Additionally, there has been an attempt by a website to collect European data, including speeches from the 2010s, but the results appear highly questionable and have never been used in a scientific publication ([Bjørn et al. \(2009\)](#)).

Turnover level. Some of the evidence that this dataset can provide is the examination of the EP's institutionalization process through an analysis of the turnover level. This evaluation is crucial for understanding whether the shifts in patterns observed in my work stem from a change in the preferences of the MEPs themselves, or if they arise from alterations in the preferences of the voters who consequently elected different MEPs to represent them (although both scenarios are not entirely mutually exclusive).

The turnover rate for the last eight EP elections (see Figure 1.4) was notably high, marked by significant peaks (up to 62%). This makes it challenging to discern any specific trend in the rate of MEPs' substitution. For comparison, the average turnover rates stand at 12% for the US Senate and 36% for the French National Assembly ([François and Grossman \(2015\)](#)).

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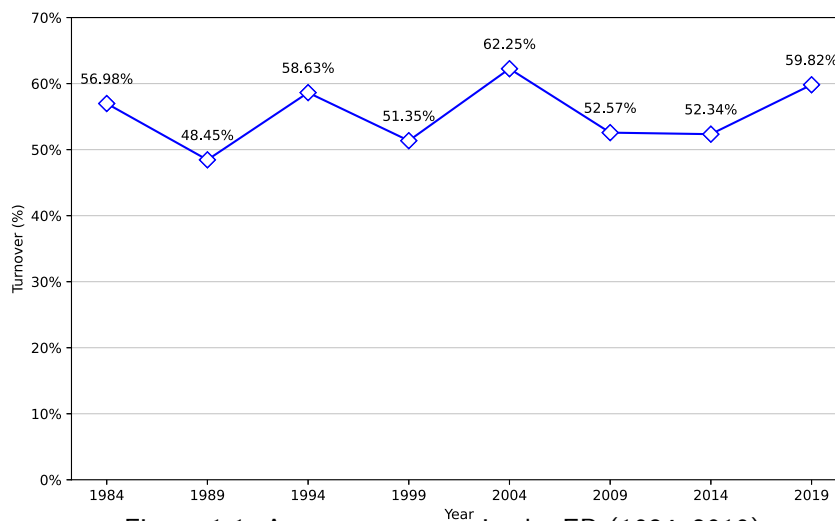


Figure 1.1: Average turnover in the EP (1984–2019).

The gender dimension. Examining Figure 1.2, a noticeable trend of convergence between male and female elected as MEPs becomes evident. In contrast to the notable gap observed 30 years ago, the latest European elections present a more balanced representation. The ninth EP parliamentary term boasts the highest percentage of female representatives. The EP stands out as one of the most feminized Parliaments in Europe. Nonetheless, the proportion of women remains lower in right-wing parties and in countries that joined the EU in the 2000s (Cypriot, Estonian, Lithuanian, and Hungarian delegations).

Extensive literature has scrutinized the selection phase of female candidatures, emphasizing various influencing variables. For instance, studies have highlighted the role of party-level patterns of selection, with a more centralized model showing a higher selection rate of female candidacy (Aldrich and Daniel (2020)). The stance of parties on EU integration plays a significant role, with pro-EU parties in new member states exhibiting greater enthusiasm in recruiting women as candidates (Chiva (2014)). Notably, when analyzing the descriptive statistics in Table 1.B.6, it becomes apparent that female newcomers to office occupy a marginal position. For female MEPs, possessing relevant political professionalism – whether in the EP or the national/subnational arenas – appears to be strategically crucial when pursuing a career in the supranational parliament.

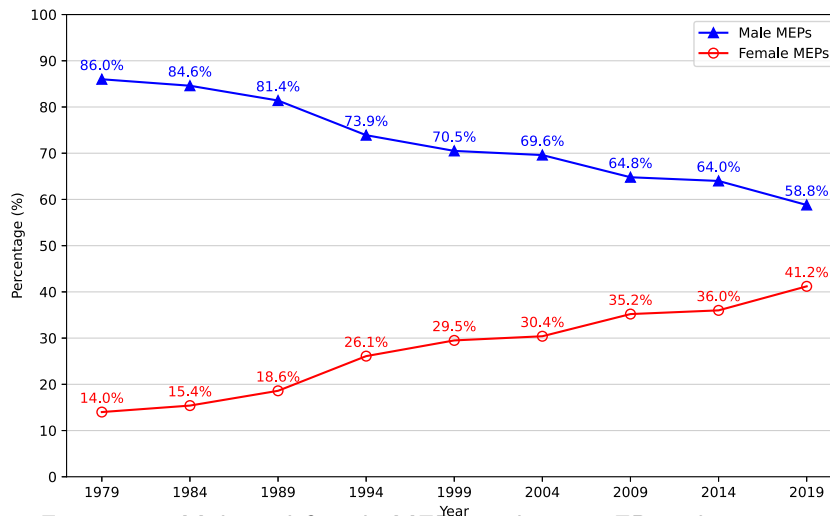


Figure 1.2: Male and female MEPs in the nine EP parliamentary terms.

Seniority and professionalization. One insight from this data is the correlation between substantial seniority within the EP and the allocation of pivotal positions within the political group and senior parliamentary offices. As depicted in Table 1.3, the distribution of top offices within the EP is predominantly reserved for MEPs who have served a minimum of two parliamentary terms. This underscores that seniority is a prerequisite for attaining positions of influence within the EP. When considered alongside an MEP’s ability to secure reconfirmation in office after an initial term in Strasbourg (Beauvallet-Haddad et al. (2016)), it affirms the presence of a core cohort of career politicians dedicated to advancing a supranational political trajectory (Daniel (2015)). These politicians thus form the focal point of professional specialization within the EP (Verzichelli and Edinger (2005)).

Table 1.3: Distribution of top offices among MEPs with at least two EP terms of seniority.

Office	Committee Chair (%)	Committee Vice Chair (%)	EP President (%)	EP Vice President (%)	European Party Group Chair (%)
2004	82	72	100	75	79
2009	86	85	100	81	83
2014	86	91	100	74	87
2019	59	69	100	72	78

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The dataset categorizes newcomers into three groups: those with a national political background, and those with an exclusively local/regional background, and amateurs lacking any political experience. Figure 1.4 paints a clear picture. It depicts a consistent trend among the EP's new members, with the majority of MEPs boasting substantial political experience. From this, I can deduce the following: political professionalism (at both national and local levels) stands out as the prevailing characteristic among all EP newcomers since the inception of direct elections to the EP. The evident predominance of career politicians among EP newcomers suggests that parties and electors have consistently leaned towards professional politicians when forming the Strasbourg delegation. Additionally, the prospect of a supranational career holds significant appeal for career politicians.

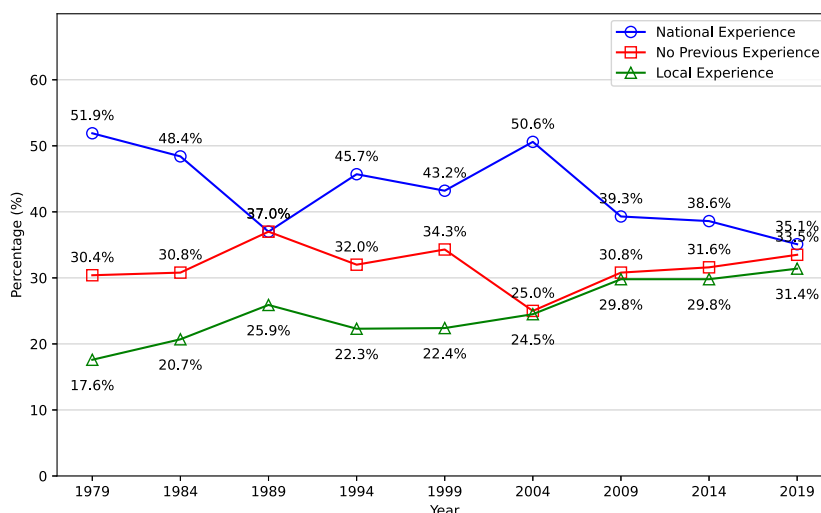


Figure 1.4: Distribution of new MEPs (EU at 15).

Note: I added data from [Salvati \(2022\)](#).

If I focus solely on the EU when it had 15 member states, considering the same variables and time span (i.e., before the 2004 and 2007 rounds of EU enlargement), the scenario takes a notable turn. Here, the significance of professionals with local-level backgrounds shows a significant surge, accounting for nearly a third of all new entrants between 2009 and 2019. This implies that examining the data in a disaggregated manner may yield a more intricate and dependable depiction.

1.4 Parliament embedding

The *parliament embedding* is a vector embedding method capturing political parties' ideologies from language use. Introduced by [Rheault and Cochrane \(2020\)](#), it extends word embeddings with political metadata. This means it captures not only the individual words but also the overall semantic meaning of the entire speech. As opposed to the two popular approaches for extracting ideology from texts – WordScores ([Laver et al. \(2003\)](#)) and WordFish ([Slapin and Proksch \(2008\)](#)) – which rely on word frequencies, word embedding models capture word relations through co-occurrences. This allows researchers to move beyond counts of words taken in isolation and naive dictionary techniques. I demonstrated that when applied to the EU context, this technique effectively captures consistent ideologies and their changes over time.

1.4.1 Vector embedding

Vector embedding is a widely-used technique in NLP for representing documents or concepts in a numerical vector space. It involves learning numerical representations of vectors based on co-occurrence statistics in a given corpus. The vectors, which have a fixed length and consist of real numbers, capture both the semantic and syntactic features of the word or concept. Similar to word embedding, vector embedding also relies on predicting a target word based on its context words using a shallow neural network with latent variables.

The core idea behind vector embedding is to preserve the relationships between words in a high-dimensional space. Highly correlated words (due to their co-occurrences) should exhibit similar correlation in this vector space. This is achieved by identifying a set of coordinates, known as the parameters of the word vectors, that determine the angles formed between the vectors. By capturing these angles, vector embeddings effectively identify and establish connections between textual elements.

One remarkable aspect of vector embedding, as word embedding, is the ability to perform algebraic operations on the vectors. The classic example is the equation $Queen = King - Man + Woman$, which demonstrates the capability to manipulate and reason with the vector representations.

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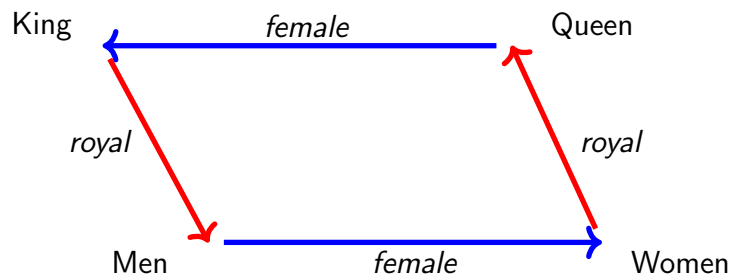


Figure 1.5: Illustration of linear word analogies of *words embedding*.
Note: A convenient property of word vectors is that word analogies can often be solved with vector arithmetic. Here is the most famously example.

In the context of vector embedding algorithms, semantic relatedness refers to the occurrence of vectors in similar contexts. The principle of "You shall know an object by the company it keeps" (Firth (1957)) guides the learning process. For instance, when considering the sentence "I was to learn that I had won reelection," words like "happy" and "joyful" would fit well in this context, while "econometrics" would not. A vector embedding algorithm learns the locations of vectors that best complete sentences.

To learn vector representations for objects in the vocabulary, I employ the *Doc2Vec* algorithm (Mikolov et al. (2013); Pennington et al. (2014)) applied to the entire corpus. The implementation uses Python's gensim library with three-hundred-dimensional vectors, an eight-object context window, and training for ten epochs. These choices align with standard hyperparameters commonly used in applied NLP. Rodriguez and Spirling (2022) and Ash and H. (2017) have demonstrated the robustness of vector embeddings to variations in these choices.

To sum up, an important difference with word embedding is that in my implementation I use indicator variables to measure the party affiliation of MEPs when they give speeches. By including these variables, I capture the influence of this affiliation on language use. The expanded model can be described as follows: I use a function to combine the context words and the metadata variables, represented by vectors, to generate a hidden representation. This hidden representation captures the interactions between the metadata and the context words. The dimension of this hidden representation determines the size of the estimated parameters for each party, which I call "parliament embeddings". Instead of estimating a single point for each party, I estimate a vector of

parameters, allowing me to compare party embeddings with the rest of the vocabulary in a common vector space. This facilitates the analysis and comparison of party positions.

I use party-year pairs as indicator variables. This approach enables to capture the dynamic nature of ideological positions over time, as language and issues discussed by parties may change across different periods. Parties are allowed to "move" within the vector space, reflecting their ideological shifts.

1.4.2 Assessing distances

With the vector representations of MEPs' speeches for a given session, denoted as ζ , I can measure the language similarity between two MEPs i and j by calculating the Euclidean distance $d_{i,j}$ between their corresponding vectors ζ_i and ζ_j . These vectors, normalized and placed in an M -dimensional space, represent their embedded political speech. ζ_{im} and ζ_{jm} are the m -th components of the vectors for MEPs i and j , respectively. A smaller Euclidean distance means greater language similarity within a given session. The distance is computed using the *Doc2Vec* training process, and is expressed as:

$$d_{i,j} = \sqrt{\sum_{m=1}^M (\zeta_{im} - \zeta_{jm})^2}$$

The Euclidean distance measure is widely used in linguistics and data mining due to its computational efficiency (Sebastiani (2002)).¹³ Economists have also started adopting this measure (Hoberg and Phillips (2016)). In this context, the measures are validated by examining whether pairs of MEPs sharing common characteristics (such as belonging to the same political group or coming from the same member state) exhibit lower Euclidean distance compared to pairs without these shared characteristics.

1.4.3 Quantifying ideological convergence

Thanks to my representation of speeches in embeddings, I can easily measure ideological convergence between political sets. For example, if I want to measure the distance between EPGs over time, I label each speech by its corresponding EPG before training.

¹³Another widely used measure is *cosine similarity*. Euclidean distance and *cosine similarity* become proportional when the vectors are normalized. A demonstration can be found [here](#).

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Once the model trained I can compute the Euclidean distance for each point in time. These analyses assess coherence in both the subject matters and the language employed between EPGs.

To illustrate that it can represent political ideology, let us extract the principal components from the vectors of a *Doc2vec* applied to all the corpora. As long as ideology is the main dimension along which political actors differ in terms of semantics, I can interpret the vectors as estimates of ideological placement.¹⁴ Figure 1.6 plots the party embeddings in a two-dimensional space for the EP. Each model includes party-year indicator variables as well as separate dummy variables for year, which account for temporal change in the discourse (e.g. $\zeta_{Soc2011}$ abbreviate S&D EPG for year 2011). *Doc2vec* captures ideological as shown on the graph. The first component can be interpreted as the pro/anti dimension, and component 2 to the traditional left/right cleavage. The socialists are on the right and upper part of the graph with a first shift toward a more nuanced support on EU and a second one more progressive. While both major parties were initially close to the center of the first and second dimensions, they gradually diverge. This aligns with the observed rise in global partisanship. Unsurprisingly, the far-right is anti-integration and leans towards the right on the political spectrum.

Table 1.7 reports the expressions with the highest and lowest correlation coefficients for the EU plenary speeches. As can be seen, the first dimension (x-axis) is positively correlated with terms like "border", "referendum", "austerity", and "anti-", which perfectly represent the anti-EU rhetoric. The second dimension (y-axis) is negatively correlated with expressions such as "social," "parliament", and "budget", these words refer to topics one would expect in the language of liberal (or left-wing) parties in Europe. Conversely, issues like "commission," "migrant," the "poor," and the "bureaucracies" are associated with the conservative. Consistent with expectations, the figure suggests that the Pro-EU parties are located on the right, and the liberal parties are located on the upper side of the projection.

¹⁴The goal is to map the party embeddings, originally in an M -dimensional space, into a vector space that holds substantive meaning. Party embeddings can be modelised in a two-dimensional space using dimensionality reduction techniques like PCA. This technics identifies the one-dimensional component that maximizes variance among the party embedding vectors. The subsequent component is determined in a similar manner, while ensuring zero covariance with the first component.

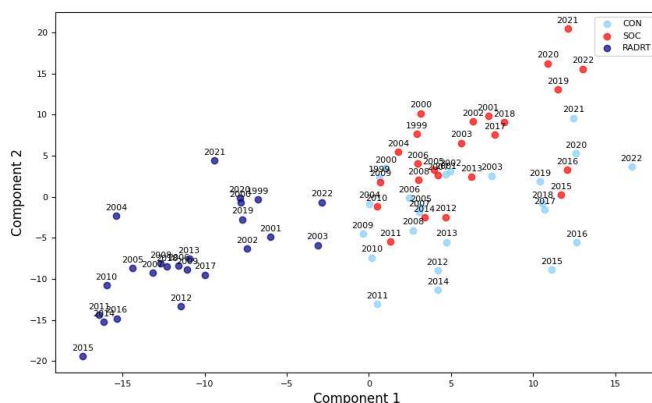


Figure 1.6: Party placement using unguided projection in the European Parliament.

Note: The figure displays the two primary components of party embeddings for the EP (1999-2022). "CON" stands for conservatives, "SOC" for socialists, and "RADRT" for far-right, as per the Chapel Hill Classification.

1.5 Results

After 40 years of EP elections, political convergence can be analyzed through three different scales, yielding these observations. The decades of European integration have not led to an ideological convergence between member states (1.5.1). However, a convergence within the European political groups occurred. While EPGs were heterogeneous groups in the early 2000s, they have become internally more and more

Component	Orientation	Words/Phrases with Highest Correlation
First	Positive (Pro-EU)	schengen, rights, integration, multi-, solidarity, responsibility unit, digitisation, justice, sovereign
	Negative (Anti-EU)	border, withdrawal, referendum, austerity, control, dissent, crisis, autonomy, anti-, dissatisfaction
Second	Positive (Left)	disabled, lgbt, poor, elderly, decent, consumer, bargaining, deepest, handicapped, wealthiest,
	Negative (Right)	decentralization, centralized, identity, heritage, mentioned earlier, governmentrun, bureaucracies, feed, bureaucratic,

Table 1.7: Interpreting PCA axes with word correlations.

coherent, which has led them to drift apart from each other (1.5.2). While all national parties are becoming closer to their EPG than their member states. Yet, on average they are still closer to their countries (1.5.3).

1.5.1 Absence of between member states convergence

Overall, European ideological coherence has decreased since 1999. If Europe experienced a fairly significant convergence before 2012 and after 2016, the divergence was so pronounced in-between that, overall, member states are less ideologically aligned today than in the early 2000s (Figure 1.8). The divergence mainly results from both the expansion into eastern Europe and the crisis from 2012 to 2016.¹⁵ Moreover after Eastern Europe joined, the variance of the sample increased significantly, confirming substantial heterogeneity in the newer countries.

Before 2012, Europe experienced a substantial convergence in ideology. The average ideological distance across countries was approximately 15.61 with my standardized measures in 2004. The average ideological distance between two randomly selected countries decreased by about 10% over the period 2004-2012 (0.16 units per year Figure 1.A.3). Between 2017 and 2022, the trend continued, albeit at a slightly slower pace (0.11 units per year, with an initial value of 19.24). This indicates that without crisis there is still a continuing trend towards ideological convergence, although it is progressing at a slightly slower pace compared to the earlier period. However, between 2013-2016 ideological divergence has increased by 69% making EU diverged overall.

While eastern and western Europe maintained the same ideological distance before the 2013-2016 crisis (2.5 units of my standardized metric), certain states in the eastern bloc diverged from each other after this crisis, particularly after the 2019 elections. Today, a country from one of these member states does not show a closer similarity to any other country from western Europe than they did in 2004 when they joined. EU integration has neither led to any ideological convergence between the West and

¹⁵Throughout this paper, I group the 28 member states in my sample into four broad and non exclusive regional categories: North/South and East/West. The West is composed of South and North. The North, comprises Denmark, Finland, Iceland, Ireland, Norway, Sweden, Austria, Belgium Germany, the Netherlands and the United Kingdom. The South includes Cyprus, Greece, Italy, Portugal, France and Spain. The East (the former post-soviet transition countries) is composed of Bulgaria, the Czech Republic, Croatia, Estonia, Hungary, Latvia, Lithuania, Poland, Romania, Slovakia, and Slovenia.

the East nor within the eastern countries themselves. On the contrary, the arrival of eastern European countries has marred the integration process of western European countries. Western European countries were more likely to share ideological similarities in 2004, after years of convergence, than they are today.

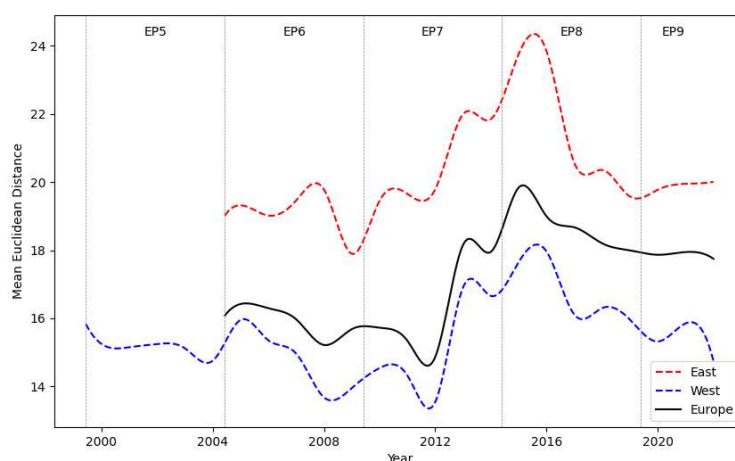


Figure 1.8: Ideological coherence between countries over EU over time.

Note: This figure illustrates the ideological coherence of Europe as a whole (black line), Western Europe (blue line), and Eastern Europe (red line). Ideological coherence is calculated by averaging pairwise Euclidean distances between country embeddings, weighted by the number of their representatives in the EP.

Western Europe has experienced only marginal convergence over the period 1999-2022, even though it experienced two periods of convergence: firstly, between 1999 and 2012, and then again from 2017 to 2022. The western pace of convergence was almost three times faster after 2018 compared to the initial period. However, due to the divergence experienced when the eastern countries joined and then during the 2012-2016 crisis, western EU is not more homogeneous today than it was in 1999 (Figure 1.8). The north and south of western EU have drifted apart over the period. While northern member states have become more internally coherent, the same cannot be said for southern European countries, resulting in increased cross-country difference. During the first period, before the 2008 crisis, northern and southern EU countries both experienced increased coherence, but the northern countries did so at a faster pace than their southern counterparts. As a result, cross-country disparities widened. To some

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extent this first sub-result aligns with one major finding of [Alesina et al. \(2017\)](#), that northern and southern EU before the 2008 crisis converge in institutional and cultural trends. Then southern Europe started to diverge, driving the whole western divergence. Northern EU continued to converge over the period, albeit at different rates, while southern Europe, after experiencing a phase of convergence as rapid as the north's, has been experiencing a strong divergence since the sovereign debt crisis that plunged Southern Europe into a deep recession (notably Greece, Italy, and Portugal), which has become so pronounced since 2014 that it surpasses the convergence movement of the North (Figure 1.9). I also observe that northern Europe has experienced a twice faster convergence than the southern part, despite starting from a higher initial level of proximity. The convergence path of the North appears to have been almost unaffected by the 2012-2016 crisis – the Brexit did not create divergence between them. Unlike the northern countries, there are separatist parties in southern Europe that have seized upon Brexit to assert their claims.

This result reaffirms previously documented findings that the EU has effectively incorporated the "periphery" countries of the south into the European model ([Raiser and G. \(2012\)](#)). Nevertheless, the economic crisis brought to light inadequacies in the architecture of EU economic and political institutions. EU citizens seem discontented with both politicians and institutions. This not only fuels but also is bolstered by the surge of political extremism ([Algan et al. \(2017\)](#)).

During the EU debt crisis, when I focus on what has been called the PIGS (Portugal, Ireland, Greece, and Spain) – countries most affected by the crisis – I found that they are the ones with the highest level of within-country divergence at that time. This is reflected in the conditional analysis by economic-related topics (Figure 1.14). The variation can be explain by the disparities in unemployment dynamics ([Algan et al. \(2017\)](#)). Following a brief surge in 2008–09, Germany saw a return to pre-crisis unemployment levels, while Greece and Spain experienced rates surpassing 20 percent.¹⁶

¹⁶In certain cases, the increase in unemployment can lead to a rise in support for far-left parties, exemplified by the emergence of Podemos in Spain. Conversely, it can also strengthen far-right nationalist and xenophobic parties, as observed in Hungary and the Netherlands. At times, escalating unemployment engenders backing for both radical-left and ultra-right nationalistic parties that are increasingly cooperating, exemplified by the coalition between Syriza and the Independent Greeks.

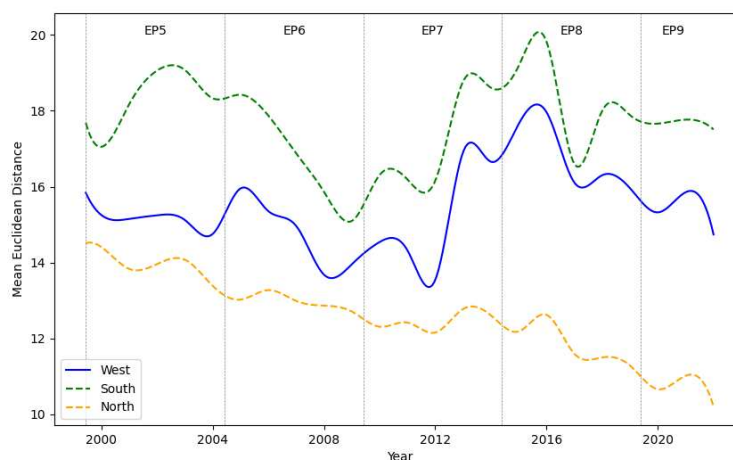


Figure 1.9: Ideological coherence between countries over Western EU over time.

Note: This figure illustrates the ideological coherence of Western Europe (blue line), Southern Europe (green dashed line) and Northern Europe (yellow dashed line). Ideological coherence is calculated by averaging pairwise Euclidean distances between country embeddings, weighted by the number of their representatives in the EP.

Trade integration can explain part of this difference. Because it changes relative prices and the structures of production, it leads some member states to specialize in different sectors (Krugman (2001)). This can destabilize certain communities, both economically and culturally (Olivier et al. (2008)), which can result in antagonizing public opinions, increase conflicts (Feldstein (1997)), and possibly helped new parties to win elections. The single currency reinforced this tendency, because it led to exchange rate appreciation in southern Europe, pushing more resources in the non-tradable sectors. These changes, in turn, could have altered political incentives in opposite directions in these two groups of countries.¹⁷

Eastern member states, have neither converged with the West nor between themselves since their integration in 2004. Today, an MEP from one of the eastern states does not speak more like other MEPs from western Europe than in 2004, when they joined the Union. Although the integration of eastern European countries

¹⁷A paper by Calligaris et al. (2016) suggests that a comparable phenomenon might have occurred within countries. For example, in Italy, the introduction of the common currency exacerbated the gap between modern sectors and firms that capitalized on European integration, and those that lagged behind. See also Gopinath et al. (2015).

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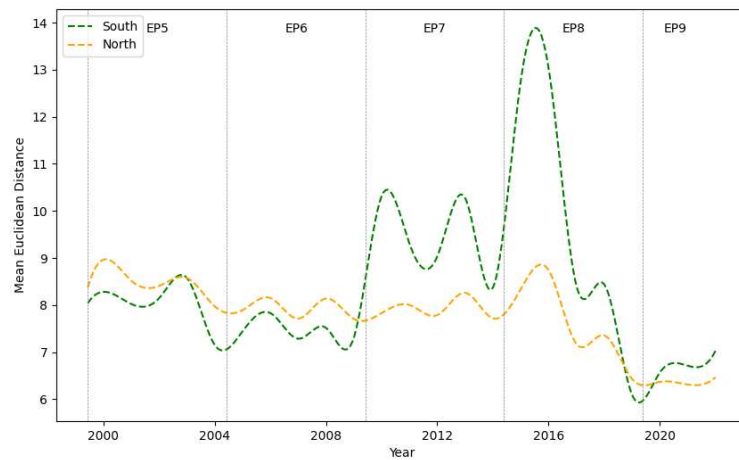


Figure 1.10: Ideological coherence within country over Western EU over time.

Note: This figure illustrates the ideological coherence of Southern Europe (green dashed line) and Northern Europe (yellow dashed line). Ideological coherence is calculated by averaging pairwise Euclidean distances between MEPs' embeddings, weighted by their representation in terms of the number of MEPs in the EP.

has led to convergence in terms of GDP *per capita* (Kutan and Yigit (2009)), to greater trade integration (Gil-Pareja et al. (2008)), more financial integration (Jappelli and Pagano (2010)), and more labour mobility (Portes (2015)), it has neither been accompanied by a political ideology convergence with the rest of Europe nor between themselves. Almost 20 years after their integration, they remain political outliers in the EU ideological landscape. This divide has been exacerbated with the rise of populist leaders who appear inclined to pursue their own paths. This is even more surprising considering the initially high level of difference, and the widespread expectation that these new member would converge.

The EP representatives, however, have converged on topics related to sovereignty, wishing to expand the EP's its prerogatives. When I divide the sample into different topics (see Appendix 1.G) and re-run my convergence analyses, I find that the East and the West, and thus the EU as a whole, have converged on more sovereign topics that are not normally within the Union scope, such as defense and security, justice, or foreign affairs regarding migrants, for example. This demonstrates a desire from all sides to see an expansion of the parliament's prerogatives. This is

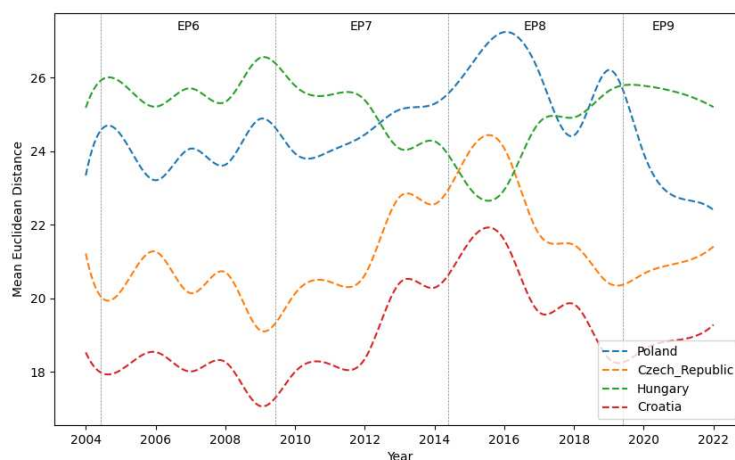


Figure 1.11: Ideological coherence between eastern member states over time.

Note: This figure illustrates the ideological coherence between some eastern Europe countries: Poland (blue dashed line), Croatia (red dashed line), Czech Republic (orange dashed line) and Hungary (green dashed line). Ideological coherence is calculated by averaging pairwise Euclidean distances between all eastern Europe countries embeddings, weighted by the number of their representatives in the EP.

also reflected in the evolution of proposed topics: less time on procedures, more on areas beyond the usual scope. When subdividing by party, these sovereign topics are less polarized. Overall, countries are more aligned on this issue today than before. The significant increase in Euclidean distance for economic topics demonstrates that, before the 2008 crisis, economic issues were mainly based on a left-right dimension in which the conflict centered on the degree of market regulation - and thus divided countries symmetrically. The eurozone crisis, and the sovereign debts elements in particular, mean that EU decision-making has increasingly been about strengthening EU powers, such as budgetary surveillance and rules on national budgets deficits. This has revealed significant differences in each member state's vision. It echoes a finding by [Otjes and van der Veer \(2016\)](#) which showed that, particularly for votes on economic issues, MEPs' positions on EU integration have become better predictors of their roll-call votes.

One must not ignore the effect that the single currency in the Eurozone has had on the correlation of economic shocks (e.g. of a monetary nature), also necessitating policy coordination ([Krugman \(2001\)](#)). This is undoubtedly the cause of the convergence of thinking about economic policies. It has also reinforced political similarities, with

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national media and public debates devoting more attention to common European issues and policies. Even though one can see that economic policy greatly divided the Union during the debt crisis, today, countries seem to have converged. Although the West has not yet regained its pre-crisis level of coherence, the East has, to some extent, drawn closer to the West and has become more internally coherent. So, this moderates my previous analysis. If the East is not yet as close to the rest of Europe, it is because new divisive topics have emerged for them, such as environment or governance, for example.

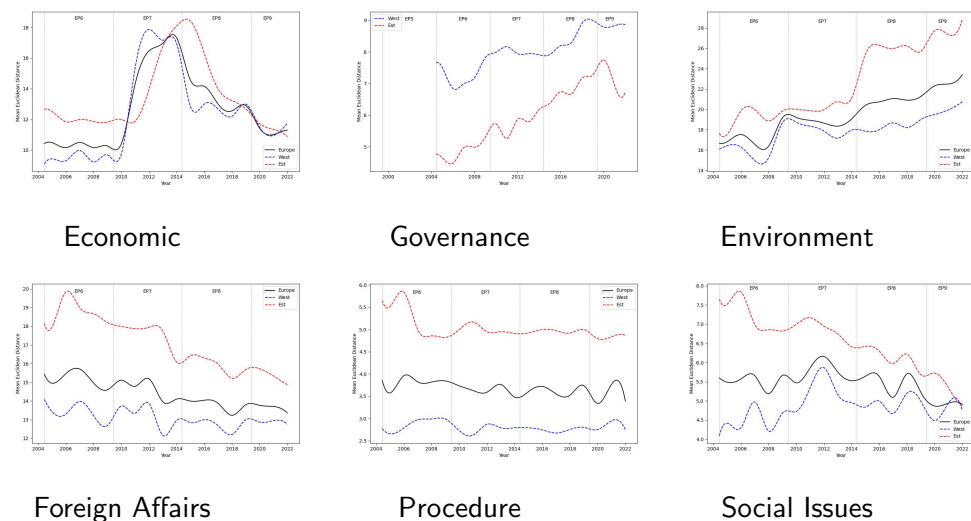


Figure 1.12: Ideological coherence between member states on certain topics over time.

Note: These figures illustrate the ideological coherence on each topic in the EU as a whole (black line), Western Europe (blue line), and Eastern Europe (red line). In each LDA classification subsample, ideological coherence is calculated by averaging pairwise Euclidean distances between country embeddings, weighted by the numbers of their representatives in the EP.

1.5.2 Intra-EPG growing cohesion, inter-EPG distinction

While EPGs were heterogeneous groups in the early 2000s, they have become increasingly coherent. National political parties with the same ideology have successfully created increasingly clear ideological platforms: the European political groups. By finding points of convergence to advance their ideas, they sought to become coherent and have thus differentiated their political group from one another along

distinct ideological lines. European political groups tend to adopt a more cohesive ideology as the EU progresses in its integration. In the early 2000s, a national party was more likely to speak like any party from its member state, rather than like a national party supporting the same ideology in the same group but coming from another state. However, over time, national parties have begun to speak more and more like other national parties sharing their ideology, creating a broad and cohesive ideological coalition in the EPG. This convergence appears to have accelerated after the 2012 debt crisis, albeit some fluctuation, even divergence, with the 2005 and 2012 referendum. In contrast to the period up until 2012, where there were greater differences within each EPG than between them, since 2014 the opposite has been true, leading to a complete reversal in the ideological gaps.

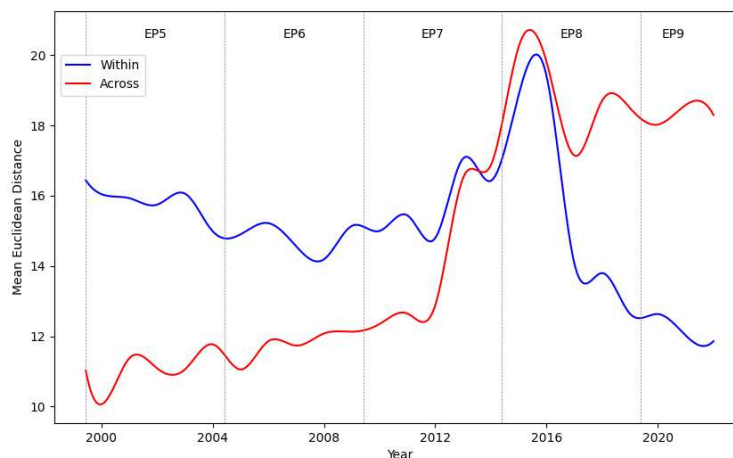


Figure 1.13: Ideological coherence between and within EPGs over time.

Note: This figure compares the ideological coherence within (blue line) and between (red line) EPGs. Within (resp. between) ideological coherence is calculated by averaging pairwise Euclidean distances between country (resp. EPGs) embeddings belonging to the same EPG, weighted by the number of their representatives in the EP.

This initial phase, quite surprisingly, indicated that each EPG aggregated very diverse set of ideas. However, as shown below, these ideas have continuously moved closer together. As they converged, they differentiated themselves from the ideas of others EPGs.

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This 25% decrease reveals the gradual alignment in ideology inside the different European political groups, parallel to the evolving dynamics of integration and cooperation across the EU. This trend was most pronounced among the European Greens (23% convergence), the Radical Left (although due to a numerical effect), and the Radical Right (28%).¹⁸ The latter figure for the Radical-right EPG is particularly remarkable, given that the number of MEPs in this group more than quadrupled over the period,¹⁹ and this increase was accompanied by tighter discipline in roll-call votes. It is worth noting that newly elected MEPs seem more aligned with the ideology of their EPG than with their agendas at national level (1.C).

Also, members of this EPG are even more coherent when discussing matters related to national sovereignty and topics that, in their view, should not fall under the Union's jurisdiction. This demonstrates a surprising coherence among these MEPs from different member states. However, it does not mean that they support further integration of the EU. On the contrary, when I look at far-right MEPs, I see a high level of shared demands, but they focus on issues specific to their member states rather than on broader European integration.

As the EU expanded, and as economic and political integration deepened, it became increasingly necessary to coordinate policies at the EU level (Spolaore (2013) and Eichengreen (2012)). The rise in power of the European Parliament with increased legislative prerogatives (see Section 1.F), prompted European political groups to develop more coherent and coordinated positions to function effectively. In addition to this, the experience gained from decades of working together mechanically aligns members of the same EPG in how they discuss various subjects. Bigger groups are more cohesive

¹⁸Democrats/conservatives (EPP) and the Socialists (S&D) are the two traditional political groups of the EP, but their seat shares have declined over time. The Liberals (ALDE) have a smaller seat share but have often been pivotal in votes and coalitions due to their centrist position. The Radical Left (GUE/NGL) includes communist or former communist parties and extreme left parties. The Greens (G/EFA) are pro-environment parties allied with some regionalist parties. Outside these five groups, other groups have been unstable. They gather mostly nationalist and/or anti-European parties to the right of the EPP. Since the seventh session of the European Parliament (EP7), the British Conservatives have broken away from the EPP to form a separate party group called European Conservatives and Reformists (ECR). Appendix 1.B.2 and 1.A.12.

¹⁹In the 2019 EP elections, over 28% of elected MEPs were eurosceptic, a proportion similar to 2014 but higher than 2009. However, the composition shifted towards more radical right representatives. The Identity and Democracy group, consisting of hard-right parties, became the fifth-largest political group, absorbing some 'soft' eurosceptic parties such that the ECR group (Treib (2021)).

than smaller ones, and cohesion has increased as these groups have become ever larger (S. Hix and Roland (2006)). Although larger groups can allow for more specialization and division of labour, which aids cohesion, Bailer (2018) shows that some party leaders are indeed more able to unite their groups in roll-call votes than others.

It should be noted that drawing closer to one ideology does not automatically lead to a distancing from the other. A national party may align itself more closely with both the ideology of its EPG and with the rest of the MEPs from its country, who belong to other groups. This can occur for two reasons: between two legislatures it might be because a broader proposition from one party is now more represented, causing the entire country to move closer to the EPGs to which the over-represented party belongs. Secondly, during a legislature, it might be because the other parties in the country are moving closer to the ideology of the given EPGs. This happened with Luxembourg and Belgium, both of which moved closer to the EPP during a legislature.

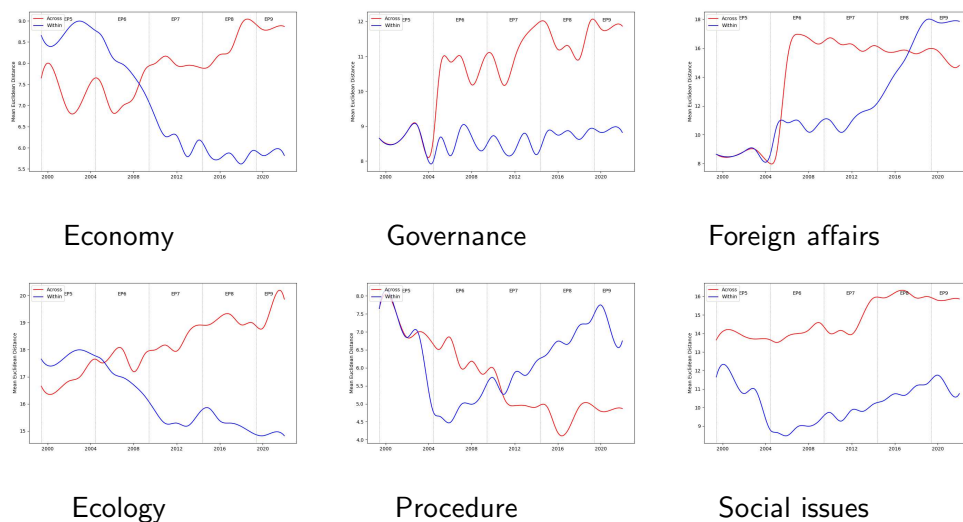


Figure 1.14: Ideological coherence between EPGs over EU across topics over time.

Note: These figures illustrate the ideological coherence within (blue line) and across (red line) EPGs. In each LDA classification subsample, ideological coherence is calculated by averaging pairwise Euclidean distances of EPGs embeddings, weighted by the number of their representatives in the EP.

Interestingly, it is not so much the way of speaking that has allowed different national parties to become closer to each other in their EPG, but rather the number of topics they share. This difference is relevant, as it is easy to think that the way of

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speaking might mechanically increase as MEPs interact within European institutions.²⁰ Sharing the same concerns matters more. It reveals a certain ideological convergence, creating common values. I demonstrate that, for all national parties, the scale of sharing topics became less and less national and more and more European. While EPGs were heterogeneous groups in the early 2000s, they have become increasingly coherent. It logically follows that differences between EPGs have simultaneously been accentuated.

Increased coherence within EPGs creates distinct blocks. Between the EPGs, coherence is becoming more important. The process of integrating ideologies within them comes at the expense of proximity between ideologies. For instance, in the early 2000s, two MEPs from two different EPGs had an average Euclidean distance of 10 units, whereas today it has almost doubled to 18 units (Figure 1.13). Over time, ideologies have begun to clarify the EPG line, making it easier to adhere to and therefore to join, consequently becoming more differentiating than the others. This has led to the creation of a broad and cohesive ideological coalition within the EPG.

These changes in the structure of the EPG indicate an increased politicization of EU integration. Conflicts between those who oppose the process and those who advocate further progress have become more pronounced. Paradoxically they are leading to a pan-Europeanization of relations, even for eurosceptic parties (Hutter and Grande (2008)). Liesbet and Gary (2018) argue that this politicisation has affected the structure of political conflicts in EU member states through the emergence of new transnational cleavages and regarding changes to economic and socio-cultural divides. Hutter and H. (2016) argue that it reflects tensions between winners and losers of the globalisation process.

To me, lesser coherence between EPGs is less concerning because it is accompanied by a greater convergence within each EPG. Thus, I argue that this new partisanship allows, in a way, to empower EPGs. They are legitimate, as they are coherent, to speak on behalf of certain groups and consequently to ultimately shape decisions and party lines for this ideology that goes beyond the aggregation of national party lines within this ideological framework. This is observed through my *identification metric* (Appendix 1.C) which demonstrates that in addition to the coherence change, captured so far, there is also a shift in the claimed affiliation by MEPs. They have increased their

²⁰See Chapter 2 for a more nuanced analysis of peer effects in the European Parliament.

sense of belonging to their EPG rather than to their country by 33% since 1999 (this is manifested, for example, by the fact that they speak more on behalf of the EPG than the country, with phrases like: "in line with the Greens EPG," thanks to my party.)

All in all, I argue that European interest took over national unity for national parties. They no longer put forward different claims according to their own national interest, they are aligning with the EPG line.

1.5.3 National parties are still closer to their member states than to their political ideology.

All national parties are becoming closer to their EPGs than to their countries. Since 2012, there has been a convergence of national political parties towards their EPGs (Figure 1.15). National parties are aligning more closely with their respective EPGs (blue curve), while simultaneously distancing themselves from the broader political landscape within their countries (red curve).

From 1999 to the early 2010s, EU partisanship decreased. This resulted in each MEP being less inclined towards European integration: in EP5, the cosine similarity between a national party and its EPG decreased from 0.60 to 0.48. Simultaneously, the similarity between a national party and the rest of their country also decreased, indicating a strengthening of national party identity. While coherence with the country of origin continued to decrease, national parties started to identify more strongly with their respective EPGs. In 2022, national parties were, on average, as close to their EPGs as they were to their member states, with a cosine similarity of around 0.63 units.

The emergence of various transnational ideologies in which MEPs are integrated is demonstrated by a simple metric: the increase in cosine similarity between the vector representation of a national political party's speeches and those of the EPG to which it belongs. Meanwhile, the distance to the embedding that represents the speeches of the rest of the MEPs from its member state decreases. To sum up, if I take the example of the French socialists, I can say that over time, they are moving closer to the non-French European socialists and further away from the non-socialist French MEPs – and this is true on average for all European socialist parties (Figure 1.16)

Combining these two evolution's, a striking long-term transformation in the structure of European political cleavages is emerging. Until the early 2010s, EU party systems

1 United in Diversity?

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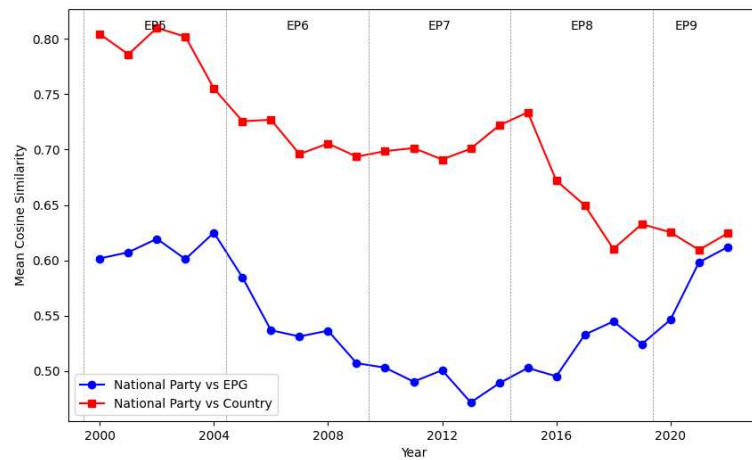


Figure 1.15: Nationals ideological convergence within country and between EPGs.

Reading: the ideology proximity between any national political party was on average 0.6 in 2000 drop to 0.58 in 2012 to grow up to 0.63 in 2022. *Note:* This figure compare the evolution of national party ideological proximity with their EPG (blue line) and their country (red line). Ideological proximity is calculated on one hand by averaging pairwise cosinus similarity between national party embeddings and their country and on the other hand between national party embeddings and their EPG, all weighted by the number of their representatives in the EP.

were "national", in the sense that national parties were closer to their countries than to their EPGs. These party systems have gradually evolved towards an "ideology-based" system, in which the national party identifies more with the EPG than with the country.

It is not just a weakening of coherence within countries; there is indeed a shift from national parties towards EP groups, indicating a desire to ideologize the European debate. Furthermore, these results support that there is often as much or even more divide within each member state than between them (Alesina et al. (2017)). This is not true for political elites, and it provides a contrasting view of the dynamics at play with citizens, trust and institutions.

In other words, if I were to characterize a speech affiliation by how easily a reader can deduce the party or nationality of the speaker solely from their themes and choice of words: the greater the difference in cosine similarity, the easier it will be to do so. This corresponds to an increase in Euclidean distance and, for some, signifies polarization.

Until the 2010s, it was straightforward to identify the member state of origin of a national party, but difficult to associate a political inclination with it. Today, it is easier to say what ideology they reflect, but almost impossible to say which country they are from.

Some national parties are closer to their EPG than their member state.

Firstly, I observe that both Right and Left established ideologies are decreasing in consensus within their countries of origin (as indicated by the red curve). Their ideologies are becoming less and less aligned with those of their respective countries.²¹

Secondly, I observe that both the Left and the Green national parties have, on average, shifted closer to their EPG to such an extent that their ideological proximity to their EPGs now surpasses their ties to their home countries (Figure 1.16). This development is not surprising, given that these two parties typically align more closely with trans-national interests. It does not necessarily imply an outright endorsement of EU integration, as that position is often held by the liberals. Rather, they aim to forge compromises that transcend mere party affiliations. While immigration issues were already a part of political discourse in many Western democracies, anti-immigration parties began to gain traction in the late 1970s. Their support has continued to grow steadily since then, averaging around 11% of votes in the past decade (Gethin et al. (2022)). On the other hand, Green parties emerged on the political scene in the 1970s and 1980s and have also experienced consistent progress, garnering an average of 8% of votes in the past decade. It's worth noting that Greens often have a regionalist focus. Both ideologies tend to perform better in European elections compared to national ones.

Thirdly, Figure 1.16 shows that green and anti-establishment parties have witnessed a growing alignment of their ideologies with the broader national sentiment. This indicates an increasing similarity between their policy positions and the prevailing stance of their respective countries. In contrast, both the traditional Left and Right parties have experienced a decline in this alignment, with their policy positions diverging from the broader national sentiment. To me, the increasing support for green parties on the

²¹This phenomenon is part of a broader trend seen in most Western democracies: the rise of multiparty systems has coincided with a substantial realignment of political dynamics (Gethin et al. (2022)). Traditional socialist parties have witnessed a decline in their average vote share, dropping from around 40% to 34% since the end of World War II. Similarly, Christian democratic and conservative parties have experienced a decrease from 38% to 30%.

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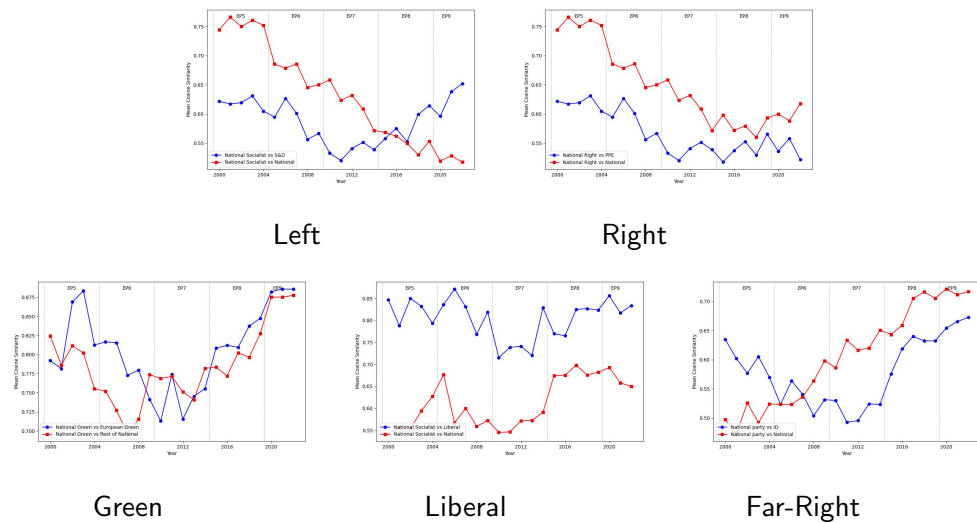


Figure 1.16: National party ideological convergence within country and between EPGs.

Note: For each political group, these figures compare the evolution of national party ideological proximity with their EPG (blue line) and their country (red line). Ideological proximity is calculated on the one hand by averaging pairwise cosinus similarity between national party embeddings and their country, and on the other hand between national party embeddings and their EPG, all weighted by the number of their representatives in the EP.

Left and anti-immigration parties on the Right has clearly contributed to the reversal of the party identification in the EU.²² But while the national Green parties are closer to their EPG than to the rest of their country, this is not the case for the far-right parties, which remain closer to their own country.

1.6 Discussion

To increase agreement among EU member states, one has to foster more cross-border debate. Different views and cultures are not bad *per se*, as long as they are debated; this can sometimes lead to better solutions. Diversity can make systems more resilient

²²The recent surge of populist politicians has been evident, with parties like the Freedom Party in Austria, AfD in Germany, Golden Dawn in Greece, Jobbik in Hungary, the Five Star Movement in Italy, Law and Justice in Poland, the Swedish Democrats, and the U.K. Independence Party making significant gains since 2012. In France, Le Pen's National Front gained prominence in the 2014 European elections and the first round of the 2015 regional elections.

to shocks, while total homogeneity limits advantages from cooperation and risk sharing (Brunnermeier et al. (2016)). This tension arises from the trade-off between the advantages of integration in terms of economies of scale and scope, and the cost of enlargement due to heterogeneity in preferences (Alesina and Spolaore (1997)). Heterogeneity also promotes experimentation; the fact that Finland is trying out a universal basic income, for example, is a useful laboratory test for the whole of the EU. One way to spur debates could be to foster a pan-European platform. Heterogeneity can also make an economic and political systems more resilient, because diversification increases specialization, risk sharing, and, ultimately, cooperation. Differing views, if they foster constructive debates, may lead to better outcomes and solutions. Misunderstandings, conversely, lead to unproductive disagreements.

More theoretically, if I expand the framework of the optimal political area proposed by Alesina et al. (2017), my results may not be a bad thing. Some may argue that the increase in cross-EPG distance reflects polarization. On the contrary, others, like myself, can argue that effective representation at EU level, characterized by the development of coherent European ideologies, and certainly a distancing of EPGs from one another, is crucial for addressing asymmetrical shocks, i.e. shocks that unequally impact all member states. If certain shocks do not affect countries in the same way, due to exogenous elements such as international trade openness, cultural diversity, or geography. For example, when it comes to immigration, countries like Italy or Greece are much more affected than others like Sweden or Finland. Clearly, not all decisions can be taken at national level. As in an optimal currency zone, when it comes to asymmetric shocks (which have a different impact on different countries), decision-making at national level often leads to deadlock, with each country advocating the optimal solution for its own situation. By transferring decision-making to the level of EPGs, made up of MEPs from different member states who share common values and goals, better solutions can be found. For a political arena to be optimal, having decision-making instances that transcend states, such as EPGs level, seem more effective within the EU framework. In this way, EPGs play a vital role in promoting collective decision-making, discouraging policies that prioritize one country at the expense of others.

1.7 Conclusion

In this paper, I used a novel dataset on speeches in the European Parliament to identify the ideological evolution of its members. Specifically, I investigated how speech behaviour reflects an evolution in partisan affiliation.

A striking long-run transformation in the structure of EU political cleavages emerges. My analysis suggests that MEPs shifted whom they identified with, moving from a purely national identity towards a broader EU identity. Until the early 2010s, the party systems in the EP were “national-based,” in the sense that national representatives were closer to the rest of their national colleagues than to the other members of their EPG. This has gradually evolved toward what I propose to call an “ideological-based” system, where national party representatives tend to identify rather with the other members of their European political group, whatever member states they come from. It is particularly the case for the Greens and the Left. This does not necessarily imply support for more EU integration; it rather reflects a growing alignment with their respective European ideological affiliations, effectively becoming their new partisan allegiance in the European Parliament.

One can argue that this is consistent with [Bonomi et al. \(2021\)](#) on cultural identities and the rise of populism as a response to economic and cultural distress. Or that my findings can relate to belief partisanship, where individuals align their beliefs with the typical views of their group, which further fuels societal divisions. This shift leads to group polarization: individuals adopt more extreme positions in line with their group’s distinctive traits.

I argue that all else being equal, the evolving cleavages and therefore their identification in the area of the European Parliament is a positive development. This facilitates a shift in the debate to a pan-EU level, potentially leading to moving away from nationalistic and confrontational stances, towards political debates that foster effective decision-making.

Appendix

1.A Complementary figures

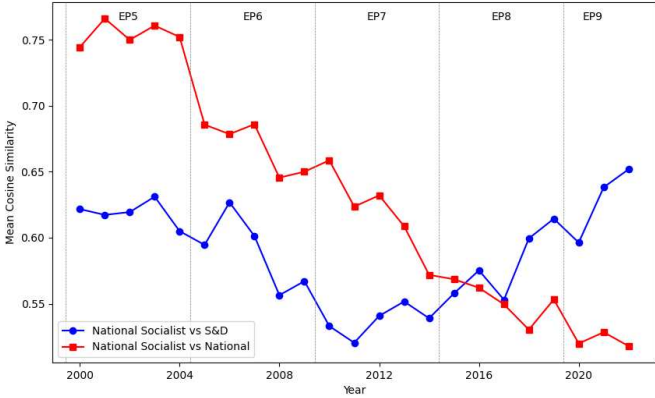


Figure 1.A.1: National Socialist ideological convergence within country and between S&D over time.

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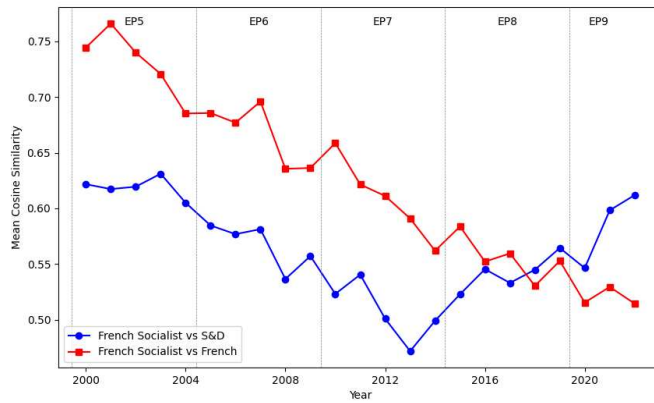


Figure 1.A.2: French Socialist ideological convergence within France and between S&D over time.

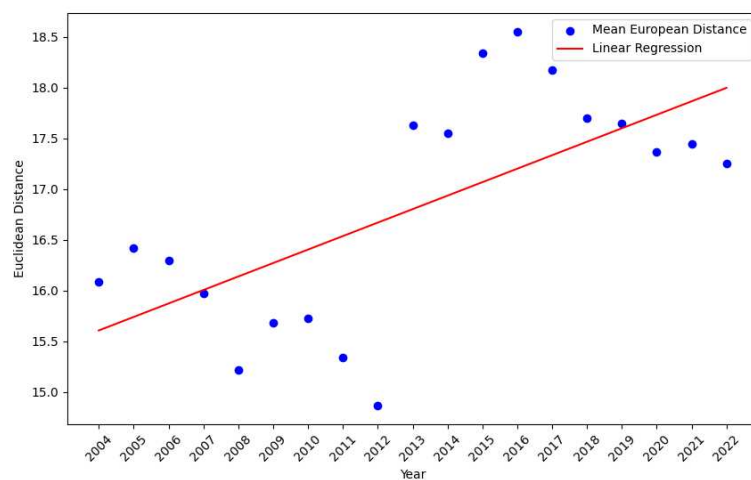


Figure 1.A.3: Linear regression between countries.

Note: Slope: 0.133 / Intercept: 15.608 / R^2 : 0.430

1.A Complementary figures

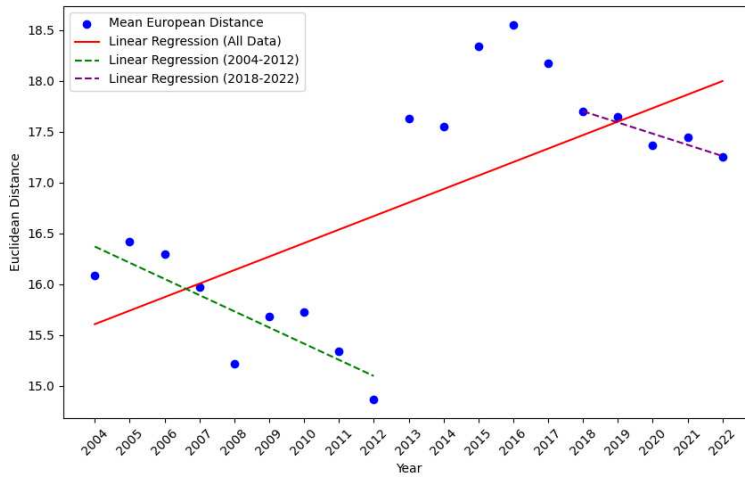


Figure 1.A.4: Linear regression between countries.

Note: Slope: -0.160 / Intercept: 16.371 / R^2 : 0.710

Intercept (2017-2022): -0.110 / Intercept (2018-2022): 19.243 / R^2 : 0.847

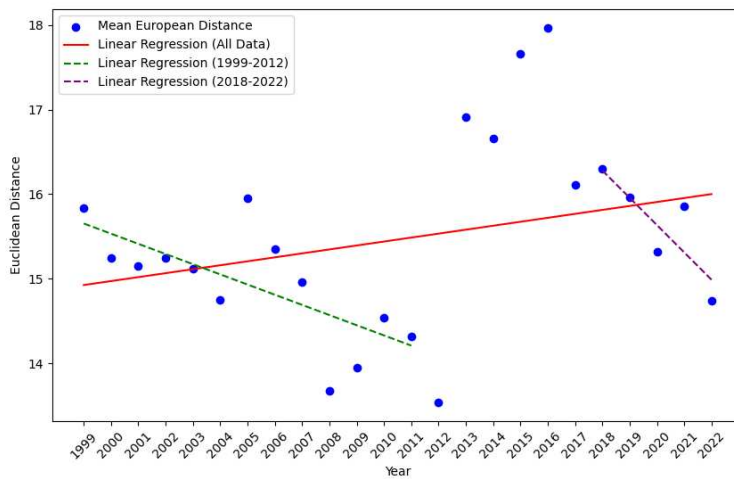


Figure 1.A.5: Linear regression between western countries.

Note: Slope: 0.0466 / Intercept: 14.927 R^2 : 0.085

2004-2012 Slope: -0.1201 / Intercept: 15.654 / R^2 : 0.484

2017-2022 Slope: -0.322 / Intercept: 22.410 / R^2 : 0.696

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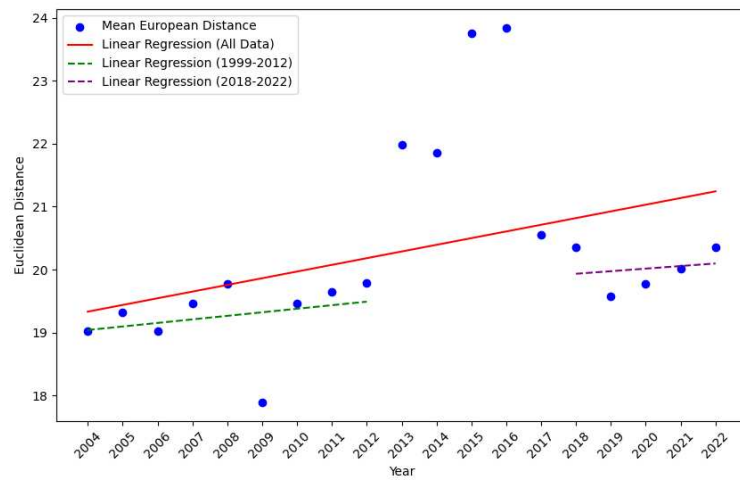


Figure 1.A.6: Linear regression between eastern members.

Note: Slope: 0.1061 / Intercept: 19.332 / R^2 : 0.149

2004-2012 Slope: 0.056 / Intercept: 19.040 / R^2 : 0.068

2017-2022 Slope: 0.041 / Intercept: 19.359 / R^2 : 0.035

1.A Complementary figures

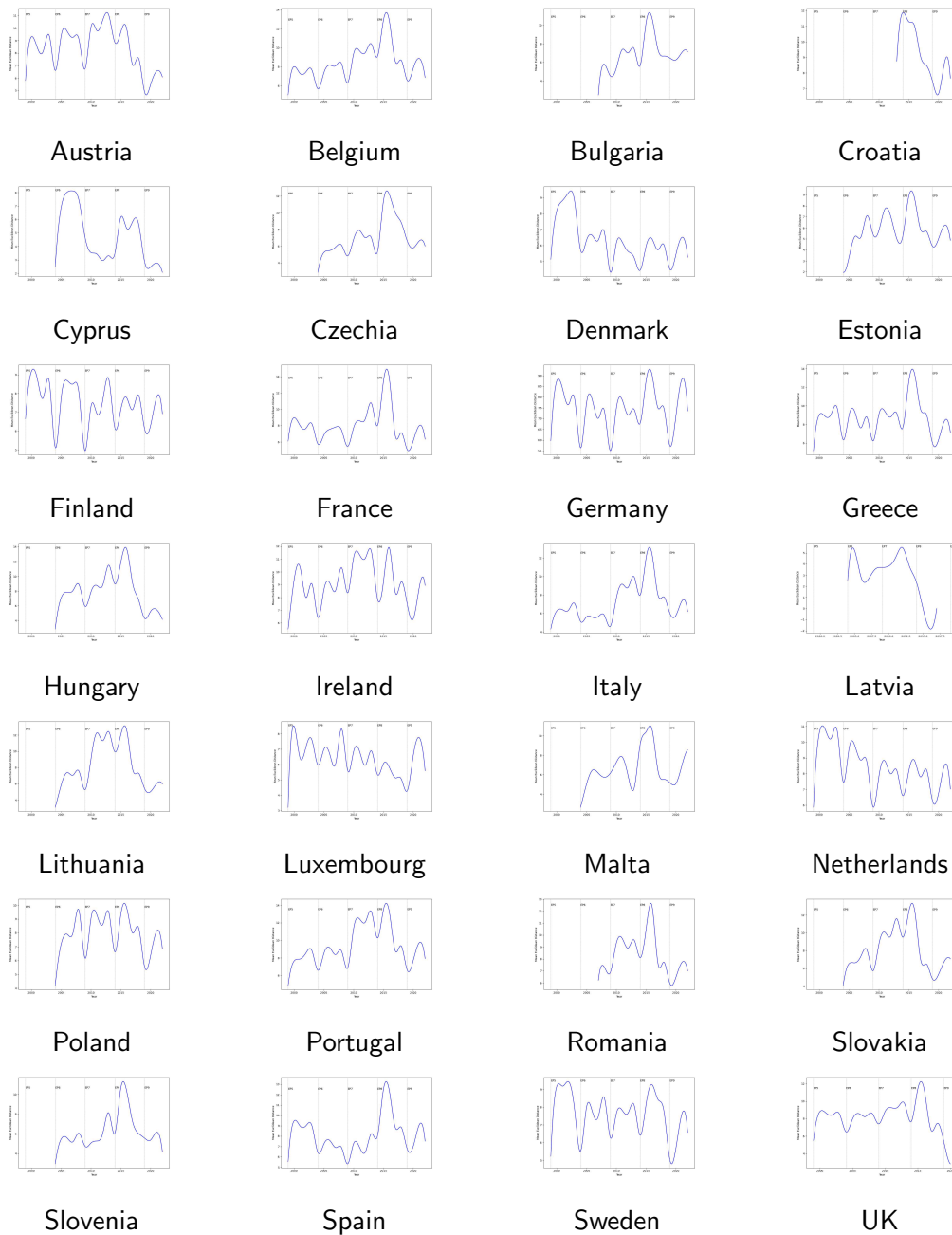


Figure 1.A.7: Ideological coherence within country coherence over time.

Note: These figures show within country political coherence evolution.

Ideological coherence is calculated by doing pairwise Euclidean distances between MEPs' embeddings.

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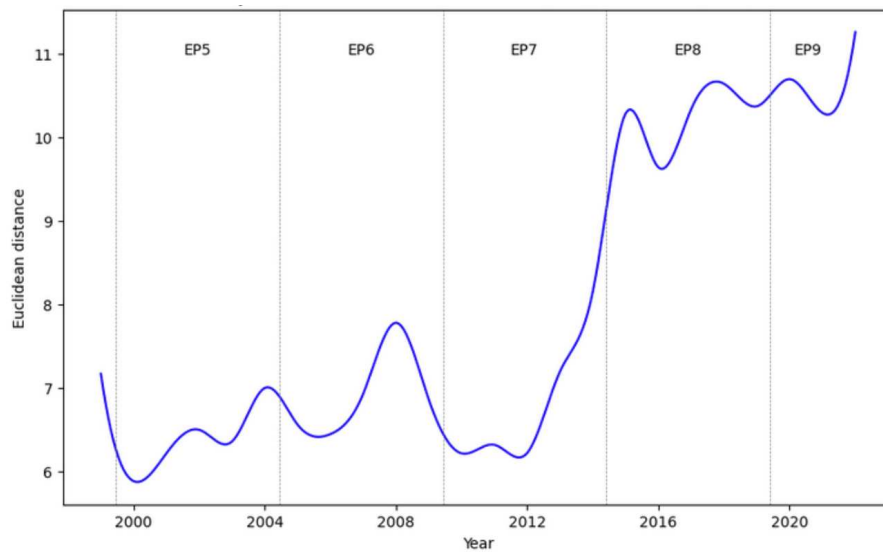


Figure 1.A.8: Polarisation in the European Parliament (Left vs Right).
Note: Measuring Political Polarization using Euclidean distance between the Socialist (ζ_i) and Conservative (ζ_j) party embedding vectors.

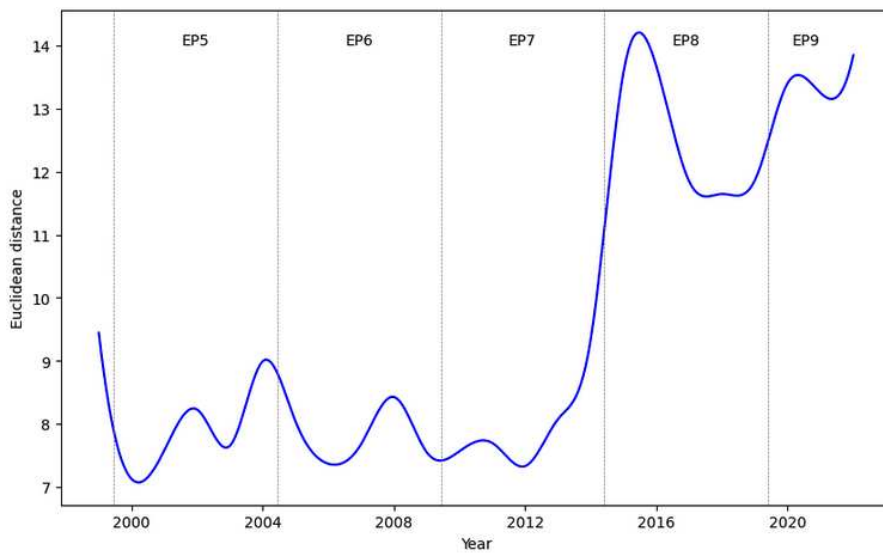


Figure 1.A.9: Polarisation between Left vs extended Right (EPP + Far-Right).
Note: Measuring Political Polarization using Euclidean distance between the Socialist (ζ_i) and Extended Right (ζ_j) party embedding vectors.

1.A Complementary figures

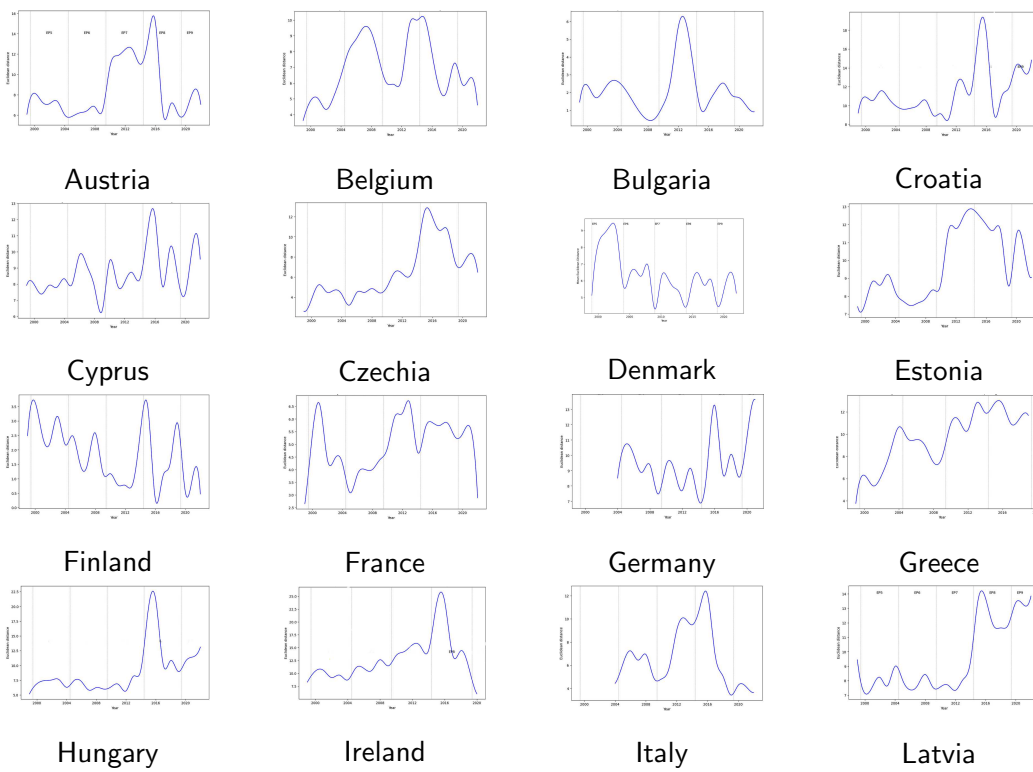


Figure 1.A.10: Polarisation within countries.

Note: These figures show within country political polarisation between left and right. Political Polarization is calculated using Euclidean distance between the Socialist and Right party embedding vectors for each country.

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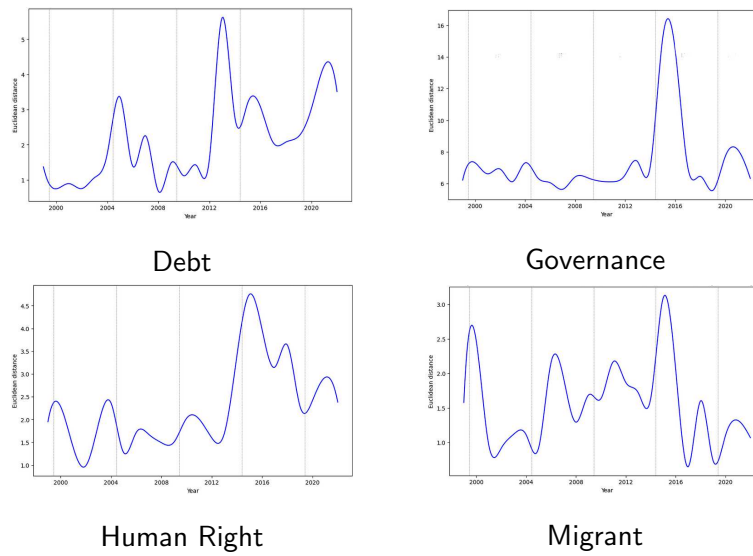


Figure 1.A.11: Polarisation within topics.
Note: These figures show within topic political polarisation between left and right. Political Polarization is calculated using Euclidean distance between the Socialist and Right party embedding vectors for each topic.

1.A Complementary figures

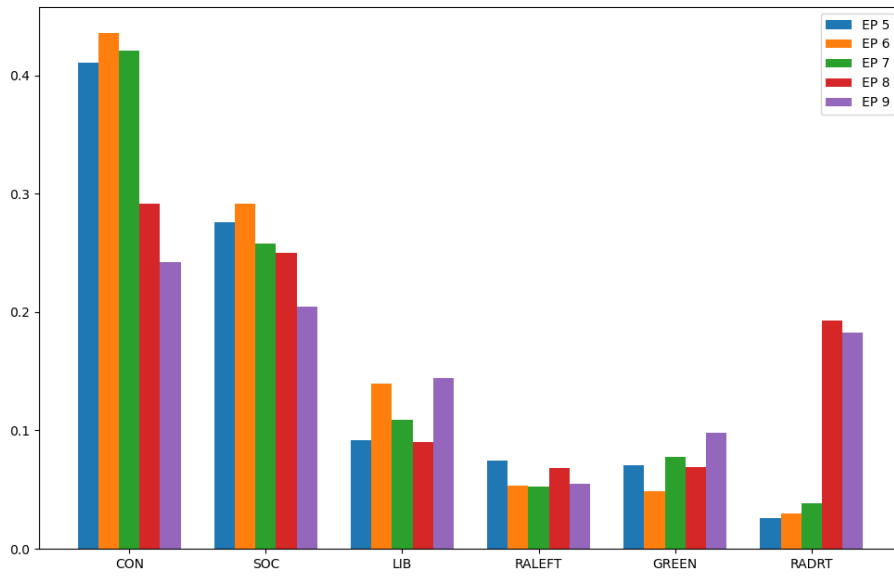


Figure 1.A.12: Evolution of the distribution of EPGs during each EP legislature.
Note: Evolution of political groups according to *Chapel Hill* annotations of political orientation (author's own calculations).

1.B Complementary tables

Legislature	Years	Plenary Sessions per Legislature	Sittings per Legislature
5th	1999-2004	94	298
6th	2004-2009	92	314
7th	2009-2014	86	278
8th	2014-2019	75	260
9th	2019-2024	55	177

Table 1.B.1: Distribution of legislative sessions and sittings during each legislature.

Note: Plenary Sessions per Legislature refers to the number of legislative sessions held during a specific legislature. *Sittings per Legislature* denotes the total number of meetings or gatherings held within the same legislative period.

Political Group	EP6	EP7	EP8	EP9
Christian Democrats and Conservatives (EPP)	288 (36.7%)	265 (36.0%)	219 (29.2%)	176 (25.0%)
Socialists (S&D)	217 (27.6%)	184 (25.0%)	189 (25.2%)	144 (20.5%)
Liberals (ALDE)	104 (13.2%)	84 (11.4%)	68 (9.0%)	101 (14.4%)
Radical Left (GUE/NGL)	41 (5.2%)	35 (4.8%)	51 (6.8%)	38 (5.4%)
Greens (G/EFA)	43 (5.5%)	56 (7.6%)	52 (6.9%)	73 (10.4%)
Extreme Right (ENF)	–	–	36 (4.8%)	–
National Conservatives (UEN)	40 (5.1%)	66 (9.4%)	–	–
Non-attached members (NA)	30 (3.8%)	29 (3.9%)	20 (2.6%)	46 (6.3%)
British Conservatives and allies (ECR)	–	55 (7.5%)	71 (9.4%)	–
Anti-Europeans (I/D, EFD, EFDD)	22 (2.8%)	27 (3.7%)	44 (5.8%)	62 (8.9%)
Total MEPs	785	736	750	703

Table 1.B.2: Representation statistics by EPG.

1.B Complementary tables

	mean	median	std	min	max	count
Age	51.7064	53.0	10.2313	22.0	93.0	653,899
Female	0.3771	-	0.4846	-	-	655,458
PhD	0.1755	-	0.3804	-	-	299,559
Chapel Hill Scales (examples)						
Environmental policies	0.9455	0.7957	-	-	11.7585	406,643
Right/left	0.4396	0.4339	-	3.5798	3.3018	406,643
Pro- / Anti- EU	0.7751	0.3857	-	-	6.1358	406,643
Field of Studies						
Law	0.2320	-	0.4221	-	-	299,559
Humanities	0.1853	-	0.3885	-	-	299,559
Social sciences	0.1421	-	0.3492	-	-	299,559
Other	0.0363	-	0.1871	-	-	299,559
Economics	0.1956	-	0.3967	-	-	299,559
Engineer	0.1149	-	0.3190	-	-	299,559
Military	0.0031	-	0.0561	-	-	299,559
Medicine	0.0683	-	0.2523	-	-	299,559
Agriculture	0.0219	-	0.1463	-	-	299,559
European Political Group						
GUE/NGL	0.1184	-	0.3231	-	-	595,953
RE	0.0656	-	0.2477	-	-	595,953
OTHER	0.0405	-	0.1973	-	-	595,953
ID	0.1545	-	0.3614	-	-	595,953
S&D	0.2274	-	0.4191	-	-	595,953
EPP	0.2700	-	0.4439	-	-	595,953
VERTS/ALE	0.0750	-	0.2634	-	-	595,953
ECR	0.0481	-	0.2140	-	-	595,953
Location of sittings						
Strasbourg	0.7757	-	0.4170	-	-	686,439
Brussels	0.2242	-	0.4170	-	-	686,439
Legislature						
5 th	0.0774	-	0.2672	-	-	686,439
6 th	0.0952	-	0.2936	-	-	686,439
7 th	0.2319	-	0.4220	-	-	686,439
8 th	0.5411	-	0.4983	-	-	686,439
9 th	0.0542	-	0.2264	-	-	686,439

Table 1.B.3: Descriptive statistics.

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	mean	median	std	min	max	count
Age	49.4707	50.0	10.5454	22.0	92.0	2,664
Female	0.3416	-	0.4743	-	-	2,675
Phd	0.1683	-	0.3743	-	-	1,188
Chapel Hill Scales (examples)						
Environmental policies	1.1632	0.8965	1.2663	-	11.7585	1,395
Right/left	0.1059	0.1200	1.0791	2.7320	3.3018	1,395
Pro- / Anti- EU	0.9424	0.6245	1.0365	-	6.1358	1,395
Field of Studies						
Law	0.2037	-	0.4029	-	-	1,188
Humanities	0.2146	-	0.4107	-	-	1,188
Social sciences	0.1456	-	0.3528	-	-	1,188
Other	0.0538	-	0.2258	-	-	1,188
Economics	0.1683	-	0.3743	-	-	1,188
Engineer	0.1245	-	0.3303	-	-	1,188
Military	0.0117	-	0.1079	-	-	1,188
Medicine	0.0496	-	0.2173	-	-	1,188
Agriculture	0.0277	-	0.1644	-	-	1,188
European Political Group						
GUE/NGL	0.0642	-	0.2452	-	-	2,552
RE	0.1167	-	0.3212	-	-	2,552
OTHER	0.0650	-	0.2466	-	-	2,552
ID	0.0869	-	0.2818	-	-	2,552
S&D	0.2527	-	0.4346	-	-	2,552
PPE	0.3013	-	0.4589	-	-	2,552
VERTS/ALE	0.0736	-	0.2612	-	-	2,552
ECR	0.0391	-	0.1940	-	-	2,552

Table 1.B.4: Individual characteristics of all observed speakers.

1.B Complementary tables

	OLS
Age	0.0025*** (93.782)
Female	0.0166*** (28.277)
PhD	0.0001 (0.1774)
Rebel_dummy_mean	-0.0293*** (-28.936)
Score_mean_standardized	0.0784*** (339.88)
Humanities	0.0366*** (41.850)
Social sciences	0.0442*** (46.456)
Other	0.0299*** (21.159)
Economics	0.0390*** (44.632)
Engineer	0.0651*** (62.255)
Military	0.0030 (0.7976)
Medicine	0.0587*** (39.364)
Agriculture	0.0580*** (29.193)
Country Fixed-Effects	X
Political groups Fixed-Effects	X
No. Observations	76,163
Cov. Est.	Robust

Table 1.B.5: Linear probability model - outcome of interest: taking the floor.

Note: T-stats reported in parentheses. Column shows the OLS regression of the probability of taking the floor a given speech on individual politician characteristics. Rebel dummy, is a dummy variable that takes one if the MEP voted rebel following speeches. Score mean standardized is the emotionality score. The sample is composed of all speeches pronounced in European parliament between 1999 and 2022. All specifications include day fixed effects, Country fixed effects and Political groups Fixed Effects. Standard errors are clustered at the politician level. *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$.

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	Role in the EP				Seniority in the EP		Newcomers
	Committee chair	Committee vice-chair	EP president	EP vice president	MEPs with at least one legislative term of experience before assuming an EP office	Amateur	
1979	0	0	1	0	0	0	1
1984	4	8	0	2	11	1	2
1989	2	17	0	3	12	2	8
1994	7	30	0	4	21	7	13
1999	8	21	1	5	27	2	6
2004	13	35	0	4	24	10	18
2009	13	32	0	12	46	2	9
2014	10	28	0	3	28	4	9
2019	10	36	0	9	24	8	23

Table 1.B.6: Female MEPs holding senior offices in the EP

Political group	Term 1	Term 2	Term 3	Term 4	Term 5	Term 6	Term 7	Term 8	Term 9
EPP	53.6	52.5	52.7	51.7	50.6	51.1	51.4	52.1	51.6
S&D	48.9	48.9	49.1	48.9	50.2	50.5	51.9	51.2	51.1
Renew Europe	52.8	48.4	50.0	50.3	50.7	51.1	50.4	53.7	48.9
Non-attached	54.6	47.8	51.1	48.3	50.6	52.0	49.5	52.8	47.7
Greens/EFA	43.2	46.6	47.3	48.5	49.0	50.8	47.5	-	-
GUE/NGL	50.3	52.9	51.1	52.7	49.3	48.2	-	-	-
Country									
Belgium	49.3	46.5	49.6	52.4	49.4	51.6	51.3	49.9	52.5
Denmark	47.3	48.6	49.2	50.2	53.2	52.5	47.1	46.8	37.6
France	54.2	52.4	48.9	50.3	50.8	53.8	52.8	55.4	50.1
Germany	50.2	49.8	50.6	48.9	49.3	50.6	51.5	52.9	49.3
Ireland	48.2	52.0	52.8	49.9	53.9	49.9	52.9	50.0	54.3
Italy	55.4	55.7	52.9	50.7	52.4	54.2	53.1	48.3	49.6
Luxembourg	47.2	54.4	53.6	51.4	56.1	61.3	56.6	53.6	52.5
Netherlands	50.4	48.7	47.7	51.1	49.3	47.6	47.4	48.2	46.8
UK	45.6	48.5	49.0	48.9	49.6	53.0	53.9	52.6	51.4
Greece	55.8	54.6	53.8	55.4	55.2	51.5	51.9	55.5	51.2
Czech Republic	49.8	49.6	51.5	48.8	46.7	-	-	-	-
Portugal	45.7	46.3	48.7	49.4	50.1	48.2	49.8	50.8	-
Slovenia	49.3	50.9	49.9	53.9	50.1	-	-	-	-
Spain	48.2	50.5	49.4	51.4	51.5	52.9	50.7	50.7	-
Sweden	47.6	51.4	48.4	50.9	50.8	45.0	-	-	-
Cyprus	48.0	59.2	53.7	54.4	55.2	-	-	-	-
Austria	47.3	47.9	51.1	51.5	50.5	47.3	-	-	-
Croatia	47.7	48.9	47.9	-	-	-	-	-	-
Estonia	49.0	56.3	53.0	55.2	48.6	-	-	-	-
Hungary	47.3	46.2	48.5	49.3	46.6	-	-	-	-
Lithuania	49.3	51.1	52.7	53.8	60.8	-	-	-	-
Slovakia	48.8	50.6	53.8	54.5	49.1	-	-	-	-
Finland	50.3	49.2	51.7	49.7	52.3	55.7	-	-	-
Malta	46.6	40.7	48.8	49.9	44.2	-	-	-	-
Romania	45.7	46.4	47.0	49.2	-	-	-	-	-
Poland	49.2	50.5	49.1	56.6	56.4	-	-	-	-
Bulgaria	43.6	44.1	43.4	46.1	-	-	-	-	-
Latvia	46.7	49.9	55.2	53.3	57.5	-	-	-	-
EU	51.5	50.7	50.3	49.9	50.5	51.0	51.2	51.5	50.1

Table 1.B.7: Average age of MEPs by term and nationality (in years).

1.B Complementary tables

Country	Accession to EU	Introduction of €	W/E	N/S
Austria	1 January 1995	1999	W	N
Belgium	Founder (1952)	1999	W	N
Bulgaria	1 January 2007		E	S
Croatia	1 July 2013		E	S
Cyprus	1 May 2004	2008	E	S
Czech Republic	1 May 2004		E	N
Denmark	1 January 1973		W	N
Estonia	1 May 2004		E	N
Finland	1 January 1995		W	N
France	Founder (1952)		W	N
Germany	Founder (1952)		W	N
Greece	1 January 1981	2001	W	S
Hungary	1 May 2004		E	N
Ireland	1 January 1973		W	N
Italy	Founder (1952)		W	N
Latvia	1 May 2004		E	N
Lithuania	1 May 2004		E	N
Luxembourg	Founder (1952)		W	N
Malta	1 May 2004	2008	E	S
Netherlands	Founder (1952)		W	N
Poland	1 May 2004		E	N
Portugal	1 January 1986	1999	W	S
Romania	1 January 2007		E	S
Slovakia	1 May 2004		E	N
Slovenia	1 May 2004		E	N
Spain	1 January 1986	1999	W	S
Sweden	1 January 1995		W	N
United Kingdom	1 January 1973		W	N

Table 1.B.8: Foundation and enlargement of the EU and categorization into West/East and South/North.

1.C Measuring national and EPG affiliation

I used a dictionary of word embeddings to assess changes in identification from national to European group identification. The results indicate an increase in European identification. Because this increase occurs between legislatures and not within a single legislature, I argue that the identification score is even more pronounced among newly elected members (Table 1.C.1) who represent on average 50% of a legislature.

1.C.1 Word embedding dictionary method

Rather than counting the occurrences of words like 'EPG,' 'Nation,' or 'national party' they use which, such approaches prove to be unsatisfactory. Because they (i) rely too heavily on the presence or absence of a specific word and (ii) struggle to measure the varying levels of identification intensity.

Following [Ash and Genaro \(2021\)](#), I first trained a word embedding model. As vector embedding developed in 1.4 word embedding is a natural language processing tool that consists of learning a digital vector representation of words from the context in which they appear in a given corpus. Words with similar semantic use tend to be located close to each other in the word embedding vector space.

The innovation brought by [Ash and Genaro \(2021\)](#), is to use word embedding to locate the texts on a semantic axis that they define using dictionaries of words associated with the end of this axis. I focused on a nationalist-Europeanist axis.²³

A speech score is then obtained by calculating the relative distance between the vector representation of speech and the two semantic poles. A score greater than 1 means that the speech is closer to the the 'European pole' than to the 'national pole'.

My main descriptive results for affiliation over time are reported in Figure 1.C.1. The time series shows the average affiliation score of speeches by semester in a plenary session of the EP. Overall, I observe a generally increasing affiliation index in political language. Interestingly the index is quite stable within a legislature but increases between

²³**Dictionary identification National:** Nation, Country, Homeland, Sovereignty, Identity, Autonomy (+all the national parties names.) **Dictionary identification European:** Europe, Integration, Cooperation, Pan-, Transnational, Europhile Supranational, group (+all the party groups names).

legislaure. Also there is a significant decrease at the beginning of the 6th, when the eastern countries first joined the EP.

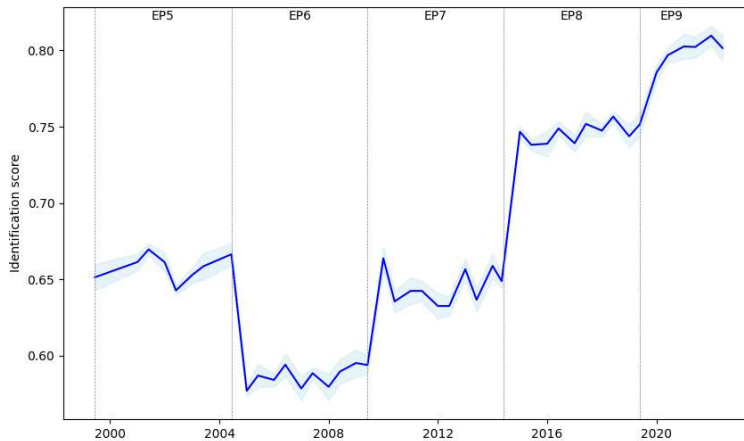


Figure 1.C.1: Evolution of identification score.

Table 1.C.2 presents a sample of most affiliated speeches for both national and European affiliation. These figures convincingly show that the methodology developed by the Ash and Genaro (2021) methodology works on my corpus.

A limitation of this study is that it may capture European *identification* versus nationalist *identification* more accurately than *affiliation* with one's national party rather than their European political group. Thus, seed words are very important. Further research is needed to validate this strategy.

1.C.2 Most affiliated sentences

Most national affiliated sentences to national sentiment. Random sample of 4 sentences from the top 1% most affiliated documents in the corpus.

(i) Madam President, my national party, the British Conservatives – for those who do not know, I am a Conservative – has expressed serious concerns in the past about the ICC and its enforcement of international criminal jurisprudence, as encapsulated in the Rome Statute, in the areas of crimes against humanity, war crimes and genocide.

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(ii) Mr President, colleagues, the citizenship of the nation states is closer to my heart than the largely artificially constructed citizenship of the European Union. The European Union should remain a voluntary platform of cooperation and it should stop pretending to be a centralized state.

(iii) "Small Practical Guide for Municipal Elected Officials of the National Front" (Guide for local councilors in the Front National party). The accusation is clearly not related to Jean-François Jalkh's position as a representative in the European Parliament, but exclusively refers to national or regional activities.

(iv) It is important that we should build up a network of contacts in the national parliaments, and for this I would particularly like to extend warm thanks to our colleagues in the Danish parliament

Most national affiliated sentences to European sentiment. Random sample of 4 sentences from the top 1% most affiliated documents in the corpus.

(i) "Political parties at a European level contribute to forming European political awareness and to expressing the will of citizens of the Union". With these words, Article 10(4) of the Treaty on the European Union sets out the role that European political parties must have. Although this role is given to them by the Treaty of Lisbon, they cannot always fulfil it in the optimum manner. I believe that the European political parties can and should contribute more effectively to the political and social life of Europe in order to increase public interest in the internal affairs of the Union.

(ii) Power would also be transferred from smaller countries to larger ones and from medium-sized countries to the largest ones. It would be transferred from ordinary party members to transnational party bureaucracies and from living democracies to a stronger Commission, a stronger European Parliament and the strongest power federation of all: the prime ministers of the largest Member States who would be at the very centre of power in the form of a directorate revolving around a French-German axis.

1.C Measuring national and EPG affiliation

(iii) I hope that the Danish people will demonstrate the same determination when it comes to joining the common European currency.

(iv) In light of these considerations, it is vital that European political parties be given recognised legal status, and single, uniform tax policies which allow true convergence of organisation. Indeed, I believe that the statute on political parties at a European level could pave the way not only towards the involvement of the population, but also to the creation of a truly transnational party system which would be vital to guaranteeing greater democracy in Europe.

1.D Data appendix

In this section, I give further details on my data sources.

- You can find the link to the speech data by session [here](#).
- MEP biographies are scraped from both EP websites and Parltrack pages – with one example [here](#) for Manon Aubry and [ParlTrack](#) for complementary information on MEPs.
- Speeches are scraped from [here](#). For each speech I have: MEP name, MEP ID, date, Session Topics, Session Law reference, order of the speech and the speech text. [Here](#) is an example for May 9, 2023.
- Roll-call voting data, which is not used for my main analysis, can be found [here](#).
- Further details on the scraping methods below. [1.E.1](#)

1.E Additional material on data

1.E.1 Scraping details: Python script explanation

This description of my Python script is designed to scrape and process data from the European Parliament website to a collection of debate speeches stored in HTML files then to a csv. Let me break down the main steps and provide some insights:

1. **Collecting the HTML Pages** from the <https://www.europarl.europa.eu/plenary/en/debates-video.html> Website

My focus lies on speeches pages with URLs of the following format: https://www.europarl.europa.eu/doceo/document/CRE-9-2023-10-04_EN.html

So I first perform an HTTP GET request for [https://www.europarl.europa.eu/doceo/document/CRE-`<legislature>`-`<year>`-`<month>`-`<day>`_EN.html](https://www.europarl.europa.eu/doceo/document/CRE-<code><legislature></code>-<code><year></code>-<code><month></code>-<code><day></code>_EN.html)

For all: legislature, year, month and day.

Upon receiving a 200 OK response, I store the result in a directory. If a 404 Not Found response is obtained, I disregard it.

2. **Extracting Data from HTML Pages**

For each HTML page, I extract the data.

2.1 Extracting Data from an HTML Page

- **Date:** Obtain the date from the filename and convert it to ISO format.
- **Location:** Proceed to extract the location by searching on the page: Strasbourg/Brussels. The first returned result is considered the location.
- **Agendas:** Subsequently, search for all `table` tags with a class of `doc_box_header`. Remove the first one and retain all others, each dedicated to an agenda.

2.2 Extracting Data from an Agenda

- **Agenda_Item:** Locate the `td` tag with a class of `doc_title` and retrieve its text.
- **Agenda:** The agenda is the portion immediately following the number (followed by a period) of the `agenda_item`.

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- **Position of Agenda Item:** The first number in the agenda_item.
- **Agenda Item Speeches:** Search for all table tags with attributes width="100%", border="0", and cellpadding="5".

2.2.1 Extracting Data from a Speech

- **Speaker_id:** In the speech, look for an img tag with an alt attribute equal to "MPphoto". Parse the source of the image to retrieve the tree structure and remove the image format.
- **Text:** Capture all p tags (for paragraphs) with a class of contents. Normalize the paragraphs and concatenate them.

Then I matched the speeches data base with a meta information data base directly download from the Parltrack website via the MEP ID which is common to both database.

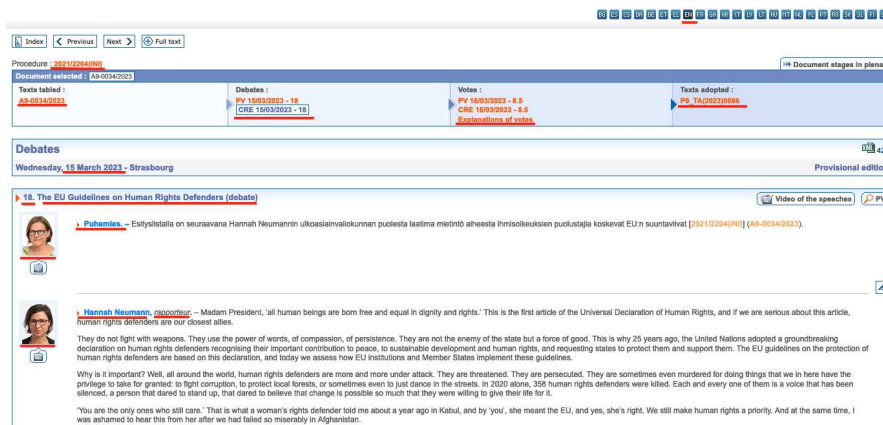


Figure 1.E.1: European Parliament website page example.

Notes: Example of a page scraped from the European Parliament website, the elements highlighted in red are the elements retrieved by the technique explained above.

1.E.2 Text pre-processing

I processed all text corpora in the same way. I identified and dropped readings of pieces of legislation as those containing list identifiers, e.g. (a), (b). I then dropped 1,892 speeches where the translation score is less than or equal to 90% accuracy. I then dropped speeches that fall in the bottom 5% in terms of the number of words. I then took the following pre-processing steps to obtain the document vectors: (1) Remove punctuation, (2) Remove capitalization, (3) Tokenize, (4) Remove digits, (5) Remove words with less than three letters, (6) Assign parts of speech to words, and keep only adjectives, Verbs, and Nouns, (7) Stemming (Snowball Stemmer), (8) Remove stopwords.

The model was trained on the full set of sentences obtained by splitting the documents in the corpus. The above-mentioned steps were applied to the sentences, and the final corpus was then used as an input to the document embedding model.

1.F The European Parliament

The *European Parliament* is the only institution with elected representatives in the European Union. There are 705 members of the European Parliament (MEPs), representing the 27 EU nationalities proportionally, according to the population of each EU member states. Before Brexit, there were 751 MEPs.²⁴ Their responsibilities include legislative, supervisory and budgetary tasks. The Parliament was first established in 1952 as *Common Assembly of the European Coal and Steel Community*, then in 1962 it changed as *European Parliament*. Since the first direct elections to the EP in 1979, European elections have been held every five years. In 2019 began the ninth legislature of the European Parliament. Each member state has a fixed number of MEPs, ranging from six for Malta, Luxembourg, and Cyprus, to 96 for Germany.

The Parliament has three main roles: legislative, supervisory and budgetary. In the legislative arena, they are responsible for the following: passing EU laws — together with the Council based on the proposals of the European Commission —, deciding on international agreements and enlargements and reviewing the Commission's work program and requesting new proposals for legislation. The supervisory agenda includes discussion of monetary policies with the European Central Bank, electing the European Commission's president and approving names for the College of commissioners. The Parliament also has a role of democratic scrutiny of all EU institutions and also examining citizens' petitions and setting up inquiries. Finally, on budget issues, they establish the EU budget with the Council and approve the EU long-term budget, the "Multiannual Financial Framework".

The Parliament works in two main stages: first it is divided in twenty committees and three subcommittees, each handling a particular policy area. The committees examine proposals for legislation, and MEPs and political groups can put forward amendments or propose to reject a bill. These issues are also debated within the political groups. Then MEPs gather in the chamber (plenary sessions) to give a final vote on the proposed

²⁴In February 2018, the Parliament approved to decrease the number of seats to 705 in response to Brexit. This plan reallocates 27 seats to under-represented member states and keeps the remaining 46 seats for potential future EU expansions.

1.F The European Parliament

legislation and the proposed amendments. Normally held in Strasbourg for four days a month, but sometimes there are additional sessions in Brussels²⁵.

In order to ensure the democratic accountability of supranational governance, member states delegated three major competences to the European Parliament: supervisory powers over other EU institutions, budgetary powers, and legislative powers. Firstly, the European Parliament has the right to censure the European Commission and its consent is necessary for the appointment of the Commission president and the entire College of Commissioners. In addition, the European Parliament has a number of further instruments at its disposal to monitor and control the behaviour of the other EU institutions, such as the right to table written and oral questions, the right to set up a committee of inquiry that investigates alleged cases of misconduct of other EU institutions, or the right of recourse before the European Court of Justice to ask for an annulment of a legislative act or to complain if the Commission and the Council fail to fulfill their institutional obligations. Secondly, the European Parliament has important budgetary powers. Together with the Council, it is responsible for the adoption of the annual budget of the European Union. The Council cannot approve the annual budget against the veto of the European Parliament. Thirdly, are the legislative powers of the European Parliament. On the basis of a legislative proposal elaborated by the European Commission, the Council of the Union and the European Parliament are responsible for the adoption of Community legislation. Whereas the European Parliament has only limited powers under the Consultation and the Cooperation procedure, its consent is required for the adoption of proposals under the Codecision procedure. The Treaty of Lisbon renamed the Codecision procedure the “ordinary legislative procedure” and almost doubled its reach by extending its scope from 44 policy areas under Nice to 85 policy areas (European Parliament 2009).

²⁵https://www.europarl.europa.eu/doceo/document/RULES-9-2021-09-13_EN.pdf

1.G Topic model

In addition to quantifying the convergence between ideologies, I introduced an LDA topic model to partition my dataset into several clusters, which I labeled *ex-post* as political issues. I condensed the initial 80 clusters assumed for training my model into thirteen and then six broader categories: governance, social issues, foreign affairs, economic policy, procedure, and environment. As for the distribution of each topic over time, Figure 1.G.1 illustrates the historical proportions of the thirteen overarching topic categories in parliamentary speeches. The most prevalent category is *technicities*. The rankings of *social issues* (e.g., crime, poverty, and wages), *party politics*, and *immigration* may be surprisingly due to the EU's prerogatives as well as the increasing emphasis on *regalian powers*, for which the EU is normally devoid of a mandate.

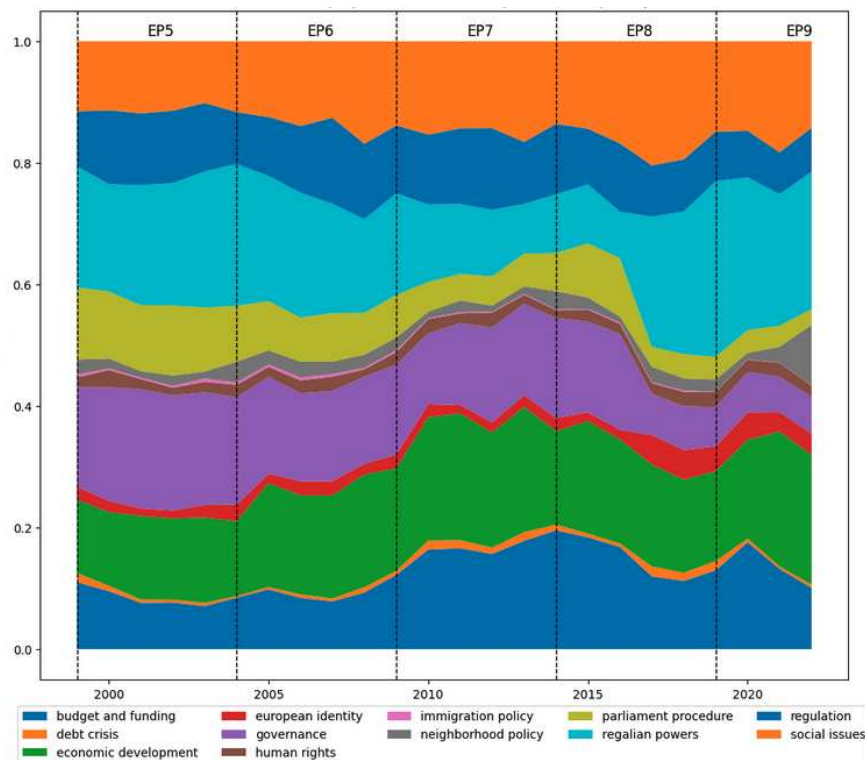


Figure 1.G.1: Distribution of topics in the MEPs speeches over time (without procedure).

1.G.1 Introduction to LDA

The main idea is that each text addresses one or more topics, and these topics are described by words in the corpus. Each word has a more or less elevated probability of belonging to a topic, and each topic has a probability of being present in a document.

More formally, my textual dataset, called the corpus, is a collection of D documents, where a document d is a list of words $\mathbf{w}_d = (w_{d,1}, \dots, w_{d,N_d})$ ²⁶. Let V be the number of unique words in all the documents. These words form K topics, where a topic $\beta_k \in \Delta^V$ is a distribution over these V words. The v th element of topic k β_k^v represents the probability that a given word appears in topic k . In turn, each document is represented as a distribution over topics. The documents are distributed independently but not identically. Let $\theta_d \in \Delta^K$ be the distribution of topics in document d , where θ_d^k represents the "part" of topic k in document d . (Note: this last paragraph could be simplified if it is too formal for your taste)

The statistical process that generated the list of words in document d had two steps. I remove the indices d for notation convenience. Let's imagine a document is composed of N "entries" (note: I would like to replace this term but haven't found a more suitable one yet) corresponding to the N observed words. In the first step, each "entry" is independently assigned a topic assignment z_n according to the probability vector θ corresponding to the distribution of topics in the document. These theme assignments are not observed and are therefore latent variables in the model. In the second step, a word is drawn for the n -th "entry" from the topic β_{z_n} corresponding to the assignment z_n . Given θ and the topics β_k for $k = 1, \dots, K$, the overall probability of observing the list of words corresponding to document d is

$$\prod_{n=1}^N \sum_{z_n} \Pr[z_n | \theta] \Pr[w_n | \beta_{z_n}] \quad (1)$$

where the sum is over all possible topic assignments for word w_n . Calculations based on (1) are generally difficult to perform, so direct maximum likelihood approaches are not feasible.

²⁶Here, "word" should more formally be called a "token", which is not necessarily an actual word but should rather be understood as a simple abstract element.

Instead, LDA assumes that each θ_d is drawn from a symmetric Dirichlet distribution (α) with dimensions of K , and that each β_k is drawn from a symmetric Dirichlet distribution (η) with dimensions of V . Realizations of Dirichlet distributions with dimensions M lie in the M -simplex, and the hyperparameters α and η determine the concentration of the realizations. The higher they are, the more evenly the probability mass is spread across the dimensions. Given these prior probabilities, the probability of document d becomes

$$\int \dots \int \prod_{k=1}^K \Pr[\beta_k | \eta] \Pr[\theta | \alpha] \left(\prod_{n=1}^N \sum_{z_n} \Pr[z_n | \theta] \Pr[w_n | \beta_{z_n}] \right) d\theta d\beta_1 \dots d\beta_K (2)$$

Two assumptions of LDA deserve emphasis.

Firstly, LDA is a bag of words model in which the order of words does not matter, only their frequency. While this assumption leads to some loss of information, it is a useful simplification when the main goal is to measure the topics covered by a document. The order of words becomes more important when the goal is sentiment analysis, or how a document treats a subject.

Secondly, documents are assumed to be independent. LDA can be extended to model various dependencies between documents²⁷. Dynamic topic models allow β_k to evolve over time²⁸. These models are particularly important when documents span multiple decades. For example, Blei and Lafferty (2006) study the evolution of scientific topics over the 20th century.

One of the reasons for the popularity of LDA is its ability to consistently estimate topics that appear natural despite the absence of pre-assigned labels. The basic intuition on how LDA generates topics is related to the co-occurrence of words in documents. As explained by Blei (2009), LDA groups words that regularly coincide in topics because this technique tends to distribute words across a few topics in order to maximize the probabilities of words for each given topic, i.e., the term $\Pr[w_{d,n} | \beta_{z_{d,n}}]$ in (1). Another advantage of LDA is that it is a mixed membership model which

²⁷For a discussion on extensions of LDA, see Blei and Lafferty (2009) or the lectures given by David Blei at the Machine Learning Summer School in 2009 (Blei 2009).

²⁸A separate question is whether the distribution of topics in a particular statement is affected by the distribution of topics in previous statements.

allows the same word to appear in multiple topics with different probabilities, whereas a standard mixture model would require each word to appear in only one topic. For example, the word "growth" can appear in both a theme about economic activity (with words like "GDP") and in a theme about labor markets (with words like "wage"). This flexibility loosens the typical definition of co-occurrence and leads to more precise descriptions of content.

1.G.2 Estimation

The model's parameters of interest are the topics β_k and the document-topic distributions θ_d . For estimation, there are several techniques, and here I used the Gibbs sampling approach introduced in the literature by Griffiths and Steyvers (2004). Their approach directly estimates the posterior distribution on the topic assignments $(z_{d,n})$ given the observed words. The algorithm starts by randomly assigning topics to words, then updates the topic assignments by repeatedly sampling from the appropriate posterior distribution.

As with all Markov Chain Monte Carlo methods, the realized value of a chain depends on the random starting values. Here, I performed 8000 iterations from 5 different starting values and chose for the analysis the chain that best fitted the data in terms of its average post-convergence perplexity - a common goodness-of-fit measure in the natural language processing literature. In practice, the differences in perplexity between chains are marginal, indicating that the estimates are not particularly sensitive to starting values.

Document inspired by the academic paper *Transparency and Deliberation within the FOMC: A Computational Linguistics Approach* by Stephen Hansen, Michael McMahon, and Andrea Prat (2014).

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1.G.3 Additional results on topics

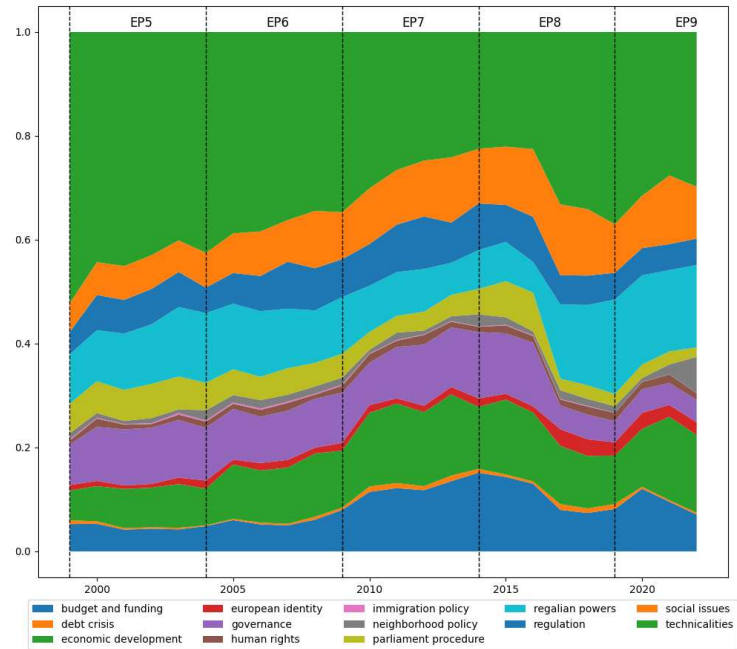


Figure 1.G.2: Distribution of topics in the MEPs speeches over time (with procedure).

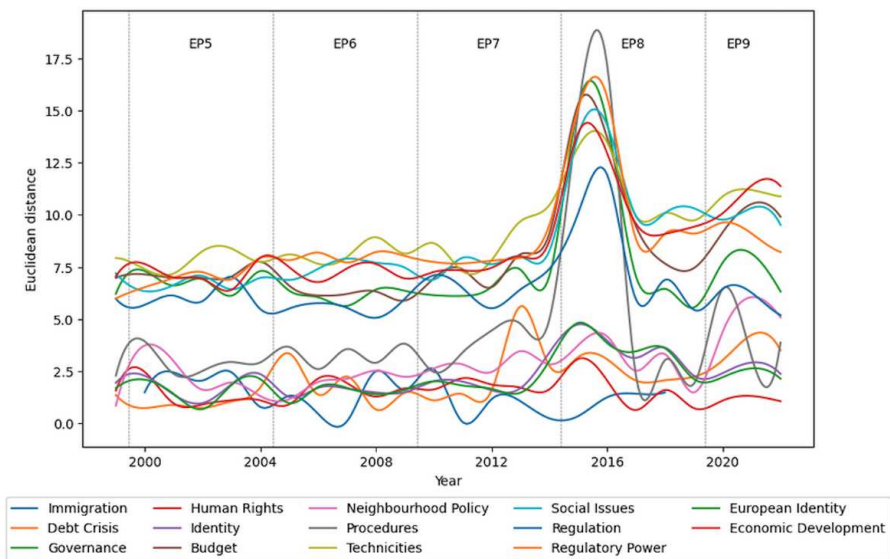


Figure 1.G.3: Polarisation across topics.

Table 1.G.4: Detailed relative changes.

	Topics	Relative change
0	European identity	2.09
1	Budget and funding	1.22
2	Economic development	0.97
3	Neighborhood policy	0.87
4	Social issues	0.86
5	Regalian powers	0.58
6	Human rights	0.23
7	Debt crisis	-0.14
8	Regulation	-0.23
9	Technicalities	-0.35
10	Parliament procedure	-0.58
11	Governance	-0.59
12	Immigration policy	-0.77

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1.G.4 Topics across committees

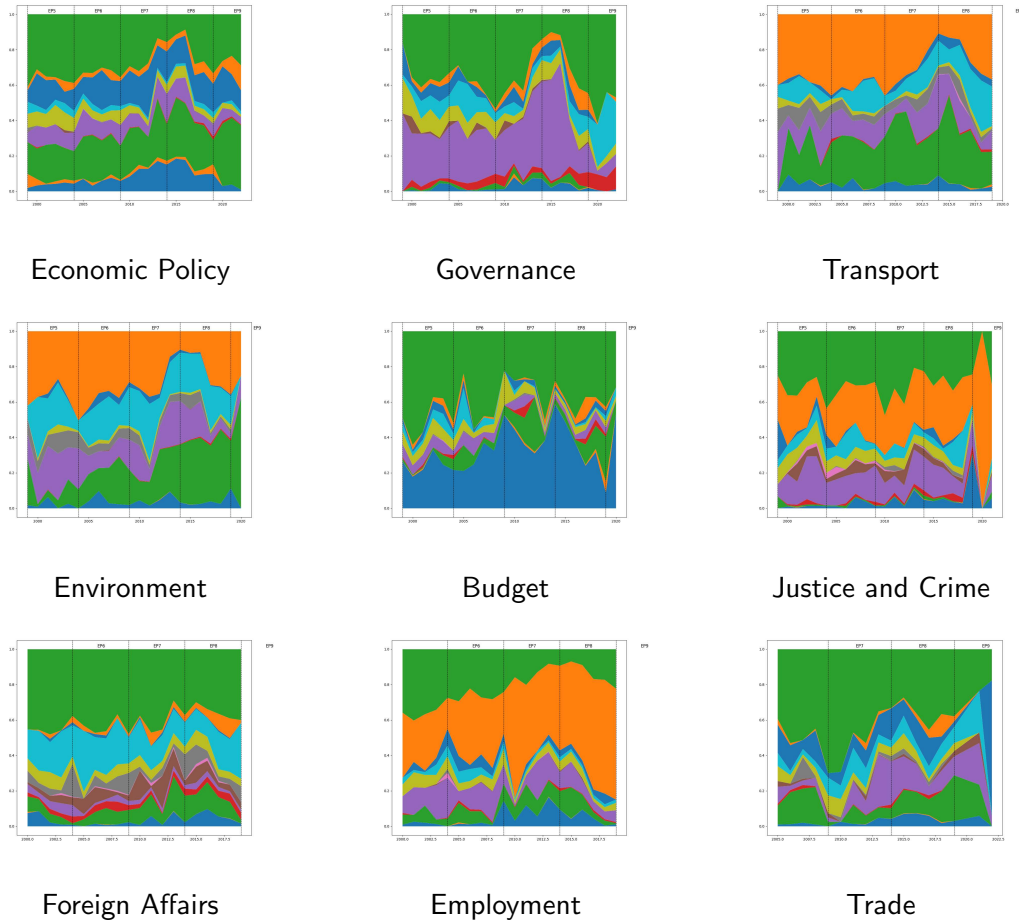


Figure 1.G.5: Evolution of topics across committees

1.G.5 Main member states time series

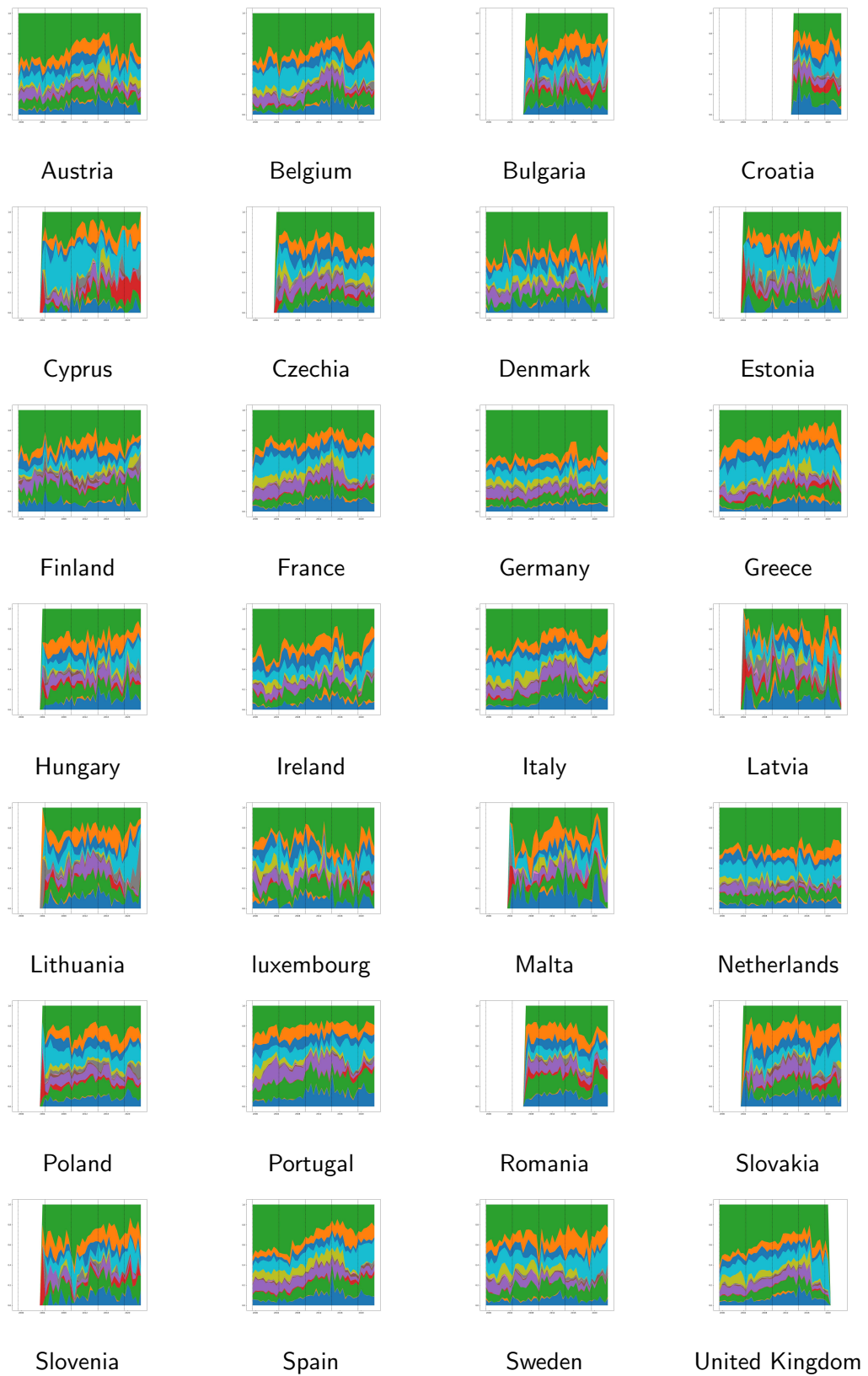


Figure 1.G.6: Evolution of topics across countries

1.G.6 List of topics in speeches

In Table 1.G.1, I report all the topics produced by the LDA model and my categorization in macro categories.

Table 1.G.1: Topics and topic categories

	Topic 1	Topic 2	Theme
0	Foreign Affairs	Foreign Affairs	china, republ, recogn, czech, chines, india, vietnam, taiwan, status, hong, kong, libyan, relat, beij, quo, tibet, tibetan, strateg, couldn, cameron, peopl, deaf, dialogu, xinjiang, world, asean, autonomi, communist
1	Human Rights	Foreign Affairs	right, human, presid, freedom, prison, journalist, situat, countri, govern, regim, violat, express, author, polit, resolut, arrest, condemn, releas, peopl, year, intern, repress, protest, continu, case, opposit, parliament
2	Governance	Governance	administr, cost, burden, reduc, red, simplifi, bureaucraci, bureaucrat, unnecessari, simplif, excess, tape, expens, complex, reduct, avoid, complic, trademark, lng, incur, easier, duplic, cut, rent, streamlin, remov, simpler, lead, elimin

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3	Consumer Protection	Economic Policy	market, servic, competit, singl, intern, public, sector, consum, compani, busi, access, european, rule, regul, ensur, protect, economi, provid, direct, benefit, open, creat, oper, barrier, price, function, procur, increas, good, need
4	Procedure	Procedure	amend, propos, commiss, accept, tabl, reject, paragraph, text, read, adopt, articl, support, posit, list, refer, origin, includ, word, agre, second, version, draft, vote, compromis, present, submit, concern, approv
5	Procedure	Procedure	presid, european, gentlemen, ladi, minist, commission, madam, ask, like, want, commiss, europ, today, govern, said, know, prime, parliament, colleagu, germani, german, itali, let, countri, talk, tell, year, franc
6	Environment	Social Issues	climat, chang, global, develop, world, goal, sustain, green, challeng, commit, achiev, countri, intern, ambiti, fight, need, transit, new, pari, target, action, economi, ambit, lead, confer, polici, futur, poverti, planet, effort

7	Parliament Affairs	Governance	european, union, citizen, institut, parliament, romania, transpar, work, import, access, public, bulgaria, initi, commiss, activ, document, interest, support, repres, petit, believ, ombudsman, year, ensur, increas, romanian, report, trust, possibl, improv
8	Procedure	Procedure	issu, question, problem, point, like, commiss, concern, presid, case, fact, think, import, situat, certain, believ, view, matter, commission, clear, discuss, debat, time, cours, differ, said, mention, particular, relat, way, know
9	Parliament Affairs	Procedure	group, parti, socialist, democrat, european, left, peopl, green, polit, sport, liber, allianc, ppe, behalf, wing, christian, peru, footbal, conserv, free, game, support
10	Economic crisis	Economic Policy	econom, crisi, european, growth, economi, europ, invest, need, union, job, social, polici, term, recoveri, measur, face, time, current, reform, new, financi, creat, situat, long, increas, challeng, employ, problem, effect, competit

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11	War	Foreign Affairs	iran, arm, weapon, nuclear, export, viraq, pakistan, iranian, saudi, prolifer, iceland, arabia, use, intern, eea, non, regim, iraqi, control, destruct, secur, mass, countri, world, militari, sanction
12	Consumer Protection	Economic Policy	digit, internet, media, onlin, vtechnolog, communic, inform, servic, use, platform, new, electron, access, public, vcontent, protect, citizen, freedom, intellig, network, user, artifici, websit, societi, advertis, televis, compani, surveil, neutral, mobil
13	Consumer Protection	Social Issues	cultur, divers, properti, heritag, intellectu, creativ, ident, europ, european, tradit, protect, art, counterfeit, preserv, valu, copyright, film, artist, promot, sector, industri, book, work, site, access, right
14	Law and order	Social Issues	victim, violenc, children, traffick, human, crime, abus, protect, drug, sexual, prevent, exploit, combat, women, crimin, forc, be, child, form, realiz, fight, action, rape, support, commit, measur, girl, practic, vulner, right

15	Parliament Affairs	Governance	european, parliament, treati, union, constitut, decis, nation, council, institut, power, lisbon, vote, polit, democrat, articl, major, repres, elect, commiss, referendum, new, mandat, process, seat, decid, presid, govern, candid, function, role
16	Social Issues	Social Issues	money, presid, peopl, time, year, govern, want, come, actual, good, way, thing, vbritish, pay, right, look, like, instead, deal, far, hous, go, simpli, fail, long, littl, wrong, away, stop, know
17	Energy	Economic Policy	energi, gas, renew, price, suppli, effici, electr, sourc, invest, fuel, secur, depend, increas, vimport, fossil, need, europ, oil, project, market, transit, green, european, use, build, vinfractuatur, union, reduc, heat, coal
18	Procedure	Procedure	like, thank, rapporteur, work, report, presid, import, parliament, commission, compromis, congratul, good, committe, hope, point, excel, final, colleagu, particular, negoti, reach, achiev, time, madam, support, abl, shadow, posit, group, balanc

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19	Law and order	Foreign Affairs	death, penalti, bosnia, punish, herzegovina, execut, tortur, sentenc, abolit, bangladesh, countri, abolish, uzbekistan, degrad, in-human, moratorium, good, use, treatment, cotton, cruel, practic, prohibit, capit, carri, resolut, impos, world, dayton, condemn
20	Consumer Protection	Economic Policy	product, consum, protect, label, market, produc, origin, import, inform, qualiti,indic, european, manufactur, countri, food, industri, sale, buy, standard, good, wine, safeti, chain, process, mark, purchas, traceabl, place, geograph, addit
21	Economic Development	Economic Policy	region, local, cohes, polici, area, develop, territori, fund, rural, citi, urban, structur, communiti, econom, popul, mountain, specif, invest, infrastructur, differ, remot, special, municip, level, live, particular, disadvantag, town, geograph, wale
22	Fiscal Policy	Economic Policy	tax, compani, small, busi, size, medium, enterpris, smes, taxat, corpor, evas, countri, profit, vat, multin, avoid, larg, fraud, pay, competit, haven, support, report, transpar, propos, direct, commiss, rate, fight, measur

23	Environment	Economic Policy	fish, fisheri, stock, sustain, sea, fishermen, manag, marin, resourc, plan, measur, sector, vessel, catch, water, polici, tuna, fleet, conserv, common, speci, ocean, area, coastal, support, activ, report, aquacultur, atlant, commiss
24	Foreign Affairs	Foreign Affairs	africa, south, north, african, east, countri, middl, korea, west, asia, develop, contin, sub, horn, korean, asian, color, poverti, dalli, mozambiqu, world, solvit, peninsula, dma, caffein, famin, potato, part, procrastin, thesi
25	Trade	Foreign Affairs	agreement, trade, countri, negoti, union, european, cooper, partnership, relat, import, develop, econom, free, partner, intern, sign, wto, conclud, bilater, access, conclus, tariff, world, vote, parti, new, protocol, export, associ, benefit
26	Law and order	Social Issues	secur, cooper, fight, crime, terror, corrupt, european, terrorist, organ, crimin, effect, prevent, strengthen, polic, threat, fraud, europol, combat, attack, intern, need, measur, money, launder, oper, protect, author, support, activ, investig

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27	Parliament Affairs	Procedure	council, committe, parliament, european, affair, report, behalf, commiss, decis, item, recommend, propos, adopt, draft, regul, debat, posit, direct, approv, read, com, conclus, agenda, home, question, joint, gue, justic, ngl, opinion
28	Economic crisis	Economic Policy	euro, debt, central, rate, monetari, stabil, countri, econom, ecb, bank, currenc, area, pact, polici, fiscal, govern, eurozon, deficit, zone, billion, inflat, singl, public, price, troika, year, interest, budgetari, mechan, auster
29	Procedure	Procedure	rule, question, debat, procedur, card, vote, presid, blue, speaker, request, session, ask, answer, plenari, time, speak, agenda, agre, minut, place, like, welfar, statement, order, close, sit, floor, written, colleagu, accord
30	Social Protection	Social Issues	peopl, million, live, countri, year, thousand, situat, suffer, problem, popul, presid, number, children, help, world, famili, affect, need, time, day, life, die, home, today, hundr, madam, europ, poverti, face, european

31	Economic Policy	Economic Policy	spain, spanish, air, aviat, portug, airport, flight, airlin, portugues, morocco, aircraft, sky, plane, fli, civil, cancel, basqu, catalan, govern, catalonia, airspac, pilot, moroccan, franc, compens, ground, oper, icao, madrid, author
32	Social Protection	Economic Policy	system, pension, scheme, age, insur, reform, retir, occup, draghi, effici, secur, old, nation, longer, generat, base, older, like, contribut, long, expect, pillar, rais, function, elder, entir, reimburs, rrf, countri, introduc
33	Social Issues	Social Issues	convent, intern, child, state, children, protocol, access, ratifi, parent, legal, member, abduct, sign, protect, forc, union, countri, cooper, hagu, ratif, case, decis, civil, adopt, nation, law, parti, famili, establish, coupl
34	Immigration	Social Issues	minor, discrimin, languag, roma, hungarian, hungari, christian, religi, communiti, anti, religion, ethnic, nation, racism, belief, persecut, hate, group, integr, peopl, muslim, includ, societ, intoler, hatr, educ, racist, form, church, toler

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35	Governance	Governance	state, member, nation, countri, differ, level, individu, compet, sweden, union, principl, appli, situat, subsidiar, common, exampl, oblig, practic, non, remain, number, decid, accord, certain, area, implement, best, fact, abl, case
36	Immigration	Foreign Affairs	turkey, greec, greek, turkish, cyprus, european, union, mister, erdogan, access, negoti, presid, continu, cypriot, occupi, govern, countri, kurdish, armenian, island, open, kurd, time, relat, ankara, question, aegean, violat, syria, stop
37	Consumer Protection	Social Issues	health, safeti, risk, medicin, diseas, public, substanc, food, care, patient, medic, use, effect, prevent, cancer, human, protect, treatment, control, healthcar, environ, scientif, need, new, chemic, caus, drug, pharmaceut, level, danger
38	Procedure	Procedure	agenc, european, report, financi, discharg, year, budget, control, court, auditor, account, manag, vote, implement, grant, institut, annual, committe, execut, parliament, budgetari, audit, procedur, joint, regular, error, transpar, undertak, general, author

39	Procedure	Procedure	vote, report, resolut, favour, text, support, call, parliament, motion, believ, reason, posit, abstain, adopt, concern, consid, contain, particular, decid, recommend, aim, propos, oppos, major, issu, point, final, fact, colleagu, despit
40	Social Protection	Social Issues	social, work, employ, worker, poverti, labour, condit, wage, protect, right, job, minimum, exclus, unemploy, peopl, econom, incom, inequ, increas, guarante, market, fight, direct, employe, live, servic, secur, decent, europ, standard
41	Social Issues	Social Issues	vanim, organ, ban, patent, genet, modifi, feed, food, ethic, gmos, plant, author, use, commiss, cultiv, clone, object, breed, market, gmo, human, prohibit, seed, place, protect, decis, authoris, scientif, techniqu, v environ
42	War	Foreign affairs	europ, peopl, today, world, presid, war, year, histori, attack, democraci, day, freedom, let, fight, live, valu, nation, time, european, ukip, peac, like, countri, power, face, ago, islam, disinform, rememb, truth

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43	Immigration	Foreign Affairs	border, cross, schengen, croatia, island, area, extern, control, guard, cooper, outermost, croatian, european, union, denmark, intern, arctic, territori, oversea, french, greenland, coast, canari, slovenia, check, acqui, slovenian, access, protect, manag
44	Procedure	Procedure	need, want, think, europ, presid, colleagu, know, let, time, today, work, good, thing, talk, european, madam, come, peopl, dear, clear, way, import, futur, commission, look, cours, like, don, said, lot
45	Economic Policy	Economic Policy	budget, financi, fund, year, program, payment, increas, resourc, european, financ, eur, parliament, billion, propos, framework, commiss, appropri, budgetari, million, council, commit, new, multiannu, money, expenditur, union, cut, addit, spend, contribut
46	Economic crisis	Economic Policy	fund, aid, eur, billion, european, million, support, assist, solidar, countri, provid, financi, help, project, develop, financ, union, commiss, alloc, affect, money, euro, programm, receiv, instrument, avail, grant, addit, use, mobil

47	Foreign Affairs	Foreign Affairs	presid, europ, council, communiti, new, polici, wish, hope, futur, mean, summit, programm, shall, need, ladi, gentlemen, way, area, achiev, regard, european, organis, enlarg, polit, set, great, success, fact, offic, common
48	Economic Policy	Economic Policy	research, innov, technolog, industri, space, develop, programm, scientif, program, europ, horizon, scienc, invest, project, competit, field, knowledg, sector, framework, new, qui, joint, satellit, cell, area, galileo, global, european, privat, particip
49	Environment	Economic Policy	emiss, car, vehicl, pollut, industri, reduc, reduct, air, carbon, fuel, limit, greenhous, environment, sector, propos, target, measur, environ, direct, new, level, gas, commiss, technolog, set, manufactur, automot, engin, european, qualiti
50	War	Foreign Policy	ukrain, russia, russian, war, sanction, putin, ukrainian, european, support, aggress, belarus, union, presid, invas, feder, situat, eastern, partner, poland, clear, action, territori, militari, intern, madam, propaganda, moscow, stop, belarusian, regim

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51	Environment	Social Issues	agricultur, food, farmer, product, sector, produc, farm, price, cap, market, support, increas, milk, polici, import, measur, rural, fruit, chain, meat, subsidi, common, suppli, quota, develop, export, re-form, commiss, need, european
52	Social Protection	Social Issues	emerg, pandem, vaccin, spread, lesson, learn, coordin, virus, re- spons, prevent, quick, epidem, crise, diseas, outbreak, react, mea- sur, rapid, coronavirus, infect, oli- garch, test, reaction, equip, foot, mask, event, bahrain, centr, case
54	Foreign Affairs	Foreign Affairs	unit, state, nation, american, king- dom, america, afghanistan, british, transatlant, latin, usa, world, trump, union, pnr, afghan, rela- tionship, borrel, general, taliban, secretari, withdraw, alli, mexico, britain, atlant, western, canada, sahara, washington
55	Parliament Affairs	Governance	polit, elect, democrat, govern, democraci, societ, civil, parti, countri, dialogu, support, elec- tor, rule, opposit, process, inde- pend, law, repres, parlamentari, assembl, organis, media, peopl, campaign, free, transpar, institut, observ, power, particip

56	Environment	Economic Policy	water, wast, materi, environment, environ, use, raw, resourc, plastic, recycl, direct, circular, pollut, manag, industri, economi, reduc, drink, repair, bag, sustain, product, miner, extract, legisl, impact, public, batteri, life, dispos
57	Environment	Social Issues	sea, harmon, maritim, port, ship, safeti, accid, inspect, oil, black, libil, oper, compens, vessel, flag, damag, coast, pollut, intern, environment, european, transport, baltic, caus, prevent, danger, carri, offshor, standard, risk
58	Consumer Protection	Social Issues	duti, custom, tourism, tobacco, alcohol, destin, tourist, season, smoke, cigarett, illicit, good, holiday, industri, health, smuggl, product, excis, hotel, harm, consumpt, brand, rate, para, cosmet, elimin, reduc, caus, restaur, direct
59	Immigration	Foreign Affairs	refuge, migrat, immigr, asylum, countri, migrant, european, illeg, europ, polici, border, crisi, protect, solidar, need, union, return, flow, manag, seeker, legal, situat, respons, humanitarian, integr, migratori, arriv, support, recept, problem

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60	War	Foreign Affairs	polic, european, union, secur, foreign, state, defens, interest, common, defenc, sovereignti, power, countri, nato, militari, nation, polit, report, defend, impos, interfer, forc, call, intern, capabl, strateg, extern, base, promot, strengthen
61	Governance	Governance	mrs, van, behalf, ale, mari, lopez, sanchez, vert, malmstrom, lambert, ferreira, pen, cohn, bendit, debat, pack, situat, shall, roth, baro, garcia, gonzalez, palacio, den, rede, perez, kinnock, harbour, lull, breton
62	Immigration	Foreign Affairs	movement, visa, free, travel, citizen, countri, union, european, freedom, stay, agreement, day, resid, short, period, relat, vis, facilit, nation, exempt, territori, person, passport, requir, certif, term, document, vote, peopl, issu
63	Economic Policy	Economic Policy	financi, bank, invest, market, financ, capit, risk, credit, supervis, investor, sector, privat, fund, regul, crisi, european, loan, eib, institut, guarante, transpar, ecr, supervisor, specul, public, author, activ, transact, economi, instrument

64	Fiscal policy	Foreign Affairs	paper, prefer, inquiri, malta, interim, scandal, panama, gsp, maltes, epa, investig, sri, shed, bori, light, lanka, daphn, generalis, peripheri, golden, grant, paradis, tiger, flander, solomon, commonwealth, beneficiari, norwegian, vincent, nemtsov
65	Commission	Procedure	commiss, council, work, parliament, member, presid, year, issu, discuss, continu, european, action, commit, state, meet, forward, propos, need, plan, import, debat, address, implement, month, thank, let, week, honour, time, new
66	Economic Policy	Economic Policy	transport, road, passeng, safeti, railway, infrastructur, traffic, rail, european, network, driver, mobil, sector, improv, tran, accid, connect, good, packag, europ, vehicl, increas, travel, mode, carrier, servic, reduc, drive, inland, train
67	Consumer Protection	Social Issues	inform, data, protect, person, exchang, statist, collect, provid, author, access, transfer, use, privaci, process, avail, ensur, reliabl, decis, purpos, databas, regist, guarante, monitor, transpar, necessari, individu, record, relev, compar, accur

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68	EU Enlargement	Foreign Affairs	countri, european, union, reform, access, process, eastern, moldova, progress, balkan, polit, western, kosovo, serbia, georgia, region, integr, stabil, support, enlarg, membership, import, negoti, relat, candid, associ, continu, macedonia, econom, croatia
69	Social protection	Economic Policy	educ, young, peopl, train, youth, skill, school, unemploy, european, program, support, employ, profession, learn, mobil, opportun, need, programm, job, age, student, europ, import, work, erasmus, qualif, initi, vqualiti, promot, access
70	Environment	Economic Policy	natur, forest, damag, protect, dist, biodivers, caus, fire, flood, area, prevent, speci, loss, land, manag, resourc, affect, environment, environ, endang, ecosystem, risk, import, drought, soil, deforest, illeg, forestri, consequ, cite
71	Procedure	Procedure	der, semest, que, von, die, les, nous, des, est, pour, und, plus, une, dan, das, pas, par, union, ist, mai, del, fur, nos, den, ursula, tout, europ, donald, europeenn, sin

72	Law and order	Social Issues	law, court, justic, legal, case, rule, poland, investig, crimin, european, proceed, judg, polish, member, immun, judici, request, parliament, procedur, alleg, independ, public, accus, author, judgment, prosecutor, disput, parlamentari, person, matter
73	Social protection	Social Issues	women, equal, gender, men, disabl, right, famili, life, discrimin, work, access, abort, report, girl, care, societi, leav, children, sexual, pay, femal, woman, support, opportun, violenc, mother, educ, gap, promot, parent
74	Human rights	Social Issues	right, human, fundament, respect, law, european, freedom, union, valu, rule, protect, principl, violat, democraci, defend, charter, guarante, intern, citizen, ensur, basic, countri, promot, base, includ, standard, digniti, state, univers, equal
75	Economic Development	Economic Policy	develop, polici, european, import, strategi, report, support, need, role, promot, implement, object, cooper, improv, effect, union, level, action, achiev, new, sustain, strengthen, ensur, area, contribut, commiss, integr, instrument, play, framework

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76	Economic Policy	Economic Policy	worker, industri, compani, european, fund, support, sector, global, adjust, job, redund, market, mobil, globalis, vote, steel, trade, employe, chang, financi, product, provid, crisi, world, applic, econom, employ, help, measur, affect
77	Foreign Affairs	Foreign Affairs	mediterranean, southern, tunisia, libya, egypt, transit, spring, euro, algeria, barcelona, compact, lebanon, cluster, explos, mine, partner, shore, morocco, lawmak, countri, basin, sul, particip, munition, process, associ, partnership, personnel, maghreb, clearanc
78	Energy	Foreign Affairs	ireland, nuclear, power, irish, northern, lithuania, plant, slovakia, safeti, latvia, estonia, test, instal, slovak, station, countri, slovenia, japan, lithuanian, govern, latvian, radioact, liberia, poland, reactor, rohingya, euratom, standard, oper, friday
79	Procedure	Procedure	regul, commiss, legisl, propos, direct, legal, rule, measur, implement, applic, procedur, adopt, new, provis, act, report, framework, establish, requir, european, ensur, appli, vote, necessari, law, order, provid, current, council

2 Social Learning of Political Elites

Peer effects in legislators' political speech

2.1 Introduction

Politicians belong to social groups called political parties. Like any other social group, each political faction tends to be isolated from the others during their day-to-day occupations. Within legislative chambers, politicians of the same party typically have to sit together. To collaborate with members from other groups, they must bridge the gap by reaching *across the aisle*. This separation is clearly showcased in the British House of Commons' design: the government on one side and the opposition on the opposite, separated by a 3.96-meter aisle. This width was meant to approximate the length of two swords, symbolizing the adversarial nature of politics. On the other hand, countries like Norway and Sweden seat their MPs together based on constituencies,¹ while Iceland assigns seats randomly each year. These diverse arrangements raise questions about the possible impact of integrating politicians on partisanship and whether they can learn from each other despite holding different convictions.

Analyzing data on U.S. Congressional speech, [Gentzkow et al. \(2019b\)](#) demonstrated a significant increase in polarization since the 1990s, with language partisanship reaching unprecedented levels. In the same spirit, Chapter 1 of this thesis reveals a similar trend of heightened partisanship in language within the European Parliament (EP) since 2014. This raises an important question: would partisanship be as prominent if politicians from different parties were physically closer to one another? The answer lies

¹In the Norwegian Storting, the seating order within constituencies is determined by the Sainte-League vote score. In the Swedish Riksdag, MPs are seated based on their tenure, followed by age.

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in the nature of social learning among politicians: if they are to achieve some form of mutual understanding, they must learn from those who are different. The EP's seating arrangement presents two distinct types of diversity: individuals from different political groups and individuals from various member states. Nevertheless, existing polarization tends to make cross-party learning difficult.

In this paper, I address these questions by studying the nature of social learning among members of the European Parliament (MEPs) using an unprecedented outcome: language. I do not only confirm the existence of peer effects within the EP, but I also investigate how repeated interactions shape the nature of deliberations through the learning process. Moreover, I identify the main characteristics of MEPs who have the most significant influence on their peers.

An ideal experiment would be to randomly integrate some legislative chambers while leaving others unaffected, allowing for a comparison of the subsequent trends in partisanship. Unfortunately, such scenario does not currently exist. However, like [Harmon et al. \(2019\)](#), I leverage the seating arrangement in the EP as a quasi-random experiment. I use alphabetical adjacency within the party as an instrument to determine if two MEPs are seated next to each other. This allows me to examine the influence of peer effects among the members thanks to an instrumental variable approach (IV). While [Harmon et al. \(2019\)](#) focused on the effects on voting behaviour, I examine language similarity. I investigate whether two MEPs seating next to each other are more likely to use the same type of language.

To assess language similarities, I use vector embeddings, specifically *Doc2Vec*, to represent text as vectors in a multi-dimensional space. *Doc2Vec* is a document vectorization algorithm that learns dense numerical representations of documents—MEPs' speeches in this context – based on co-occurrence statistics in large corpora ([Mikolov et al. \(2013\)](#)). A document, normally an item in a large vocabulary, is embedded in a lower-dimensional space, where semantically related documents tend to locate near each other. I then use Euclidean distance as a metric to quantify language dissimilarity, enabling to condense the multi-dimensional vectors of two politicians into a value between zero and one. This value reflects the degree of language overlap between the two politicians in both what they say and how they say it. Using data from 1999 to

2023, I first establish that *Doc2Vect* effectively captures meaningful partisan differences in the EP (as discussed in Chapter 1). Secondly, I find significant differences in distance between politicians within the same European political group (EPG) compared to those in other political groups, as well as between politicians from different member states of the European Union.

My main result indicates that two MEPs from the same political group sitting side-by-side narrows their language distance by 1.5 percentage points. It signifies a 7 per cent decrease compared to the average rate of within-group distance. It is roughly one-third the size of the effect observed when MEPs are from the same member state. Then, I disentangle my language similarity measure and find that exactly one half of the effect can be attributed to the MEPs' choice of topics, while the other half is linked to how they discuss topics during the debates. This could suggest that when people already share strong attributes, it becomes easier to exchange ideas. It advocates for peer effects through cognitive channels, emphasizing mutual learning over monitoring or conformism.

For validating the identification strategy, I employ placebo tests, capitalizing on the four small political groups that do not sit in alphabetical order. Reassuringly, I find that alphabetical contiguity has no impact on speaking behaviour among these MEPs. I also verify that once present and past seats are taken into account, future seat contiguity does not increase the current similarity of speeches.

The second main result generalizes the first one: peer effects exist not only within party but also across groups. Focusing on MEPs who are assigned seats at the edges of their EPGs' sections, there is a subgroup that is seating next to MEPs from other groups. The cross-party influence results in a 4 per cent decrease compared to the average rate of distance between parties. In contrast to peer effects within the same EPG, when examining the language similarity across EPGs, I find that three-fourths of the influence is related to how MEPs discuss topics. The remaining effect cannot be attributed to MEPs' choice of topics due to the non-significant coefficient, although it still aligns with the analysis within the group. This means that cross-partisan influence is primarily shaped by how MEPs discuss a particular topic rather than the actual substance of their statements. This mitigates the effect of learning when there is a significant disparity in pre-existing MEP attributes. In this scenario, the transmission

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channel of the peer effects could primarily be monitoring and conformity driven by social pressure. However, because a significant proportion of these effects remain unexplained and can be attributed to the exchange of ideas, cognitive channels such as information transmission or persuasion may still account for peer effects. This implies that repeated contacts and face-to-face interaction with peers sitting nearby play an important role in MEPs' speaking behaviour through learning. The presence of cross-group learning suggests that political integration might be an effective means of reducing polarization, making it a policy worth advocating.

The third result confirms this hypothesis: not only does peers' influence grow stronger over time, it also has a lasting effect. Firstly, speech similarity between adjacent MEPs increases by about 0.07 percentage point with each session. Secondly, using the unique organization of the EP, with two separate venues in Strasbourg and Brussels and different seating arrangements, I can examine both current and past adjacency effects. This enables me to differentiate between 'contemporaneous' peer effects, which occur while individuals occupy neighbouring seats, and 'persistent' peer effects, which continue to have an impact even in the absence of the peer. I find that having sat adjacently in Strasbourg during a prior session influence current speaking behaviour in Brussels, even after controlling for the proximity of current seating arrangements in Brussels. These results demonstrate a lasting component within peer effects. The presence of persistent effects suggests that the mechanism at play is learning rather than simply following or social pressure. I argue that this does not support the hypothesis that the main driver of the previous results is limited attention, in which MEPs might react to the most salient information without fully processing all available details, implying a more superficial and transient response. Instead, they align with an alternative hypothesis: the exchange of ideas through repeated interactions.

Fourthly, analysis of heterogeneity in peer effects reveals that these are much stronger when the two MEPs are both women, or both from the same member state or both new MEPs. For these groups, I estimate that seat adjacency reduces distance in language by about 2.2 to 3.6% percentage points. This represents a 9 to 17 per cent decrease compared to their respective average rate distance. This implies that being exposed to peers complements the presence of other shared attributes, such as the state of origin or gender, that facilitate communication and then learning. Interestingly, the effect for two male MEPs, if it were significant, would be the opposite. The distance in

their language would be 4% greater when they are sitting adjacently, compared to the average male rate of within-party distance. The effect is similar for two senior members, regardless of their gender, as their language distance increases by 2%. The desire of some candidates to stand out from the crowd to secure political positions could explain this desire for distinction.

Lastly, I explore the mechanism of influence. Given that convergence between MEPs can be asymmetric, I address the question of 'who influences whom'. I shift from observing the behaviour of pairs to focus on the influence of individuals. My results show that being surrounded by a pair of men reduces the language distance of any MEP to the average male language by 0.5 percentage point over a legislature, resulting in a 9% convergence. However, while being surrounded by two women has no significant impact on the language of the male MEP positioned between them, it triggers a 35% convergence effect on the affected woman toward the average female language. This influence seems to be conveyed through more fundamental cognitive processes than temporary channels such as cue-taking or social pressure.

Social interactions between legislators can influence their behaviours through several distinct mechanisms, including (i) *Cognitive channels* such as information transmission and persuasion. They can deliberate, reflect on their opinions, understand others' reasoning, and change their beliefs (DellaVigna and Gentzkow (2010)). These cognitive shifts are not solely dependent on the situation and can consequently exert a lasting influence, persisting even after the social interactions are over. (ii) *Affective changes* such as increased partisan tolerance through personal encounters. Mutz (2002) argues that cross-partisan contacts can lead to greater partisan tolerance. Interpersonal contact with out-groups can reduce prejudice under certain conditions (Allport (1954); Paluck et al. (2018); Lowe (2021)). (iii) *Legislative cue-taking*, since legislators cannot be fully informed about all issues, they may take cues from peers (Matthews and Stimson (1975)). This mimicking behaviour is likely temporary, not persisting into subsequent sessions, as peer behaviours are no longer immediately observed. (iv) *Social pressure and monitoring*. Legislators' actions are witnessed by their seating neighbours, leading them to act in line with the latter's views, perhaps to signal agreement or avoid conflict and stigma. This influence is likely to dissipate once social interactions cease.

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These mechanisms clarify the various individual effects of proximity and whether these effects are temporary or lasting. I use this logic to map my results along them.

Providing further evidence on channels, in a survey taken by 56 sitting MEPs, most doubt the possibility of any peer influence – suggesting that the effects I find are either too small to be detectable and remembered by MEPs. Alternatively, some argue that if any peer influence were to exist, it would likely occur outside the plenary session, in corridors or at the famously frequented coffee machine. Paradoxically, many acknowledge that it is not insignificant to sit next to the same person for five years, and that connections, born out of small talk, can become enduring. The newly elected members acknowledge that their neighbours have been very effective integration facilitators, especially when these neighbours were also new and, like them, had a lot to learn. Only a few truly recognize that the person seated beside them serves as a conduit for additional information they might not have otherwise had – another channel with learning effects, and thus consistent with my main findings.

In recent years, there has been growing concern about the adverse effects of escalating political polarization. Given the influence of peers and the role of social interaction in shaping the voting and speaking behaviour of MEPs, fostering connections between members of different political groups can help bridge the political divides. A Westminster-style arrangement, where the members of a party sit next to each other and the other groups occupy non-adjacent benches, would seem to increase the political distance between them. Conversely, as in Iceland's Parliament, a random seating arrangement to promote interaction between politicians from different groups may be a cost-effective way of reducing political distance in the arena.

The remainder of this paper is organized as follows. Section 2.2 presents the related literature. Section 2.3 provides an overview of European political data and the EP seating rule. Section 2.4 explains the phrase embedding techniques. Section 2.5 outlines my empirical specifications and investigates within EPG effects of being neighbours on language similarity. Section 2.6 explores peer effects between political group. Section 2.7 investigates who influences whom, while Section 2.8 highlights what makes peer dynamics: topics or the way of speaking. Section 2.9 concludes.

2.2 Literature

Political economists have long been interested by the impact of legislators' social relationships on the legislative process, a topic explored since [Rouff \(1938\)](#) and [Truman \(1956\)](#). Recently, there has been a renewed focus on peer effects in political networks (see [Lazer \(2011\)](#) for an overview). [Canen and Trebbi \(2016\)](#) and [Trebbi and Weese \(2015\)](#) have demonstrated how peer effects play a role in socialization and career trajectories within the U.S. Congress. [Battaglini and Patacchini \(2016\)](#) have illustrated how legislators' social networks influence political contributions.

Other recent studies examined the impact of peer effects among political elites. [Masket \(2008\)](#) studies California's Assembly and found that legislators working in adjacent offices tended to have more similar voting patterns. However, it is important to acknowledge that in this instance, the seating arrangements might have been determined based on shared viewpoints. [Cohen and Malloy \(2014\)](#) observed that 'logrolling', the practice of exchanging votes, was more common among members belonging to the same alumni network in the U.S. Senate. [Rogowski and Sinclair \(2012\)](#) leveraged the office assignment lottery for new members of the U.S. Congress to generate causal estimates regarding the impact of closeness in terms of office location and its effect on voting behaviour and bill co-sponsorship. They found small-point estimates suggesting no substantial impact of office proximity on legislative behaviour. [Harmon et al. \(2019\)](#) explored peer effects in voting behaviour by leveraging the alphabetical seating arrangement of members in the European Parliament. Similarly, [Saia \(2018\)](#) and [Lowe and Jo \(2023\)](#) examined also the concordance in voting by exploiting random seating in Iceland's national Parliament. [Holden et al. \(2016\)](#) investigated peer effects in voting decisions in the U.S. Supreme Court, using the quasi-random absence of justices and their tendency to uphold the decisions of their "home" court. In relation to these studies, I make two distinct contributions.

Firstly, I estimate peer effects not in voting but in language use. This provides new evidence on the diffusion of language and allows me to uncover social influence among politicians. This is particularly relevant when voting is strongly influenced by party discipline, as demonstrated in [Hix \(2004\)](#) and verified in [Harmon et al. \(2019\)](#). In the EP, 94% of votes align with those of the respective EPG, underlining the importance

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of language study as an alternative measure. Secondly, it allows me to study the direction of the peer's influence, namely who persuades whom, as well as the nature of persuasion. Unlike voting, which is one-dimensional, studying language allows me to understand whether the influence between pairs is based on the way they speak or on the topics they discuss. This better explains the nature of the influence between them. The EP, characterized by its trans-national composition, provides an ideal setting for understanding how factors such as gender and member state of origin interact with peer effects.

More precisely, in contrast to [Harmon et al. \(2019\)](#), my study benefits from a ten-times larger time period, providing greater statistical power. This allows me to estimate peer effects separately for interactions between the in-group and the out-group (in-group being defined as the EPG and the out-group as all EPGs). This differentiation is crucial to understand the nature of political polarization. If there are out-group peer effects, this suggests that integrating politicians from different groups is more likely to reduce polarization effectively and at a lower cost. Specifically, I use the same instrumental variable approach as [Harmon et al. \(2019\)](#), but my advantage lies in the extended time period I examine. Whereas they focused on a 4-year period, I analyze a 23-year period which allows me to investigate persistent peer effects across legislatures. This wider time-frame allows me to observe significant effects within the smaller subset of MEPs involved in the across-group comparisons. In their study, due to lack of statistical power, they found no significant effects. That said, in the within-group analysis, I obtain results quite similar to theirs, but with tighter standard errors, regarding my pairwise effects on language, just as they do with their pairwise effects on voting. I present further evidence on the mechanism behind the observed peer effects and the inter-group effects – which are almost as consistent as the intra-group ones.

[Lowe and Jo \(2023\)](#) and [Saia \(2018\)](#) also examined peer effects in voting using the seating lottery in the Icelandic Parliament to estimate the effects of seating integration on bipartisanship. [Saia \(2018\)](#) focused primarily on the voting turnout due to the high degree of party discipline in Iceland, making it difficult to examine voting concordance in this context. Both papers identified peer effects in voting participation and discourse using the same Icelandic experiment. However, unlike Saia's work, [Lowe and Jo \(2023\)](#) explored how social learning differs between in-group and out-group interactions, and they used additional findings to distinguish mechanisms such as monitoring, peer

pressure and learning. Like [Lowe and Jo \(2023\)](#) and [Harmon et al. \(2019\)](#), my study analyzes the persistence of peer effects, which helps me to differentiate between short-term mimicry or social pressure and true changes in thinking and behaving. However, [Lowe and Jo \(2023\)](#) concluded that physical proximity effects are short-lived, and thus more consistent with legislative cue-taking and social pressure mechanisms than with cognitive and affective changes. Their study concluded that physical integration has limited power to durably increase bipartisanship in a setting with strong groups. In contrast to this view, and similarly to [Saia \(2018\)](#), I argue that the random assignment of seats, by forcing legislators to interact, may facilitate more informal exchanges of ideas and can help mitigate the ideological divide between groups.

This paper also connects to the literature on the *contact hypothesis* ([Allport \(1954\)](#)), which suggests that interpersonal contact with out-groups can reduce prejudice under specific conditions. Previous studies have examined this hypothesis by exploiting the random assignment of students to roommates ([Burns et al. \(2022\)](#); [Boisjoly et al. \(2006\)](#)). However, to the best of my knowledge, no rigorous research has yet examined the effects of cross-partisan contacts. By examining social learning from out-groups, I contribute to filling this gap.

Moreover, my contribution expands the scope of the wider literature on peer effects. Various studies have delved into political peer effects among citizens. For example, [Nickerson \(2008\)](#) conducted a canvassing experiment showcasing the impact of household members on voter turnout. [Campos et al. \(2013\)](#) leveraged the random assignment of Brazilian freshmen to classrooms to investigate the influence of peers on political preferences and engagement. Additionally, substantial peer effects were uncovered among U.S. Supreme Court justices in the study conducted by [Holden et al. \(2016\)](#). Moving beyond politics, peer influence has been extensively examined in the realms of academic and workplace performance by [Duflo et al. \(2011\)](#), [Guryan et al. \(2009\)](#), [Herbst and Mas \(2015\)](#), [Mas and Moretti \(2009\)](#), and [Sacerdote \(2011\)](#).

By choosing language similarity as my outcome variable, I align with a growing body of literature that leverages the informational content of text ([Gentzkow et al. \(2019b\)](#)). While earlier studies primarily focused on measuring partisanship trends in the U.S. Congress ([Gentzkow et al. \(2019b\)](#) or [Rheault and Cochrane \(2020\)](#)) or emotions and metaphors in politics ([Ash and Genaro \(2021\)](#)), my research investigates language as a tool for understanding social learning. Similar to this approach, [Hoberg and Phillips](#)

(2016) measured language similarity, but their focus was on creating a finer measure to capture how firms differ from their competitors. Additionally, [Chen \(2013\)](#) explored not what factors impact language use, but how language use affects economic outcomes. He found that speakers of languages that grammatically associate the future and the present are more future-oriented. Lastly, in their analysis of peer effects on voting in the Icelandic Parliament, [Saia \(2018\)](#) found that peer influence accounts for nearly one sixth of an MP's party's tendency to use a certain wording. On the other hand, [Jo and Lowe \(2017\)](#) attempted to incorporate a language similarity measure, but their results did not yield significant findings, possibly due to the use of less advanced techniques. In my view, having recourse to word embeddings is more likely to reveal the convergence of language compared to relying solely on stemmed words.

2.3 Background and data

2.3.1 The European Parliament

The European Parliament is the legislative chamber of the European Union. Since 1979, its members are elected for a 5-year term in local or national elections in each EU member state.² Once elected, MEPs join one of several trans-national EPGs based on their political inclinations.³ Each EPG is composed of MEPs from diverse member states and national parties. In the everyday work, EPGs undertake a variety of tasks similar to what national parties do in member states. Specifically, they gather during the plenary sessions and establish (non-binding) *party lines*. The parliament's activities are primarily focused on its plenary sessions, which convene once or twice a month, alternating between Strasbourg and Brussels.⁴ These consist of several daily *sittings* of

²The process of electing officials has evolved over time. In 2019, elections were held at the level of a single national constituency, except in Belgium, Ireland, Italy, Poland, and the United Kingdom. In May 2022, the European Parliament voted on a reform that allows for the use of only national and pan-European lists. [More here.](#)

³A small number of MEPs are not affiliated with any EPG (currently 43 out of 705 MEPs).

⁴The Parliament's annual calendar includes twelve plenary sessions which take place over four days in Strasbourg (from 5 pm on Monday until Thursday evening). Since MEPs do not sit in August two sessions are organized during another month. Apart from that, there are six mini-sessions per year which last two days and take place in Brussels. MEPs look into draft directives and regulations put forward by the European Commission. The parliamentary committees meet in Brussels two weeks per month.

debate and voting. During plenary sessions, speeches are organized by theme throughout the day, and strict rules govern the speaking process. The authors of oral questions speak in chronological order, with limited speaking time. The rapporteur, an appointed member responsible for preparing and presenting a report on a specific matter, speaks for six minutes. Meanwhile, a point of order, which is a procedural interruption to address potential breaches of rules or procedural issues, is limited to a maximum of one minute.⁵

2.3.2 Data

Speeches and MEPs' characteristic dataset. The corpus was scraped from the [European parliament website](#). It includes transcripts of 686,439 speeches pronounced in the EP between July 1999 and October 2022. The dataset covers all plenary sessions of the EP since the beginning of the 5th legislature until the middle of the 9th legislature both in Strasbourg and in Brussels. During this time period, speeches were pronounced by 2,675 different MEPs discussing 5,870 draft laws (see Table 2.3.3 for the distribution by plenary sessions and days of sittings by legislature observed). Note that only 40% of speeches were pronounced in English, as MEPs have the option to speak in any of the 24 official languages of the EU. To ensure comprehensive analysis, the remaining speeches were automatically translated into English using *Google Translate*. This translation platform was trained on the [Europarl corpus](#) (including the speeches I use), a collection of documents professionally translated into 21 languages by the European Parliament, making it particularly suitable for my study.

My scraped dataset includes metadata associated with each speech. For instance the speaker's name, the title of the discussion, its purpose (debate, voting time, amendment, vote explanation, oral questions, etc.), the order of the section in the session agenda, the order of the speech in the discussion and among all speeches in the day and the set pieces of texts of laws draft legislation that are under MEPs' scrutiny in that discussions. I also have speeches pronounced by people invited to the Parliament. This includes members of the European Commission and Council and potentially invited heads of state, etc.

⁵More information [here](#).

I complemented this dataset by incorporating MEPs' individual characteristics from [parltrack website](#) such as gender, age, member state of origin, and EP political group. I also matched my database with that of [Salvati \(2022\)](#), allowing to add the current term of MEPs, their seniority in the EP, as well as their former occupation (which helps construct the dummy of whether or not they are career politicians). This additional information allows me to investigate the links between individual characteristics and peer effects. Relying on the [European Parliament's website](#), I am able to access additional characteristics of some MEPs related to their educational background – for instance whether an MEP holds a PhD.⁶

Table 2.3.3 summarizes the individual characteristics of all observed speakers in my dataset. I also observe the distribution of speeches between Strasbourg and Brussels as well as between legislatures. Table 2.5.1 describes the MEPs peers characteristics.

Seating dataset. In both Strasbourg and Brussels, every MEP is allocated a designated seat within their respective political group. EP staff provided me with the seating plans used during each voting procedure for the periods of October 1999 to November 2022 in Strasbourg and Brussels. For only two sessions no seating plan was available, so I assumed that the seating remained the same as in the previous plan. The main analysis goes from 2004 to 2019 mostly for two reasons. Firstly, the Covid pandemic forced MEPs to shift to online sessions for more than 12 sessions during 2020 and 2021, followed by a period of hybrid mode when only leaders were physically present but with great physical distance between them. Secondly, it is important to note that the alphabetical seating rule was abolished for non-voting sessions in 2019 onward. The primary motivation for this decision was communication. By encouraging MEPs to occupy front-row seats during low-attendance sessions, the appearance of the EP is improved, mitigating a sparsely-populated look in the hemicycle that might otherwise invite criticism of laziness.

Although MEPs from the same political group can be separated by an aisle – there are four aisles in the EP, as mentioned in interviews (Appendix 2.F), interactions can still occur across those aisles during breaks, which does not rule out the possibility of peer effects.

⁶This measure of education level is more useful than having a university degree because in my sample virtually every MEP holds a college degree.

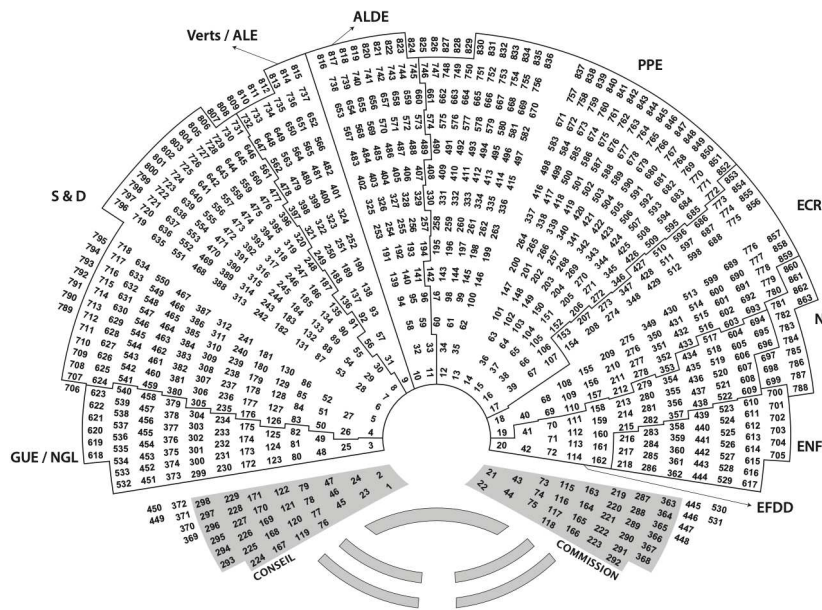


Figure 2.3.1: Seating plan - European Parliament 09.05.2016 (Strasbourg).

Figure 2.3.1 in this paper shows an example of a seating plan for the Strasbourg venue, mentioning the associated EPGs (ALDE, PPE, VERTS/ALE, S&D, etc.) for each group of seats. The numbers in the chart correspond to specific seats and can be linked to a list of MEP names provided separately (see Figure 2.A.2). For charts for both venues, see Figure 2.A.1.

2.3.3 Alphabetical seat assignment in the EP

Seating arrangements in the European Parliament are determined by the guidelines established by the venue’s Conference of Presidents. As mentioned earlier, MEPs belonging to the same EPG sit together. Within each political group, the leaders, including the president and vice presidents, occupy the front rows in an indeterminate order. Significantly for my objective, until 2019, the rules of the European Parliament mandated that seats for MEPs without leadership positions be “generally allocated in alphabetical order” by last name, though the seating policies did permit a MEPs to “occasionally occupy another place for organizational or technical reasons.”⁷

⁷See this link.

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I leverage the quasi-random variation in seating arrangements generated by the alphabetical seating rule. Upon examination of the seating arrangement, it is apparent that four minor EPGs and the group of unaffiliated MEPs deviate from the rule of assigning seats based on alphabetical name order.⁸ Out of the six other groups (encompassing over 80% of all individuals in my dataset), the alphabetical seating rule applies to the majority of MEPs. Within "alphabetical groups," I notice a leadership section in the initial rows where seat assignment is independent of the members' names. Following this, there is a section for non-leaders where seat assignments show a notable (though not flawless) correlation with the alphabetical order of surnames.⁹ To demonstrate the capacity to predict seat assignments thanks to alphabetical order, Figure 2.3.2 provides a visual representation of within-group alphabetical rank plotted against within-group seat number for two distinct groups. In Panel A, it is evident that the GUE (Confederal Group of the European United Left) does not follow seating policies: there is no correlation between alphabetical order and seat allocation in this group. In Panel B, I illustrate the relationship for the S&D (Socialists & Democrats). Within the first few seats, there is no apparent correlation between alphabetical rank and seat allocation — this is where MEPs with leader positions seat.

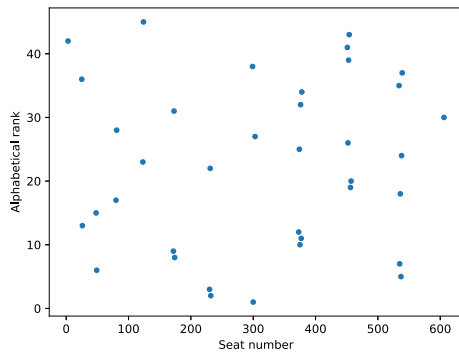
Among the non-leaders, starting from seat 319 onwards, the position in the alphabetical order proves to be a consistently reliable indicator of seat assignment, as evidenced by the strong correlation between the two variables. It is important to note, however, that adherence to this pattern is not perfect, as two MEPs in seats 637 and 688 deviate from alphabetical order.

Considering all days, the correlation between within-group seat number and alphabetical rank stands at 0.87 within the sample of non-leaders from EPGs that adhere to alphabetical seating.

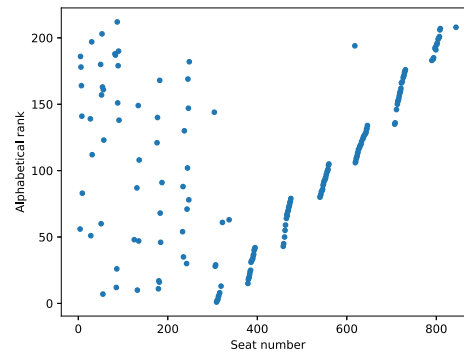
⁸The four groups that diverge from the alphabetical seating rule are the European United Left–Nordic Green Left, Independence–Democracy, Union for Europe of the Nations, and Identity, Tradition and Sovereignty.

⁹Another group that deviates from the seating policy is the "Alliance of Liberals and Democrats for Europe." It appears that this group applies alphabetical seating in a segment of its leadership section. As a result, I have chosen to omit this particular group's leadership section from the placebo exercise outlined in Table 2.5.4.

Figure 2.3.2: Seating and alphabetical rank.



Panel A - GUE/NGL (non-alphabetical).



Panel B - S&D (alphabetical seating).

2.4 Language similarity

2.4.1 Vector embedding

To measure the influence of peer effects on MEPs' speeches, I employ advanced techniques in natural language processing, specifically vector embedding. This approach captures both the similarity in topics chosen by speakers and in the phrases they use to discuss them.

Vector embedding is a cutting-edge method in natural language processing. It shares its technology with word embeddings. Word embedding is an algorithm that generates dense numerical representations of words based on their co-occurrence statistics in large corpora (Mikolov et al. (2013); Pennington et al. (2014)). It maps each word to a lower-dimensional space, where semantically related words are grouped closer together. Words with strong co-occurrence relationships will exhibit similar correlations in this vector space. The model identifies a set of coordinates for each word vector, determining the angles between vectors. By capturing these angles, word embeddings establish meaningful connections between textual elements. For example, words like "economics" and "markets" will be close to each other, whereas "economics" and "constitution" will be farther apart. Additionally, words like "economics" and "economy" will demonstrate even higher similarity, resulting in a higher measured similarity. This word embedding approach provides a continuous measure of semantic distance, addressing the limitations of sparse word counting from a dictionary.

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Table 2.3.3: Overview of samples used in the analysis.

	Main analysis Non-leaders, EPGs using alphabetical seating	Placebo sample 1: EPGs not using alphabetical seating	Placebo sample 2: Leaders, EPGs using alphabetical seating	Total available
EP5 (1999-2004)				
<i>Frequencies:</i>				
Nbr of EPGs	4	3	4	7
Nbr of MEPs	463	194	90	747
Nbr of speeches	34,562	6,253	12,166	52,981
<i>MEP characteristics:</i>				
Mean age	54.35	56.06	55.95	55.12
Mean tenure in EP	0.81	1.38	1.14	1.02
Share women	0.34	0.13	0.23	0.23
Share PhD	0.6	0.4	0.9	0.6
Share newcomer	0.44	0.23	0.15	0.34
Share reelected	0.5	0.41	0.73	0.46
EP6 (2004-2009)				
<i>Frequencies:</i>				
Nbr of EPGs	4	3	4	7
Nbr of MEPs	637	674	354	908
Nbr of speeches	39,356	8,568	17,398	65,322
<i>MEP characteristics:</i>				
Mean age	49.86	55.23	52.01	51.12
Mean tenure in EP	0.75	0.86	1.64	0.88
Share women	0.43	0.18	0.39	0.40
Share PhD	0.11	0.08	0.06	0.09
Share newcomer	0.55	0.37	0.16	0.44
Share reelected	0.44	0.31	0.84	0.40
EP7 (2009-2014)				
<i>Frequencies:</i>				
Nbr of EPGs	4	4	4	8
Nbr of MEPs	578	770	26	844
Nbr of speeches	101,232	18,323	30,919	150,474
<i>MEP characteristics:</i>				
Mean age	52.33	54.41	57.69	53.62
Mean tenure in EP	0.55	0.62	1.27	0.61
Share women	0.45	0.21	0.21	0.34
Share PhD	0.17	0.3	0.13	0.14
Share newcomer	0.46	0.49	0.13	0.42
Share reelected	0.44	0.31	0.79	0.37
EP8 (2014-2019)				
<i>Frequencies:</i>				
Nbr of EPGs	4	4	4	8
Nbr of MEPs	504	809	25	850
Nbr of speeches	159,954	23,369	30,866	214,186
<i>MEP characteristics:</i>				
Mean age	48.23	53.57	51.28	51.62
Mean tenure in EP	0.66	0.45	1.33	0.60
Share women	0.46	0.21	0.28	0.35
Share PhD	0.13	0.08	0.057	0.09
Share newcomer	0.57	0.68	0.06	0.60
Share reelected	0.38	0.23	0.82	0.33
EP9 (2019-2022)				
<i>Frequencies:</i>				
Nbr of EPGs	4	4	4	8
Nbr of MEPs	418	725	28	797
Nbr of speeches	26,362	2,325	6,895	35,582
<i>MEP characteristics:</i>				
Mean age	49.24	53.82	50.9	51.22
Mean tenure in EP	0.71	0.81	0.84	0.78
Share women	0.48	0.21	0.28	0.41
Share PhD	0.11	0.09	0.06	0.10
Share newcomer	0.52	0.48	0.55	0.49
Share reelected	0.39	0.34	0.44	0.37

Notes: The table depicts MEPs categorized into three subgroups based on their observed presence at different times, potentially causing some overlap between these groups. As a result, the numbers in the table might not reconcile with the total count of the entire dataset. MEP attributes are noted at the time of their initial recorded speech in the data.

One remarkable aspect of vector embedding is the ability to perform algebraic operations on the vectors. The classic example is the equation " $Queen = King - Man + Woman$ " which demonstrates the capability to manipulate and reason with the vector representations.

I expand the use of word embeddings by incorporating additional input variables, working at the speech level, in addition to the context words (Le and Mikolov (2014)). This approach, initially referred to as paragraph vectors or party embeddings (Rheault and Cochrane (2019)), allows for a more comprehensive analysis. In this study, the unit of analysis is MEP by session. Just as words have their embeddings, MEPs will possess their own corresponding vectors, effectively representing their language patterns¹⁰ for a given session.

One significant advantage is that these MEP embeddings can be compared against the rest of the corpus vocabulary in a shared vector space, facilitating straightforward comparisons.

I use MEP-session pairs as indicator variables because considering combinations of MEPs and time periods allows to represent language dynamics depending on the discussed laws (and thus topics) on specific dates. Each MEP within a given session has a unique embedding. This approach captures the possibility that the language and issues debated by each MEP may evolve from one session to the next, reflecting the dynamic nature of peer influence. MEP language representations can "move" over time in the vector space.

Among the various vector embedding algorithms and model training options available, I selected the algorithm developed by Mikolov et al. (2013) and Pennington et al. (2014) called *Doc2Vec*. The implementation uses Python's gensim library with three-hundred-dimensional vectors, an eight-object context window, and training for ten rounds. These choices align with standard hyperparameters commonly used in applied natural language processing research. Previous research has shown that in social-science contexts, downstream measurements are not highly sensitive to these choices (Rodriguez and Spirling (2022) and Ash and H. (2017)).

A particularity of this corpus is that it gathers the 24 official languages of the European Union since MEPs are allowed to speak in their native language. Therefore, the corpus

¹⁰*Language pattern* can be understood as a mathematical representation of how a particular MEP communicates or expresses themselves in a given session.

was translated into English when needed using *Google Translate*. As demonstrated by Gao et al. (2023), Li et al. (2019) and Artetxe and Schwenk (2019), automated translation typically maintains consistency and accuracy, especially when using *Doc2Vec*, minimizing potential biases or distortions.

In summary, vector embeddings enable me to capture the intricacies and contextual use of language in MEPs' speeches, facilitating a more comprehensive analysis of peer effects and their impact on language patterns.

2.4.2 Assessing distances

With the vector representations of MEPs, denoted as ζ , I can measure the language similarity between two MEPs i and j by calculating the Euclidean distance $d_{i,j}$ between their corresponding vectors ζ_i and ζ_j . These vectors, normalized and placed in an M -dimensional space, represent their embedded political speech. ζ_{im} and ζ_{jm} are the m -th components of the vectors for MEPs i and j , respectively. A smaller Euclidean Mean distances greater language similarity within a given session. The distance is computed using the *Doc2Vec* training process, and is expressed as:

$$d_{i,j} = \sqrt{\sum_{m=1}^M (\zeta_{im} - \zeta_{jm})^2}$$

The Euclidean distance measure is widely used in linguistics and data mining due to its computational efficiency (Sebastiani (2002)).¹¹ Economists have also started adopting this measure (Hoberg and Phillips (2016)). In this context, the measures are validated by examining whether pairs of MEPs sharing common characteristics (such as belonging to the same political group or coming from the same member state) exhibit lower Euclidean distance compared to pairs without these shared characteristics (Table 2.5.1). The Euclidean distance is found to be significantly lower for same-group and same-country pairs compared to cross-characteristic pairs, at the 5% or 1% significance level. The difference in Euclidean distance between same-group and same-country pairs and cross-group and cross-country pairs ranges from 0.21 to 0.37 standard deviations of

¹¹Another widely used measure is cosine similarity. It should be noted that Euclidean distance and *cosine similarity* become proportional when the vectors are normalized. A demonstration can be found [here](#).

the outcome. This suggests that the language similarity measures capture the partisan nature of speech observed (Gentzkow et al. (2019b)).

2.5 Empirical strategy and results

2.5.1 Empirical strategy

To investigate the potential influence of physical proximity on speaking behaviour, I examine the Euclidean distance among pairs of MEPs who are seated next to each other. First, the main analysis focuses on each session within each EPG and considers all possible pairs of MEPs within the same EPG who are present and participate from September 2004 until June 2019. In this section, I adopt the empirical strategy used by Harmon et al. (2019). Thus, data is at the MEP pair-session level, with one observation for each possible MEP pair in any given session. With N MEPs in a given session, this means a total of $\frac{N(N-1)}{2}$ observations for that session. Using the indexing notation, ij represents the MEP pairs, and t represents the specific session. The variable $Distance_{ijt}$ represents the normalized Euclidean distance of speaking between individual i and individual j during time t . Additionally, the variable $SeatNeighbours_{ijt}$ is created to indicate if MEP pair ij were seated side by side during the respective session t .

To estimate the causal impact of sitting together on speaking concordance, a naive approach would compare the speaking behaviour of MEP pairs who sit adjacent to each other (treated observations) with those who do not (untreated observations). This is achieved by regressing the dependent variable, $Distance_{ijt}$ on the explanatory variable, $SeatNeighbours_{ijt}$:

$$Distance_{ijt} = \beta_0 + \beta_1 SeatNeighbours_{ijt} + \nu_{ijt} \quad (2.5.1)$$

Considering the estimate of β_1 as the causal impact of sitting side by side on speaking behaviour raises two concerns. Firstly, MEPs who already exhibit similar speaking behaviour might be more inclined to *decide* to seat next to each other. Secondly, even among MEPs who adhere to the alphabetical seating rule, the rule itself may prompt MEPs with a higher likelihood of having similar speaking behaviour to choose to sit

together. This could be attributed to factors such as individuals with more similar names tend to have more similar backgrounds.

To overcome the potential endogeneity concerns regarding the interpretation of β_1 as the causal impact of sitting together on language distance, I follow two steps. To tackle the first issue, the focus is restricted to the group sections where non-leadership seat. Secondly, the seating assignment rule is used as an instrument for seating adjacency. The main analysis sample is defined to include observations $ij t$ where the MEP pair ij belongs to an alphabetically seated EPG, and both MEPs do not hold leadership positions at time t . In this sample, I created the indicator variable $NameAdjacent_{ijt}$ to identify whether the last names of MEP pair ij are sequentially ranked in the alphabetical name order within their respective sections during a specific session. Table 2.5.1 furnishes descriptive statistics for the main analysis sample along with all pertinent variables.

By using these defined sample and variable specifications, an intent-to-treat (ITT) estimate, denoted as $\hat{\gamma}_1$, is derived from the following estimation:

$$Distance_{ijt} = \gamma_0 + \gamma_1 NameAdjacent_{ijt} + \varepsilon_{ijt} \quad (2.5.2)$$

I can use $NameAdjacent_{ijt}$ as an instrument for $SeatNeighbours_{ijt}$ in Equation 2.5.1 to get a Local Average Treatment Effect (LATE) estimate, β_1^{IV} . In order to guarantee that the ITT and LATE estimates accurately measure peer effects, it is crucial that the assignment indicator, $NameAdjacent_{ijt}$, is not systematically linked to unobservable factors that could impact MEP pairs' tendency to speak more similarly. This gives rise to two potential concerns that require attention. Firstly, the mechanical correlation between $NameAdjacent_{ijt}$ and MEP pairs belonging to smaller groups could potentially influence the results, since a greater proportion of MEP pairs in smaller groups are likely to be name-adjacent.

To mitigate this risk, group-by-parliamentary term fixed effects are included as controls. Secondly, MEPs with closely related surnames might share comparable backgrounds, which can potentially influence their speaking behaviour. To address this, I add controls for name similarity.

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Table 2.5.1: Summary statistics.

	N	mean	sd	min	max
MEP Pair characteristics					
Same member states	810,945	0.08	0.27	0	1
Both PhD	810,945	0.08	0.86	0	1
Same freshman status	810,945	0.72	0.45	0	1
Same tenure	810,945	0.49	0.50	0	1
Age difference (years)	810,945	10.89	8.32	0	57.00
Tenure difference (years)	810,945	1.06	1.10	0	5
Same gender	810,945	0.56	0.50	0	1
Speaking and seating					
Distance	810,945	0.2359	0.00005	-0.053652	0.0937163
Name adjacent	810,945	0.8737	0.1163	0	1
Seat neighbours	810,945	0.9127	0.1119	0	1
Seat neighbours, predicted	810,945	0.0126	0.1117	0	1
Seat neighbours, previous venue	570,945	0.0124	0.1107	0	1
Seat neighbours, previous venue, predicted	570,945	0.0124	0.1106	0	1
Seat neighbours, both venues	570,945	0.0108	0.1033	0	1
Seat neighbours, both venues, predicted	570,945	0.0114	0.1059	0	1
Name similarity measures					
Same name	810,945	0.0003	0.0080	0	1
Overall name rank gap	810,945	416	293	1	1,258
Names sound alike	810,945	0.0015	0.028	0	1
Levenshtein name similarity	810,945	0.134	0.1452	0	1
Bigram-Jaccard name similarity	810,945	0.056	0.0625	0	1

Notes: This data consists of observations at the session-by-MEP-pair level for the main analysis sample. 'Both PhD' signifies the simultaneous possession of a PhD degree by both MEPs. 'Same freshman status' indicates if both MEPs are newly elected in the EP. 'Name adjacent' denotes whether the MEP pair is one after another in alphabetical order of surnames within their seating section (non-leadership section of their EPG) during the session.

'Seat neighbours' signifies that the MEPs' pair are seating side by side during the given session. 'Seat neighbours, previous venue' indicates if MEPs were seating neighbours in the preceding meeting at the other venue. 'Seat neighbours, both venues' signifies MEPs who are currently seat neighbours and were also seat neighbours during the most recent meeting at the other venue. 'Names sound alike' indicates similarity in MEPs' surnames using the 'SoundEx' algorithm. 'Overall name rank gap' represents the difference in alphabetical ranking between MEPs' last names among all MEP last names in the dataset. Other variables' meanings are self-explanatory. Variables with the 'predicted' suffix are derived from hypothetical seating charts, assuming perfect compliance with alphabetical seating rules within the non-leadership section of each EPG on each day. Same description table as in [Harmon et al. \(2019\)](#).

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To test for this possibility, I examined whether EPGs with last names that are alphabetically adjacent share similarities in predefined attributes. Following the standard method of assessing covariate balance in randomized trials, the left-hand side of the regression in Equation 2.5.2 can be substituted with various predetermined characteristics observed in the MEP pair data. This enables an evaluation of whether MEPs with last names that are alphabetically adjacent exhibit greater similarity in terms of predefined attributes, both prior to and after accounting for the controls. The six predefined attributes considered are: whether they are both new in the EP, whether they share the same gender, whether they come from the same member state, the age-gap between them in years, whether they are both freshmen or both non-freshmen in politics and their difference in European Parliament seniority in years.

Table 2.5.2 presents the association between alphabetical order and similarity in predetermined attributes. Panel A displays the results without any controls, while Panel B includes group-by-parliamentary term fixed effects and a set of name similarity controls. They consist of dummy if individuals share similar surname and an indicator of the closeness between their surnames in the overall alphabetical ranking of all MEPs in the dataset. To address potential correlations in behaviour within clusters of MEPs sitting in close proximity, dyadic-cluster robust standard errors are employed throughout the analysis, with clustering at the level of row-by-EP-term-by-group.

Panel A - no controls

	(1)	(2)	(3)	(4)	(5)
	Seat-neighbours	Freshman-status	Same-country	Tenure-difference	Age-difference
Name adjacent	0.8774*** (0.001)	0.0090 (0.020)	0.0335** (0.016)	-0.4568 (0.060)	-0.0520 (0.055)
Constant	0.2348*** (0.000)	0.7562*** (0.002)	0.0196*** (0.008)	1.9620*** (0.001)	0.7520*** (0.008)
Observations	810, 945	810, 945	810, 945	810, 945	810, 945
Clusters	76	76	76	76	76

Panel B - name resemblance controls

	(1)	(2)	(3)	(4)	(5)
	Seat-neighbours	Same-country	Freshman-status	Same-gender	Age-difference
Name adjacent	0.8359*** (0.002)	0.0552 (0.033)	0.0520 (0.027)	0.0350 (0.082)	0.0302 (0.018)
Same name	-0.06300 (0.061)	0.4610* (0.186)	0.0366** (0.159)	0.0632 (0.185)	0.4200* (0.202)
Rank gap is 1	0.9632*** (0.0348)	0.0285 (0.056)	-0.6301*** (0.064)	-0.0852*** (0.013)	-0.0263 (0.061)
Rank gap is 2-5	0.0686 (0.061)	0.6320*** (0.006)	0.0252 (0.018)	0.0200 (0.033)	-0.2520*** (0.027)
Rank gap is 6-10	0.0201*** (0.085)	0.3520 (0.093)	0.0250 (0.097)	-0.0141 (0.076)	0.0252 (0.080)
Rank gap is 11-20	0.0282 (0.024)	-0.7410*** (0.002)	-0.8500*** (0.012)	-0.0015 (0.017)	-0.8510*** (0.016)
Rank gap is 21-40	0.0048** (0.004)	0.5620*** (0.000)	-0.2525** (0.004)	-0.0562 (0.021)	-0.2335*** (0.013)
Rank gap is 41-80	0.0005 (0.008)	-0.0007 (0.001)	-0.0143** (0.006)	0.0224*** (0.004)	-0.0038 (0.013)
Rank gap is 81-160	-0.0001 (0.0003)	0.0012 (0.0048)	0.0044 (0.0100)	0.0199** (0.0097)	-0.0176 (0.011)
Rank gap is 161-320	0.0001 (0.002)	0.05820*** (0.002)	0.0150 (0.009)	0.8505*** (0.003)	-0.0258 (0.060)
Rank gap is 321-640	0.0002 (0.003)	0.0000 (0.007)	0.3005 (0.008)	0.0259* (0.019)	-0.0259 (0.060)
Legislature-by-EPG FE	Yes	Yes	Yes	Yes	Yes
Observations	1, 890, 420	1, 890, 420	1, 890, 420	1, 890, 420	1, 890, 420
Clusters	76	76	76	76	76

Notes: This data consists of observations at the session-by-MEP-pair level for the main analysis sample. Each section of the table displays the results of Ordinary Least Squares (OLS) regressions. Column (1) contains an indicator for seating side by side. Column (2) is an indicator for sharing the same freshman status. Column (3) includes an indicator for both MEPs originating from the same constituency. Column (4) includes an indicator for both MEPs having the same surname. In Panel A, the independent variable is an indicator for shared gender. In Panel B, the independent variable is an indicator for shared gender. Panel B adds Legislature-by-EPG fixed effects, an indicator for both MEPs having the same surname, and a flexible set of indicators capturing the of surnames within their seating section. Panel B adds Legislature-by-EPG fixed effects, an indicator for both MEPs having the same surname, and a flexible set of indicators capturing the of surnames within their seating section. Standard errors, shown in parentheses, are cluster-robust at the dyadic level, clustered at the row-by-EPG-by-parliamentary-term level. The number of such clusters is listed in the first row of each column. *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$. This table description matches that of [Harmon et al. \(2019\)](#).

Before examining covariate balance, Column (1) presents the first stage of the instrumental variable approach, demonstrating a strong predictive relationship between alphabetical adjacency and sitting close to each other. In both panels, the coefficient on $NameAdjacent_{ijt}$ exceeds 0.88 and is accurately estimated, with a standard error below 0.002 in both panels. Moving on to the correlation between alphabetical proximity and pre-existing characteristics, Column (3) reveals that in the without name similarity control, alphabetical adjacency can predict if the pair comes from the same member state. However, this relationship disappears when conditioning on political group and name similarity in Panel B. Columns (2) and (4) to (8) demonstrate that alphabetical adjacency is not associated with other measures of similarity, such as age gap, EP seniority gap, gender, freshmen, irrespective of the inclusion of name similarity controls. These findings suggest that once political group and name similarity are taken into account, the most apparent confounding factors related to alphabetical adjacency do not appear to be correlated with my instrument.

2.5.2 Estimated peer effects within a political group

I present my main findings in Table 2.5.3. Firstly, I conduct an intent-to-treat analysis by reporting the specification in Column (1), which only includes time fixed effects. The estimated coefficient is -0.0166 , and it demonstrates high significance. To address risks related to potential correlations between name adjacency and group identity, as well as the influence of name similarity, I address these issues by including legislature-by-EPG fixed effects and my baseline set of name similarity controls in Column (2). Despite the inclusion of these controls, the coefficient only experiences a slight decrease to -0.0142 . These outcomes are expected, considering the findings from Table 2.5.2.

	(1) Distance OLS	(2) Distance OLS	(3) Distance OLS	(4) Distance OLS	(5) Distance OLS	(6) Distance 2SLS
Name adjacent	-0.0166*** (0.001)	-0.0142**** (0.002)	-0.0142**** (0.002)	-0.0143**** (0.004)	-0.0143**** (0.003)	-0.0137*** (0.003)
Seat neighbours						
Same education level			-0.0029**** (0.001)	-0.0029**** (0.001)	-0.0029**** (0.001)	
Same freshman status			-0.0058**** (0.002)	-0.0054**** (0.002)	-0.0051**** (0.001)	
Same country			-0.0303*** (0.015)	-0.0303*** (0.016)	-0.0303*** (0.016)	
Age difference			-0.0004**** (0.001)	-0.0004**** (0.001)	-0.0004**** (0.001)	
Tenure difference			-0.0021**** (0.000)	-0.0021**** (0.000)	-0.0021**** (0.001)	
Same gender			-0.0017**** (0.000)	-0.0014**** (0.000)	-0.0015**** (0.001)	
Day-level FE	Yes	Yes	Yes	Yes	Yes	Yes
Name controls	No	Yes	Yes	Yes	Yes	Yes
EP-by-EPG FE	No	Yes	Yes	Yes	Yes	Yes
Additional name controls	No	No	No	Yes	Yes	No
Additional rank gap controls	No	No	No	No	Yes	No
Observations	810,945	810,945	810,945	810,945	810,945	810,945
Clusters	76	76	76	76	76	76
F-stat						988.3

Notes: This data consists of observations at the session-by-MEP-pair level for the main analysis sample. The dependent variable is the Euclidean distance between the document embedding vectors are self-explanatory (refer to Table 2.5.2 notes for detailed definitions). The "Name controls" include an indicator variable to determine if the MEPs share the same last name, along with a flexible MEPs' last names in the alphabetical ranking of all MEP last names in the dataset. The "Additional name controls" consist of cubic polynomials in both the *Beyrarn* – *Jaccard* and *Levenshtein* to ascertain whether the names sound alike under the *SoundEx* algorithm. The "Additional rank gap controls" are indicators for every 10-seat ballot box in the "overall name rank gap" columns (1)–(5) were obtained through Ordinary Least Squares (OLS), while estimates in Columns (6) and (7) were derived from Two-Stage Least Squares (2SLS), using the indicator for name seated adjacently. Standard errors, shown in parentheses, are cluster-robust at the dyadic level, clustered based on row, EPG, and parliamentary term. The number of clusters is provided in the bottom 2SLS column correspond to the first-stage F-statistic measure of instrument strength proposed by Stock and Yogo (2005). Significance levels are indicated as follows: *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$, Harmon et al. (2019).

As in Harmon et al. (2019) columns (3), (4), and (5) explore the robustness of my estimate by introducing additional controls. In Column (3), I incorporate controls for the proximity of each MEP pair in terms of observable pre-determined personal attributes. Columns (4) and (5) focus on additional measures of name similarity to investigate whether my baseline set effectively mitigates potential omitted variable bias. Specifically, in Column (4), I include other standard measures of name similarity such as *Jaro – Winkler* distance and *Levenshtein* measures, along with an indicator for whether the MEPs' names phonetically resemble each other, as determined by the algorithm *SoundExalgorithm*.¹² In Column (5), I further enhance the set of controls by incorporating indicators for each possible ballot box of ten values (e.g., 21-30, 41-50, etc.) based on the overall name rank gap. Throughout all these specifications, the coefficient on $NameAdjacent_{ijt}$ stays reliably constant around -0.0142 .

Lastly, in Columns (6) and (7), I present my LATE estimates, employing Table 2.5.2, Column (1) to instrument for $SeatNeighbours_{ijt}$ with $NameAdjacent_{ijt}$. In my preferred specification, Column (6), which only includes the benchmark set of name similarity controls, the consequence of being $Seatneighbours_{ijt}$ on $Distance_{ijt}$ is -0.0137 . It suggests that sitting side by side decreases the language distance of two MEPs from the same group by 7 percentage points.

To give a sense of the magnitude of seat adjacency, I can compare it with the effects of other characteristics within the pairs. Shared nationality is notably the most influential, exhibiting a coefficient of -0.0303 . Hence, the overall impact of seating adjacency is roughly half that of shared nationality. This is consistent with national interests as a crucial determinant of MEPs' behaviour (see Chapter 1 and Hix (2002)) and common origins leading to a similar patterns in the way of talking. The coefficient

¹²The *Jaro – Winkler* distance is a string similarity measure that extends the *Jaro* distance, comparing two strings based on the number of matching characters and transpositions. It considers the common prefix shared by the strings, giving more importance to the initial characters. This weighting is useful for comparing strings with common prefixes, like names or addresses. The distance ranges from 0 to 1, with 0 indicating no similarity and 1 indicating an exact match. A higher value indicates greater similarity between the strings. The *Levenshtein* distance between two names represents the minimum number of operations required (including additions, deletions, or substitutions) to transform one name into the other. To convert this distance into a similarity measure, I calculate it as follows for each pair: I first determine the size of the longer name, subtract the Levenshtein distance, and then divide by the size of the longer name. This conversion ensures that *Levenshtein* and *Jaro – Winkler* similarity fall within the range of zero to one, and they are only equal to one when the two names are an exact match.

on 'Same freshman status' carries the third highest predictive power for language similarity in my analysis, with a value of -0.0056 . To put it in perspective, the overall impact of seating adjacency is roughly twice the effect observed for the members of the pair being both new-MEPs. In Column (7), I examine a specification that includes the complete set of controls, and the coefficient remains stable. Additionally, in Appendix 2.D.2, I investigate whether peer effects occur at greater physical distances beyond immediate neighbours by comparing the language similarity of MEPs seated two, three, or four seats apart or in the same row. Aligned with [Harmon et al. \(2019\)](#) in terms of voting behaviour, the results show no statistically significant evidence of seating peer effects beyond pairs of MEPs who are immediate neighbours. Moreover, the effect weakens as the seats are further apart. This further reinforces my interpretation that the patterns observed are indeed peer effects based on learning due to seating proximity rather than a result of name similarity.¹³

To address the possible risk of unobserved differences altering my results, I perform placebo tests utilizing MEP pairs from four political groups that do not adhere to alphabetical seating rule, as well as with leaders of the alphabetical groups. If the ITT and LATE estimates in my primary regressions exclusively capture causal peer effects of seat proximity, I would not expect finding a correlation between speaking distance and alphabetical adjacency in these alternative groups, where surnames do not dictate how to seat. I define $NameAdjacent_{ijt}$ as a dummy if the two MEPs, from the leadership section, were adjacent in the order of names.¹⁴ In Table 2.5.4, Panel A, I investigate the impact of alphabetical proximity on seating and speaking for the heads MEPs. The first

¹³As [Harmon et al. \(2019\)](#) discussed, the layout of the European Parliament creates a significant distance between front and back neighbours compared to side-to-side ones. Additionally, the tiered seating arrangement and large desks further hinder physical interaction. Due to these factors, I do not anticipate peer effects to result in a correlation with the voting behaviour of MEPs seated in front of or behind each other. Furthermore, I lack an instrument to measure the proximity of front-and-back seated MEPs.

¹⁴The definition of $NameAdjacent_{ijt}$ closely resembles the one used in the primary dataset under examination, focusing on alphabetical adjacency in a specific group. As there are less leaders than non-leaders, with leaders making up approximately 32 percent of MEPs in alphabetically seated groups, one might question whether name adjacency among leaders is a weaker indicator of name similarity. To address this risk, in Appendix 2.D.3, I perform for the leadership section the placebo test, assessing the ranking of names over the entire group. This approach yields same findings, providing reassurance regarding the strength of the correlation between name adjacency and similarity for leaders.

two columns demonstrate that, in line with the non-alphabetical arrangement among leaders (supported by my empirical findings in Figure 2.3.2), alphabetical adjacency does not predict whether leaders are seat neighbours.

The subsequent columns replicate the ITT analysis from Table 2.5.3 using this other subsets. The estimated effects of $NameAdjacent_{ijt}$ are almost null but positive. Across every estimation, I can reject the null hypothesis that adjacency in the alphabetical order of last names results in an increase of more than 0.4 percentage point in speaking distance. In Panel B, I conduct similar estimate for the subset of non-alphabetical groups. Here, there is evidence suggesting that alphabetical adjacency predicts seat neighbours for a very small subset of them (8%). However, it does not predict speaking behaviour. The absence of correlation between alphabetical adjacency and speaking behaviour throughout Table 2.5.2 helps alleviate risks that my findings are influenced by unobservable factors of MEP pairs, such as socioeconomic backgrounds or regional origins within EU member states.

Data from non-alphabetical groups also illustrates the importance of my instrumental variable approach and highlights the shortcomings of a simplistic specification that only examines the correlation between sitting side by side and language similarity without considering potential selection biases. In Table 2.D.1 in Appendix 2.D.5, I find that in groups that do not impose alphabetical seating, sitting together increases language distance by 3 percentage points, an estimate that is five times larger than the selection-proof LATE estimate from my main specification.

2.5.3 Contemporaneous versus persistent peer effects

The analysis of peer effects has so far only focused on static effects, only examining the influence of sitting together during a particular session. This approach considers contemporaneous peer effects, where an MEP is influenced by her immediate neighbours during a single session. However, it is also possible for peer effects to persist thereafter, so that they influence future speeches even when the peers are no longer seated next to each other.

By investigating persistent effects, I can rule out direct forms of peer influence such as social pressure, monitoring or 'parroting'. The influence of nearby peers should intensify over a legislature as social links strengthen through repeated interactions. Their

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Table 2.5.4: Placebo test - leaders and non-alphabetical groups.

Panel A - leadership sections of alphabetical parties							
	(1) Seat neighbours	(2) Seat neighbours	(3) Distance	(4) Distance	(5) Distance	(6) Distance	(7) Distance
Name adjacent	-0.0255 (0.039)	-0.0455 (0.045)	0.0031 (0.012)	0.0035 (0.007)	0.0040 (0.014)	0.0041 (0.017)	0.0037 (0.009)
Observations	18,560	18,560	18,560	18,560	18,560	18,560	18,560
Cluster	69	69	69	69	69	69	69
Panel B - non-alphabetical groups							
	(1) Seat neighbours	(2) Seat neighbours	(3) Distance	(4) Distance	(5) Distance	(6) Distance	(7) Distance
Name adjacent	0.0844* (0.032)	0.0602* (0.070)	-0.0002 (0.021)	0.004 (0.027)	0.0012 (0.030)	0.0017 (0.011)	0.0017 (0.024)
Observations	111,091	111,091	111,091	111,091	111,091	111,091	111,091
Cluster	49	49	49	49	49	49	49
Day-level fixed effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes
EP-by-EPG fixed effects	Yes	No	Yes	No	Yes	Yes	Yes
Baseline name controls	No	Yes	No	Yes	Yes	Yes	Yes
Observable pair characteristics	No	Yes	No	Yes	No	No	Yes
Additional name similarity controls	No	Yes	No	No	No	Yes	Yes
Additional name rank gap controls	No	Yes	No	No	No	No	Yes

Notes: This data consists of observations at the session-by-MEP-pair level for the placebo analysis sample. The dependent variable is the Euclidean distance between the document embedding vectors representing their speeches. The remaining variables are self-explanatory (refer to Table 2.5.2 or Table 2.5.3 notes for detailed definitions). Panel A includes observations where both MEPs are leaders of the same alphabetically seated EPG, while Panel B comprises observations where both MEPs are from the same non-alphabetically seated EPG. Standard errors, shown in parentheses, are cluster-robust at the dyadic level, clustered based on row, EPG, and parliamentary term. The number of clusters is provided in the bottom row of each panel. Significance levels are indicated as follows: *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$. Same description table as in Harmon et al. (2019).

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proximity leads to a decrease in the language distance between MEPs, reflecting a more substantial connection. Rather than mechanical effects, this connection emphasizes cognitive channels like information transmission and persuasion.

To distinguish between these two types of peer effects, I leverage two key elements: (i) by exploiting the two-venue organization of the European Parliament (Strasbourg and Brussels), and (ii) the availability of data from four different legislatures in my dataset.

Figure 2.5.5: Variation in seating between venues.

Panel A - Strasbourg, September 14, 2009, Rows 9-12, Greens-European Free Alliance group (VERTS/ALE)

<i>S & D:</i>	<i>VERTS/ALE:</i>						<i>ALDE:</i>
Row 12:	:	:	:	:	:	:	
Row 11: ...	Seat 561: JADOT	Seat 562: JOLY	Seat 563: KELLER	Seat 564: KIIL-NIELSEN	Seat 565: LAMBERT	Seat 566: LAMBERTS	...
Row 10: ...		Seat 478: GREZE	Seat 479: HAFNER	Seat 480: HASSI	Seat 481: HAUSLING	Seat 482: HAUTALA	...
Row 9:		:	:	:	:	:	

Panel B - Brussels, October 7, 2009, Rows 12-15, Greens-European Free Alliance group (VERTS/ALE)

<i>S & D:</i>	<i>VERTS/ALE:</i>						<i>ALDE:</i>
Row 15:	:	:	:	:	:	:	
Row 14: ...	Seat 603: KELLER	Seat 604: KIIL-NIELSEN	Seat 605: LAMBERT	Seat 606: LAMBERTS	Seat 607: LOCHBIHLER	Seat 608: LOVIN	...
Row 13: ...		Seat 545: HASSI	Seat 546: HAUSLING	Seat 547: HAUTALA	Seat 548: JADOT	Seat 549: JOLY	...
Row 12:		:	:	:	:	:	

Note: The panels display seating arrangements in consecutive EP sittings in (A) Strasbourg and (B) Brussels.¹⁵

Contemporaneous peer effects across venues

In the European Parliament's venues, members of a political group are distributed across multiple rows. Even with strict adherence to the alphabetical seating rule, instances may occur where pairs with adjacent names do not sit adjacently. This can happen if the first MEP in the pair is allocated the last seat in one row, whereas the other member is in the first seat of the subsequent row. Differences in the placement of row endings between Strasbourg and Brussels add further complexity, resulting in situations where alphabetically adjacent MEPs may sit side by side in one location but not in

the other. Figure 2.5.5 illustrates this phenomenon, focusing on rows occupied by the Greens. It depicts MEPs Jadot, Joly, and Keller during the September-October 2009 sessions. While Jadot and Joly are seated adjacent to each other in both Strasbourg and Brussels, Joly and Keller's seating varies, separated by a row ending in Brussels. I will use this variation in seating arrangements to examine the persistence of peer effects and their dependence on the physical vicinity of peers.

Let $SeatNeighboursPreviousVenue_{ijt}$ be an indicator of whether the MEP pair ij sat together during the most recent session in a different venue than the current session t . Similarly, let $SeatNeighboursBothVenues_{ijt}$ indicate if ij sat side by side in both the present venue and the last one held in the another venue, thus representing the interaction between $SeatNeighboursBothVenues_{ijt}$ and $SeatNeighboursPreviousVenue_{ijt}$. To identify persistent peer effects, I examine the subsequent two estimations:

$$Distance_{ijt} = \delta_0 + \delta_1 SeatNeighbours_{ijt} + \delta_2 SeatNeighboursPreviousVenue_{ijt} + \xi_{ijt} \quad (2.5.3)$$

$$Distance_{ijt} = \eta_0 + \eta_1 SeatNeighbours_{ijt} + \eta_2 SeatNeighboursPreviousVenue_{ijt} + \eta_3 SeatNeighboursBothVenues_{ijt} + v_{ijt} \quad (2.5.4)$$

In Equation (2.5.3), parameter δ_1 represents the effect of pair sitting adjacently in the present session, while δ_2 captures the impact of having previously sat together. To examine the persistence of the observed peer effects, I test whether past seating adjacency influences the present session, specifically whether δ_2 is statistically different from zero. Equation (2.5.3) assumes that the impacts of present and past seating are additively separable. To relax this assumption, Equation (2.5.4) allows for an interaction between present and past seating. In this case, the hypothesis that prior seating arrangements do not impact present language use corresponds to a coefficient of zero on both the past seating variable and its interaction with the present seating, i.e., $\eta_2 = \eta_3 = 0$.¹⁶

¹⁶One concern is that being seat neighbours in the previous venue may be correlated with the present proximity of seats, even when they are not immediate neighbours. However, as demonstrated in Appendix 2.D.2, contemporaneous peer effects are limited to immediate neighbours, making this confounding factor less significant thus mitigating this concern.

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Due to potential sorting of like-minded MEPs into adjacent seats, I do not directly estimate Equation (2.5.3) using OLS. Instead, as in [Harmon et al. \(2019\)](#), I leverage the variation in present and past seatings generated by the interaction between the alphabetical seating rule and modifying seat arrangements. By using the seat configurations assigned to each political group during meetings in different venues, I construct predicted seating arrangements, assuming perfect adherence with the seating policies. From these predicted seating configurations, I derive predicted counterparts of the variables defined above: $SeatNeighboursPredicted_{ijt}$, $SeatNeighboursPreviousVenuePredicted_{ijt}$, and $SeatNeighboursBothVenuesPredicted_{ijt}$. In the absence of differences in seat layouts between venues, these variables would exhibit almost perfect collinearity, differing only on dates when MEPs join or leave non-leadership groups. However, due to variations in seat layouts between venues, there is substantial independent variation in these variables, which allows me to use them as instruments in Equation (2.5.3).¹⁷

Table 2.5.6 presents the results that capture peer effects in both venues. In the table, I emphasize my preferred specification, which includes time fixed effects, legislature-by-EPG fixed effects, and the baseline name similarity controls. Initially, I display the results from the specification that only includes $SeatNeighbours_{ijt}$ and $SeatNeighboursPreviousVenue_{ijt}$. (i.e. Equation (2.5.3)). Column (1) displays the reduced form estimates obtained by regressing $Distance_{ijt}$ directly on the two instruments (similar to the ITT estimates in previous tables). Column (2) presents the 2SLS estimates, where I instrument for $SeatNeighbours_{ijt}$ and $SeatNeighboursPreviousVenue_{ijt}$ (similar to the LATE estimates in previous tables). The results from both sets clearly show long-lasting peer effects. Concentrating on the 2SLS estimates, the coefficient on $SeatNeighboursPreviousVenue$ is -0.0087 and significant at 1 percent level ($p = 0.004$), rejecting the null hypothesis that only present seating matters. The coefficient on $SeatNeighbours_{ijt}$ has a similar magnitude (-0.0080) but is not statistically significant. However, the wide standard errors prevent me from ruling out substantial effects

¹⁷In Appendix 2.D.4, I provide the first-stage results for these instruments, which demonstrate their high significance across all specifications. Additionally, each predicted seating variable exhibits strong predictive power for its corresponding non-predicted variable (e.g., $SeatNeighboursPredicted_{ijt}$ strongly predicts $SeatNeighbours_{ijt}$, and $SeatNeighboursPreviousVenuePredicted_{ijt}$ strongly predicts $SeatNeighboursPreviousVenue_{ijt}$). This guarantees sufficient independent strength in all three instruments to identify the distinct effects of the endogenous variables. Consequently, the [Sanderson and Windmeijer \(2016\)](#) conditional first-stage F-statistic measures of instrument strength are high for all endogenous variables.

of present seating or the possibility that the coefficients on $SeatNeighbours_{ijt}$ and $SeatNeighboursPreviousVenue_{ijt}$ are the same. In Columns (3) and (4), I propose to use a more comprehensive specification that permits the interaction between present and past seating (Equation (2.5.4)). The results from this analysis align with the previous findings. Again shifting to the 2SLS estimates, I compute a coefficient of -0.0097 for both $SeatNeighboursPreviousVenue$ and the interaction variable, which are both significant, indicating the influence of past seating on the present session. In this specification the coefficient on $SeatNeighbours_{ijt}$ remains negligible and even marginally positive. Yet, the standard errors prevent me from ruling out the possibility of significant independent effects of present seating or the equality of coefficients across all three seating variables. Thus, I find that past seating proximity continues to affect the present session, regardless of the present seating arrangement. This supports the existence of persistent peer effects.

The two-venue organization of the EP provides me with an opportunity for additional placebo tests, investigating whether being neighbours in a future venue has an effect on the current distance measure. Table 2.5.7 presents the augmented specifications in Equations (2.5.3) and (2.5.4), incorporating the variables $SeatNeighboursFutureVenue_{ijt}$ (in the OLS specification) and $SeatNeighboursFutureVenuePredicted_{ijt}$ (in the 2SLS specification). The former variable is an indicator that identifies whether members of the MEP pair will be seating neighbours in the upcoming session, which will take place in the other venue. The latter variable is constructed using predicted seating indicators for present seating adjacency in the future venue. Reassuringly, the results show no significant impact of being (predicted) neighbours in the next venue at the current levels of language distance.

Persistent peer effects across legislatures

A non-negligible proportion of members are present from one legislature to another. The maximum re-election rate was 45% during the 7th legislature, and the minimum was 37.5% during the 8th one. Thus, I can verify whether the MEPs who sit adjacently in a previous legislature and no longer sit adjacently in the new one still share more language proximity with each other compared to other pairs. Then, I investigate how

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Table 2.5.6: Measuring contemporaneous versus persistent peer effects using venue variation.

	(1)	(2)	(3)	(4)
	Distance	Distance	Distance	Distance
	OLS	2SLS	OLS	2SLS
Seat neighbours, predicted	-0.0080 (0.007)		-0.0057 (0.004)	
Seat neighbours, previous venue, predicted	-0.0097*** (0.001)		0.0069 (0.004)	
Seat neighbours, both venues, predicted			0.0112 (0.007)	
Seat neighbours		-0.0070 (0.004)		-0.0072 (0.004)
Seat neighbours, previous venue		-0.0087** (0.004)		-0.0072 (0.007)
Seat neighbours, both venues				0.0099 (0.009)
Day-level fixed effects	Yes	Yes	Yes	Yes
Legislature-by-EPG fixed effects	Yes	Yes	Yes	Yes
Baseline name controls	Yes	Yes	Yes	Yes
Observations	1, 890, 420	1, 890, 420	1, 890, 420	1, 890, 420
Clusters	76	76	76	76
F-stat: Seat neighbours		320		102
F-stat: Seat neighbours, previous venue		221		110
F-stat: Seat neighbours, both venues				62.92
p-value: past seating does not matter			0.012***	0.001***
p-value: coefficients are equal	0.423	0.425	0.635	0.852

Notes: This data consists of observations at the session-by-MEP-pair level for the main analysis sample. This excludes dates before the first observed venue change, where there is no information about the previous venue. The dependent variable is the Euclidean distance between the document embedding vectors representing their speeches. The remaining variables are self-explanatory (refer to Table 2.5.2 or Table 2.5.3 notes for detailed definitions). Panel A includes observations where both MEPs are leaders of the same alphabetically seated EPG, while Panel B comprises observations where both MEPs are from the same non-alphabetically seated EPG. Standard errors, shown in parentheses, are cluster-robust at the dyadic level, clustered based on row, EPG, and parliamentary term. The number of clusters is provided in the bottom row of each panel. The listed F-statistics in the 2SLS column correspond to *Sanderson and Windmeijer* (2016)'s "conditional first stage F-statistic" measures of instrument robustness under multiple endogenous variables. For Columns (3) and (4), the table shows *p*-values from a *Waldtest* of the hypothesis that the coefficients on Seat neighbours, previous venue and Seat neighbours, both venues or their predicted versions are both zero ("past seating does not matter"). For all columns, the table shows *p*-values from a *Waldtest* of the hypothesis that all listed coefficients are the same ("coefficients are equal"). Significance levels are indicated as follows: ****p* < 0.01, ***p* < 0.05, **p* < 0.1. Same description table as in *Harmon et al.* (2019).

2.5 Empirical strategy and results

Table 2.5.7: Placebo test - the effect of future seating.

	(1)	(2)	(3)	(4)
	Distance	Distance	Distance	Distance
	OLS	2SLS	OLS	2SLS
Seat neighbours, future venue, predicted	0.0080 (0.009)		0.0067 (0.004)	
Seat neighbours, future venue		0.0095 (0.007)		0.0080 (0.005)
Seat neighbours, predicted	-0.0009 (0.001)		0.00013 (0.004)	
Seat neighbours, previous venue, predicted	-0.0101*** (0.003)		-0.0098 (0.009)	
Seat neighbours, both venues, predicted			-0.0087 (0.006)	
Seat neighbours		0.0001 (0.003)		0.007 (0.006)
Seat neighbours, previous venue		-0.0108*** (0.002)		-0.0097 (0.009)
Seat neighbours, both venues				-0.0084 (0.006)
Day-level fixed effects	Yes	Yes	Yes	Yes
Legislature-by-EPG FE	Yes	Yes	Yes	Yes
Baseline name controls	Yes	Yes	Yes	Yes
Observations	1, 517, 817	1, 517, 817	1, 517, 817	1, 517, 817
Clusters	76	76	76	76
F-stat: Seat neighbours, future venue		82.48		82.71
F-stat: Seat neighbours		88.96		60.35
F-stat: Seat neighbours, previous venue		75.82		115.7
F-stat: Seat neighbours, both venues				43.17
<i>p</i> -value: same effect of future/previous venue	0.0213**	0.0381**	0.0998*	0.158

Notes: This data consists of observations at the session-by-MEP-pair level for the main analysis sample. This excludes dates before the first observed venue change, where there is no information about the previous venue. The dependent variable is the Euclidean distance between the document embedding vectors representing their speeches. The remaining variables are self-explanatory (refer to Table 2.5.2 or Table 2.5.3 or 2.5.6 notes for detailed definitions). Significance levels are indicated as follows: *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$. Same description table as in Harmon et al. (2019).

long it takes for them to become more similar in language usage with their new pair than with their former pair when they are separated by more than two seats.

As in the different venues configuration, let me define $SeatNeighboursPreviousLegislature_{ijt}$ as an indicator of whether the MEP pair ij were seated adjacent to each other in the previous legislature, and $SeatNeighboursBothLegislature_{ijt}$ as an indicator of whether that pair ij was seated adjacently in both the current and previous legislatures. In other words, $SeatNeighboursBothLegislature_{ijt}$ represents the interaction between $SeatNeighbours_{ijt}$ and $SeatNeighboursPreviousLegislature_{ijt}$. To identify the presence of persistent peer effects, I estimate the following:

$$Distance_{ijt} = \delta_0 + \delta_1 SeatNeighbours_{ijt} + \delta_2 SeatNeighboursPreviousLegislature_{ijt} + \xi_{ijt} \quad (2.5.5)$$

$$Distance_{ijt} = \eta_0 + \eta_1 SeatNeighbours_{ijt} + \eta_2 SeatNeighboursPreviousLegislature_{ijt} + \eta_3 SeatNeighboursBothLegislature_{ijt} + v_{ijt} \quad (2.5.6)$$

As in the different venues configuration, in Equation (2.5.5), parameter δ_1 represents the impact of an MEP pair being seated adjacently to each other during the current legislature, while δ_2 captures the effect of their past seating adjacency. Table 2.5.8 displays the results that represent peer effects between legislatures. In this table, I emphasize my preferred specification, which incorporates time fixed effects and legislature-by-EPG fixed effects and the baseline name similarity controls. Initially, I present the results from the specification that only includes $SeatNeighbours_{ijt}$ and $SeatNeighboursPreviousLegislature_{ijt}$ (i.e. Equation (2.5.5)). In Column (1), I display the reduced form estimates obtained by directly estimating $Distance_{ijt}$ with the two instruments (similar to the ITT estimates in the last tables). Column (2) presents the 2SLS estimates, where I instrument for $SeatNeighbours_{ijt}$ and $SeatNeighboursPreviousLegislature_{ijt}$ (similar to the LATE in the last tables).

The results from both sets of estimates show evidence of long-lasting peer effects. Shifting to the 2SLS estimates, the coefficient on $SeatNeighboursPreviousLegislature$ is -0.0027 and significant at 5 percent level ($p = 0.007$), rejecting the null hypothesis that the present seating arrangement is the only that matters. $SeatNeighbours_{ijt}$ coefficient is much smaller (-0.0015) and not significant. However, the wide standard errors prevent me from ruling out substantial effects of current seating or the possibility

that the coefficients on $SeatNeighbours_{ijt}$ and $SeatNeighboursPreviousLegislature_{ijt}$ are the same.

By observing when the coefficient of the persistent effect from the previous legislature exceeds the contemporaneous effect of the current legislature (comparing the results of Equations 2.5.3 and 2.5.5), I notice that, on average, the MEPs who were separated by more than two seats from their former neighbour take about two years to adopt a language usage pattern more similar to their new neighbours than to their former ones. This effect remains consistent regardless of the number of seats that separated them. Additionally, for the pairs that remain adjacent over several legislatures (about 7% of the sample), the peer effect is, on average, 28% higher than for the new pairs in the legislature.

Overall, these results suggest that mechanisms of peer influence associated with peer presence, such as social pressure and monitoring, are unlikely to be the primary drivers of the observed effects. Conversely, the increasing influence of nearby peers over time suggests that cognitive mechanisms, such as information transmission, are more likely at play.

2.5.4 Heterogeneity in peer effects

The results concerning the persistence of peer effects, discussed in the previous section, point to underlying mechanisms that likely go beyond simple 'parroting' behaviour. In this section, I examine variations in the strength of these effects, based on the specific characteristics of MEP pairs: does the sharing of salient social characteristics reinforce such effects?

I investigate whether seat neighbours who share important social characteristics, such as gender, political office, parliamentary mandate or member state of origin, exert greater influence on each other. These shared characteristics could reinforce peer effects, either because of the greater deference individuals show to the ideas and interests of their colleagues in the same political group (Tajfel (1970)), or because social connection leads to closer communication and therefore influence.¹⁸ For example, a common country of origin can give rise to shared culture, language and social ties.

¹⁸Refer to Garlick (2018), where it is demonstrated that peer influence is more pronounced among South African university students living in the same dormitory, particularly when they share the same racial background or are enrolled in the same curriculum.

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Table 2.5.8: Measuring persistent peer effects across legislatures.

	(1)	(2)	(3)	(4)
	Distance	Distance	Distance	Distance
	OLS	2SLS	OLS	2SLS
Seat neighbours, predicted	−0.0018 (0.007)		−0.0008 (0.008)	
Seat neighbours, previous venue, predicted	−0.0027*** (0.001)		0.0011 (0.011)	
Seat neighbours, both venues, predicted			0.0128 (0.008)	
Seat neighbours		−0.0015 (0.012)		−0.0013 (0.008)
Seat neighbours, previous venue		−0.0017 (0.008)		−0.0012 (0.013)
Seat neighbours, both venues				0.0109 (0.009)
Day-level fixed effects	Yes	Yes	Yes	Yes
Legislature-by-EPG FE	Yes	Yes	Yes	Yes
Baseline name controls	Yes	Yes	Yes	Yes
Observations	1, 890, 420	1, 890, 420	1, 890, 420	1, 890, 420
Clusters	76	76	76	76
F-stat: Seat neighbours		320		102
F-stat: Seat neighbours, previous venue		221		110
F-stat: Seat neighbours, both venues				62.92
p-value: past seating does not matter			0.012***	0.001***
p-value: coefficients are equal	0.423	0.425	0.635	0.852

Notes: This data consists of observations at the session-by-MEP-pair level for the main analysis sample. The dependent variable is the Euclidean distance between the document embedding vectors representing their speeches. The remaining variables are self-explanatory (refer to Table 2.5.2 or Table 2.5.3 or 2.5.6 notes for detailed definitions). Significance levels are indicated as follows: *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$. Same description table as in Harmon et al. (2019).

2.5 Empirical strategy and results

Firstly, I explore heterogeneity regarding gender mix and shared member state of origin. I re-estimate my main specification, Equation 2.5.2, on the sample split by either gender mix or shared national origin. The results show that peer effects are significantly more pronounced if the pair of MEPs come from the same member state (see Table 2.5.9). In this case, I find a coefficient of -0.0375 for *SeatNeighbours*, which is significant at the 5% level ($p = 0.020$). Thus, sitting together in this case reduces the language distance by 3.6 percentage points. This represents a 17 per cent decrease compared to the average rate of same country distance, which is three times the size of the effect for within-group peer influence. When the pair is composed of women sitting together, it leads to a reduction in language distance of 6% per cent points compared to the average rate of women distance (Table 2.5.10). These two sources of social proximity only have a cumulative effect for women. When the sample is divided along both dimensions simultaneously, the influence of sitting together triples for two female MEPs who share the same nationality (Appendix, Table 2.B.2). This suggests that the effectiveness of peer effects increases as the extent of pre-existing social affinities grows.

While female MEPs sitting side by side appear to have significantly closer language than the average pair of members. Interestingly, there is no significant such effect observed when two men sit adjacently. If they were to do so, the sign of the estimated coefficient indicates that they would have greater linguistic differences compared to the average pair of men. Physical proximity therefore seems to have a different effect on language distance between MEPs, depending on gender. This raises questions about what causes this difference. What may explain male behaviour is that the competitive nature of the political arena prevents the convergence of opinions and ideas. This prompts candidates who want to stand out to maintain distinct political positions and/or identities.

Digging further in this direction, I examined both dimensions of gender and seniority in EP in Appendix 2.B.3 and gender and experience in politics. This analysis confirms that when two men of the same seniority sit adjacently, they are more distant in language than any other pair. In both tables the effect is strong and highly significant, once again pointing to a differentiation effect, rather than a convergence effect, among pairs of men. If I assume that senior MEPs are more likely to hold positions of leadership in the Parliament or in their home member state, the differentiation theory is confirmed. For

women, the effect is negative when they are newcomers, which means they speak more similarly. But it is positive when they are senior, aligning with men in differentiation.

Secondly, I investigated whether peer effects are stronger among seat neighbours who share other observable characteristics beyond those previously discussed. To streamline the discussion, I specifically concentrated on reduced form ITT estimates in this context. To delve into this, I introduced characteristic C_{ij} and derived heterogeneous ITT estimates from the interaction term in the subsequent equation:

$$Distance_{ijt} = \kappa_0 + \kappa_1 NameAdjacent_{ijt} + \kappa_2 NameAdjacent \times C_{ij} + \kappa_3 C_{ij} + \nu_{ijt} \quad (2.5.7)$$

The additional characteristics I investigated include whether the members of the pair belong to the same generation (i.e. are less than twelve years apart), if they are both newcomers or both seniors, both new to politics, and their difference in EP tenure in years. I also measured the same indicators as above, namely gender and member state of origin. The corresponding results are displayed in Tables 2.B.5 in Appendix 2.B. Across this table, the coefficients on the interaction terms consistently indicate a limited reduction in language distance, yet statistically significant. This suggests that peer interaction acts as a complement to other common characteristics, such as national origin, seniority or gender, that ease communication, then learning. This is especially true when two new MEPs sit adjacently: their language distance diminishes by 2.5 percentage points, adding support to the learning mechanism.

Doing the same analysis [Harmon et al. \(2019\)](#) never yielded statistically significant results. So they found no evidence that peer effects vary due to any of those characteristics. Since their coefficient points in the same direction as my analysis, I argue that language captures more subtle changes than binary outcomes like votes, but this might also be due to a lack of statistical power.

2.6 Peer effects between groups

In this analysis, I primarily focused on estimating peer effects among MEPs from the same European political group. However, it is important to explore whether they can also occur between EPGs. Recent quantitative research has shown that legislators do influence each other, but, the evidence is of influence between trusted peers, embedded in homophilic networks ([Elizer \(2019\)](#), [Harmon et al. \(2019\)](#), [Lowe and Jo \(2023\)](#))

2.6 Peer effects between groups

Table 2.5.9: Peer effects by same member state of origin.

<i>SAMPLE:</i>	From different countries		From same country	
	(1)	(2)	(3)	(4)
	Distance	Distance	Distance	Distance
	OLS	2SLS	OLS	2SLS
Name adjacent	-0.0097 (0.029)		-0.0326*** (0.012)	
Seat neighbours		-0.0126*** (0.003)		-0.0375* (0.020)
Day-level fixed effects	Yes	Yes	Yes	Yes
EP-by-EPG fixed effects	Yes	No	Yes	No
Baseline name controls	Yes	Yes	Yes	Yes
Observations	775891	775891	38631	38631
Cluster	69	69	69	69
Mean distance	0.2359	0.2359	0.2366	0.2366
F-stat		224		617

Notes: This data consists of observations at the session-by-MEP-pair level for the main analysis sample. The columns represent various sub-samples of MEP pairs. The dependent variable is the Euclidean distance between the document embedding vectors representing their speeches. The remaining variables are self-explanatory (refer to Table 2.5.2 or Table 2.5.3 or 2.5.6 notes for detailed definitions). Significance levels are indicated as follows: *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$. Same description table as in Harmon et al. (2019).

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Table 2.5.10: Peer effects by gender mix.

<i>SAMPLE:</i>	Two women		One woman, one man		Two men	
	(1)	(2)	(3)	(4)	(5)	(6)
	Distance	Distance	Distance	Distance	Distance	Distance
	OLS	2SLS	OLS	2SLS	OLS	2SLS
Name adjacent	−0.060*** (0.030)		−0.0125 (0.012)		0.0004 (0.004)	
Seat neighbours		−0.0063* (0.002)		−0.0191*** (0.004)		0.0007 (0.005)
Day-level fixed effects	Yes	Yes	Yes	Yes	Yes	Yes
EP-by-EPG fixed effects	Yes	No	Yes	No	Yes	Yes
Baseline name controls	Yes	Yes	Yes	Yes	Yes	Yes
Observations	450224	450224	364298	364298	1346771	346771
Cluster	69	69	69	69	69	69
Mean distance	0.2358	0.2358	0.2361	0.2361	0.2377	0.2377
F-stat		224		617		744

Notes: This data consists of observations at the session-by-MEP-pair level for the main analysis sample. The columns represent various sub-samples of MEP pairs. The dependent variable is the Euclidean distance between the document embedding vectors representing their speeches. The remaining variables are self-explanatory (refer to Table 2.5.2 or Table 2.5.3 or 2.5.6 notes for detailed definitions). Significance levels are indicated as follows: *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$. Same description table as in Harmon et al. (2019).

and Fong (2020)). A pressing question then is whether physical proximity can create cross-party links between members of the European Parliament. Although my empirical approach so far relies on the random assignment of seats within groups, I can modify my data and specifications to explore if there is confirmation of peer effects between groups as well. Specifically, I examine MEPs who are allocated seats at the peripheries of their EPGs' sections, which means they are seated next to MEPs from other groups. In contrast to Harmon et al. (2019), who could only estimate imprecise effects for cross-party pairs due to the data they had, my extended time period allows for a more precise estimation of these effects.

To investigate between-group peer effects, I select non-leadership MEPs from alphabetically seated EPGs. I then create all possible pairs of MEPs and sessions where both MEPs are present and participate. These pairs consist of MEPs from different political groups. Using the indices ij to denote MEP pairs and t to denote the session, I define the variables $Distance_{ijt}$ and $Seatneighbour_{ijt}$ as in my above analyses. I now consider the following estimation:

$$Distance_{ijt} = \psi_0 + \psi_1 SeatNeighbours_{ijt} + \iota_{ijt} \quad (2.6.1)$$

Here, the coefficient ψ_1 measures whether MEPs from distinct groups, when seated adjacent to each other, exhibit a lesser likelihood of speaking more similarly compared to pairs from different groups who are not seated in close proximity. To address potential sorting biases in seat assignments, I instrument $Seatneighbour_{ijt}$ using predicted adjacency based solely on the alphabetical name rankings and seat arrangements for each groups and every session. Additionally, I include group-pair-by-EP-term fixed effects to account for possible different talking positions between EPGs and my baseline set of name controls. The results are presented in Table 2.6.1.

In this table, Column (1) displays the first-stage regression for the predicted seating instrument, while Column (2) gives the ITT estimate. Column (3) presents the LATE estimates using 2SLS. These estimates provide evidence of peer effects operating between groups as both the ITT and LATE estimates are negative. In Column (3), the impact of being $Seatneighbour_{ijt}$ on $Distance_{ijt}$ for MEPs of different EPGs is -0.0108 . When sitting side-by-side while belonging to two different groups, the language distance between the two MEPs decreases by 1 percentage point. The cross-party influence

results in a 4 percentage points decrease compared to the average rate of distance between political groups, which is one-third smaller than the effect of within group peers effects.

Harmon et al. (2019) find little evidence that peer effects operate between parties, with both their ITT and LATE estimates being positive but insignificant. However, the large standard errors in their analysis does not rule out the possibility that cross-party peer effects might reduce vote disagreement.

In the context of Iceland's parliament, results concerning cross-party peer effects are mixed. Lowe and Jo (2023) found no evidence that cross-party neighbours influence bipartisan voting in their MP-session level specification. While their simulations imply that this null effect may be due to a lack of statistical power, they also present a theoretical argument that pair- and individual-level effects do not necessarily align.

More in line with my findings, Saia (2018) demonstrates that MPs seated next to other-party legislators are 30 to 50 percentage points more likely to vote against their party leader's stance compared to those seated beside no other-party legislators. This is consistent with broader results on cross-party influence, where Fong (2020) uncovers cross-party cue-taking between already-linked legislators.

When segmenting the data by political group, three distinct combinations emerge.¹⁹ The most pronounced influence, and the only significant one, is observed between the Left and the Greens (over 10 percentage points). As for the two others, although the coefficients are not significant at 5% level – largely due to sizable standard errors – I cannot reject that seat adjacency decreases language distance by 8 percentage point between the Centre and the Right groups. Intriguingly, the language distance expands for members situated at the peripheries of their groups when it comes to Centre and Greens MEPs – by 7 percentage (Table 2.B.6 Appendix). These results do not dismiss the potential significance of cross-party peer effects.²⁰

¹⁹S&D vs. Verts/ALE; Verts/ALE vs. ALDE or RE; ALDE or RE vs. PPE

²⁰Note that the fact that few MEP are seated at the edge of their groups (0.04 percent of the data) and the weak correlation between alphabetical seating and cross-group adjacency (since a single MEP listed out of order can affect the ordering of all row-end MEPs) make the standard error large and the analysis difficult.

2.6 Peer effects between groups

Table 2.6.1: Peer effects between groups.

	(1)	(2)	(3)	(4)
	Seat neighbours	Distance	Distance	Distance
	OLS	OLS	2SLS	2SLS
Seat neighbours, predicted	0.2883*** (0.029)	-0.0083*** (0.003)		
Seat neighbours			-0.0108*** (0.003)	-0.0106*** (0.003)
Same freshman status				-0.0029*** (0.000)
Same gender				-0.0017*** (0.000)
Same country				-0.0028*** (0.000)
Tenure difference				-0.0016*** (0.000)
Day-level fixed effects	Yes	Yes	Yes	Yes
Legislature-by-EPG FE	Yes	Yes	Yes	Yes
Baseline name controls	Yes	Yes	Yes	Yes
Observations	1,420,373	1,420,373	1,420,373	1,420,373
Clusters	76	76	76	76
Mean distance		0.2328	0.2264	0.2264
F-stat: Seat neighbours			100.7	96.7

Notes: This data consists of observations at the session-by-MEP-pair level for the main analysis sample. The sample only includes MEP pairs who are from two different alphabetically seated groups and where both MEPs are non-leaders. The dependent variable is the Euclidean distance between the document embedding vectors representing their speeches. The remaining variables are self-explanatory (refer to Table 2.5.2 or Table 2.5.3 or 2.5.6 notes for detailed definitions). Significance levels are indicated as follows: *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$. Same description table as in Harmon et al. (2019).

This trend strengthens the hypothesis that a common set of values is pivotal for effective peer influence. This might be less prevalent between Centre and Greens MEPs compared to the connection between the Left and the Greens.

2.7 Who is influencing whom?

Having documented substantial peer influence, let me now examine the nature of this influence within a pair. In particular, the observed simultaneous convergence in the language of MEPs i and j can be generated by three main channels (see Manski (1993)). The first is the endogenous outcome-on-outcome peer effect, which is the actual causal effect that MEP i has on MEP j 's outcome (language in this case). The second channel refers to exogenous (contextual) peer effects, whereby a member's language varies with some predetermined exogenous characteristics of their peer. Lastly, correlated effects might emerge when both MEPs are exposed to common external shocks or environments. For instance, if they are influenced simultaneously by neighbouring colleagues, such as MEP $i - 1$ and MEP $j + 1$, this can lead to what is known as the *waterfall problem*.²¹

Each of these three hypotheses have different implications for the process of deliberation. Endogenous outcome-on-outcome effects may lead to increased homogeneity within chambers, where potentially dominant voices might disproportionately affect others, potentially limiting diverse viewpoints. Exogenous or contextual peer effects might lead members to align their viewpoints and form distinct factions based on shared characteristics, potentially introducing biases, if, for example, the dominant gender becomes over-represented. Finally, correlated effects suggest that politicians react similarly to shared external events, potentially leading to a uniformity of response and collective biases in decision-making.

²¹To address the *waterfall problem*, I could have investigated the effect for MEPs positioned at the edge of the hemicycle, which corresponds to those located at the end of a row. However, this approach faces three challenges: firstly, the parties positioned at the extreme edges of the hemicycle do not follow alphabetical seating; secondly, more than half of these MEPs, are accompanied by distant neighbours who are members of the European Council or Commission; thirdly, the limited number of such cases (8 MEPs without two neighbours) would result in statistically insignificant outcomes.

2.7 Who is influencing whom?

In this section, I focus primarily on the second channel to determine if the observed effects arise from predetermined, exogenous peer characteristics. I begin by examining the influence of a peer's gender. The same methodology can also be applied to other characteristics, which I shall explore later in the section.

I propose a three-step approach. In this way, I can answer questions such as: how does the language of a female MEP evolve when surrounded by two male MEPs? Firstly, I construct embedding representations for the speeches of male and female MEPs, enabling me to measure the similarity between an MEP vector and the speech patterns associated with a specific gender. Secondly I focus on women that are surrounded by two men, evaluating Equation 2.7.1. Thirdly, I add the two men's distance to the women's centroid as a control in Equation 2.7.2. This approach allows for a nuanced examination of situations where a female MEP may be seated between two males colleagues. As illustrated in Figure 2.7.1, in February 2017, there were 33.58% of women surrounded by two men, while 13.78% were between two women. On the other hand, 36.20% of men were surrounded by two men, while 9.85% were between two women.²²

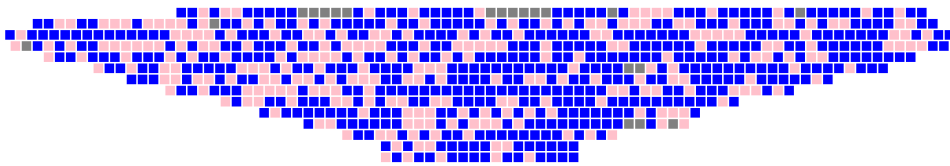


Figure 2.7.1: Schematic representation of the European Parliament – February 2017.

A female MEP is represented by a pink square, a male MEP by blue, and a vacant seat by grey. At that date, 33.58% of women were surrounded by two men, while 13.78% of women were between two women and 36.20% of men were surrounded by two men, while 9.85% of men were between two women.

In detail, to construct embedding representations for the speeches of male and female MEPs, I use one of *Doc2Vec*'s features which, starting from the label, such as "woman" or "man", on each of the MEPs' speeches, will gradually allow the model to learn the embedding that captures gender-specific linguistic patterns. Once trained, the model provides two distinct vectors representing the unique way women and men express themselves at any given point in time. Next, I form a centroid for each set of embeddings, which act as representative points for women and men in parliamentary discourse. Then,

²²Refer to Figure 2.A.2 in Appendix 3.A for a breakdown by legislature.

I calculate the Euclidean distance between the embeddings of each MEP per session and the female and male centroids. To ensure comparability, I normalize these mean distance scores, creating a relative measure of gender-specific language use in parliamentary speeches. The two final outcomes, $DistanceToWomen_{it}$ and $DistanceToMen_{it}$, are calculated for each MEP i for each session t and correspond to the distances to the centroids for both genders. It allows me to assess the magnitude of convergence over time between the language of one gender and that of another MEP.

I then estimate simple OLS because I know that gender is randomly distributed in the alphabetical section as demonstrated in the previous section. I define $WomanSurroundedMen_{it}$ as an indicator of whether the woman MEP i sat between two men $i - 1$ and $i + 1$ during the current session t .²³ Let me recall that distance here, is the Euclidean distance of a specific MEP to a gender centroid. To examine the presence of persistent peer effects, I consider the following two specifications:

$$DistanceToWomen_{it} = \delta_0 + \delta_1 WomanSurroundedMen_{it} + \xi_{it} \quad (2.7.1)$$

In Equation (2.7.1), parameter δ_1 measures by how much being surrounded by two men for a female MEP affects the distance to the women's centroid for a female MEP. Secondly, in order to control the MEP i language might have on the two male MEPs and the influence that the two MEPs surrounding the women might experience from their peers ($i - 2$ and $i + 2$) during the legislative period, I introduce a control variable denoted as the average distance of these two male MEPs to the centroid of women at the beginning of the legislature, $MenSurroundingDistance_i$. It controls the initial distance of these two men to the female's centroid and mitigates the *waterfall problem*. This allows me to estimate the following equation:

$$DistanceToWomen_{it} = \delta_0 + \delta_1 WomanSurroundedMen_{it} + \delta_2 MenSurroundingDistance_i + \xi_{it} \quad (2.7.2)$$

In Equation (2.7.2), parameter δ_2 captures the effect of the two male MEPs on their female colleague's language, regardless of the impact of the surrounded woman and of the influence that the other peers could have on them throughout the legislation. The

²³I could have originally named the variable $Woman_i Surrounded Men_{i-1, i+1, t}$ but for the sake of brevity, I shortened it to $Woman_i Surrounded Men_t$.

2.7 Who is influencing whom?

coefficient measures the influence that the spatial arrangement of male MEPs around a female MEP at the start of the legislative period has on the evolution of their language differences over time.

The OLS estimates show a strong negative correlation between the surrounded woman's language and the average women language when sitting side by side with two men. While these results confirm the pattern found in the heterogeneity analyse (Section 2.5.4) the difference in coefficients shows that there is important differences in who gets to influence whom in mix gender pairs.

It is important to note that the influence of peer vicinity differs according to the gender of the MEP. A woman surrounded by two men strongly diverges from the women's language and converges towards the male language (see Table 2.7.2). In contrast, a male always reinforces his male language regardless of his neighbours. Moreover, a man surrounded by two men experiences a substantial convergence towards the average male language. As highlighted in [Harmon et al. \(2019\)](#), recent news coverage also supports the idea that women might wield particularly strong influence on each other in the male-dominated context of parliamentary politics. Barbara Murkowski and Susan Collins, both female members of the U.S. Senate, sit side by side and consistently vote together on pivotal legislation, even when it opposes their group's stance. Highlighting the heightened influence of their close seating arrangement, a New York Times column on their divergence from the group's position reported that, “[Ms. Collins and Ms. Murkowski] discussed the possibility that the leadership might want to change their seating arrangement to keep them from having a bad influence on each other.”²⁴

My analysis further investigates the variability of peers' influence based on MEPs' seniority in the European Parliament. One might hypothesize that new members, lacking experience, are more susceptible to be influenced and that their inexperience could make them more willing to interact with and seek guidance from nearby peers. Conversely, politicians with much political experience would more easily reach and influence newer members. The empirical results do not entirely corroborate these hypotheses. They show that being surrounded by two senior MEPs slightly reduces the newcomers' language distance to the average senior language. However, the opposite

²⁴See “*Lisa Murkowski, a Swing Vote on Health Care, Isn't Swayed*” New York Times, page A1, July 26, 2017.

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scenario, in which a more senior MEP is surrounded by two newcomers, proves far more influential. In this situation, both newcomers and the senior MEPs converge towards the newcomer's language.

Table 2.7.2: Who is influencing whom.

	(1) DistanceToWomen OLS	(2) DistanceToMen OLS	(3) DistanceToWomen OLS	D
WomanSurroundedMen	-0.0323** (0.011)	0.0024* (0.001)		
MenSurroundingDistance	-0.0041* (0.002)	0.00135**** (0.000)		
MenSurroundedWoman			-0.0061** (0.003)	
WomanSurroundingDistance			-0.0001** (0.000)	
Day-level FE	Yes	Yes	Yes	
EP-by-EPG FE	Yes	Yes	Yes	
Observations	1,325	1,325	952	
Mean Distance	0.0377	0.0831	0.0685	

Notes: This data consists of observations at the session-by-MEP-pair level for the main analysis sample. The outcome variable is the normalized Euclidean distance of the centroid of a specific gene to Table 2.5.2 or Table 2.5.3 or 2.5.6 notes for detailed definitions). Significance levels are indicated as follows: *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$.

2.8 Topic influence

My baseline measure of language similarity captures changes both in the topics discussed and in the phrases used to address them. But peer influence can manifest in both ways. For instance, an MEP may start discussing environmental issues instead of taxation, or it may lead them to continue talking about taxation but using phrases such as « tax burden » or « tax breaks » instead of « tax benefits », which probably conveys different perspectives on the topic.

To explore this further, I conducted two different analyses: on one hand, an Latent Dirichlet Allocation (LDA) that allows focusing on topics, and on the other hand, a TF-IDF similarity score to disentangle how MEPs talk about topics.

Firstly, I ran a LDA separately for each session, determining the optimal number of topics for each of them thanks to *Gensim's Coherence Score*.²⁵ This process identified the distribution of topics within speeches for each MEP during each session. I then transformed each MEP's topic distribution into a probability list for that session. As a result, I generated a vector for each MEP, representing the distribution of topics discussed during that session. Having established individual thematic distributions, I now measure the similarity between the topics discussed by two MEPs for a given date. I calculate the Euclidean distance between each pair of vectors, reflecting the divergence in the subjects discussed by the two MEPs ij over time t , denoted as $TopicsDivergence_{ijt}$. In my first specification, I estimate whether topics peer effects exist and are stronger among seating neighbours:

$$TopicsDivergence_{ijt} = \beta_0 + \beta_1 NameAdjacent_{ijt} + \nu_{ijt} \quad (2.8.1)$$

Table 2.8.1 shows within group peer effects across topics. I focus on my main specification, with time-fixed effects, legislature-by-EPG fixed effects, and the baseline name similarity controls. Initially, I present the results from the specification that only includes the variable $SeatNeighbours_{ijt}$. Column (1) presents the 2SLS estimates, where I instrument for $SeatNeighbours_{ijt}$ (comparable to the LATE estimates in

²⁵ *Gensim's coherence score* is a metric that quantifies the semantic quality of the topics produced by a topic model, reflecting how well the words in a topic cohere together. Selecting the number of topics that yields the highest coherence score can lead to an optimal solution, capturing the most meaningful thematic structure in the data.

previous tables). In Column (3) I examine a specification that includes the complete set of controls, and the coefficient remains quite stable. The results from both sets clearly show evidence of topic peer effects. Focusing on Column (1), the coefficient on *SeatNeighbours* is -0.0203 and significant at the 1 percent level ($p = 0.001$), rejecting the null hypothesis that peer effects capture only the current way of talking. This implies that sitting together reduces the topics distance of two MEPs from the same party by a 3.4 per cent decrease compared to the average rate of within-party distance.

Secondly, I employ standard similarity measures known as TF-IDF similarity scores, separately for each legislative session between MEP speeches, to understand how language is used. I obtain a similarity score, named *SemanticScore_{ijt}*, ranging between 0 and 1, to measure the way of talking between MEPs *ij* over time *t*. This score serves as a measure of the differences in their word preferences for each session and thus becomes my new outcome variable. To ensure that this score does not capture the use of topics, since words create topics, I control for topic usage in my now-standard regression. Thus, my estimate captures how two MEPs talk similarly about the same topics.

In this second specification, I estimate whether semantic peer effects exist. Table 2.8.1 presents the results that capture peer effects across language within a political group. I focus on my favorite specification, which incorporates time-fixed effects, legislature-by-EPG fixed effects, topic controls, and the baseline name similarity controls. As above, Column (2) presents the 2SLS estimates and Column (4) includes the complete set of controls. The results from both sets clearly show evidence of topic peer effects. The coefficient on *SeatNeighbours* is -0.0224 , rejecting the null hypothesis that peer effects capture only the topic discussed. Sitting together reduces the semantic distance of two MEPs in the same group by 3.4 per cent compared to the average rate of within-party distance.

Table 2.8.1 shows that within-party peer effects among adjacent MEPs are equally influenced by convergences in how they discuss topics and what topics they address.

When analyzing differences between groups, results are different. From Table 2.8.2, the coefficient on *SeatNeighbours* for *SemanticScore_{ijt}* is -0.0237 and significant at the 1% level while the coefficient for *TopicsScore_{ijt}* is -0.0122 but insignificant.

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This implies that sitting adjacently while belonging to different groups reduces the semantic distance but has no impact on the topic distance. The semantic effect accounts for three-fourths of the size of the impacts, while the effect of the substance of the discussions is insignificant. This suggests that in cross-party interactions among MEPs, the manner of communication has more weight than the content and political issues. This is not surprising, as the topics being discussed often serve to distinguish political groups and are decided before going to the plenary session, thus closely scrutinized.

Table 2.8.1: Nature of language peer effects within groups.

	(1) Topics Divergence 2SLS	(2) Semantic Score 2SLS	(3) Topics Divergence 2SLS
Seat neighbours	-0.0203*** (0.001)	-0.0224*** (0.001)	-0.0137* (0.008)
Same freshman status			-0.0041* (0.002)
Same country			-0.0051*** (0.001)
Age difference			-0.0001*** (0.000)
Tenure difference			-0.0031*** (0.001)
Same gender			-0.0031 (0.001)
Day-level FE	Yes	Yes	Yes
Name controls	Yes	Yes	Yes
EP-by-EPG FE	Yes	Yes	Yes
Additional name controls	Yes	Yes	Yes
Additional rank gap controls	Yes	Yes	Yes
Observations	810, 945	810, 945	810, 945
Mean Distance	0.6807	0.7596	0.6807
Clusters	76	76	76
F-stat			958.3

Notes: This data consists of observations at the session-by-MEP-pair level for the main analysis sample. The outcome variable is the normalized Euclidean distance of the topics used in document TF-IDF measure of the same document. The remaining variables are self-explanatory (refer to Table 2.5.2 or Table 2.5.3 or 2.5.6 notes for detailed definitions). Significance levels are indicated

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These findings of distinct natures regarding pair effects confirm my previous argument: pair effects do indeed exist, and their significance and depth are amplified when pre-existing shared attributes are present. On one side, members of the same group are arguably more disposed and receptive to listening to one another, thus facilitating the exchange of ideas. This advocates for peer effects through cognitive channels, prioritizing learning over mere monitoring or conformity. On the other side, members of the different groups there is less influence and when it does occur, its nature is more rooted in how MEPs express themselves rather than in the substance of what they say. One could argue that this mitigates the effect of learning when the gap in pre-existing attributes is larger, potentially favoring more monitoring and conformism driven by social pressure in this scenario. However, I argue that since a substantial portion (one-fourth) remains unexplained, this suggests the need for further investigation. Even though the coefficient for topic influence is not statistically significant, its direction still aligns with the idea of an exchange of ideas. This underscores the ongoing importance of cognitive channels like information transmission and persuasion. Additionally, having an influence on how one speaks can also be sought after through a cognitive channel.

The presence of cross-group positive peer effects suggests that political integration might be an effective means of reducing polarization, making it a policy worth advocating. After all, even if only semantic convergence occurs, it still provides evidence that MEPs are willing to converse and listen to their colleagues from different groups. This implies that repeated contacts and face-to-face interactions with peers sitting nearby play an important role in MEPs' speaking behaviour through learning.

It is important to note that in the European Parliament, groups are arranged in a spectrum from left to right based on their ideologies. As a result, cross-group interactions occur with MEPs from the ideologically closest groups. The potential outcome of completely opposing MEPs sitting side by side remains unknown and cannot be addressed within the current framework.

	(1)	(2)	(3)
	Topics Divergence 2SLS	Semantic Score 2SLS	Topics Divergence 2SLS
Seat neighbours	-0.0152 (0.014)	-0.0237*** (0.007)	-0.0143 (0.014)
Same freshman status			-0.0032*** (0.001)
Same country			-0.0021*** (0.001)
Age difference			-0.0012** (0.001)
Tenure difference			0.0006 (0.001)
Same gender			0.0008 (0.001)
Day-level FE	Yes	Yes	Yes
Name controls	Yes	Yes	Yes
EP-by-EPG FE	Yes	Yes	Yes
Additional name controls	Yes	Yes	Yes
Additional rank gap controls	Yes	Yes	Yes
Observations	810, 945	810, 945	810, 945
Mean Distance	0.6790	0.7576	0.7207
Clusters	76	76	76
F-stat			958.3

Notes: This data consists of observations at the session-by-MEP-pair level for the main analysis sample. The dependent variable is the normalized Euclidean distance of the topics found in document TF-IDF measure of the same document. The remaining variables are self-explanatory (refer to Table 2.5.2 or Table 2.5.3 or 2.5.6 notes for detailed definitions). Significance levels are indicated

2.9 Conclusion

In this paper, I used the quasi-random allocation of seats in the European Parliament to identify the causal effects of social interaction on MEPs' behaviour. Specifically, I investigated how the MEP's speech behaviour is influenced by colleagues sitting nearby.

I showed that MEPs who are assigned to sit together do indeed speak more alike. The magnitude of the in-group effect on language similarity is approximately 6%, as against 4% between groups. The effects of proximity intensify with the duration of treatment and persist over time, aligning more with legislative learning and cognitive shifts than with social pressure mechanisms. Further analysis suggests that this learning effect mainly occurs when MEPs share common characteristics like gender, seniority or belong to the same member state. I observed convergence both in language type, and in the topics addressed. Most surveyed legislators are not aware of this small peer influence.

These findings suggest that politicians can learn from their peers, thus revealing that their ideological positions are not fixed. The observed heterogeneity in learning between groups also highlights the conditions under which social learning is more likely to occur. Several mechanisms may explain this heterogeneity, although further research would be needed to explore them and dig simple demographics characteristics further. Individuals may be more inclined to learn from those they trust. In the case of politicians, this manifests as a convergence in policy topics when information is provided by members of their own group, while proximity to a colleague from another group leads to using more similar phrases without necessarily aligning on policy. Moreover, the language cues shared by the executives establish a clear communication channel, enhancing language closeness. Or, individuals may selectively expose themselves to information from their own group, engaging more with their in-group neighbours who share *common goals*.

In a broader context, these results have important implications for party-political policies. Physical proximity may help reduce political polarization, as MEPs do learn from those outside their political group. It can potentially mitigate language polarization by fostering contacts across the Parliament floor. Implementing seating schemes that could promote cross-group interactions, such as randomized seating assignments, might be a cost-effective strategy to facilitate dialogue and exchange of ideas. In some

2.9 Conclusion

countries, influential politicians have already advocated for this, as seen in Canada's motion supporting random seating. Moreover, randomization is already used in various parliaments for different purposes, such as furthering opportunities for backbenchers to submit draft legislation.

Appendix

2.A Complementary figures

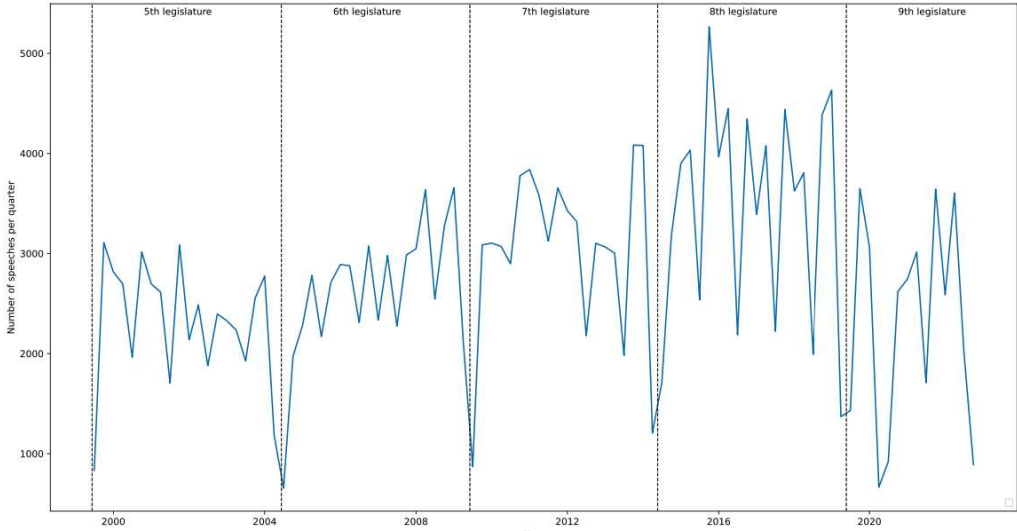


Figure A1: Evolution of the average number of speeches per quarter.

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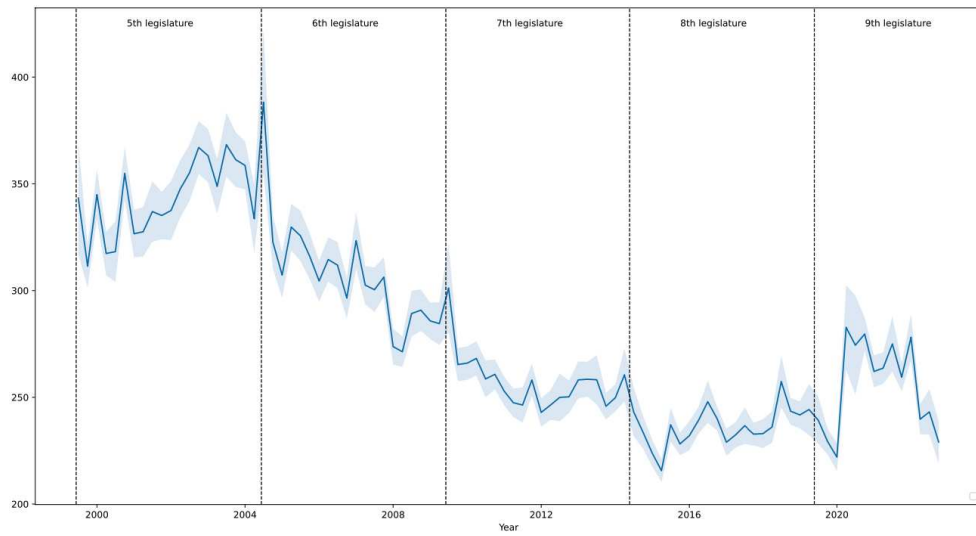


Figure A2: Average length of speeches per quarter.

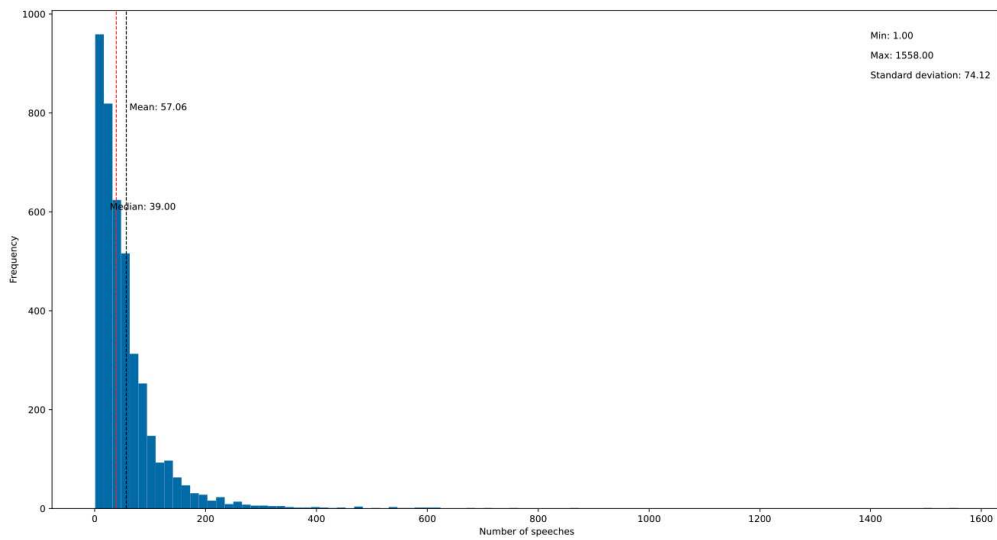


Figure A3: Number of speeches per quarter.

2.A Complementary figures

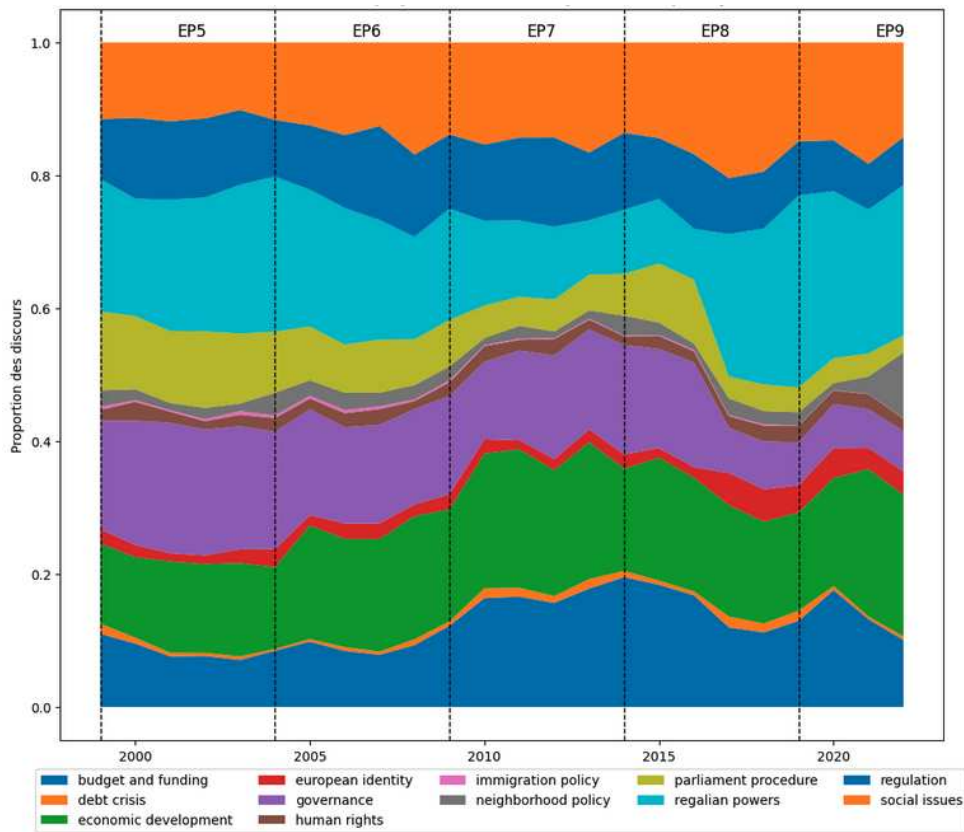
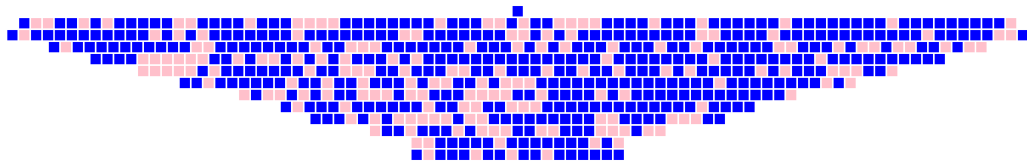


Figure A4: Distribution of topics over time 1999-2022.

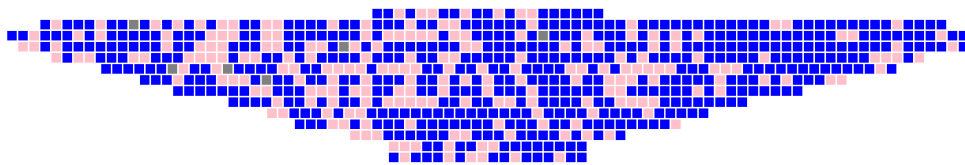
Notes: Reports all topics, including *Parliament procedure*.

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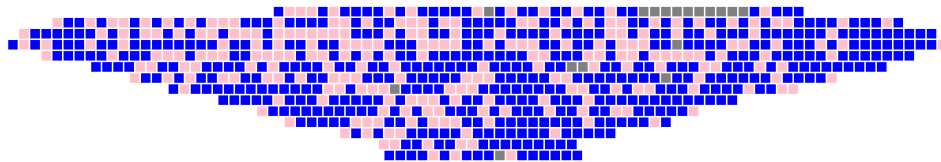
Schematic representation of the fifth legislature of the European Parliament – 09/1999.

A female MEP is represented by a pink square, a male MEP by blue, and a vacant seat by grey. During EP5 35.87% of women were surrounded by two men, while 13.59% were between two women.



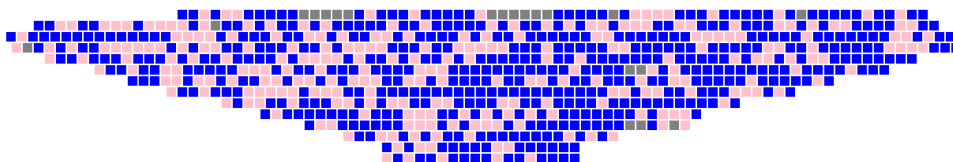
Schematic representation of the sixth legislature of the European Parliament – 09/2004.

A female MEP is represented by a pink square, a male MEP by blue, and a vacant seat by grey. During EP6 40.72% of women were surrounded by two men, while 11.31% were between two women.



Schematic representation of the sixth legislature of the European Parliament – 09/2009.

A female MEP is represented by a pink square, a male MEP by blue, and a vacant seat by grey. During EP7 35.25% of women were surrounded by two men, while 11.89% were between two women.

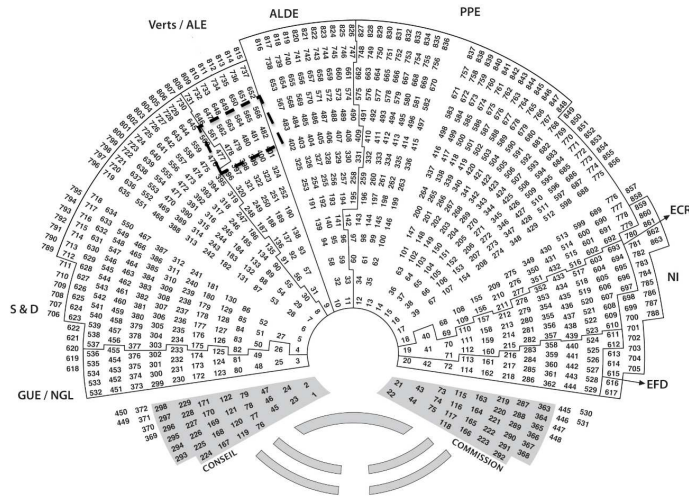


Schematic representation of the sixth legislature of the European Parliament – 09/2014.

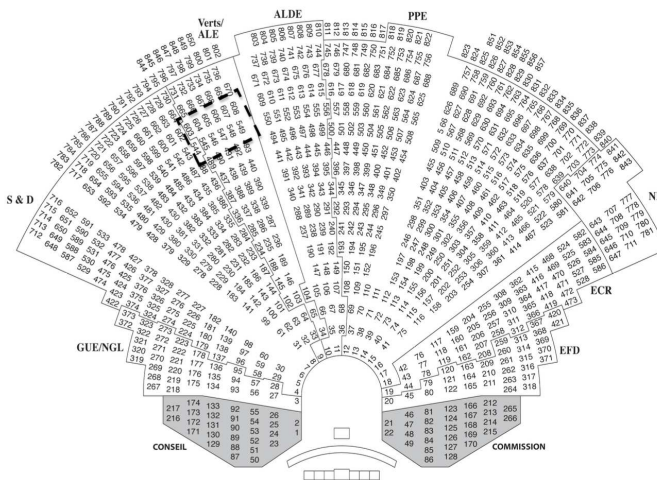
A female MEP is represented by a pink square, a male MEP by blue, and a vacant seat by grey. During EP7 31.98% of women were surrounded by two men, while 9.72% were between two women.

Figure 2.A.1: Sample seating charts

Panel A - Strasburg, September 14, 2009.



Panel B - Brussels, October 7, 2009.



Panel A shows a representative seating arrangement for the European Parliament in Strasbourg, while Panel B illustrates a seating chart for Brussels. Each numerical label corresponds to a specific MEP, with their respective group indicated around the perimeter of the chart. The seats within the dashed rectangle in both charts are enlarged in Figure 2.5.5. (Credit to [Harmon et al. \(2019\)](#) for these figures.)

2.B Complementary tables

Table 2.B.1: Foundation and enlargement rounds of the EU and the euro area.

Country	Accession to EU	Intro Euro	Intro EP
Belgium	25 March 1957	1999	1979
Germany	25 March 1957	1999	1979
France	25 March 1957	1999	1979
Italy	25 March 1957	1999	1979
Luxembourg	25 March 1957	1999	1979
Netherlands	25 March 1957	1999	1979
Denmark	1 January 1973	-	1979
Ireland	1 January 1973	1999	1979
United Kingdom	1 January 1973	-	1979
Greece	1 January 1981	2001	1981
Spain	1 January 1986	2002	1986
Portugal	1 January 1986	2002	1986
Austria	1 January 1995	1999	1995
Finland	1 January 1995	1999	1995
Sweden	1 January 1995	-	1995
Cyprus	1 May 2004	2008	2004
Malta	1 May 2004	2008	2004
Slovenia	1 May 2004	2007	2004
Slovakia	1 May 2004	2009	2004
Estonia	1 May 2004	2011	2004
Latvia	1 May 2004	2014	2004
Lithuania	1 May 2004	2015	2004
Czech Republic	1 May 2004	-	2004
Hungary	1 May 2004	-	2004
Poland	1 May 2004	-	2004
Bulgaria	1 January 2007	-	2007
Romania	1 January 2007	-	2007
Croatia	1 July 2013	-	2013

2.B Complementary tables

Table 2.B.2: Peer effects by same member state of origin and gender

Panel A - MEPs from different member state						
<i>SUBSAMPLE:</i>	Two women		One woman one man		Two men	
	(1)	(2)	(3)	(4)	(5)	(6)
	Distance	Distance	Distance	Distance	Distance	Distance
	OLS	2SLS	OLS	2SLS	OLS	2SLS
Name adjacent	-0.0063** (0.009)		-0.0104** (0.002)		0.002 (0.014)	
Seat neighbours		-0.0088** (0.005)		-0.0185*** (0.000)		0.0006 (0.005)
Observations	428, 722	428, 722	347, 169	347, 169	329, 920	329, 920
Cluster	69	69	69	69	69	69
Mean distance	0.2358	0.2358	0.2360	2360	0.2378	0.2378
F-stat		224		617		744
Panel B - MEPs from same member state						
<i>SUBSAMPLE:</i>	Two women		One woman, one man		Two men	
	(1)	(2)	(3)	(4)	(5)	(6)
	Distance	Distance	Distance	Distance	Distance	Distance
	OLS	2SLS	OLS	2SLS	OLS	2SLS
Name adjacent	-0.318*** (0.039)		0.0221** (0.012)		0.0030 (0.014)	NAN NAN
Seat neighbours		-0.0455** (0.014)		-0.0327** (0.022)		NAN NAN
Observations	21502	21502	17129	17129	18, 560	18, 560
Cluster	69	69	69	69	69	69
Mean distance	0.2350	0.2350	0.2386	0.2386	0.2363	0.2363
F-stat		224		617		744
Day-level fixed effects	Yes	Yes	Yes	Yes	Yes	Yes
EP-by-EPG fixed effects	Yes	No	Yes	No	Yes	Yes
Baseline name controls	Yes	Yes	Yes	Yes	Yes	Yes

Notes: This data consists of observations at the session-by-MEP-pair level for the main analysis sample. The variables are self-explanatory or already defined in Table 2.5.2 or Table 2.5.3 or 2.5.6 notes for detailed definitions. Significance levels are indicated as follows: *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$. Same description table as in Harmon et al. (2019).

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Table 2.B.3: Peer effects by gender mix and same seniority in the EP.

Panel A - MEPs in pair, both newcomers in the EP						
SUBSAMPLE:	Two women		One woman, one man		Two men	
	(1)	(2)	(3)	(4)	(5)	(6)
	Distance OLS	Distance 2SLS	Distance OLS	Distance 2SLS	Distance OLS	Distance 2SLS
Name adjacent	-0.0134** (0.029)		-0.0084** (0.002)		0.0220** (0.011)	
Seat neighbours		-0.0321** (0.006)		-0.0150*** (0.006)		0.0369*** (0.000)
Observations	118,764	118,764	97,926	97,926	91,816	91,816
Cluster	69	69	69	69	69	69
Mean distance	0.2332	0.2358	0.2350	0.2350	0.2378	0.2378
F-stat		224		617		744
Panel B - MEPs in pair, both senior in the EP						
SUBSAMPLE:	Two women		One woman, one man		Two men	
	(1)	(2)	(3)	(4)	(5)	(6)
	Distance OLS	Distance 2SLS	Distance OLS	Distance 2SLS	Distance OLS	Distance 2SLS
Name adjacent	-0.0021** (0.001)		-0.0048** (0.002)		0.0040 (0.004)	
Seat neighbours		-0.0040** (0.001)		-0.0091*** (0.000)		0.0090*** (0.000)
Observations	118764	118764	17129	17129	18,560	18,560
Cluster	69	69	69	69	69	69
Mean distance	0.2332	0.2332	0.2350	0.2350	0.2363	0.2363
F-stat		224		617		744
Day-level fixed effects	Yes	Yes	Yes	Yes	Yes	Yes
EP-by-EPG fixed effects	Yes	No	Yes	No	Yes	Yes
Baseline name controls	Yes	Yes	Yes	Yes	Yes	Yes

Notes: This data consists of observations at the session-by-MEP-pair level for the main analysis sample. The variables are self-explanatory or already defined in Table 2.5.2 or Table 2.5.3 or 2.5.6 notes for detailed definitions. Significance levels are indicated as follows: *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$. Same description table as in Harmon et al. (2019).

Table 2.B.5: Heterogeneous peer effects interactions.

	(1)	(2)	(3)	(4)	(5)	(6)
	Distance	Distance	Distance	Distance	Distance	Distance
Name adjacent	-0.0089** (0.004)	-0.0133*** (0.004)	-0.0063 (0.004)	-0.0133*** (0.004)	-0.0191*** (0.004)	-0.0204*** (0.004)
Generation	0.0042*** (0.000)					
Name adj. X Generation	-0.0087 (0.006)					
Newcomer		-0.0026*** (0.001)				
Name adj. X Newcomer		0.0015 (0.006)				
No Exp			0.0003* (0.000)			
Name adj. X No Exp			-0.0128** (0.006)			
No Newcomers				-0.0026*** (0.000)		
Name adj. X No Newcomers				0.0015 (0.006)		
Female					-0.0003* (0.000)	
Name adj. X Female					0.0128** (0.006)	
Male						0.0032*** (0.000)
Name adj. X Male						0.0210*** (0.006)
Diff tenure						
Name adj. X Diff Tenur						
Member state						
Name adj. X Member state						
Day-level fixed effects	Yes	Yes	Yes	Yes	Yes	Yes
EP-by-EPG fixed effects	Yes	No	Yes	No	Yes	Yes
Baseline name controls	Yes	Yes	Yes	Yes	Yes	Yes
Observations	814,522	814,522	814,522	814,522	814,522	814,522
Mean distance	0.2358	0.2358	0.2361	0.2361	0.2377	0.2377
F-stat		224		617		744

Table 2.B.6: Peer effects between specific groups.

<i>SUBSAMPLE:</i>	S&D vs. Grenn		Green vs. Renew		Renew Distance OLS
	(1) Distance OLS	(2) Distance 2SLS	(3) Distance OLS	(4) Distance 2SLS	
Seat neighbours, predicted	-0.0164* (0.009)	-0.0222*** (0.006)	0.0065 (0.012)	0.0075 (0.006)	-0.0106 (0.014)
Seat neighbours					
Observations	225, 852	225, 852	198, 125	198, 125	124, 052
Cluster	69	69	69	69	69
Mean distance	0.2456	0.2446	0.2378	0.2385	0.2354
F-stat		224		617	
Day-level fixed effects	Yes	Yes	Yes	Yes	Yes
EP-by-EPG fixed effects	Yes	No	Yes	No	Yes
Baseline name controls	Yes	Yes	Yes	Yes	Yes

Notes: This data consists of observations at the session-by-MEP-pair level for the main analysis sample. The variables are self-explanatory or already defined in Table 2.5.2 or Table 2.5.3 or 2.5.4 indicated as follows: *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$. Same description table as in Hammon et al. (2019).

2.C Data

In this section, I provide additional information regarding the sources of my data and the methods used for its compilation. Any external sources are appropriately cited and linked.

- The link to MEPs speeches can be found [here](#).
- MEP biographies are scraped from both EP websites and Parltrack pages – with one example [here](#) for Manon Aubry and [ParlTrack](#) for complementary information on MEPs.
- The information regarding seating for each session can be partly accessed [here](#), while the rest was directly obtained from the European Parliament's [Session Services](#). The PDF provided contain the physical location of each seat along with the names of the MEPs occupying them (as shown in the example in [Figure 2.A.2](#)).
- Speeches are scraped from [here](#). For each speech I have: MEP name, MEP ID, date, session topics, session law reference, order of the speech and the speech text. [Here](#) is an example for May 9, 2023.
- Roll-call voting data, which is not used for the main analysis, can be found [here](#).

2.D Additional results

2.D.1 Standard error calculations by Harmon, Fisman and Kamenica

Harmon et al. (2019) identify two main issues in the correlation structure of their data. Firstly, the presence of seating-based peer effects (and/or effects of having similar last names) implies potential behaviour correlation among adjacent MEPs. When clusters are defined based on proximity (such as rows), it becomes a standard clustering problem where voting (here speaking) behaviour is correlated within each cluster. Secondly, the data is dyadic, meaning observations reflect the behaviour of pairs of individuals during sessions rather than individual actions. On its own this suggests a mechanical correlation between all pairs in my dataset that share a common member. When combined with the clustering concern, it also suggests the possibility of a correlation between two pairs in my data if one member from each pair is seated in close proximity and belongs to the same cluster.

To deal with these issues Harmon et al. (2019) use dyadic cluster-robust standard errors throughout. This method, as outlined by Cameron and Miller (2014) and Aronow et al. (2015), involves estimating the covariance matrix of the regressions. The key modification replaces a portion of the standard (Huber-Eicker-White) sandwich estimator with a sum over observations to account for clustering.

The implementation closely follows Cameron and Miller (2014)'s recommendations. They incorporate a degree-of-freedom correction based on the number of clusters, total observations, and estimated regression coefficients. Additionally, they use eigenvector decomposition to handle variance matrices in finite samples.

Clusters are defined as row-by-legislature-by-EPG, allowing for arbitrary correlation within each row of each EPG in both parliamentary terms analyzed. ²⁶

²⁶A practical challenge arises due to variations in seating arrangements between the two venues where the EP convenes. In the Brussels layout, MEPs are spread out over more rows compared to the Strasbourg layout. As a result, many MEPs do not occupy the same row number in both venues. To maintain consistency and avoid constant cluster switching for MEPs when the EP changes venues, I consistently assign all MEPs to their respective Strasbourg row numbers when computing standard errors. It's worth noting that over 80 percent of the voting instances in my dataset occur in Strasbourg. Additionally, given that the rows in Strasbourg are wider, this approach can be considered conservative as it implies a broader level of clustering.

2.D.2 Peer effects at longer distances

In the main text, I primarily focused on estimating seating peer effects between immediate seat neighbours. However, it is possible that peer effects could also extend to MEPs sitting further apart. Aligned with [Harmon et al. \(2019\)](#) regarding voting behaviour, the results show no statistically significant evidence of seating peer effects beyond pairs of MEPs who are immediate neighbours.

To explore this possibility, I introduced dummy variables denoting if a pair of MEPs are sitting 2, 3, or 4 seats apart ($Seated2Apart_{ijt}$, $Seated3Apart_{ijt}$, $Seated4Apart_{ijt}$).

To examine potential peer effects at greater distances, I used an IV to account for MEP sorting.

$$Distance_{ijt} = \pi_0 + \pi_1 SeatNeighbours_{ijt} + \pi_2 Seated2Apart_{ijt} + \pi_3 Seated3Apart_{ijt} + \pi_4 Seated4Apart_{ijt} + \epsilon_{ijt}$$

I used a set of dummy if MEPs are 2, 3, or 4 seats away in the alphabetical ranking of last names in their row ($Names2Apart_{ijt}$, $Names3Apart_{ijt}$, $Names4Apart_{ijt}$) as instruments. Table D.2 displays the estimated peer effects when I included dummy for sitting 1, 2, 3, or 4 seats apart. Columns (1)–(4) present reduced form OLS estimates, wherein the endogenous variables are substituted with the corresponding instruments. Meanwhile, Columns (5)–(8) display 2SLS estimates. Remarkably, in both sets of columns, the estimated impact of being immediate neighbours remains largely consistent with the main text specification. However, the estimated effects of being 2, 3, or 4 seats apart are nearly negligible, and surprisingly, lean towards a positive direction.

Although the inclusion of extra variables resulted in higher standard errors, none of the individual estimated effects are statistically significant when multiple seating variables are taken into account. However, at the bottom of the table, it becomes evident that the seating variables collectively hold significance across all specifications. This leads me to confidently reject the notion that sitting next to each other has an equivalent impact as sitting at a greater distance.

In conclusion, as in [Harmon et al. \(2019\)](#) my analysis indicates that peer effects are limited to immediate neighbours and do not extend to MEPs sitting further apart.

	(1)	(2)	(3)	(4)	(5)	(6)
	Distance	Distance	Distance	Distance	Distance	Distance
	OLS	OLS	OLS	OLS	2SLS	2SLS

Table D.2: Peer effects at longer distances.

Name adjacent	−0.0098** (0.002)	−0.0092 (0.023)	−0.0088 (0.033)	−0.0088 (0.034)		
Names 2 apart		0.0010 (0.031)	0.0010 (0.012)	0.0013 (0.012)		
Names 3 apart			0.0002 (0.021)	0.0004 (0.061)		
Names 4 apart				0.0015 (0.021)		
Seat neighbours					−0.0131*** (0.003)	−0.00 (0.013)
Seated 2 apart						0.001 (0.022)
Seated 3 apart						
Seated 4 apart						

Day-level fixed effects	Yes	Yes	Yes	Yes	Yes	Yes
EP-by-EPG fixed effects	Yes	Yes	Yes	Yes	Yes	Yes
Baseline name controls	Yes	Yes	Yes	Yes	Yes	Yes

Observations	810,945	810,945	810,945	810,945	810,945	810,945
Clusters	76	76	76	76	76	76

2.D.3 Alternative placebo test

In my placebo test conducted on the subset of EPG leaders in Panel A of Table 2.5.4, I determined name adjacency by assessing if a pair of leadership MEPs were positioned adjacently in the alphabetical ordering of names in their respective leaders' group. This definition of $NameAdjacent_{ijt}$ closely mirrors the one utilized in the main analysis sample, as it specifically examines alphabetical adjacency in the group of MEPs who are seated together, regardless of their leadership status.

However, a concern may arise due to the significantly lower number of leaders in comparison to non-leaders. This could result in name adjacency among leaders being a less robust indicator of name similarity. For instance, when there are only two MEPs in the leading fraction of a group, they will be considered name adjacent regardless of how similar their surnames actually are. Conversely, in a group with a very large number of members, a pair of them will be considered name adjacent only if their last names are nearly identical.

To address the potential impact of variations in group size on the findings of my placebo test, Table D.3 reproduces the placebo test presented in Panel A of Table 2.5.4 using a different criterion for name adjacency. Rather than considering a pair of leaders as name adjacent solely based on their proximity in the alphabetical ordering of leaders, I then defined them as name adjacent only if they were contiguous in the alphabetical ordering of all MEPs within their EPG.

The results obtained using this other measure of name adjacency closely mirror those presented in the core of the paper. The other measure of name adjacency does not forecast seating patterns and also does not correlate with language similarity. In all specifications, I found that name similarity does not reduce distance by more than 0.6 percentage point, allowing me to draw consistent conclusions from both measures.

Table D.3: Leadership placebo test, alternative name adjacency definition.

	(1)	(2)	(3)	(4)	(5)	
	Seat	Seat	Distance	Distance	Distance	Dis
	neighbours	neighbours				
Name adjacent, full group	-0.0093 (0.079)	-0.0003 (0.032)	0.0010 (0.009)	0.0020 (0.0036)	0.0021 (0.009)	0.
Day-level fixed effects	Yes	Yes	Yes	Yes	Yes	
EP-by-EPG fixed effects	Yes	No	Yes	No	Yes	
Baseline name controls	No	Yes	No	Yes	Yes	
Observable pair characteristics	No	Yes	No	Yes	No	
Additional name similarity controls	No	Yes	No	No	No	
Additional name rank gap controls	No	Yes	No	No	No	
Observations	18,560	18,560	18,560	18,560	18,560	18
Clusters	69	69	69	69	69	

Notes: This data consists of observations at the session-by-MEP-pair level for the main analysis sample. The variables are self-explanatory or already defined in Table 2.5.2 or Table 2.5.3 or 2.5.4 indicated as follows: *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$. Same description table as in Hammon et al. (2019).

2.D.4 Regression results for first stage (exploiting venue variation)

Table D.4 showcases the initial regression analyses that align with Table 2.5.6. I observe that all of the predicted seating variables demonstrate predictive power across all first-stage specifications. Interestingly, each of the predicted seating variables is notably influential in predicting its non-predicted counterpart (e.g., $SeatNeighboursPredicted_{ijt}$ significantly predicts $SeatNeighbours_{ijt}$, and $SeatNeighboursPreviousVenuePredicted_{ijt}$ strongly predicts $SeatNeighboursPreviousVenue_{ijt}$). This ensures ample independent variation in the instruments, enabling me to estimate the effect of each of the three seating variables accurately.

Similarly, Table 2.5.7 exhibits the first stages corresponding to Table 2.5.7, and I find consistent results. The Sanderson and Windmeijer (2016) conditional first-stage F-statistic measures of instrument strength, shown at the bottom of Tables 2.5.6 and 2.5.7, are notably high for all endogenous variables. This further underscores the robustness and reliability of my instrument strength, providing a solid foundation for estimating the effects of each seating variable in my analysis.

Table D.4: First stage regressions for Table 6.

	(1) Seat neighbours	(2) Seat neighbours previous venue	(3) Seat neighbours	(4) Seat neighbo previous ven
Seat neighbours, predicted	0.82229*** (0.018)	0.0867*** (0.021)	0.8941*** (0.0460)	0.1050*** (0.022)
Seat neighbours, previous venue, predicted	0.1004*** (0.015)	0.8779*** (0.019)	0.2309*** (0.020)	0.7902*** (0.018)
Seat neighbours, both venues, predicted			0.1584** (0.020)	0.1851** (0.025)
Day-level fixed effects	Yes	Yes	Yes	Yes
EP-by-EPG fixed effects	Yes	Yes	Yes	Yes
Baseline name controls	Yes	Yes	Yes	Yes
Observations	1,890,420	1,890,420	1,890,420	1,890,420
Clusters	76	76	76	76

Notes: This data consists of observations at the session-by-MEP-pair level for the main analysis sample. The variables are self-explanatory or already defined in Table 2.5.2 or Table 2.5.3 or 2.5.6 notes for follows: *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$. Same description table as in Harmon et al. (2019).

	(1)	(2)	(3)	(4)	(5)
	Seat neighbours next venue	Seat neighbours	Seat neighbours other venues	Seat neighbours next venue	Seat neighbours
Seat neighbours, next venue pred	0.8391** (0.025)	0.0852** (0.026)	0.0369 (0.023)	0.8792*** (0.036)	0.0985*** (0.039)
Seat neighbours, pred	0.0341*** (0.010)	0.8728*** (0.021)	0.0824*** (0.019)	0.1882*** (0.038)	0.8745*** (0.039)
Seat neighbours, previous venue pred	0.0638** (0.019)	0.2023*** (0.019)	0.8689*** (0.020)	0.1578*** (0.023)	0, 3189** (0.017)
Seat neighbours, both venues pred				0.0789** (0.030)	0.1231** (0.032)
Day-level fixed effects	Yes	Yes	Yes	Yes	Yes
EP-by-EPG fixed effects	Yes	Yes	Yes	Yes	Yes
Baseline name controls	Yes	Yes	Yes		Yes
Observations	1, 517, 817	1, 517, 817	1, 517, 817	1, 517, 817	1, 517, 817
Clusters	76	76	76	76	76

Notes: This data consists of observations at the session-by-MEP-pair level for the main analysis sample. The variables are self-explanatory or already defined in Table 2.5.2 or Table 2.5.3 or 2.5.6 notes for follows: *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$. Same description table as in Harmon et al. (2019).

2.D.5 Estimated peer effects if sorting is ignored

To examine the potential bias that could arise when estimating peer effects without considering my exogenous variation in seating, I investigated language similarity in groups that do not use alphabetical seating. I analyzed data language similarity by MEP pairs in these groups and present the results in Table D.5 using a "naive" version of my main specification. In this approach, I directly regress MEP-pair language Distance on an indicator for being seat neighbours.

The findings reveal a significant upward bias in estimating peer effects if one overlooks endogenous seat selection. The estimated effects are notably larger than those obtained in my main analysis. Specifically, adjacent MEPs in these non-alphabetical groups are between 5 and 15 percentage points less likely to Distance, depending on the specification.

These results underscore the importance of accounting for endogenous seat selection in estimating peer effects accurately and highlight the potential distortions in conclusions when such factors are not appropriately considered. My exogenous variation in seating provides a valuable source of unbiased estimation, ensuring the reliability and validity of my findings regarding the impact of peer influence on speaking behaviour.

	(1)	(2)	(3)	(4)
	Distance	Distance	Distance	Distance
	OLS	OLS	OLS	OLS
Seat neighbours	-0.0155*** (0.004)	-0.0209*** (0.005)	-0.0109*** (0.004)	-0.0110*** (0.002)
Same tenure status			-0.0050 (0.003)	-0.0593 (0.002)
Same freshman status			0.001 (0.002)	0.001 (0.002)
Same country			-0.0346 (0.009)	-0.0330 (0.003)
Age difference			0.0097 (0.007)	0.0094 (0.009)
Tenure difference			-0.0098 (0.009)	-0.0089 (0.007)
Same gender			0.0046 (0.003)	0.0053 (0.008)
Day-level fixed effects	Yes	Yes	Yes	Yes
Baseline name controls	No	Yes	Yes	Yes
EP-by-EPG fixed effects	No	Yes	Yes	Yes
Additional name similarity controls	No	No	No	Yes
Additional name rank gap controls	No	No	No	No
Observations	817,460	817,460	817,460	817,460
Clusters	49	49	49	49
Mean distance	0.2472	0.2472	0.2472	0.2472

Figure 2.D.1: Table D.6: Estimated peer effects without accounting for sorting.

Appendix References

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Sanderson, E. and F. Windmeijer. "A weak instrument F-test in linear IV models with multiple endogenous variables." *Journal of Econometrics* 190(2), 212–221.

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2.E Allocation time rules

Procedure of the European Parliament, rule 171: Allocation of Speaking Time and List of Speakers²⁷

1. The Conference of Presidents may propose to Parliament that speaking time be allocated for a particular debate. Parliament shall decide on this session without debate.
2. Members may not speak unless called upon to do so by the President. Members shall speak from their places and shall address the President. If speakers depart from the subject matter of the debate, the President shall call them to order.
3. The President may draw up, for the first part of a particular debate, a list of speakers that includes one or more rounds of speakers from each political group wishing to speak, in the order of the relative size of those political groups.
4. Speaking time for this part of a debate shall be allocated in accordance with the following criteria:
 - (a) a first fraction of speaking time shall be divided equally among all the political groups;
 - (b) a second fraction shall be divided among the political groups in proportion to the total number of their members;
 - (c) the non-attached Members shall be allocated an overall speaking time based on the fractions allocated to each political group under points (a) and (b);
 - (d) the allocation of speaking time in the plenary shall take into consideration the fact that Members with disabilities might need more time.
5. Where a total speaking time is allocated for several items on the agenda, the political groups shall inform the President of the fractions of their speaking time to be used for each individual item. The President shall ensure that these speaking times are respected.

²⁷<https://www.europarl.europa.eu/doceo/document/lastrules/RULE-171EN.html?redirect#def1>

6. The remaining part of the time for a debate shall not be specifically allocated in advance. Instead, the President may call on Members to speak, as a general rule for no more than one minute. The President shall, as far as possible, ensure that speakers who hold different political views and who come from different Member States are heard in turn.
7. On request, the President may give priority to the Chair and to the rapporteur of the committee responsible, as well as to those Chairs of political groups who wish to speak on their groups' behalf, or to speakers who are deputizing for them.
8. The President may give the floor to Members who indicate, by raising a blue card, their wish to put to another Member, during that Member's speech, a question of no longer than half a minute's duration related to what that Member has said. The President shall only do so if the speaker agrees to the question and if the President is satisfied that this will lead neither to disruption of the debate nor, through the putting of successive questions by raising a blue card, to a gross imbalance in the political group affinities of Members speaking in that debate.
9. No Member may speak for more than one minute on any of the following subject matters: the minutes of the sitting, procedural motions, or amendments to the final draft agenda or the agenda.
10. In the debate on a report, the Commission and the Council shall, as a rule, be heard immediately after the presentation, by the rapporteur, of his or her report. The Commission, the Council, and the rapporteur may be heard again, in particular in order to respond to the statements made by Members.
11. Members who have not spoken in a debate may, no more than once per part-session, hand in a written statement of not more than 200 words, which shall be appended to the verbatim report of the debate.
12. Having due regard to Article 230 of the Treaty on the Functioning of the European Union, the President shall seek to reach an understanding with the Commission, the Council, and the President of the European Council on an appropriate allocation to them of speaking time.

2.F Appendix: expert survey

2.F.1 Script

I contacted Members of the European Parliament for a brief survey. I successfully sent emails to all current MEPs using the email addresses listed on the EP website. I received 56 responses via email and conducted 10 phone interviews. Additionally, I interviewed 3 parliamentary assistants, and one assistant responsible only for the seating arrangement of one alphabetical group. My email contained three questions, requesting concise qualitative responses. The complete script is outlined below:

Dear [MEP name],

I am currently a PhD student at Ecole Polytechnique in France, and I have been conducting research on the effects of the alphabetical seating arrangement in the European Parliament. I am reaching out to seek your expert insights on the following questions, to ensure an accurate representation of how the European Parliament functions. I'd be grateful if you could reply (even very briefly) by return e-mail or by contacting me on +33 6 XXX.

1. How much interaction do MEPs assigned to sit next to each other have, and what types of interactions do they engage in? For instance, do seating neighbours commonly engage in discussions or form close friendships that extend beyond the chamber? Do you tend to interact more with colleagues from the same nationality?
2. In your opinion, how might an MEP influence the voting behaviour of another MEP who sits next to them, even if only to a small extent?
3. How do you choose the language in which you will speak during your speeches in plenary sessions? And what language do you most frequently use when communicating with your colleagues in the European Parliament?

Please note that any quotes from your responses will be attributed to "an MEP" to ensure your anonymity.

Thank you for considering these questions and contributing to my research!

Best regards,

Hugo Subtil

2.F.2 Anonymized responses

For the sake of space, I have not included here the complete responses to each of the three questions. I assigned a random ID to uniquely identify a given MEP's answers to those questions, and then I randomly selected 20 responses from my dataset. Responses from phone interviews are marked with asterisks, while all other responses are from email correspondence.

Feel free to reach out if you would like to access all the responses. The phone interviews were conducted either in French or in English. Please note that it appears there may be a slight over representation of French MEPs in my replies, likely due to my nationality.

1. How much interaction do MEPs assigned to sit next to each other have, and what types of interactions do they engage in? For instance, do seating neighbours commonly engage in discussions or form close friendships that extend beyond the chamber? Do you tend to interact more with colleagues from the same nationality?

(1) Informal talks depending on what's relevant and on the agenda right now. Can be both private and professional topics. Mostly related to neighbours of my own group.

(2) Les députés européens siègent en groupe donc la plupart sont assis à côté de collègues partageant leur vision politique. Les interactions sont généralement amicales. Mais il peut arriver que certains eurodéputés siègent à côté de parlementaires d'un autre groupe, auquel cas des discussions peuvent avoir lieu, ou au contraire le silence régner si les uns décident d'ignorer les autres. Personnellement ce n'est pas ma vision des choses, mais la gauche et l'extrême-gauche ont souvent cette tendance à ostraciser

leurs adversaires politiques. De toute façon, nous siégeons à proximité de députés ayant des sensibilités proches puisque l'hémicycle est organisé ainsi. Une nationalité identique aide grandement dans les interactions puisqu'elle enlève la barrière de la langue.

(3) Les députés assis côte à côte ont souvent des interactions amicales dans l'hémicycle, cela dépend de la langue de chacun et des contacts que l'on peut ainsi établir en échangeant quelques mots.

(4) Interaction réelle, surtout quand il s'agit de collègues de la même nationalité. Des amitiés peuvent effectivement naître.

(5) The extent and nature of interactions depend on the individuals involved. People with similar outlooks, regardless of party affiliation, tend to engage in more conversation and "joking around" compared to those with conflicting views. However, this isn't a strict rule; the personality of the MEPs sitting together plays a larger role. Naturally, more talkative or outgoing individuals will converse more than others. MEPs often form personal connections with those they differ from politically, sometimes even more so than with their own party members (who are their competitors). The seating arrangement itself isn't a significant factor in this regard. Such friendships more frequently result from communications outside the chamber, in committees, during travels, over coffee, and so on. Therefore, MEPs who already have a rapport with each other will take advantage of their proximity, rather than the seating arrangement being the determining factor.

(6) Interactions hinge on the individuals and their personalities, but generally, there is a friendly atmosphere between parliamentarians sitting next to each other, even when they belong to different parties. While some voting days may be a bit tense, MEPs make an effort to keep it professional while seated in their designated spots. Occasionally, you get to know someone well who sits next to you, someone you might not otherwise interact with, as you may not serve on the same MEP committees or come from different groups.

(7) I'm in my second year at the EP, so I can only speak from my own experience and what I observe from my seat. I would say it varies. Sometimes you end up sitting next to someone from your party, and that can affect the interactions. I find that I do engage in conversation on voting days, especially when I don't need to be quiet to not miss anything. Some MEPs have had more encounters with other MPs, and interactions with Ministers (who are all MPs this term) are usually more formal. It's

2 Social Learning of Political Elites
Peer effects in legislators' political speech

quite common for MEPs to form friendships that cross party lines. There might be some division between those in government and those in opposition each term. I come from a nation of only 370 thousand, so some of us may have had close ties even before being elected.

(8) Friendly conversation, mostly small talk.

(9) In summary, I would say the atmosphere in the parliament is professional and friendly, at least in general.

(10) We "chat" (whisper) to each other while other MEPs are at the podium speaking or challenging what they are saying. I will also often give each other positive feedback after a neighbour has given a speech or asked a member a good challenging question. In my case, both my neighbours, like me, are from my group, so I guess the interaction is different when you have someone from a different group sitting next to you. Last year, I did have one coalition member sitting next to me, and since we also shared a committee, we got to know each other much better - and that then also led to us working closer on finding common ground on some bills being discussed in the committee. On voting days, the interaction isn't much different; I usually vote more as a party group rather than being influenced by someone sitting next to me. I'm sure some people become good friends, but I think it's more common that people at least become a bit closer - which then enables them to have better discussions with each other outside of the chamber.

(11) Not much. MEPs generally don't spend much time in the chamber during discussions, and since it's a big chamber, whispering disrupts the proceedings. I would say the seating arrangement has little to no impact outside of the chamber.

(12) It's inevitable that I get to know people and become friendly. It's also inevitable that I like some people more than others. I've never felt that who I sat next to during voting has any effect, as the time spent voting in the assembly is limited. If I like the person sitting next to me, I'll chat with them; otherwise, not. Much more of my time is spent in committee meetings. The MEPs I get to know the best are the ones I work with the most in committees or other groups.

(13) Le Parlement Européen attribue les sièges aux députés, ceux-ci interagissent entre eux. Il n'y a pas vraiment de considérations qui sont faites quant à la nationalité des députés à côté de qui on est assis, le seul problème peut se trouver au niveau de la

langue, puisque les députés ne parlent pas tous anglais, et donc ne se comprennent pas nécessairement et n'interagissent donc tout simplement pas entre eux.

(14) If we are talking about the plenary chamber, delegations can ask to sit next to each other, so usually you are surrounded by your national party colleagues. If you don't have any, or if they hold a higher position in the house and thus sit closer to the Chair, it is more random and yes, you do interact with those people more. I wouldn't say that in the plenary chamber that would lead to friendships, but the seating order in Group meetings and Committee hearings, where you are either with your Group colleagues (so close by values) or with MEPs focusing on similar subjects as you do (so close by topic/interests), might support engagement that would otherwise not start. I personally have a colleague in the Greens/EFA Group who sits next to me thanks to alphabetical order (XXX - XXX). We are on completely different committees and would thus probably never cross paths, but as we sit next to each other and took liking to each other's character (I hope I can speak on his behalf, too!), we are actively co-signing our open letters, liking Tweets and endorsing ourselves.

As for the last question, I would say this would greatly depend on the respective MEP. Logically, your national colleagues are your biggest competitors, so there should not be that much room to form close bonds; however, if you are an MEP focused on national values (maybe from ID or ECR), you find it more natural to talk in your own language with your "kin". And alas, this mandate, my Renew and The Left colleagues from Czechia actually found love between them. So anything is possible. :) I am, however, in the first group. My friendships and contacts stem from similar values and characters, rather than nationality.

(15) It really depends on the relationship between the members how much they interact. I have been very interactive with some who sit next to me, while others I barely speak to. Personally, I cannot consider sitting next to someone as the basis for my friendship. Often there is chitchat between people sitting next to each other.

(16) By design the interactions are much higher with those sitting close to each other, may it be in plenary or the Commissions (but on the plenary we have fixed seat and on the Committees that can easily be changed). I would say there is a cordial interaction that goes beyond the seats and is reinforced due to that proximity. I tend to interact with those that speak English (that is the main language used by all MEPs).

(17*) It depends on the person you're sitting next to. If you personally like the person you're sitting next to, you'll interact quite a lot. Mostly on non-political stuff. Everyday kind of things, like you would with a co-worker. Jokes are quite common.

(18*) Usually, the MEPs do not spend that much time in the main chamber. During longer plenary discussions, mostly just a couple of MEPs actively taking part in the discussion are present. Others are in their offices. So you do not necessarily spend that much time with your assigned neighbour. This is different during voting sessions when most MEPs are actually in the room. But then the communication is mostly limited to one-line sentences ranging from "what item is this again?" to political trash-talk. I usually did not find these randomly assigned neighbours becoming close friends or interacting outside.

(19) He almost exclusively speaks to the other Pirate MEP, because they are in the same delegation. There is more interaction with his fellow German MEPs than other nationalities, mostly due to the fact that they share their national audience. [In the hemicycle this member sits next to a French MEP from S&D and on the other side a fellow MEP from the Pirate Party movement from the Czech Republic.]

(20) It is natural that you chat with the person sitting next to you. However, the people you are sitting next to are from the same political group. Hence, there are frequent interactions with those colleagues anyway, in delegation meetings, group meetings, committee meetings. In my experience, sitting next to one another in the plenary does not result in more or less meaningful relationships than with other colleagues.

2. In your opinion, how might an MEP influence the voting behaviour of another MEP who sits next to them, even if only to a small extent?

(1) Not at all.

(2) Pour être tout à fait honnête, je doute fort de l'impact qu'un député peut avoir sur un autre lors d'une séance de vote. Chacun est concentré sur sa liste de votes, l'exercice demandant de l'attention. Tout est d'ailleurs préparé à l'avance et a fait l'objet de discussions entre nous lors de nos réunions de délégation. La séance de vote est assez formelle, il ne peut y avoir de véritables revirements. Peut-être qu'en perturbant son voisin il est possible de l'empêcher de voter, mais personne ne pratique une telle méthode. Il ne peut y avoir que de l'inattention à mon sens.

(3) Les positions de vote sont déjà arrêtées en amont de la séance, chacun suit donc sa liste de vote sans prêter attention à son voisin. En étant assis par groupes politiques, cette position a d'ailleurs été discutée en réunion de groupe au préalable.

(4) Influence très légère, mais possible dans des cas rares. Difficile toutefois car les votes sont rapides et ne laissent guère le temps de discuter.

(5) Voting decisions are typically predetermined by parliamentary groups, and there's minimal influence from seating arrangements.

(6) MEPs usually don't discuss their votes due to the fast pace of proceedings. Votes are generally aligned with party lines, with little discussion on voting intentions.

(7) Seating arrangements have no bearing on voting decisions.

(8) In my experience, I haven't voted on legislation directly. My participation has focused on parliamentary scheduling and procedural matters. Votes on these issues can take on political dimensions. Party leaders may signal a stance, and I tend to follow suit. Interactions with neighbouring MEPs are limited but friendly. While it's conceivable that influence could occur, my experience is limited.

(9) The impact of seating arrangements on voting is highly unlikely. Party whips play a more significant role in instructing MEPs on how to vote.

(10) Seating arrangements have no influence on voting.

(11) I believe seating arrangements have no sway on votes. Decisions are typically made in party meetings before voting.

(12) While not a significant factor, close conversations could potentially garner additional support for a majority.

(13) L'influence ne se fait pas en plénière et au moment des votes puisque le choix du vote est défini avant d'arriver à la plénière, il en va de même dans les commissions parlementaires. Le choix du vote se fait en amont pour étudier les textes et définir les positions. En plénière, les députés d'un même groupe, harmonisent leurs votes et s'accordent sur la ligne à suivre.

(14) This would be a long-term effect of frequent talking. Even studies prove that we as humans oftentimes decide based on incomplete information, emotions, impressions. It is a human thing to do, although we might legitimately criticise it in politicians more than in others. And if you talk to a certain person, whom you might even like, more often than to others, it is almost impossible that you will not be influenced by their explanations and points of view. However, I think it is important to note that each

MEP has a job of then explaining their voting behaviour at home, where different national contexts might apply. So I'd say there can definitely be an influence over non-priority votes for certain MEP, but if it is about controversial or priority issues, many more factors than just friendship come into play.

(15) Seating arrangements may have a minor impact by allowing neighbours to point out potential misunderstandings about specific articles or sections of the vote. For instance, by asking, "hmm, are you sure about that?"

(16) If so I would say it's very residual. Our voting behaviour is very much defined by our group positions or between other MEPS from the same Committee. The seat next to ours in the plenary doesn't make a substantial chance in my analysis.

(17*) For most groups, votes are determined in advance, and the entire party votes in a certain manner. I don't believe an MEP seated next to you could influence the vote in any significant way.

(18*) Seating arrangements don't significantly affect voting behaviour. Parliamentary groups hold meetings to coordinate their votes ahead of time. During votes, each MEP follows a predetermined script, and if uncertain, they look to the chairman's lead. While there may be significant issues that divide groups, even then, seating arrangements have limited impact on voting decisions.

(19) Within the Pirate delegation there are discussions on how to vote in the plenary and therefore MEP XXX is influenced in how he votes by his seated neighbour. This however would not be the case if he didn't sit next to a MEP of the same delegation. On his other side, the French S&D MEP has no influence on his voting behaviour.

(20) I do not think that there is a meaningful effect on voting behaviour. Plenary votes are often long and complex, which results in MEPs voting in line with a voting list they have prepared for the vote in question. Therefore, there is little room for spontaneous vote-switching in the chamber.

3. How do you choose the language in which you will speak during your speeches in plenary sessions? And what language do you most frequently use when communicating with your colleagues in the European Parliament?

(1) I speak Danish, when having speaking time, informal talks are either in English or German.

(2) Je m'exprime toujours en français lors de mes interventions. C'est une question de principe. En tant que représentant des Français au Parlement européen, il est normal d'utiliser notre langue commune, qui est la plus à même d'exprimer le fond de ma pensée et de transmettre la sincérité de mon engagement. La même logique prévaut lors de mes échanges avec mes collègues eurodéputés, notre belle langue étant parlée par une grande partie d'entre eux. La langue française apporte d'ailleurs de nombreuses nuances que ne possèdent pas d'autres langues. Les interprètes au Parlement européen préfèrent d'ailleurs que nous utilisions nos langues d'origine plutôt qu'un anglais de très mauvaise qualité difficilement traduisible pour eux!

(3) Je m'exprime toujours en français car c'est ma langue maternelle. C'est aussi la langue que j'utilise avec les collègues francophones au Parlement, même si l'anglais est parfois utile comme intermédiaire si on ne parle pas la langue du député à côté

(4) Je choisis ma langue, le français, quand c'est possible, à la fois par principe (non à l'omnipotence de l'anglais !) et par commodité. Sinon je me résous à utiliser l'anglais.

(5) I usually speak in English during plenary sessions for wider understanding. However, when discussing with colleagues, I prefer to use French as it's more comfortable for me.

(6) Being from Malta, I find it best to use English in plenary sessions for broader comprehension. But when chatting with fellow Maltese MEPs, we often switch to Maltese for a more informal and natural conversation.

(7) Always in English.

(8) As an MEP from Estonia, I find it practical to use English in plenary sessions. However, when discussing matters with fellow Estonian MEPs, we tend to switch to Estonian for a more nuanced and native conversation.

(9) I generally speak in English for better understanding. However, when conversing with Latvian colleagues, we usually switch to Latvian for a more authentic and sincere conversation. English serves its purpose, but there's a certain depth in our native tongue.

(10) Depends on the goal: to reach my constituents I speak my mother tongue, with colleagues in English.

(11) As I speak very little English I always speak in French and when having to talk with other colleagues that don't speak English we figure it out.

(12) I'm a from Luxembourg, so I generally speak in French because many colleagues know how to handle it. If not, English during plenary sessions for wider accessibility.

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(13) Lors des discours, les députés privilégient leur langue maternelle, ce qui leur est plus agréable. Pour ce qui est de l'écoute des discours, les députés peuvent faire usage d'un casque mis à leur disposition pour choisir la langue de l'interprétation lorsqu'ils ne maîtrisent pas la langue employée par l'orateur. Enfin, pour sa part M. XXX utilise le français pour communiquer avec ses collègues.

(14) Personally, I always speak in English. I think I made one or two exceptions, when the topic was extremely relevant for Czech voters and I spoke directly to them. Although the speeches are a way of presenting my views to the voters, I am still speaking in a room full of colleagues who might want to immediately react to me. I'd prefer more interactive plenaries, where we actually contest each other's views. In that regard, it is more comfortable for all of us to listen and speak in English, not put up and down headphones all the time and hope nothing will get "lost in translation".

In general, I communicate with my colleagues in English, as it is the *lingua franca*, a common language which (mostly) everybody understands and is thus the most inclusive. I find it slightly rude that sometimes, when there is a smaller meeting with prevalence of one nationality, people of that nationality tend to small-talk in their language. If they have something secret to discuss, they can leave the room; if they are just small-talking, they can include others, it is more polite.

(15) When addressing the chamber, I typically use English to create content for social media. Within the European Parliament, I communicate in German with my German colleagues and use English when interacting with others.

(16) Mainly in Portuguese because the plenary interventions are more for the outside than to debate (the model is not that efficient to that purpose). However in debating in Committees is mainly English. However every language should continue to be translated because there are official EU languages and a part of our cultural baggage.

(17*) I consistently address the plenary session in my native language, as I believe it is a tribute to my constituents. When engaging with colleagues, I adapt my language choice to ensure the most effective communication, given that I am proficient in four different languages.

(18*) C'est un point d'importance pour moi de m'exprimer en français afin de soutenir la langue de Molière et de plaider contre la prédominance de l'anglais au sein des institutions.

(19) Depending on the audience the MEP addresses with their speech and what they want to achieve. If the goal of the speech is to criticize the Commission or stress a point which has come up in negotiations with other MEP colleagues they will speak English. If the point of the speech is to convey information to the German audience, they will speak German.

(20) When I speak in the chamber, I usually speak in German. That also facilitates "re-using" my plenary interventions, e.g. for generating social media content. In the European Parliament, I speak German with German colleagues and English with everyone else.

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The Libor manipulation as a Bayesian experiment

Note: This chapter is co-authored with Guillaume DUPÉRET (Mines Paris — PSL) and Pierre FLECKINGER (Mines Paris — PSL, CERNA).¹

Introduction

The London Interbank Offered Rate (Libor) was a major interest rate benchmark, licensed by the British Bankers Association (BBA) in 1986. It aimed to reflect the average rate for borrowing unsecured funds on the London interbank market. The BBA would set it every morning as a truncated arithmetic average after asking a panel of 16 to 18 large banks the rate at which they would agree to borrow from other banks. Trillions of dollars of financial contracts, ranging from adjustable-rate mortgages to complex interest rate derivatives, were explicitly tied to Libor since its introduction — so much that the BBA called it “the most important number in the world” (Snider and Youle (2014)).

But as the banks participating in the panel were chosen among the Libor users, they happened to be tempted to jointly manipulate it, up or down, according to their own interests. True each bank was supposed to contribute to the panel without knowing the contributions of the other banks during “the reporting window” every morning. But the contributors could easily communicate and their responses were all revealed publicly *ex post*. So, many traders in those banks did contact their colleagues to request and

¹[Git-hub link to simulation](#)

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obtain submissions favorable to their trading positions. *Wall Street Journal* articles by [Mollenkamp \(2008\)](#) and [Mollenkamp and Whitehouse \(2008\)](#) publicly revealed such practice. Later in-depth investigations by regulators worldwide confirmed that they had been wide-ranging and going on for years.² This resulted in court cases that imposed a total of more than \$9 billion in fines ([Dick and Rafferty \(2016\)](#)).

The fact remained that, although the possibility of Libor manipulations had been suspected within the Federal Reserve system as early as June 2008 ([Hilsenrath et al. \(2008\)](#)), their existence and their extent apparently went unnoticed by financial market regulators. The initial public concerns over Libor manipulations focused on the traders of the different banks involved, and the academic literature mainly addressed their collusive behaviour, particularly at the height of the 2008 financial crisis ([Chen \(2020\)](#), [Boot et al. \(2019\)](#) and [Rafeld et al. \(2020\)](#)). In this paper, we examine a specific mechanism encouraging such fraudulent practice: the absence of clear rules, which left unknown the financial market supervisors' real activity. This sheds light on the long-term dynamics of the manipulation.

The banks composing the BBA's panel were asked to report a rate (private information) contributing to the Libor, which they themselves would be subject to. Our model can thus be formulated as a moral hazard problem, where the supervisor must exert effort to detect manipulation, while, one of the particularities of this problem was the environment in which it occurred: the concept of manipulation is easy to grasp but lacks a clear definition. Thus it proved difficult to sue banks for engaging in rate rigging, even if the rates of contributions were obviously different from the rates of actual transactions. As explained by [Hernando-Veciana and Tröge \(2019\)](#), banks seem to have had a high level of discretion due to the lack of such a definition.³

²Based on the Barclays' July 2012 admission of manipulation, released as part of a settlement with U.S. and U.K. regulators.

³Banks in the Libor panel were asked: "At what rate could you borrow funds, were you to do so by asking for and then accepting inter-bank offers in a reasonable market size just prior to 11am London time?" ([Duffie and Stein \(2015\)](#)). Note that "reasonable market size" is not defined and that banks could submit estimates even if they had not "asked for" or accepted interbank offers. Not surprisingly, in the ensuing lawsuits, it turned out to be very difficult to prove that the banks provided wrong submissions by comparing to a true value hard to reconstruct.

Interestingly, in this context, an increase in manipulation by the banks also increased the probability of its detection, but at the same time it gave them information about their regulatory environment: if banks were not caught, they could imagine that their supervisor was not active and intrusive. Then, what was the banks' optimal manipulation to both maximize profit and at the same time not get caught, knowing that an unsanctioned manipulation constitutes a learning process about the supervisor? This is the question our model aims to address.

We propose a decision model with learning, i.e. a problem of optimal control in which the subjective probability of being noticed and sanctioned depends on the intensity of the manipulation and the gradual learning. This intertemporal optimization problem is non-standard, as it involves an endogenous discount factor in its recursive version.

We show that considering the existence of a certain future leads to manipulation for a wider range of initial priors. To put it differently, in such a framework, the more patient the agent is, the more valuable their future becomes, and therefore they are encouraged to experiment (and thus manipulate) to gain understanding. This experimental value implies that a sequence of impatient and myopic agents observing the actions of their predecessors generates less manipulation than a single agent acting in an infinite number of periods. One might expect an agent experimenting only once to take maximum risk when she has no incentive to wait. Conversely, when she has an infinite time horizon, she might consider experimenting less in the short term, knowing that she can afford to learn less quickly, thanks to the prospect of future long-term gains. However, our model shows that these intuitions are not valid: if an agent manipulates only once, she runs the risk of a penalty that clearly would exceed her gain if she recklessly cheats too much. Whereas, with an infinite horizon, taking time into account gives the future an option value: experimenting more today gives an option on more profitable experience tomorrow. This surprising result is important because it may apply to many situations other than the Libor scandal. Our model sheds light on any situation in which the action taken by an agent to maximise its utility has the additional effect of informing her about the uncertain environment in which she acts. This new information improves the next actions she can take. This is a classic case of learning processes. More information will be produced over time as to whether the norm is binding or not, according to the environment response.

Literature

The considerable amount of financial products indexed by the Libor and the extent of the alleged manipulation have given rise to many press articles and academic publications. We present an extensive review of this literature on Libor and its manipulation, followed by a technical one on our specific Libor model and its issues.

The literature on the Libor manipulation can be summarised along two main lines. (i) Empirical approaches to manipulation are essentially based on the study of the banks' contributions to the Libor panel. The analysis of the contributions submitted by the banks conducted by [Abrantes-Metz et al. \(2012\)](#) highlights the possibility of anti-competitive practice. While it does not fully validate the existence of bias in the rate, it acknowledges that many contributing banks had very different positions on both the CDS (*Credit Default Swap*) market and the Libor panel. In this respect, their methodology is similar to that of [Snider and Youle \(2014\)](#), who, using panel data, show that the rates submitted by the banks were difficult to rationalize with observable measures of their costs or even their contributions to other panels. [Kuo et al. \(2012\)](#) and [Monticini and Thornton \(2013\)](#) complement this approach by adding to the comparison other indicators of those banks' financial health (such as their engagement in refinancing with the FED, having recourse to auction facilities). (ii) A significant part of the Libor literature formulates predictions from theoretical models. In [Chen \(2020\)](#), a collusion model was precisely modelled based on key characteristics of the indicator. From this, she derived an optimal contribution and offered theoretical recommendations regarding the sanctions and the allocation of regulatory controls (which should be adjusted based on the banks' contributions). In order to complete such theoretical work with a conclusion related to the scandal, [Snider and Youle \(2014\)](#) articulated a simpler model. This enabled them to juxtapose the projected distributions of optimal contributions with those that were actually submitted by the banks in the panel from 2005 to 2011. Their study confirmed collusion.

From a *mechanism design* perspective, these studies of optimal reporting behaviour for a bank in the Libor panel could naturally lead in recommendations for its reform. [Eisl et al. \(2017\)](#) showed that replacing the truncated mean with the median would already reduce the incentive to manipulate the indicator. [Diehl \(2013\)](#), after supplementing the

gain function maximized by each bank's announcement in [Snider and Youle \(2014\)](#) with a reputation element (deviating from the final Libor might signal refinancing difficulties), proposed to no longer reveal the individual contributions of the banks to the panel.

Apart from insights into Libor manipulation, our contribution is part of a theoretical approach that seeks to account for biased contributions by an agent to its principal. Building on the Libor example, we aim to propose a model (i) articulating the associated payoff and punishment (ii) within the framework of a bandit model allowing us to account for the learning of the punishment probability. We show how this combination leads to interesting effects in an information economics perspective where a manipulator learns over time about the type of her supervisor. To this end, this is a new and original adaptation in the field of microeconomics (iii) based on the macroeconomic literature of infinite horizon discrete-time dynamic programming, in which the discount factor depends on the state variable.

(i) This model, which combines gain and sanction, follows in the tradition of the seminal article by [Gary \(1968\)](#). In this literature, fraudulent behaviour is described as the consequence of rational individual behaviour. Becker predicts how changes in the probability and severity of punishment can affect the number of crimes. A criminal act is preferred and chosen if the expected benefits exceed the expected costs – this cost-benefit calculation can be performed consciously or unconsciously. It is the expected punishment that deters people from committing a crime. We intend to contribute to this body of literature by enriching the modelling of punishment by modelling it as a double consequence of the probability of being caught and the existence of an active control instance. Whatever the probability of detection of manipulation in case of control, the latter is in fact always conditioned to an effective activity of supervision by the authority. For the agent, we insist on the fact that the absence of control is doubly good news: for the gain induced but also for the learning allowed.

(ii) Following [Bergemann and Hege \(1998, 2005\)](#), this amounts to modelling an experiment linked to the intensity chosen for the learning variable. The latter starts from a simple example of financing an innovation project whose success depends on the unobservable effort of an innovator conditional on the intrinsic and unknown feasibility of the project (which is to be discovered). More recently, [Gomes et al. \(2016\)](#) and [Halac et al. \(2017\)](#) extended this problem of experimentation to cases of adverse selection,

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but in a unique framework, without considering what the time horizon of the agents does to the dynamics of their learning. This approach is closer to [Cherian and Perotti \(2001\)](#), who show that it is even possible to endogenise the behaviour of the regulator. It shows that a political commitment to no taxation maintained for a certain period of time may in fact hide an opportunistic state that prepares the optimal moment to change the rules to its advantage. Such an endogenisation of the type of regulator is however not necessary to understand the manipulation of the Libor. We rather focus on the time horizon of the manipulators, which is here the central parameter to capture a manipulation that took place over several years or even decades.

(iii) To this end, we propose a decision model with learning that amounts to formulating an optimal control problem in which the subjective stopping probability depends on the intensity of the manipulation and the gradual learning. This intertemporal optimisation problem is non-standard, as it involves an endogenous discount factor in its recursive version. However, modelling a manipulation potential that stops upon detection requires the addition of a survival probability at the end of each period in the expected intertemporal payoff, which is an innovation compared to the existing literature. Indeed, [Bergemann and Hege \(2005\)](#) reduce the infinite horizon to a finite horizon with a certain probability, which does not correspond to the logic of a manipulation that stops with its detection. Such a problem, which complicates the calculation of continuation values for a manipulator able to consider an infinite horizon, has not yet been solved. Recent papers in macroeconomics, however, attempt to solve similar problems. Thus, whereas the standard theory of dynamic programming with an infinite horizon ([Blackwell \(1965\)](#)) does not model the continuation value as a function of the state variable,⁴ [Stachurski and Zhang \(2021\)](#) extend the main results of dynamic programming to the case where the discount factor depends on the state variable. Their value function satisfies the Bellman equation, and they show the existence of an optimal policy, the validity of the Bellman optimality principle and the convergence of the policy iteration algorithm. Similarly, [Rincón-Zapatero \(2022\)](#) shows how it is possible to endogenize the state and action dependent discount factor in a stochastic discrete time dynamic optimization model. With the model proposed below, we propose a way of posing the problem in a microeconomic application, and present a characterisation of the solution for a large class of utility function.

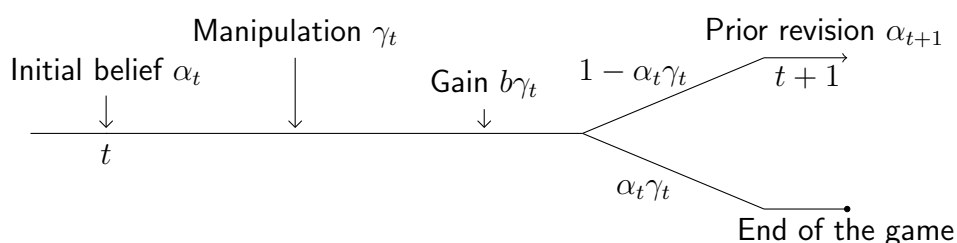
⁴It is also possible to refer to works such as [Stokey et al. \(1989\)](#) or [Bertsekas \(2017\)](#).

Model

The model draws directly on an aspect so far relatively ignored in the literature on the Libor manipulation, as opposed to its collusive dimension. We seek to capture the fact that traders (and contributors) have over time felt increasingly free to cheat. The model is based on a repeated decision to manipulate, with learning and stopping in case of detection. In order to fix ideas, we first present a more specific version than the one studied later. This is done to establish the core economic intuitions without the cost of exposing a higher generality.

Formally, a trader chooses at each period $t \geq 1$ (until potential discovery of the manipulation), a degree of manipulation $\gamma_t \in [0, 1]$ which gives them a gain $b\gamma_t$ in period t . The trader risks being detected and penalized by a supervisor. This depends on the type of supervisor: it can be either *active* or *inactive*, which is assumed to be exogenous, persistent and unknown to the trader. The trader's initial belief that the supervisor is active is denoted by α_0 . At the beginning of each period $t > 0$, this belief is updated to α_t , based on the past degrees of manipulation. This sequence of intra-period events t is summarised below.

Intra-period events timing



Importantly, only an active supervisor can spot a fraud. We assume in such a case that the probability of being checked is equal to γ_t : the larger the fraud, the more likely it is to be detected. Consequently, even if the supervisor is active, traders can still manipulate without being caught. When the trader's manipulation is detected, the game stops for good and the trader also receives a monetary penalty equal to $\frac{s\gamma_t}{2} > 0$, where $\frac{s}{2} > 0$ represents the maximum penalty. If the supervisor is inactive or

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if, although active, fails to detect the manipulation, the trader then forms a new belief α_{t+1} and the game continues in $t + 1$. Finally, $\delta \in [0, 1]$ represents the discount factor between periods.

To highlight the optimal decisions made by traders, an analysis of the generic properties of the utility function is presented in the thereafter (Sections 3.2.1 and 3.2.2). But a large part of the analysis is based on the utility function per period implied by the hypotheses set out above, namely

$$u(\alpha_t, \gamma_t) = b\gamma_t - \alpha_t\gamma_t \frac{s\gamma_t}{2} \quad (3.0.1)$$

where γ_t is both the magnitude of the manipulation and the probability of detection conditional on an active supervisor and $\frac{s\gamma_t}{2}$ the monetary penalty. This function is concave in γ_t .

Finally, anticipating the analysis somewhat, the evolution of the posterior belief α_{t+1} , conditional on the absence of a sanction at period t , is given by Bayes' theorem as a function of the belief at the beginning of the period α_t and the magnitude of the manipulation γ_t

$$\alpha_{t+1} = \frac{\alpha_t(1 - \gamma_t)}{1 - \alpha_t\gamma_t}$$

The doubt about the nature of the supervisor is reduced over time since successive manipulations produce two types of information: either a validation of the supervisor's activity in the case of a positive control which puts an end to the game, or an absence of sanction which increases the belief in the supervisor's inactivity in the following period. The revised belief decreases with time if the trader is not caught during a manipulation period.⁵ The decrease in belief in the supervisor's type is stronger for large γ_t manipulation sizes. Cheating agents become all the more optimistic about the likelihood of the supervisor's inactivity when they have successfully frauded without being detected.

⁵The sequence $(\alpha_t)_{t \in \mathbb{N}}$ is strictly decreasing. In fact, $\alpha_{t+1} < \alpha_t \iff \alpha_t < 1$, which is true by definition of α_t .

A simple two-period example

A classic intuition in dynamic models is that an impatient (or even short-sighted) agent will be more tempted by a short-term deviation than a patient agent: the prospect of a future payoff is usually the source of some discipline (Mailath and Samuelson (2006)). Applied to the Libor manipulation, this intuition suggests that a more impatient trader would be more likely to manipulate (than a more patient one), more willingly risking the rest of his career, since it matters less to him. The following two-period example shows how this intuition is incomplete when the manipulation allows one to learn about the type of regulator, and to consider the consequences this has for the manipulation of Libor.

We consider the case where the game lasts two periods ($t = 0, 1$) and γ_t is binary, equal to 0 or 1, keeping the set of assumptions presented in the previous section. This means that the trader has the choice between not cheating at all, learning nothing about the regulator's activity and thus obtaining a utility normalized to 0⁶; or cheating to the maximum, obtaining in this case perfect information about the regulator's activity, who will detect their manipulation if and only if that regulator is active. We compare the priors α inducing maximum cheating in the two horizons.

We solve the trader's problem by backward induction. The latter cheats at period $t = 1$ (the second and last one) if and only if $b - \alpha_1 \frac{s}{2} > 0$, that is if

$$\alpha_1 \leq \alpha^* \equiv \frac{2b}{s}.$$

During the first period, the trader makes their choice taking into account their anticipated behaviour according to the evolution of their belief, which remains $\alpha_1 = \alpha_0$ if she does not cheat, and becomes $\alpha_1 = 0$ if she has cheated without being detected. Thus, a trader who cheated in the first period without being detected will necessarily cheat in the second period, since in this case $\alpha_1 = 0 < \alpha^*$. We can immediately see that only three strategies are relevant: (i) never cheat, i.e. $(\gamma_0, \gamma_1) = (0, 0)$, for a total gain of 0, (ii) cheat in the first period, and in the second period if the game continues,

⁶We can consider that this level of utility is his alternative competitive wage in the economy, and that traders are competing for the position in the bank considered (where they can however obtain a higher gain by manipulating).

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i.e. $(\gamma_0, \gamma_1) = (1, 1)$, for a gain of $b - \alpha_0 \frac{s}{2} + (1 - \alpha_0)\delta b$, (iii) cheating only in the second period, i.e. $(\gamma_0, \gamma_1) = (0, 1)$, for a gain of $\delta(b - \alpha_0 \frac{s}{2})$. However, this third option is always dominated by one of the other two: if $\alpha_0 > \alpha^*$, this strategy gives a negative payoff, and is dominated by the first. Conversely, if $\alpha_0 \leq \alpha^*$, this strategy is dominated by the second one, which allows the same payoff to be made immediately, and a potential payoff in the second period. Therefore, only the strategies $(0, 0)$ and $(1, 1)$ can be optimal. We deduce that the trader cheats all the time if and only if

$$\alpha_0 \leq \alpha^{**} \equiv \frac{2b(1 + \delta)}{s + 2b\delta}.$$

This inequality shows that a more patient trader will cheat more: α^{**} is indeed increasing in δ for $\frac{s}{2} > b$, which is a necessary condition for the agent to be disciplined by the sanction (otherwise the model is trivial: the agent cheats whatever her belief). In the limit $\delta = 0$, the agent is myopic (or equivalently one who lives only one period), and $\alpha^{**} = \alpha^*$. The intuition is simple: experimentation has a short term cost of punishment, but pays off in the long run if the regulator turns out to be inactive. Thus, a more patient agent is more tempted to experiment via manipulation than a less patient one, for whom the potential short-term penalty is relatively more disciplining.

In what follows, we first analyze the special case called « finite horizon » which amounts to an infinite sequence of completely myopic agents living only one period but observing the whole past history (or, equivalently, a completely impatient agent defined by $\delta = 0$). We then study the complete model, called « an infinite horizon model » in which the choice of manipulation is continuous, the horizon infinite and the payoff function more general (or, equivalently, a patient agent defined by $\delta > 0$).

3.1 A thousand people once

In this section, we consider the optimal manipulation behaviour of an infinite sequence of completely myopic traders living only one period but observing the whole past history (or, equivalently, a completely impatient agent defined by $\delta = 0$). A trader considers the prior α_t with which she starts their period t and chooses γ_t to maximise their single gain. If the period does not end with the detection of a manipulation, each agent benefits from the information acquired by the traders who preceded them.

3.1.1 Resolution

Proposition 1. Existence of a manipulation equilibrium Because of the quadratic form of the utility function, the trader always has an interest in manipulating: $\forall t \in \mathbb{N}, \gamma_t > 0$.⁷ Even with a low gain b and a high threat $s\alpha_t$, there is always a sufficiently small manipulation γ_t that makes the utility strictly greater than 0. This equilibrium is defined differently depending on whether the solution is internal or corner.

Characterisation of the optimum

If the solution is interior, the trader solves $\max_{\gamma_t} \left\{ b\gamma_t - \frac{s\alpha_t\gamma_t^2}{2} \right\}$ which leads to choose $\gamma_t^* = \frac{b}{s\alpha_t}$. This first result establishes the magnitude of the manipulation γ_t^* , because $s\alpha_t$ is by construction in \mathbb{R}_+ , a set on which γ_t^* is a decreasing function of α_t and s . If the belief in the supervisor's activity α_t is strong or the sanction s is high, then the extent of cheating is all the lower.

Moreover, as long as γ_t^* is interior, the increasing sequence (γ_t) is positive and convex.⁸ The informational gain resulting from the absence of detection thus allows the manipulation to grow more and more rapidly.

From the interior equilibrium we can also deduce the general term of the sequence $((\alpha_t))$ as long as the (γ_t^*) are interior. By taking the expression given by Bayes' formula, we then recognise an arithmetic-geometric sequence equal to,⁹ for all periods t giving an interior γ_t^* as

⁷For any period t , $\frac{\partial u}{\partial \gamma_t}(\alpha_t; 0) > 0$.

⁸The convexity is demonstrated by comparing 1 with the value of

$$\frac{\gamma_{t+2} - \gamma_{t+1}}{\gamma_{t+1} - \gamma_t} = \frac{\alpha_{t+1}\alpha_t}{\alpha_{t+2}\alpha_{t+1}} \times \frac{\alpha_{t+1} - \alpha_{t+2}}{\alpha_t - \alpha_{t+1}} = \frac{\alpha_t}{\alpha_{t+2}} \times \frac{1 - \alpha_{t+1}}{1 - \alpha_t}$$

By considering $h : x \mapsto \frac{x}{1-x}$ positive and increasing on $[0;1]$, the decrease of $(\alpha_t)_{t \in \mathbb{N}}$ implies that $\frac{\alpha_t}{1-\alpha_t} \times \frac{1-\alpha_{t+1}}{\alpha_{t+2}} > \frac{h(\alpha_t)}{h(\alpha_{t+1})} > 1$.

⁹Because the sequence is defined by $\forall t \in \mathbb{N}, \alpha_{t+1} = A\alpha_t + B$, we have $\forall t \in \mathbb{N}, \alpha_t = A^t(\alpha_0 - r) + r$ with $r = \frac{B}{1-A}$.

Taking $\alpha_{t+1} = \frac{\alpha_t(1 - \frac{b}{s\alpha_t})}{1 - \alpha_t \frac{b}{s\alpha_t}} = \frac{s}{s-b}\alpha_t - \frac{b}{s-b}$. Then, we get $A = \frac{s}{s-b}$ and $B = \frac{-b}{s-b}$ thus $r = \frac{-b}{1 - \frac{s}{s-b}} = 1$.

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$$\alpha_t = 1 - (1 - \alpha_0) \left(\frac{s}{s-b} \right)^t.$$

Moreover, the optimum is in a corner as soon as the inner value defining γ_t^* becomes greater than or equal to 1. The solution is corner when the threat of the supervisor ($\frac{b}{s}$ in the inner term $\frac{b}{s\alpha_t}$) is not sufficiently dissuasive, which would lead to wish to cheat as much as possible.

If the supervisor is not active, or until it detects a manipulation, the α_t continues to decrease each period due to learning effects. However, once γ_t reaches 1, traders can no longer use this extra information to increase the size of their gains.

Proposition 2. By defining an equilibrium as the sequence of optimal choices given the Bayesian updating of α_t period after period, the sequence of successive equilibria $(\gamma^*(\alpha_t))_{t \in \mathbb{N}}$ can only follow two trajectories:¹⁰

- All γ_t^* are in a corner from the initial period.

or else

- γ_t^* are interior *then* systematically cornered.

If the γ_t^* are first interior ($\gamma_0^* < 1$), it is possible to calculate the period \hat{t} which transition from an interior solution to a corner solution occurs. This period being entirely determined by the parameter α_0 , we look for the integer $\hat{t}(\alpha_0)$ such that $\frac{b}{s\alpha_{\hat{t}}} > \frac{b}{s\alpha_{\hat{t}-1}}$. We obtain it with the general term of the $(\alpha_t)_{t \in \mathbb{N}}$ sequence as long as $\gamma_t^* < 1$ by posing

$$\frac{b}{s \left(\left(\frac{s}{s-b} \right)^{\hat{t}} (\alpha_0 - 1) + 1 \right)} > 1$$

which gives

$$\hat{t} \geq \left\lfloor \frac{\ln \left(\frac{b-s}{s(\alpha_0-1)} \right)}{\ln \left(\frac{s}{s-b} \right)} \right\rfloor + 1.$$

¹⁰Proof: the strict decay of the sequence $(\alpha_t)_{t \in \mathbb{N}}$ allows to establish that the sequence of interior γ_t^* is strictly increasing. As the sequence $(\alpha_t)_{t \in \mathbb{N}}$ converges towards 0 (which can be demonstrated by considering that this positive decreasing $l = \frac{l(1-\gamma_t)}{1-l\gamma_t}$), the sequence converges towards 1 defined by $(\gamma_t)_{t \in \mathbb{N}}$ is not bounded and inevitably reaches 1.

We observe that the smaller α_0 and s are and the larger b is, the faster the period \hat{t} occurs. This is consistent with the intuition that the belief that the supervisor is unthreatening (i.e. subjectively perceived as inactive or defining a relatively limited sanction compared to the expected payoff) induces one to cheat more, faster, and thus to choose a cheating magnitude that reaches $\gamma = 1$ more quickly.

Proposition 3. Characterization of the equilibrium For α_0 , b and s given, we have, for all $t \in \mathbb{N}$,

$$\gamma_t^* = \begin{cases} \frac{b}{s\alpha_t} & \text{if } t < \hat{t}(\alpha_0) \\ 1 & \text{if } t \geq \hat{t}(\alpha_0). \end{cases}$$

Graphically, we can then represent the dynamics of an inner equilibrium and then a corner equilibrium, by also proposing to study p_t , the probability of control at each period t .

Unless otherwise stated, we will use the following parameterization in all the simulations:

Table 3.1.1: Setting 1.

Parameterization	δ	b	s
Value	0.99	0.1	3

Graphically, we can see that the optimal manipulation γ_t^* is first internal before being corner from the period \hat{t} .

Proposition 4. As long as γ_t^* is interior, the probability p_t for the manipulation to be detected by the supervisor is constant equal to $\frac{b}{s}$.

This is because, in the above characterization of the equilibrium, we can rewrite the first-order condition as $\alpha_t \gamma_t = p_t = \frac{b}{s}$, where we recognize in $\alpha_t \gamma_t$ the subjectively perceived probability of being detected by the supervisor during a period t .¹¹ This result means that the decrease of α_t leads to more manipulation in each period, but only to an extent that does not increase the total risk incurred.

¹¹In the sense that the supervisor would be active *and* would detect the manipulation.

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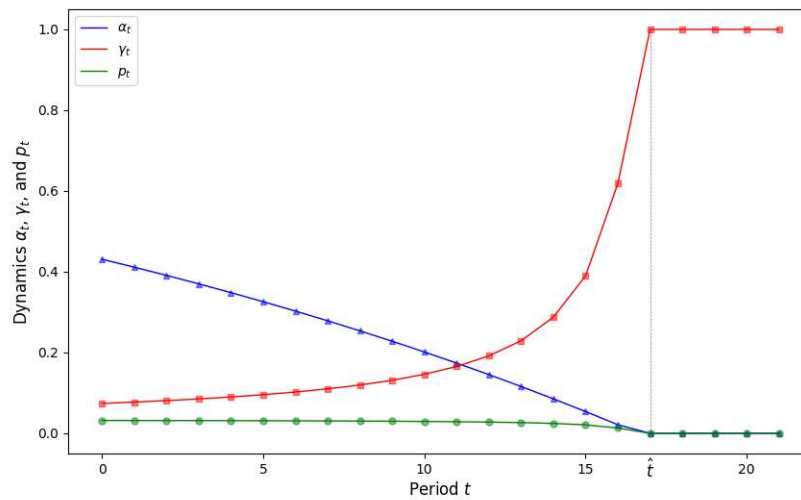


Figure 3.1.2: Finite horizon equilibrium dynamics for $\alpha_0 = 0.45$ (Setting 3.1.1).

However, although the risk of being detected is constant, the penalty incurred is not. In the utility function, the increase in the magnitude of γ_t^* over the periods goes hand in hand with an increasing penalty: the probability of the penalty being $\alpha_t \gamma_t$, the magnitude of the penalty in terms of expected utility is in fact $\frac{s\gamma_t}{2}$.

Characterization of the informational dynamics

Proposition 5. The sequence $(\alpha_t)_{t < \hat{t}}$ is convex decreasing.¹²

We deduce that the decrease in α is all the more rapid as α_0 is low. Intuitively, this means that the subjective perception of a probably inactive supervisor incites to manipulate more, which makes it possible to learn more quickly.

3.1.2 Net enrichment for the trader generated by manipulation

To complete the study of the equilibrium thus described, we study the total intertemporal gain for the bank resulting from the manipulation — which is a *net* gain, after paying, in case of a sanction. Strictly speaking, this is not a social lost (in the sense of *welfare*),

¹²As for all the other proposals in the rest of this document which do not appear here, this proof is proposed in Appendix 3.B.

insofar as any fine imposed is a transfer from one agent (the bank) to another (the state), which has a neutral effect on total society's wealth. It is therefore analysed as a private gain.

The gain induced by the learning dynamic depends on the type of supervisor. To measure it, we must consider two distinct cases, depending on whether the supervisor is actually inactive (and will never sanction) or active and likely to sanction.

Case 1: inactive supervisor. If the supervisor is not active, the game goes on *ad infinitum*, without ever stopping. The manipulation $b\gamma_t$ of each period t depends on the subjective prior α_0 , and represents a total cost for society which can be written, taking into account a discount rate δ , as

$$G_I = \sum_{t=0}^{\infty} \delta^t b\gamma_t.$$

Case 2: active supervisor. In this case, the manipulation can also be fully described from the Bayesian prior α_0 but with a stopping probability which is equal to the probability of control, conditional on the supervisor being active, γ — because the type of supervisor, if unknown to the trader, is not random. Note that this probability, from the supervisor's point of view, is objective (or « natural »). The probability of control of each period t corresponds to the magnitude of manipulation γ_t of each period. If its size results from an optimal decision based on a subjective prior from the trader's point of view, it is « natural » from the point of view of the active supervisor. In the absence of any strategic modelling of the supervisor, two sets of explanations can be proposed. Firstly, the supervisor receives stronger warning signals as the scale γ_t of the manipulation increases (whatever the reasons that led the trader to choose this γ_t). Their ability to translate these signals into an administrative or judicial sanction remains random and independent of γ_t . We can then describe γ as a probability of detecting fraud. A second range of explanations consists in describing γ as a probability of action: even if the supervisor, through various signals, has acquired the certainty that a manipulation is taking place, one can imagine that a set of institutional factors¹³

¹³Fear of scandal, inability to objectively characterize the manipulation before a judicial authority, costs linked to the judicial litigation that will perhaps follow the pronouncement of an administrative

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makes their action uncertain, even if the supervisor has not yet taken action. We will later formulate a more detailed definition of the term ‘fraud’.

We can then write an expectation of the traders’ total payoff (and not a total payoff actually obtained *ex post*, which would require knowing the actual date at which the supervisor finally intervened) as the cumulative payoff of the traders up to each period t ending the game, weighted by the probability that the audit occurs at that period t , which is

$$\sum_{t=0}^{\infty} \left(\prod_{s=0}^{t-1} \delta(1 - \gamma_s) \right) \gamma_t.$$

Furthermore, in line with the utility function used previously, the existence of a penalty must be taken into account as the revenue, for the community, of the fine imposed by the supervisor detecting a fraud. To do this, we define the amount of the penalty, in the event of action by the supervisor at a date t , as $S_t = \frac{s\gamma_t}{2}$, which makes it possible to interpret the quadratic utility previously used as an expectation utility, because if we assume that the bank’s payoff is $b\gamma - S\mathbb{1}_{\{\text{sanction}\}}$, then the subjective expectation for the bank of this payoff in t is

$$b\gamma_t - \frac{s\gamma_t}{2} \mathbb{P}_t[\text{sanction} | \text{active supervisor}] \mathbb{P}_t[\text{active supervisor}] = b\gamma_t - \frac{s\gamma_t}{2} \alpha\gamma_t = b\gamma_t - \frac{s}{2} \alpha\gamma_t^2$$

so the last term is $u(\alpha_t, \gamma_t)$. Such a specification seems realistic: the amount of the penalty increases proportionally with the size of the fraud.

Note that the probability of not having been sanctioned before the date t is $\prod_{s=0}^{t-1} (1 - \gamma_s)$ and the probability of being sanctioned for the first (and last) time at the date t is: $(\prod_{s=0}^{t-1} (1 - \gamma_s)) \gamma_t$. Since the gains associated with this probability of not being controlled are seen from the current period when the manipulation begins, they must be discounted δ . When no penalty has been incurred before t , the gain from cheating is simply $\sum_{s=0}^t \delta^s b\gamma_s$. This being the case, we can write the trader’s intertemporal gain *net of the fine* as

sanction, implicit or explicit collusion of the leaders of the supervisory authority with the banking sector out of a concern for preserving the financial health of the latter, etc.

$$\begin{aligned}
 G_A &= \sum_{t=0}^{\infty} \left(\prod_{s=0}^{t-1} (1 - \gamma_s) \right) \gamma_t \left(\sum_{s=0}^t \delta^s b \gamma_s \right) - \frac{s}{2} \sum_{t=0}^{\infty} \left(\prod_{s=0}^{t-1} (1 - \gamma_s) \right) \delta^t \gamma_t^2 \quad (3.1.1) \\
 &= \sum_{t=0}^{\infty} \left(\prod_{s=0}^{t-1} (1 - \gamma_s) \right) \gamma_t \left(\sum_{s=0}^t \delta^s b \gamma_s - \delta^t \frac{s}{2} \gamma_t \right).
 \end{aligned}$$

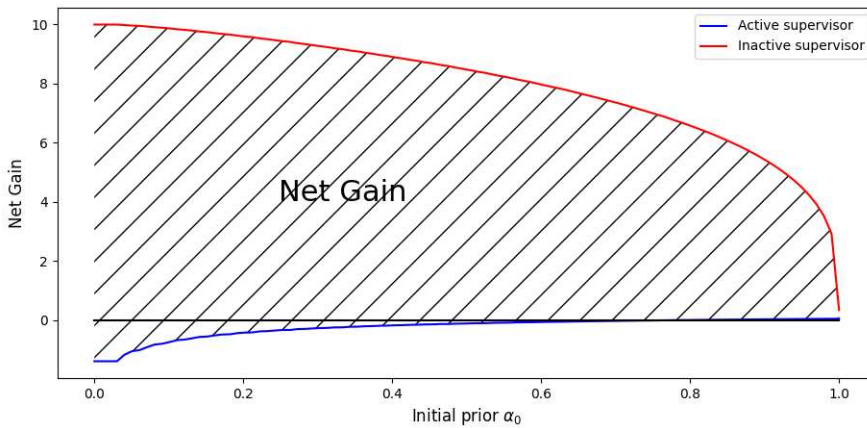


Figure 3.1.3: Finite horizon net gain from manipulation according to α_0 (Setting 3.1.1).

The hatched area represents the difference in gains from manipulation between an active and an inactive supervisor. In line with intuition, the gap between these two curves is all the more important that the belief in the supervisor's activity is weak. A low prior leads to high manipulation, while a high prior leads to low manipulation with little difference in manipulation gain between the two possible supervisor activities. Minimizing undue enrichment from manipulation makes it essential to have a supervisor who is perceived to be able to intervene.

The magnitude of this discrepancy is partly explained by the choice of a $\delta = 0.99$, which represents a very high discount rate. The gap between the two values of the gain linked to the manipulation would be smaller with a lower intertemporal discount rate.¹⁴ Beyond the value 0 of the gain when $\alpha_0 = 1$ (no manipulation, with the certainty of being detected), the discount rate acts on manipulation in the opposite direction to the belief in the supervisor's activity, as a decrease in δ reduces the future value of the manipulation, which limits its magnitude today as would an increased α_0 . With

¹⁴See for example Figure 3.A.9 of Appendix 3.A for the value $\delta = 0.95$ considered by Table 3.A.8.

an infinite horizon, one must be sufficiently convinced of the supervisor's inactivity to decide on a magnitude of manipulation that compensates for a strong preference for the present. These results are robust to all the specifications that we have tested, and in particular those that correspond to the variants presented in the Appendix 3.A.¹⁵

3.1.3 From the analysis of the model to the analysis of the Libor manipulation

1. *The consequences of supervisor inadequacy.* If the British Bankers Association does not define a sanction s or if Thomson Reuters (data collector) or especially the FSA¹⁶ (British supervisor) leave too much doubt as to their supervisory activity, then it is rational for the scale of the manipulation to increase. Even in the face of a high penalty, traders may also have chosen to manipulate the indicator because of the prospect of considerable gains in comparison to the penalty. In conclusion, it can be said that the supervisor acted insufficiently on s and, considering the fact that she was an inactive type, did not inspire a α_0 sufficiently dissuasive to slow down the dynamic of manipulation.
2. *The increase in manipulation leading to its disclosure.* In the early periods, traders are more afraid of the supervisor and its potential sanction, so $s\alpha_t$ is high (they either fear the sanction or they fear that the supervisor is active). Cheating remains limited (low γ_t), which was clearly the case in the 1960s (as described by Minos Zombanakis, who then claimed that there was no manipulation, [Vaughan and Finch \(2017\)](#)) before the first suspicions about the veracity of contributions emerged in the 1990s. These periods of limited manipulation (corresponding to small, interior γ_t in the early days of the game) were indeed followed by periods in the 2000s of larger, more rewarding manipulation for the traders who profited from it. This process continues until the magnitude of the manipulation becomes high or even maximum ($\gamma_t = 1$). Despite the absence of a supervisor, it should

¹⁵These variants correspond respectively to lower (Table 3.A.1) or higher (Table 3.A.6) values of the gain b , and to various possible values of the discount rate δ lower than the 0.99 of Table 3.1.1 (Tables 3.A.4 and 3.A.8).

¹⁶*Financial Services Authority*, which became in 2013 the *Financial Conduct Authority*.

be noted that it is indeed γ which is at the origin of the scandal, as the articles in the *Wall Street Journal* that led to the revelation were based on the construction of a counterfactual model highlighting the extent of the Libor manipulation. This fits well with the model's intuition: the increase in γ_t corresponds to the increase in the probability of control, and thus of being caught. In the case of Libor, however, this control was undertaken by an authority *a priori* outside the game (the press), which can then be analysed as an alternative form of supervisor in the event that the latter is inactive.

3. *The dynamic of wages in finance over several decades.* As the manipulation continues, α_t decreases, which leads to an increase in γ_t . The remuneration of traders, equal to $b\gamma_t$, is never as high as on the day the manipulation is revealed. This directly echoes the dynamic of rising relative wages in finance since the 1980s highlighted by Godechot (2007), Philippon and Reshef (2012) or Boustanifar et al. (2018).

3.2 A single person, a thousand times

To compare the results of Section 3.1 with what would be obtained by considering instead the learning *for itself* of a single trader living an infinite number of periods. This trader capitalizes on learning accumulated at the rate of what maximizes an intertemporal utility, and not on learning from the maximizations of traders knowing that they will only benefit from their own deviation. The general approach of this section is, first, to pose the optimal control problem which would be that of a single trader considering his choices $(\gamma_t^*)_{t \in \mathbb{N}}$ with an infinite horizon (Subsection 3.2.1).

Subsection 3.2.2 solves this problem in its general formulation. After proving the existence and uniqueness of the *policy function* $(\gamma_t^*)_{t \in \mathbb{N}}$ (Proposition 6), we show that the corner solutions, 0 « corner low » and 1 « corner high », are absorbing (Proposition 7). Then, we give the explicit expression of the value functions corresponding to these two cases, V_h for « high corner » case and V_b for « low corner » case (Proposition 8). Subject to some additional technical assumptions and intermediate results on the differentiability of V , we then study the dynamic of the interior solutions. We have,

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under mildly restrictive assumptions, shown that the values of the prior α_t leading to a « corner low » policy function are located in an interval of type $]\alpha_b; 1]$ (Proposition 11), that the priors leading to a « corner high » policy function are located in an interval of type $[0; \alpha_h[$ and that the priors leading to interior solutions are in an interval of type $[\alpha_h; \alpha_b]$ (Proposition 13). Finally, because function V is not derivable at the switching point α_b between an interior solution and a low corner solution, we propose additional conditions on u to avoid having a policy function leading to a « low corner » solution (Proposition 12).

To sum up, Subsection 3.2.3 solves the model for the same utility function as specified in the Section 3.1. Having eliminated the possibility for this utility to be a « low corner » regime via Proposition 12, Proposition 14 states a sufficient condition to have an inner solution. It calculates the threshold of switching α_h to a « high corner » regime corresponding to a maximal fraud. We finally give (Proposition 15) a value of $\gamma^*(1)$ for the case where this last value would be interior (and not yet « corner high »). To illustrate the dynamic, simulations give the evolution of the value function V as well as of the policy function γ_t .

3.2.1 General framework with an infinite horizon

We want to compare the results of Section 3.1 with what would be obtained by considering instead the learning *for itself* of a single trader living an infinite number of periods. This trader thus capitalizes on learning accumulated at the rate of what maximizes intertemporal utility, and not on learning from maximizations of traders knowing that they will live (and obtain a gain) in only one period. We first pose the problem in its general form by considering a utility function $u(\alpha_t, \gamma_t)$ decreasing in α_t and increasing in γ_t .

For the sake of consistency, we present the intertemporal utility of a trader carrying out a sequence of actions $\{\gamma_t\}_{t \in \mathbb{N}}$ with an initial *a priori* probability α_0 of being controlled by a supervisor. This intertemporal utility is equal to the expectation of the discounted sum of its future utility flows. In the absence of control, the expected utility

contains a belief updated after each manipulation period. In the case of a control, again, the game ends.¹⁷ The problem is written as

$$U(\alpha_0, \{\gamma_t\}_{t \in \mathbb{N}}) = \sum_{t=0}^{\infty} \delta^t \mathbb{E}_{t=0}[u(\alpha_t, \gamma_t)] = \sum_{t=0}^{\infty} \delta^t \left(\prod_{k=0}^{t-1} (1 - \alpha_k \gamma_k) \right) u(\alpha_t, \gamma_t) \quad (3.2.1)$$

$$s.t. \begin{cases} \alpha_0 \in [0, 1] \\ \alpha_{t+1} = \frac{\alpha_t(1-\gamma_t)}{1-\alpha_t\gamma_t} \quad \forall t \in \mathbb{N}. \end{cases}$$

The agent is thus confronted with a dynamic optimization problem where γ plays the role of a control variable included in $[0, 1]$ and α that of a state variable. This problem is formally written, under the so-called sequential formulation (SP)

$$(SP) \quad V(\alpha_0) = \sup_{\{\gamma_t\}_{t \in \mathbb{N}}} U(\alpha_0, \{\gamma_t\}_{t \in \mathbb{N}}) = \sup_{\{\gamma_t\}_{t \in \mathbb{N}}, \{\alpha_t\}_{t \in \mathbb{N}}} \sum_{t=0}^{\infty} \delta^t \left(\prod_{k=0}^{t-1} (1 - \alpha_k \gamma_k) \right) u(\alpha_t, \gamma_t) \quad (3.2.2)$$

$$s.t. \begin{cases} \alpha_0 \in [0, 1] \\ \alpha_{t+1} = \frac{\alpha_t(1-\gamma_t)}{1-\alpha_t\gamma_t} \quad \forall t \in \mathbb{N}. \end{cases}$$

¹⁷Note, however, that if the proposed problem had a continuation value L , the intertemporal utility would become

$$U(\alpha_0, \{\gamma_t\}_{t \in \mathbb{N}}) = L + \sum_{t=0}^{\infty} \delta^t \left(\prod_{k=0}^{t-1} (1 - \alpha_k \gamma_k) \right) (u(\alpha_t, \gamma_t) - (1 - \delta)L)$$

$$s.t. \begin{cases} \alpha_0 \in [0, 1] \\ \alpha_{t+1} = \frac{\alpha_t(1-\gamma_t)}{1-\alpha_t\gamma_t} \quad \forall t \in \mathbb{N}. \end{cases}$$

where L would be a negative value corresponding to the loss of utility linked to a positive control (negative value corresponding to a prison sentence, for example). This modelling detail would be more important here than in other intertemporal problems, since, in a usual intertemporal problem where (i) the probabilities do not depend on the state and control variables and (ii) the solutions are interior, defining the utility to a constant is unimportant, as the utility can be understood as ordinal and not cardinal. But in such a model, where the dynamic of the control probability is endogenous, the problem is different if the utility is modified by a constant corresponding to the continuation value: such a value L would disappear in derivation if our problem always or almost always had interior solutions, but, as we shall see, the corner solutions describe a large part of the optima subsequently obtained.

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The optimal sequence $\{\gamma_t\}_{t \in \mathbb{N}}$ is a function of the initial condition α_0 , so the value function V is also only a function of α_0 . We now rewrite this problem in its recursive formulation known as the « functional equation » (FE)

$$(FE) \quad V(\alpha) \equiv \sup_{\gamma \in [0,1]} (u(\alpha, \gamma) + \delta \mathbb{E}[V(\alpha')]) \text{ s.t. } \alpha' = \frac{\alpha(1-\gamma)}{1-\alpha\gamma}$$

$$\iff V(\alpha) = \max_{\gamma \in [0,1]} \left[u(\alpha, \gamma) + \delta(1-\alpha\gamma)V\left(\frac{\alpha(1-\gamma)}{1-\alpha\gamma}\right) \right]. \quad (3.2.3)$$

Bellman's optimality principle states that any solution of the problem (SP) is necessarily a solution of the recursive problem (FE). We reformulate the problem in the usual way by replacing α_0 by α because the sequential dimension of the (SP) formulation no longer appears in the (FE) problem, but it is indeed the same quantity, arbitrarily chosen on $[0, 1]$. The passage from sup to max is justified by the fact that γ is sought on a segment of \mathbb{R} .

Proposition 6. The recursive problem (FE) has a unique continuous and bounded solution, which is a solution of the problem (SP).

3.2.2 Characterization of corner and interior solutions

We now restrict ourselves to functional specifications of u that verify the hypothesis (H_1):

$$\frac{\partial u}{\partial \gamma}(0, \gamma) > 0 \quad (H_1)$$

This specification, which is natural, means that if the trader is certain that any sanction is impossible, his utility is strictly increasing with the intensity of fraud. The specification chosen above satisfies the condition (H_1). We can then establish the following result in the model with an infinite horizon

Proposition 7. Under (H_1), if u is such that, for certain values of α_t , $\gamma_t^* = 0$ (resp. $\gamma_t^* = 1$), then the optimal sequence $\{\gamma_T^*\}_{T \geq t}$ is $\gamma_T^* = 0$ (resp. $\gamma_T^* = 1$) for all $T \geq t + 1$. The « corner » are said to be absorbing. Moreover, if $\alpha_t = 0$ for all t , we necessarily have a « corner » solution such that $\gamma_T^* = 1$ for all $T \geq t$.

Proposition 7 underlines that the value function of the infinite horizon problem can in general be divided into three regimes: a « corner high » regime such that $\gamma_t^* = 1$ for all t , an « interior » regime such that the manipulation intensity, at least at the first period, is interior (i.e. belongs to $]0, 1[$) and finally a « low corner » regime such that $\gamma_t^* = 0$ at any date. If the « corner low » regime is likely not to exist according to the chosen utility, Proposition 7 means that the « corner high » regime necessarily exist: for any utility satisfying (H_1) , there is a neighbourhood of $\alpha_0 = 0$ for which the solution is « corner high ». It should be noted that the « interior » regime remains compatible with the fact that the optimal sequence $(\gamma_t)_t \in \mathbb{N}$ may end up becoming « corner » after a certain time, depending on the utility function chosen.

Via the (FE) formulation, the calculation of the values in the cases of « corner high » and « corner low » is actually very simple, which is detailed in the following proposal.

Proposition 8. Let $V_h(\alpha)$ be the value function in the case of « corner high » and $V_b(\alpha)$ the value function in the case of « corner low ». V_h and V_b can be explicitly calculated and take the following forms

$$V_h(\alpha) = u(\alpha, 1) + (1 - \alpha) \frac{\delta u(0, 1)}{1 - \delta}, \quad (3.2.4)$$

$$V_b(\alpha) = \frac{u(\alpha, 0)}{1 - \delta}. \quad (3.2.5)$$

Moreover, for any $\alpha \in [0, 1]$, we necessarily have

$$V(\alpha) \geq V_h(\alpha) \quad \text{and} \quad V(\alpha) \geq V_b(\alpha).$$

At this point, it is also important to specify that we have not established the uniqueness of the « policy function » $\alpha \mapsto (\gamma_t^*)_{t \geq 0}(\alpha)$. The maximum theorem,¹⁸ without further assumptions, allows to say that the correspondence associating to a given value of α the set of « policy functions » which maximize (FE) is superior semi-continuous, i.e. that the graph of correspondences is closed. On the other hand, we can provide the following result, which defines the regimes more rigorously, by introducing the cheap assumption (H_1bis)

¹⁸cf. proof in Proposition 6.

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$$(1 - \delta) \frac{\partial u}{\partial \alpha}(\alpha, 1) - \frac{\partial u}{\partial \alpha}(\alpha, 0) \neq \delta u(0, 1) \quad \forall \alpha \in [0, 1]. \quad (H_1bis)$$

The utilities that we consider is always such that $\frac{\partial u}{\partial \alpha}(\alpha, 1) \leq 0$, $\frac{\partial u}{\partial \alpha}(\alpha, 0) = 0$ and $u(0, 1) > 0$ which ensures the validity of (H_1bis) .

Proposition 9. If (H_1bis) is verified, then $\gamma^*(\alpha) = 1$ and $\gamma^*(\alpha) = 0$ are never simultaneously « policy functions » of the problem (FE) , whatever $\alpha \in [0, 1]$.¹⁹

We can now rigorously define the « corner high », « corner low » and « interior » regimes.

Definition 1. V is in « high corner » (resp. « low corner ») if and only if α is such that $\gamma^*(\alpha) = 1$ (resp. $\gamma^*(\alpha) = 0$) is one of the possible values of the optimal policy function. If V is neither in the « low corner » regime nor in the « high corner » regime, V is in the « interior » regime.

However, it is necessary to prove its differentiability if we want to study the « interior » regime, because it is obvious that if V is in the « low corner » or the « high corner », then V is differentiable if u is derivable with respect to α , as illustrated by the formulae of Proposition 8. We first determine that V is strictly decreasing, then provide sufficient conditions for its differentiability for any value of α . We first formulate two new hypotheses on u ,

$$\frac{\partial u}{\partial \alpha}(\alpha, \gamma) < 0 \quad (H_2), \quad \frac{\partial u}{\partial \alpha}(\alpha, \gamma) \leq 0 \quad (H_2bis)$$

(H_2) requires that the utility be strictly decreasing in α for any value of γ , i.e. that the trader's payoff is all the lower as the probability of being sanctioned is greater. Here again, this is a natural assumption, given that the case of independence of this payoff at α is also included in (H_2bis) .

Proposition 10. If (H_2) – resp. (H_2bis) – holds, then V is strictly decreasing — resp. decreasing — on $[0, 1]$.

¹⁹The proof is very simple: supposing that for a given α , the policy functions $\gamma = 1$ and $\gamma = 0$ both maximize the problem (FE) . In this case, we have $V_h(\alpha) = V_b(\alpha)$ that is $u(\alpha, 1) + (1 - \alpha) \frac{u(0, 1)}{1 - \delta} = \frac{u(\alpha, 0)}{1 - \delta}$. Deriving with respect to α easily shows that this equality is impossible if (H_1bis) is verified.

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We see in particular, from Proposition 8, that if $\frac{\partial u}{\partial \alpha} = 0$, then the « corner low » solutions, if they exist, will be constant and thus not strictly decreasing, which is one of the cases illustrating Proposition 10.

We now provide conditions to prove the differentiability of V on $]0, 1[$. As we shall see below, the differentiability of the value function is in fact acquired everywhere on $]0, 1[$ under relatively unconstrained conditions, except at the precise point where the value commutes to the « corner low » solutions, in cases where this happens. Proving that V is derivable is necessary if we want to use the first-order conditions and the envelope condition (see below) to characterize the optimal response γ^* in the case of interior solutions. We first introduce new assumptions on the utility function u .

$$u(\alpha, 0) = 0 \quad (H_3)$$

$$H(\tilde{u}) \text{ symmetrically defined negative for all } \alpha' \in [0, \alpha] \text{ and } \alpha \in]0, 1[\quad (H_4)$$

$$\text{with } H(\tilde{u}) = \begin{pmatrix} \frac{\partial^2 \tilde{u}}{\partial \alpha^2}(\alpha, \alpha') & \frac{\partial^2 u}{\partial \alpha \partial \alpha'}(\alpha, \alpha') \\ \frac{\partial^2 u}{\partial \alpha \partial \alpha'}(\alpha, \alpha') & \frac{\partial^2 \tilde{u}}{\partial \alpha'^2}(\alpha, \alpha') \end{pmatrix} \text{ and } \tilde{u}(\alpha, \alpha') = \frac{u\left(\alpha, \frac{\alpha - \alpha'}{1 - \alpha}\right)}{1 - \alpha}.$$

(H_3) amounts to imposing the fact that if the trader chooses the absence of fraud, then his payoff is zero independently of the subjective probability that a supervisor will intervene in case of fraud. In other words, there is no benefit to honesty over dishonesty. This seems *a priori* not very debatable. On the other hand, (H_4) , which is equivalent to the strict concavity of the \tilde{u} function whose introduction we shall justify below, is a very restrictive hypothesis.

Proposition 11. If $(H_2/H_2bis) - (H_4)$ are verified, then the values of α such that V is « corner low » are of the form $]\alpha_b, 1]$ where α_b is the switching threshold in the « corner low » regime, and V is derivable on $]0, 1[$ except in α_b .

Proposition 11 makes it possible to realize that the problem (FE) contains two real obstacles to the differentiability of V .

- i. The existence of the Bayesian revision and the specific form of the dynamic equation of the state variable α mean that imposing the concavity of u is no longer sufficient to allow the differentiability of the value function. This problem

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makes it in general impossible for an interior solution to exist. However, since we have proved that the value function V is defined and continuous on $[0, 1]$, this does not really mean that the solution will not be derivable: it will only mean that the model admits only two « corner high » and « corner low » regimes. But if u is derivable, according to Proposition 8, the value functions in these two regimes are derivable. The differentiability mentioned in Proposition 11 pertains to the conditions necessary for an interior solution.

- ii. Existence of a commutation in the « corner low » area leads to a discontinuity of the derivative of V at the commutation point. This second problem leads to a lack of differentiability at the switch to the « low corner » regime. If we make sure that there is no « corner low » solution, this problem is avoided. This is the object of the following proposal, requiring the introduction of conditions (H_5) and (H_6) :

$$\frac{\partial u}{\partial \gamma}(1, 0) \neq 0 \quad (H_5)$$

$$u(1, 1) > 0 \quad (H_6)$$

Proposition 12. If the problem (FE) admits an interior regime, then, if (H_3) and (H_5) are verified, there is never a « corner low » solution. If the problem (FE) does not admit an interior regime, then, if (H_3) and (H_6) are verified, there is never a « corner low » solution.

Note that the equation (3.B.2) proving Proposition 12 (presented in Appendix 3.B) determines $\gamma^*(1)$ and thus the value $V(1)$ if we are in the interior regime in $\alpha = 1$. We are thus always able to show $V(1)$. We necessarily have

$$V(1) = \max \left[V_h(1), V_b(1), \frac{u(1, \gamma^*)}{1 - \delta + \delta \gamma^*} \right] \quad \text{with } \gamma^* \text{ is the solution(s) of (3.B.2).}$$

As mentioned above, the condition (H_4) is extremely restrictive. This is mainly due to the fact that the division of the utility by $1 - \alpha$, which is convex, convexifies the function \tilde{u} . In fact, if we choose for example $u(\alpha, \gamma) = b\gamma$ or $u(\alpha, \gamma) = b\gamma - s\alpha\gamma$, the condition (H_4) is never verified.

By simulating the value for these two utility classes, we observe that there is no interior solution, and that the value commutes from the « corner high » regime (since there is always such a regime in $\alpha = 0$ according to Proposition 7) to the « corner low » regime at a given point of $]0, 1[$. At this point, V is not derivable.

We now consider the case where the solution is interior, either at the initial date or at a later one, and we suppose V is derivable with $V(\alpha) \neq V_h(\alpha) \neq V_b(\alpha)$. In this case, one can write that γ satisfies the condition of the first order (FOC) for any $\alpha \in]0, 1[$ such that $\alpha \neq \alpha_b$

$$\text{FOC: } 0 = \frac{\partial u}{\partial \gamma}(\alpha, \gamma) - \delta \alpha V\left(\frac{\alpha(1-\gamma)}{1-\alpha\gamma}\right) - \delta \frac{\alpha(1-\alpha)}{1-\alpha\gamma} V'\left(\frac{\alpha(1-\gamma)}{1-\alpha\gamma}\right) \quad (3.2.6)$$

as well as the envelope condition (ET) obtained by deriving the value function with respect to the state variable under the control optimality condition

$$\text{ET: } V'(\alpha) = \frac{\partial u}{\partial \alpha}(\alpha, \gamma) - \delta \gamma V\left(\frac{\alpha(1-\gamma)}{1-\alpha\gamma}\right) + \delta \frac{1-\gamma}{1-\alpha\gamma} V'\left(\frac{\alpha(1-\gamma)}{1-\alpha\gamma}\right). \quad (3.2.7)$$

We can finally formulate the general result on the commutation between the « corner high » regime and the internal one. This requires the introduction of two new assumptions, (H_7) and (H_8)

$$\delta \left[u(0, 1) + \frac{\partial u}{\partial \alpha}(0, 1) \right] - \frac{\partial u}{\partial \gamma}(1, 1) > 0 \quad (H_7)$$

$$\delta \left[u(0, 1) + \frac{\partial u}{\partial \alpha}(0, 1) \right] - \frac{\partial^2 u}{\partial \gamma^2}(\alpha, 1) > 0 \quad \forall \alpha \in]0, 1]. \quad (H_8)$$

Proposition 13. If the problem (FE) admits an interior regime, and (H_1) , (H_7) and (H_8) are verified, then there exists a unique switching threshold α_h such that the « corner high » area is of the form $[0, \alpha_h]$.

As a consequence of proposals 11 and 13, we can say that if the problem (FE) admits an interior regime and all the conditions of the proposals are satisfied, the value function is:

- « corner high » on $[0, \alpha_h]$,

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- interior on $[\alpha_h, \alpha_b]$,
- and « corner low » on $]\alpha_b, 1]$.

If we assume that the conditions of Proposition 13 are satisfied, then the switching threshold α_h verifies the following first-order equation, justified by the continuity of the value function (cf. Proposition 6), the differentiability of V_h and the upper semicontinuity of γ^* .²⁰ We can thus write, from 3.2.6,

$$\frac{\partial u}{\partial \gamma}(\alpha_h, 1) = \delta \alpha_h V_h(0) + \delta \alpha_h V_h'(0)$$

or equivalently

$$\frac{\partial u}{\partial \gamma}(\alpha_h, 1) = -\delta \frac{\partial}{\partial \gamma} \mathbb{E}[V_{h,t+1}](\alpha_h, 1).$$

We see that, if the derivative of the future value with respect to γ is positive, then $\frac{\partial u}{\partial \gamma}(\alpha_h, 1)$ must be negative, i.e. $\gamma = 1$ is above the value of γ which would maximize utility in the one-period model: we would have $\gamma^*(\alpha_h) < 1$. Moreover, let α_h^{1per} be the switching threshold in the one-period model presented in Section 3.1. This threshold verifies

$$\frac{\partial u}{\partial \gamma}(\alpha_h^{1per}, 1) = 0.$$

If we suppose that $\frac{\partial^2 u}{\partial \alpha \partial \gamma} < 0$, then we have

$$\frac{\partial u}{\partial \gamma}(\alpha_h, 1) < \frac{\partial u}{\partial \gamma}(\alpha_h^{1per}, 1) = 0 \iff \alpha_h > \alpha_h^{1per}. \quad (3.2.8)$$

This means that if the derivative of the future value with respect to γ is negative, then the magnitude of the manipulation converges faster to the maximum intensity than with a finite horizon.

Conversely, if the derivative of the future value with respect to γ is positive, then $\alpha_h < \alpha_h^{1per}$. The magnitude of the manipulation converges less quickly to the maximum intensity than with a finite horizon.

²⁰Given that $\gamma^* = 1$ upstream of α_h , even without having the uniqueness of γ^* in general, the closure of the graph resulting from the upper hemicontinuity implies that $\gamma^*(\alpha_h) = 1$.

3.2.3 Simulation solution for a particular case

We consider the same utility function as in the previous section: $u(\alpha_t; \gamma_t) = b\gamma_t - \alpha_t\gamma_t^2 \frac{s}{2}$. This utility function does not satisfy the condition (H_4) , which means that we cannot guarantee *ex-ante* via Proposition 11 that V is always derivable if the solution is neither « corner high » nor « corner low ». For all that, the condition (H_4) is a sufficient, not a necessary one. (H_4) is verified for a subset of $\{(\alpha, \alpha') \mid \alpha \in]0, 1[, \alpha' \in [0, \alpha[\}$, which will allow the existence of an « interior » solution at least for certain values of the parameters b and s . This utility function satisfies the conditions (H_1) , (H_{1bis}) , (H_2) , (H_3) , (H_5) and (H_6) , so that V

- i. is decreasing according to Proposition 10,
- ii. does not contain a « corner low » regime according to Proposition 12 (and is therefore strictly positive),
- iii. satisfies $V(\alpha) = V_h(\alpha)$ in the « corner high » regime according to Proposition 8.

Figure 3.2.1 represents the simulation of the value function for the parameterization of Table 3.1.1. The « corner high » solution V_h (linear due to the specification of u), is represented in orange. It can be seen that the simulated value function is first merged with the « corner high » solution, which means that there is a α_h such that the « corner high » regime corresponds to the interval $[0, \alpha_h]$. Over this range of values, it is optimal for the trader to engage in the maximum level of manipulation at any point in time as long as she has not been sanctioned, according to Proposition 7. We see that the value function ends up taking off from the « corner high » regime, i.e. becoming higher than V_h , which means that the solution is interior $[\alpha_h, 1]$ since there is no « corner low » regime. With the retained utility, which verifies (H_3) and (H_6) , the temptation to cheat becomes considerable. This follows from the increasing returns to manipulation near $\gamma = 0$,²¹ which exist even when the subjective probability that the supervisor is likely to sanction is 1.

The graph suggests that conditions (H_7) and (H_8) of Proposition 13 are met. This can be verified for the parameterization of Table 3.1.1. We have

²¹Theoretically, the condition (H_6) would also accommodate strictly decreasing returns around $\gamma = 0$, but this would make the utility \tilde{u} so convex that there would be no chance of an inner solution.

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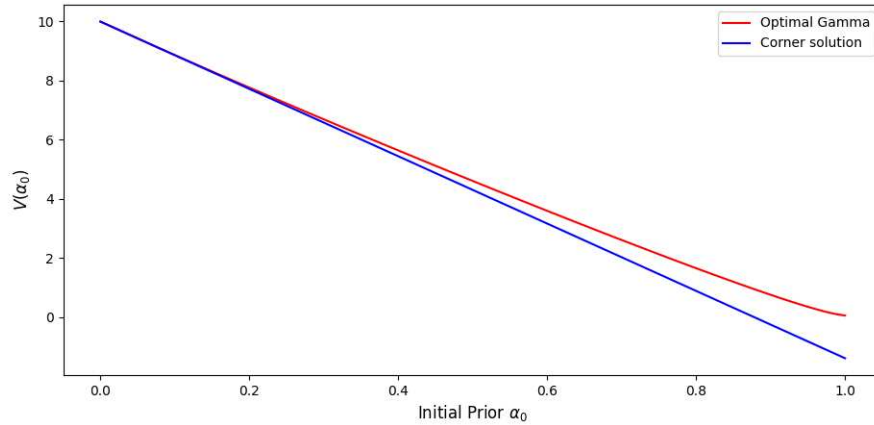


Figure 3.2.1: Simulation of $V(\cdot)$ (Setting 3.1.1).

$$\delta \left[u(0, 1) + \frac{\partial u}{\partial \alpha}(0, 1) \right] - \frac{\partial u}{\partial \gamma}(1, 1) = \delta \left[b - \frac{s}{2} \right] - (b - s) = 0.145 > 0$$

and

$$\delta \left[u(0, 1) + \frac{\partial u}{\partial \alpha}(0, 1) \right] - \frac{\partial^2 u}{\partial \gamma^2}(\alpha, 1) = \delta \left[b - \frac{s}{2} \right] + s = 0.245 > 0.$$

Visually, from Figure 3.2.1, the switching threshold α_h appears to be less than 0.2. Using the same method as that used to derive Proposition 13, we can calculate it explicitly in the case of the quadratic utility proposed here.

Proposition 14. If V admits an inner regime and is derivable, then the switching threshold α_h verifies

$$\alpha_h = \frac{b}{s + \delta \left(b - \frac{s}{2} \right)}.$$

A sufficient condition for there to be an internal regime with utility $u = b\gamma - s\alpha \frac{\gamma^2}{2}$ is then $\alpha_h \leq 1$,

$$b \leq s \frac{1 - \frac{\delta}{2}}{1 - \delta}$$

which corresponds to condition (H_7) .

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Let us note that for our particular specification of utility and the parameterization of Table 3.1.1, the condition (H_8) , which is sufficient, is no longer necessary because it is automatically satisfied if (H_7) is. With the said parameters, we obtain, in a manner consistent with Figure 3.2.1,

$$\alpha_h = 0.062.$$

In accordance with the general analyses of the switching threshold in the previous section, one can see that, with the parameterization of the Table 3.1.1

$$\begin{aligned} \delta \frac{\partial}{\partial \gamma} \mathbb{E}[V_{h,t+1}](\alpha_h, 1) &= -\delta \alpha_h V_h(0) - \delta \alpha_h V_h'(0) \\ &= -\delta \alpha_h \left[u(0, 1) + \frac{\partial u}{\partial \alpha}(0, 1) \right] \\ &= -\delta \alpha_h \left(b - \frac{s}{2} \right) > 0 \end{aligned}$$

which makes $\alpha_h > \alpha_h^{1per} = \frac{b}{s}$, in accordance with the result 3.2.8 because $\frac{\partial^2 u}{\partial \alpha \partial \gamma} < 0$ with this utility choice.

Of course s , which represents the magnitude of the financial penalty that the trader risks in case of detection of manipulation by the supervisor, has a negative effect on α_h : the higher s is, the less the range of values of α over which the trader may engage in maximum manipulation will be wide. However, the infinite time horizon reduces the effectiveness of the sanction, since we have the elasticity

$$\epsilon_s^{\alpha_h} = \frac{\partial \alpha_h}{\partial s} \frac{s}{\alpha_h} = -\frac{s(1 - \frac{\delta}{2})}{s + \delta(b - \frac{s}{2})} > -1 \quad (3.2.9)$$

where this elasticity is -1 in the case with a finite horizon. It is straightforward that if $\delta = 0$, which means considering only one period, this elasticity is that of the single-period case. In situations where the trader can sustainably engage in fraudulent behavior, it becomes necessary for the supervisor to increase the sanctions.

We can examine if $\delta = 0$, indicating that, in this scenario, only a single period is considered, representing the elasticity in the context of a single-period case.

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We have checked that the utility we use verifies (H_5), which is rewritten here $b > 0$. There is never a « corner low » regime, which would be socially the most desirable. With a utility of this type and considering that $b < s$, the supervisor's efforts must be focused more on reducing b to 0, if possible, than on increasing s , which decreases the risk of occurrence of the maximum fraud, but has no effect on the existence of a regime entirely free of fraud. In such a Bayesian specification, traders always have an incentive to test their hypothesis of whether the supervisor is controlling or not by manipulation, and thus the supervisor has no policy tools to completely deter fraud. She can only reduce its magnitude.

In the case of quadratic utility in γ , we can provide an explicit formula for the value of the policy function in $\alpha = 1$ under the assumption that the solution is not « corner high » in $\alpha = 1$ (i.e. that $b \leq s \frac{1-\delta}{1-\delta}$).

Proposition 15. If $u(\alpha, \gamma) = b\gamma - s\alpha \frac{\gamma^2}{2}$ and if $0 < b \leq s \frac{1-\delta}{1-\delta}$, then,

$$\gamma^*(1) = \frac{\sqrt{(1-\delta)^2 s^2 + 2b\delta(1-\delta)s} - (1-\delta)s}{\delta s}. \quad (3.2.10)$$

We obtain the policy function corresponding to the subjective certainty that the supervisor is active. For other values of α , in the absence of an algebraic resolution for the corresponding γ , it is possible to represent the dynamic of the policy function and to analyse the commutations in the same way as with a finite horizon (Figure 3.1.2) by simulation.

We get the analytical result, obtained with a finite horizon (Proposition 13) as well as with an infinite horizon (Proposition 11) according to which the dynamic of the equilibrium, if it does not begin in the « corner high » regime, evolves with time from the interior case to the « corner high » case. These results allow to simply present the evolution of the intertemporal gain linked to manipulation according to the supervisor's activity or lack of it (Figure 3.2.3).

As in Subsection 3.1, the difference between the two possible types of supervisor is very important. Compared to an active supervisor which would detect the manipulation

3.3 Comparing of the two specifications

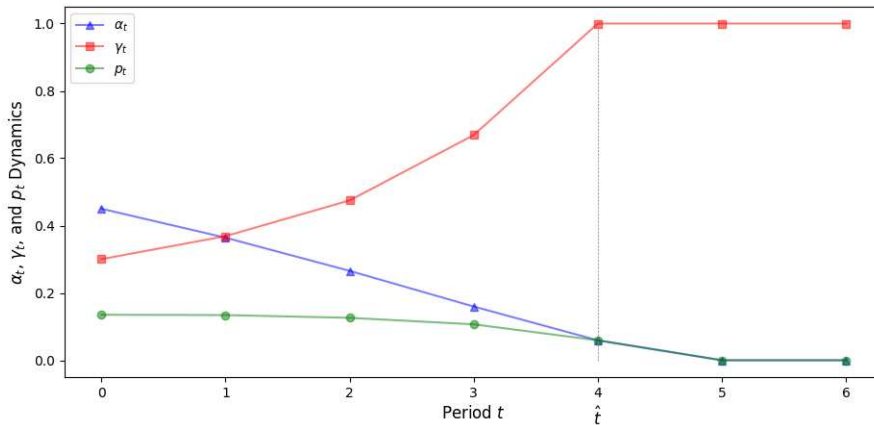


Figure 3.2.2: Infinite horizon equilibrium dynamic for $\alpha_0 = 0.45$ (Setting 3.1.1).

more or less quickly, the gain allowed with an inactive supervisor is again considerable.²² For any initial prior, the magnitude of the expected net gain from the manipulation is higher with an infinite horizon. This can be explained in two ways: on the one hand because the time horizon is infinitely long (which increases the value of the fraud), and on the other because the discount rate used here, 0.99, is very high (which encourages patience). Note that the difference between the two values of the net gain from the manipulation would be smaller with a lower intertemporal discount rate, as the value of the manipulation would be reduced by weighting future gains less.

3.3 Comparing of the two specifications

3.3.1 Learning and manipulation dynamics

We can, by simulation, compare the trajectory of the policy function between the two proposed models.

²²However, this order of magnitude strongly depends on the value of δ , cf. the Figure 3.A.10 presented in the Appendix. The same shape of the curves can be found there in connection with the initial prior. The order of magnitude is simply much smaller with an infinite horizon when δ is less than 1 (0.95 in the Table 3.A.8), which is in line with intuition.

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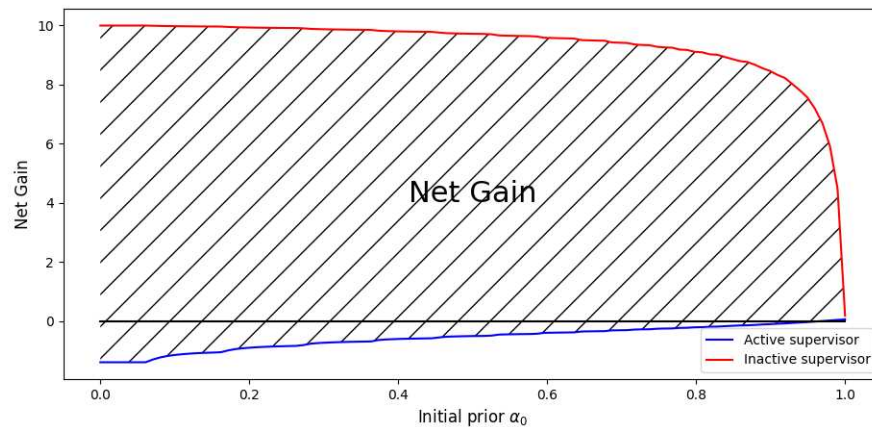


Figure 3.2.3: Infinite horizon net gain from manipulation according to α_0 (Setting 3.1.1).

This result comparing the interior γ^* establishes that, for the retained specification,²³ the magnitude of the manipulation is larger with an infinite horizon. This may seem counter-intuitive: one might expect a trader living for only one period to take maximum risk due to the lack of incentive to wait, or a trader with an infinite horizon to consider cheating less, knowing that she can afford to learn less quickly thanks to the prospect of future gains. However, our model shows that these intuitions are not correct. Indeed, a trader manipulating only one period runs the risk of a penalty far exceeding their gain if she cheats too heavily in relation to their prior. Moreover, for the trader with an infinite horizon, taking time into account gives the future an option value: cheating more today gives an option on a more profitable cheat tomorrow. This confirms the general result of equation 3.2.8 relating to the faster access with an infinite horizon the α_h corresponding to the prior for which the manipulation becomes maximum. In order to maximize the value of the manipulation in a framework where future gains are subject to a *discount*, it is preferable to cheat more in the first periods in order to learn quickly about the supervisor's activity and thus maximize the total gain expected from the manipulation.

This underlines the importance of the experimentation framework: there is a value of experimentation that the trader who lives only for one period of time cannot enjoy.

²³This result is robust to various types of specifications. See in particular Figure 3.A.3 in the Appendix 3.A for a less demanding specification on the value of b (0.01, ten times lower), which moreover presents a more visibly continuous and derivable pattern.

3.3 Comparing of the two specifications

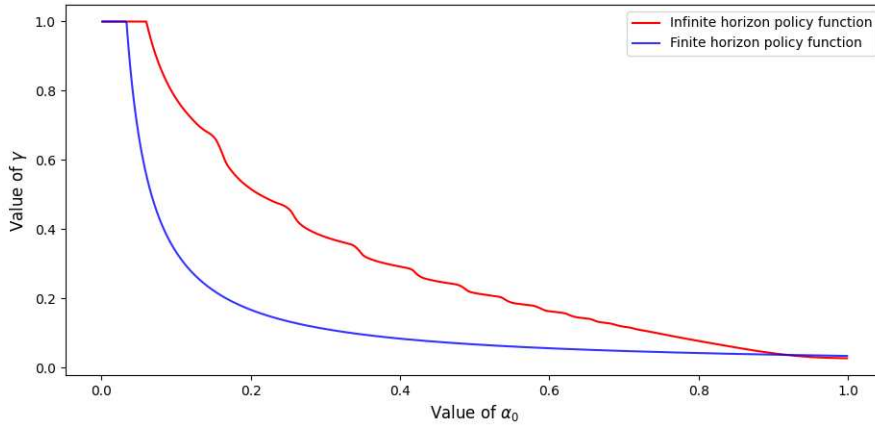


Figure 3.3.1: Optimal interior γ (policy function) according to α_0 (Setting 3.1.1).

Making the most of the value of experimentation involves learning as fast as possible, and this effect, by increasing future gains, offsets the potential consequences of the risk taken.

A result that may seem surprising is the behaviour of the two curves in Figure 3.3.1 for values of α_0 close to 1: for these values, the general result commented above is reversed. Why, for these values, does the trader with an infinite horizon restrict themselves more than the trader with a finite horizon? The intuition lies in the analysis of what a subjective probability α_0 close to 1 means for the trader: being then almost sure that the supervision is real, the trader does not act as if she were trying to test it. Believing that she has a high risk of being sanctioned in the event of a large-scale manipulation, she anticipates that she will never cheat much in the future and maximizes their intertemporal gain by contenting themselves with small, undetectable manipulations. This intuition is confirmed by various variations in the specifications: while varying the magnitude of the payoff b only changes the scale of the graph and not the relative positioning of the curves, varying the discount rate δ has a strong impact on the reasoning (as in Figure 3.A.5 in Appendix 3.A, for Table 3.A.4 with $\delta = 0.9$): the optimality of numerous small manipulations for the trader with an infinite horizon only holds if the future is valued almost as much as the present. If δ is lower than the high 0.99 of Table 3.1.1 which serves as our reference, then future

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gains, weakly valued, no longer constitute sufficient justification for the trader to be patient. As δ decreases, their behaviour gradually merges with that of the trader with a finite horizon (cf. Figure 3.A.5).

In line with the intuition stemming from the results of Subsection 3.2.2, our simulations find a more important manipulation with an infinite horizon: Figure 3.3.2 shows that, for a given initial prior, γ^* are systematically higher (or equal, for the « corner high » case) with an infinite horizon at each period of the game.

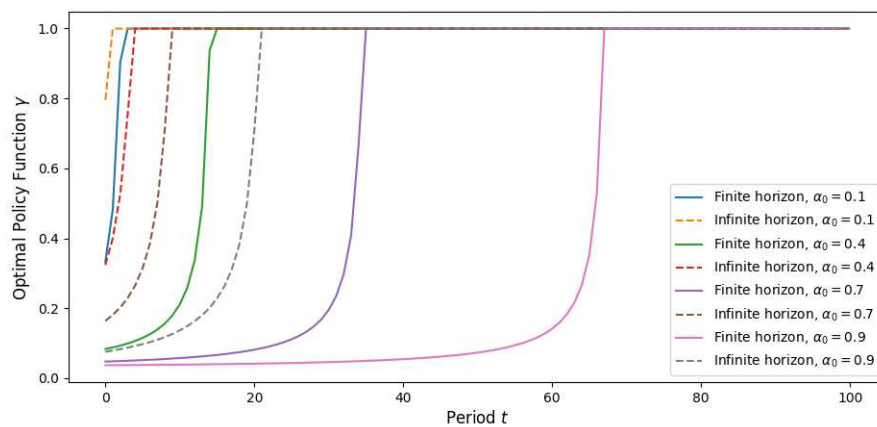


Figure 3.3.2: Manipulation intensity according to α_0 (Setting 3.1.1).

In line with the intuition developed earlier, the larger manipulation with an infinite horizon allows for faster learning. This is also illustrated by the comparison of the dynamic of the α (Figure 3.3.3).

3.3.2 Net enrichment for the trader generated by the manipulation

When the supervisor is inactive, the net gain from the manipulation is greater for traders with an infinite horizon because the extent of their manipulation is also greater for any given prior (Figure 3.3.4). The lower the initial prior, the smaller the spread between the gains from fraud, since when traders believe in the supervisor's inactivity, the

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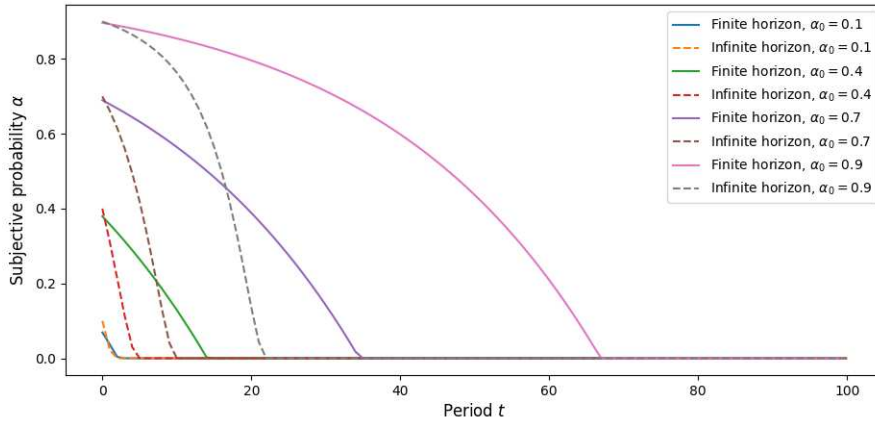


Figure 3.3.3: Learning dynamics according to α_0 (Setting 3.1.1).

manipulation seems devoid of risk. Thus, they choose γ_t very high cheating, whatever their time discount rate δ and the time horizon considered.

For priors very close to 1, the manipulation is on the contrary minimal because of the very strong fear of a control by the supervisor.

Between these two extremes, which lead to comparable amounts of fraud, the largest difference between the two horizons is when the prior is rather close to 1. This corresponds to the case where manipulation leads more to high γ_t if the horizon considered is long and the intertemporal discount rate is close to 1. It is then more profitable for the trader.

In addition to these first analyses, our simulation specifically devoted to the case where the supervisor is active (Figure 3.3.5) draws several important conclusions.

First of all, the net gain from the manipulation can be negative, with a finite horizon as well as with an infinite horizon, and all the more so for very low values of the prior. Intuitively, this means that a trader's error regarding the activity of the supervisor is very costly: with a low α_0 while the supervisor is in fact active, the manipulation is strong, but the probability of *de facto* control is also strong. Consequently, the detection of the manipulation by an active supervisor occurs quickly, and the fine imposed may exceed the gain induced by even a strong manipulation during a small number of periods.

Moreover, the growth of the net gain from manipulation as a function of α_0 is a robust result of the parameters chosen, but the negativity of the net gain in the case of

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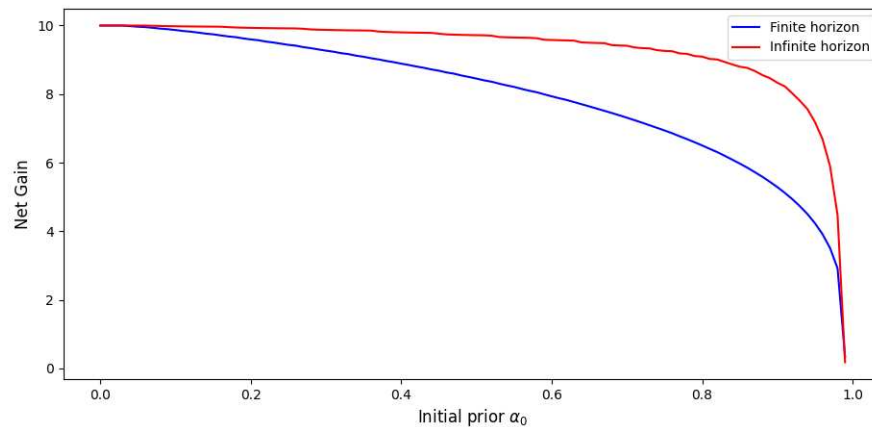


Figure 3.3.4: Inactive supervisor net gain according to α_0 (Setting 3.1.1).

an active supervisor is not always verified for any $\alpha_0 \in [0; 1]$, since that gain logically depends on the respective values of b and s (see in particular Figure 3.A.7 in Appendix 3.A, for a larger ratio b/s of Table 3.A.6).

Finally, we obtain a result symmetrical of our previous observation that the net gain to be manipulated is higher if the trader has an infinite horizon when the supervisor is inactive (because the trader with an infinite horizon defrauds more, and without ever being controlled). Conversely, when the supervisor is active, the detection of more manipulation by a trader with an infinite horizon goes hand in hand with a lower (potentially negative) net gain for this trader who cheats more. Intuitively, this can be understood by the fact that if the bank defrauds more with an infinite horizon, it increases the probability of detection and therefore of stopping the game more quickly. The manipulation having been strong, the control is on average faster and the fine is more likely to be imposed before the gain allowed by the manipulation has been very large. For the bank facing an active supervisor, it can be deduced that it is better to have a single trader with an infinite horizon who engages in a vast manipulation than a succession of more cautious myopic traders.

3.3.3 Control probabilities and the end of the fraud

The manipulation size influences the probability of control, and thus the stopping time when the supervisor is active. Here is the probability, for an active supervisor, of having

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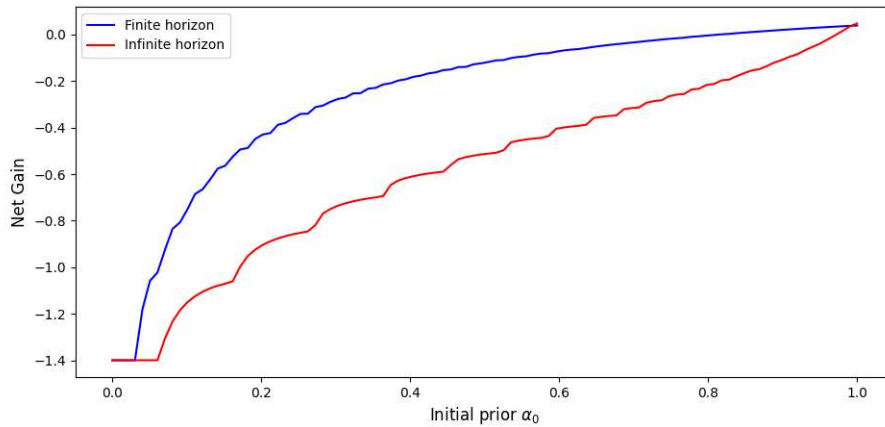


Figure 3.3.5: Active supervisor net gain from manipulation according to α_0 (Setting 3.1.1).

detected the manipulation during a certain period as a function of the initial prior — see below, period 15.²⁴

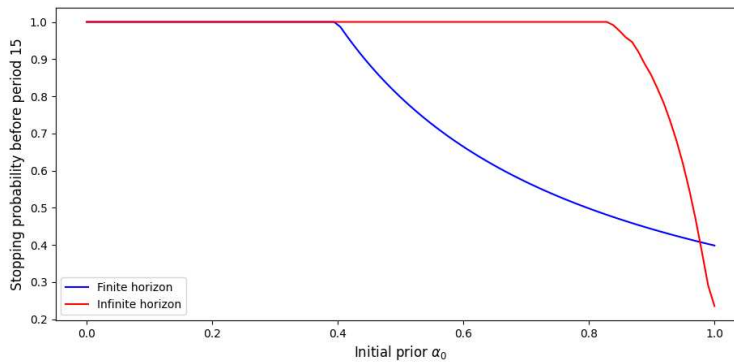


Figure 3.3.6: Active supervisor detection probability at period 15 according to α_0 (setting 3.1.1).

Reading: for an initial prior α_0 of 0.8, the probability that a supervisor's control has put an end to the manipulation at the latest at period 15 is 0.5 with finite horizon and 1 with infinite horizon.

This graphical representation takes into account, for a given α_0 , the progressive evolution of α_t and γ_t over the periods. The horizontal part common to both specifications for small values of α_0 is explained by the fact that the learning of the active or

²⁴We arbitrarily retain period 15 here, because the graphical representation is particularly readable and pleasant to interpret, but the shape and positioning of the curves is the same for other values.

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inactive character of the supervisor is faster for these values: a small α_0 induces γ being more quickly raised, and thus a risk of quicker detection of the fraud. Thus, for values of α_0 less than or equal to 0.4 in the above specification, the optimal magnitude of manipulation reaches $\gamma = 1$ before period 15, so that the bank learns the supervisor's type unambiguously regardless of the supervisor's time horizon — either by being checked with a probability of sanction equal to 1, or by actually discovering inactivity through the absence of sanction. Given the results of the previous subsection, it is easy to explain that the certainty of a stop at the latest in period 15 corresponds to higher values of α_0 with an infinite horizon than with a finite horizon. The manipulation being faster and stronger with an infinite horizon, it indeed leads to a faster discovery of the supervisor type.

In general, this result keeps a comparable aspect for other time horizons than $T = 15$. The horizontal segment corresponding to a certain stop will be all the longer as the considered horizon is long: the longer the horizon, the slower the learning process (which corresponds to high initial values of α_0 inciting to caution) so that the type of supervisor is not yet discovered with certainty after a large number of periods. We deduce that a supervisor who does not seem active in the eyes of the trader (low subjective α_0) will paradoxically put an end to the manipulation sooner, and all the more so as the trader considers that she will be able to personally profit from the manipulation during a long period of time. Note that this figure completes the result established by Proposition 4 in the specification with a finite horizon, because, the probability of control p_t was constant (equal to $\frac{b}{s}$) for each of the periods in inner solution. But this does not mean that the non-horizontal part of the two curves presented in Figure 3.3.6 (for α_t sufficiently close to 1) should be linear here, as the probability of stopping during each of the periods t integrates the probability of *not having been sanctioned* during the $t - 1$ previous periods $\prod_{s=0}^{t-1} (1 - \alpha_s \gamma_s)$. We can see why the probability of arrest at each period t , which is $\alpha_t \gamma_t \prod_{s=0}^{t-1} (1 - \alpha_s \gamma_s)$, is not monotonic: the survival probabilities $((1 - \alpha_s \gamma_s))$ are not monotonic with respect to α_0 . For a high α_0 , the control probabilities $s\alpha$ will be high but the manipulation sizes low, while for a low α_0 , the control probabilities α_s will be low but the manipulation sizes high. The derivative with respect to t of the functions presented in Figure 3.3.6 corresponds to the density of the cumulative probability of control before t and is thus maximum for an intermediate value of α_0 .

Conclusion

1. *The model and the manipulation.* The model developed above fits the observable manipulation dynamic in at least three aspects.

The informational dynamic presented in Sections 3.1 and 3.2 feature an increasing magnitude of the manipulation over time. This fits well with the history of the indicator, which some traders claim was manipulated as early as the 1990s. This is notably the view of Douglas Keenan (2012), a trader at Morgan Stanley in 1991 who discovered this manipulation at his own expense. The existence of a network of trader-contributors manipulating the indicator, including without seeking to serve their individual interests, was only acknowledged in the middle of the 2000s by the FCA and CTFC reports. The latter also underlined the increase in manipulation until the spring of 2008, when the scandal broke.

101. The communications described in Subsection 3.3.1 showed that reports on **LIBOR dislocation increased materially in the period 1 April 2008 to 25 June 2008, relative to the two previous periods** (in Sections 3.1 and 3.2).

[FSA internal audit], p. 63.

A development, over several years or even several decades, directly echoes a sequence of α_t decreasing and converging to 0 at the least, at the onset of the financial crisis — and this in both specifications, as illustrated in Figure 3.3.3. This empirical dynamic lends credence to the thesis of an inactive supervisor throughout the period (no bank having been sanctioned or even charged in the 1990s and 2000s), at least until the revelation of the Libor scandal by the *Wall Street Journal* in 2008. The manipulation having nevertheless come to an end, it should be emphasized that the conclusive interpretation adopted here consists in accrediting the Bayesian learning of the supervisor's inactivity. . . which was finally reversed, in a sense, once the manipulation was detected by an outside instance.

The discovered nullity of α goes hand in hand with an increase in γ_t towards 1, in the simulations (Figures 3.1.2 and 3.2.2) as in reality. Thus, in the hundreds of pages of extracts made public in the FCA's *final notices* as well as in the CFTC's orders of the lawsuits, it is noted that the risk taken was never, before 2008, part of the arguments invoked to limit the extent of the manipulation — whether it was manipulation carried

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out for personal profit or in the interest of other traders. Everything indicates that the nullification of the α parameter, materialized by the progressive revelation of the supervisor's type, went hand in hand with a manipulation of maximum magnitude. Moreover, it was the context (financial crisis, doubts about the liquidity and solvency of banking institutions, public attention on the scandal), which prompted actors other than the supervisor to examine the sincerity of the announced contributions, that led to the revelation of the fraud, and not an excessive scale that brought about its detection by the said supervisor.

This increasing magnitude of the manipulation up to its maximum went hand in hand with a net gain that also increased (Figure 3.3.4), until the outside revelation forced the supervisor to change from *inactive* to *active*. It should however be noted that the fines imposed on the banks slightly reduced the interest of the manipulation in the last period (cf. expression G_A page 205). This reduction in the gain when the control not only ended the game (gain G_I) but also carried a financial penalty (gain G_A net of fine) was, however, less than it would have been had the offending banks participated in leniency programmes in all jurisdictions.

These conclusions can be drawn from the common features of the two specifications proposed above: decreasing beliefs as no sanction is imposed, increasing size of the manipulation and increasing net gain to be handled.

However, an important result of the model commented on extensively in the foregoing is that the dynamics of manipulation is significantly larger, as is the gain to manipulators, in the specification with an infinite horizon. The history of Libor and its manipulation suggests that this is the specification that should be favoured. Indeed, the electronic exchanges listed in the documents made public by the courts reveal a large number of *senior traders*, so called because of their seniority in the banks — and, presumably, in the manipulation. This point, combined with the extremely high fines imposed on a very large number of banks, bears witness to a manipulation of a network of banks over a long period of time (Section 3.2) rather than to isolated traders projecting themselves over a short horizon (Section 3.1). Since this specification entails more manipulation and cost for society (Figure 3.3.4), the supervisor's inaction is all the more damaging. All the important since, by being active, the supervisor could have imposed a fine exceeding the traders' private gain (Figures 3.3.5 and 3.A.10), even if sometimes

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the fine comes too late to wipe out the undue enrichment of the manipulator (Figure 3.A.7). This naturally leads to some conclusions concerning the supervisor's action in a stylized model such as the one presented here.

2. Recommendations induced by the study of the informational dynamic.

a. *Take into account long-term learning within the trading community.* This work encourages us to consider the financial industry as a sector where one makes a career (in professional activity as, here, in manipulation) and where the infinite horizon described in Section 3.2 is the one that best accounts for the rational decision-making of traders. As we have seen, the existence of numerous *senior traders* in the documents made public validates this hypothesis, all the more as the manipulation proved to be increasingly profitable. If there is indeed a problem of insufficiently erected 'Chinese walls' between traders (tradings room) and contributors (theoretically in the treasury desks in the *back office*), the model proposed here, stripped of all strategic interaction within the bank itself, is sufficient to underline the problem induced as much by personal learning as by the transmission from generation to generation of institutional tolerances towards fraudulent practice. This point is crucial since, on the one hand, we find a faster convergence towards the maximum manipulation in this reasoning framework (equation 3.2.8), and on the other hand, the dissuasive effectiveness of a given sanction is also lower (at least with the utility retained, equation 3.2.9).

b. *Supervise and punish, or threaten to punish.* In a classic way for the literature in which this model takes place, an increased sanction has a dissuasive effect capable of slowing down the dynamic of a manipulation. However, even for an inactive supervisor (in the sense that no effective control would be carried out), any form of threat can have the same effect by increasing the prior α_0 . With an infinite horizon, as we have seen, an increased threat of a control is sufficient to reduce the interval of α_0 leading to a « corner high » manipulation (Proposition 14) as well as the total enrichment of manipulators, even if the supervisor is actually inactive (Figure 3.3.4).

It is interesting to note, however, that if the supervision is active, it is in the traders' interest to assume that it is not (low α_0), so that the manipulation is quickly important, the control occurs quickly, and this can generate a gain for the welfare of society at the traders' expense — because the fine can then exceed the discounted sum of gains obtained through manipulation (Figure 3.3.5). In the logic of Selten (1978)

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chain store paradox for a repeated game, it may thus be relevant for the supervisor to be active in the first few periods in order to quickly detect a manipulation and thus act downwards on the belief of traders who may have a new opportunity to manipulate later on. More generally, supervisors who are unwilling or unable to act on their type; which could be costly, have at least every interest in acting on the *perception of it*.

For future research, we suggest to consider an endogenisation of the supervisor, with controls stemming from an optimisation (e.g. minimising the net gain for the trader or maximising the fine imposed) rather than from an exogenous state of nature. This could highlight to what extent an announcement from the supervisor about his type or even merely a likely threat (in mixed strategies) thus completing the analysis of the deterrent effect imputed here to α_0 . The question is important for supervisors too, because our model concludes that it may be interesting to appear inactive in the short term to favour manipulation in order to better detect it, but that in the long term manipulation is lower if they appear to be active. Such research could enable to delve deeper into this essential question of temporal coherence in regulatory policies.

Appendix

3.A Complementary figures

The two simulations below contain the parameter variation $b = 0.01$ rather than $b = 0.1$.

Table 3.A.1: Setting 2.

Parameter	δ	b	s
Value	0.99	0.01	3

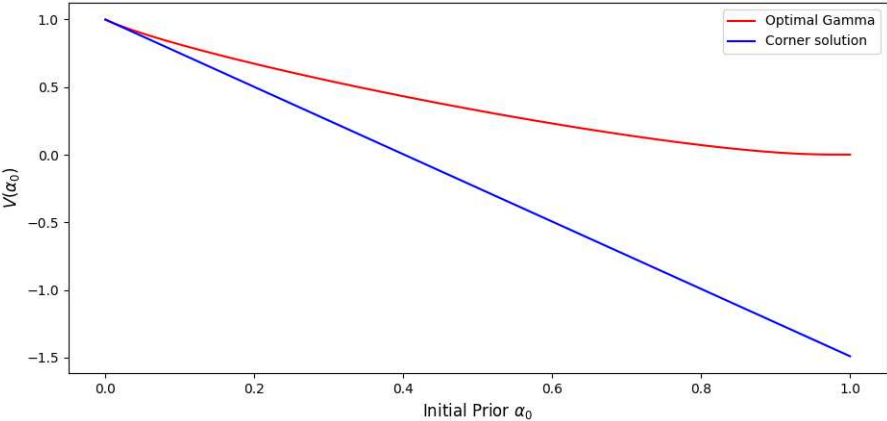


Figure 3.A.2: Simulation of $V(\cdot)$ according to α_0 (Setting 3.A.1).

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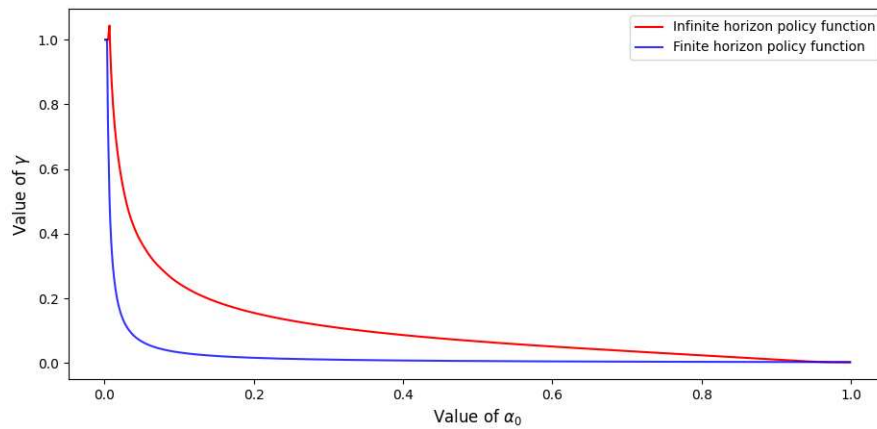


Figure 3.A.3: Optimal interior γ (policy function) according to α_0 (Setting 3.A.1).

The simulation below contains the parameter variation $\delta = 0.9$ rather than $\delta = 0.99$.

Table 3.A.4: Setting 2.

Parameter	δ	b	s
Value	0.9	0.1	3

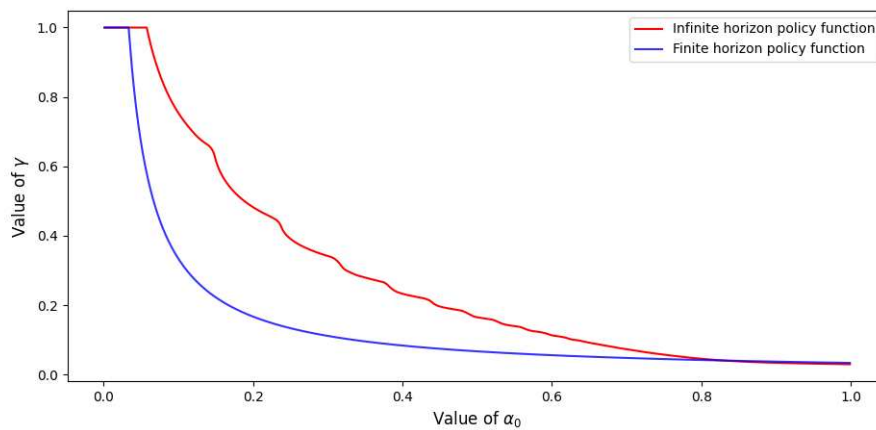


Figure 3.A.5: Optimal interior γ (policy function) according to α_0 (Setting 3.A.4).

Table 3.A.6: Setting 4.

Parameter	δ	b	s
Value	0.99	1	3

The simulation below contains the parameter variation $b = 1$ rather than $b = 0.1$.

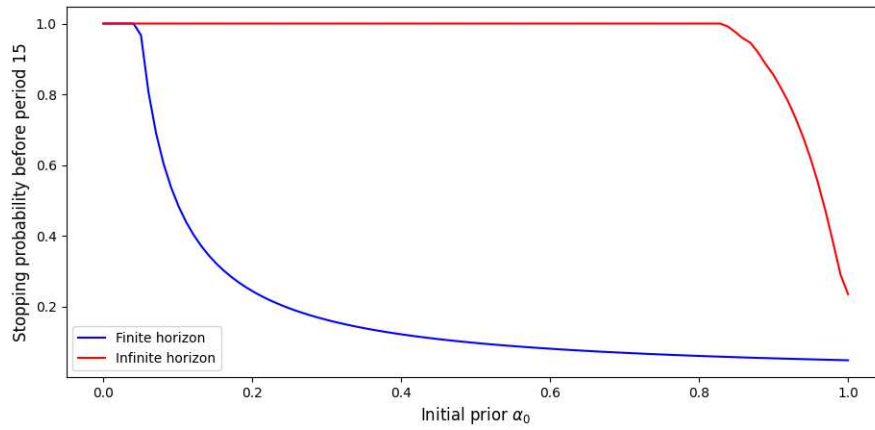


Figure 3.A.7: Active supervisor net gain from the manipulation according to α_0 (Setting 3.A.6).

The two simulations below contain the parameter variation $\delta = 0.95$ rather than $\delta = 0.99$.

Table 3.A.8: Setting 5.

Parameter	δ	b	s
Value	0.95	0.1	3

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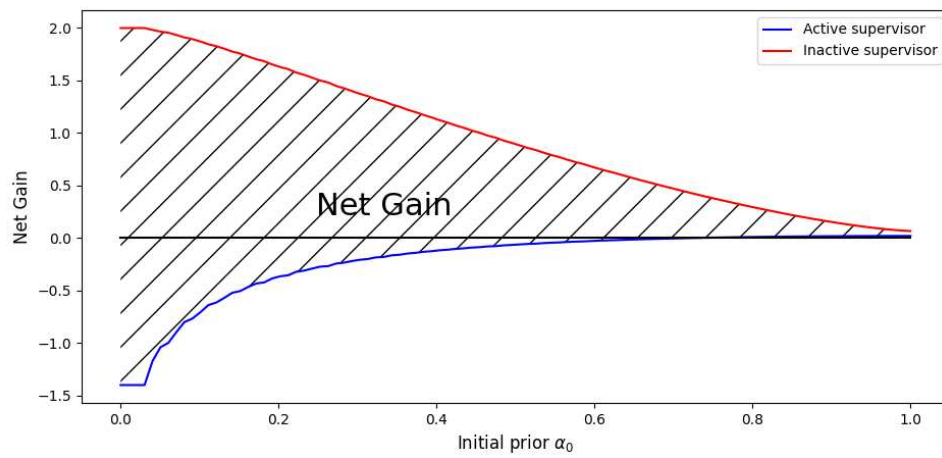


Figure 3.A.9: Finite horizon net gain from manipulation according to α_0 (Setting 3.A.8).

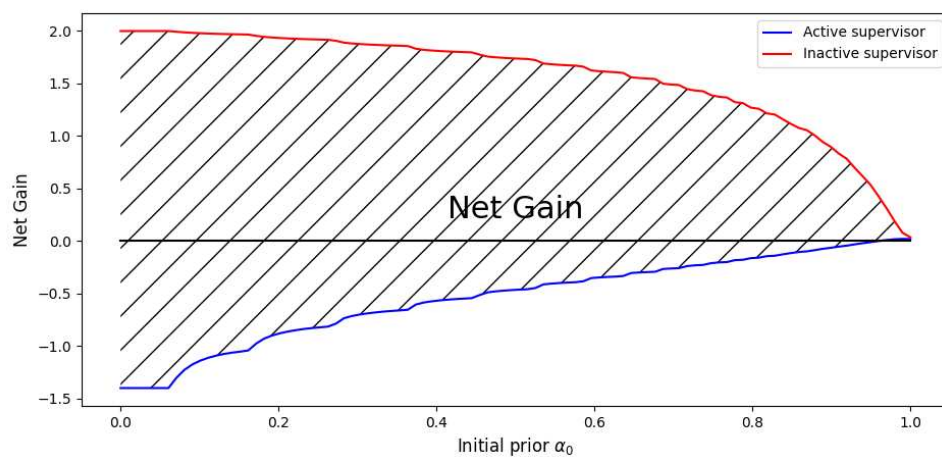


Figure 3.A.10: Infinite horizon net gain from manipulation according to α_0 (Setting 3.A.8).

3.B Proofs

This section gathers the proofs of the proposals not included in the short proofs given in the development.

3.B.1 Proof of proposition 5

We begin by studying the equation

$$\alpha_{t+1} - \alpha_t < 0$$

$$\iff \left(\frac{s}{s-b}\right)^t (\alpha_0 - 1) \left(\frac{b}{s-b}\right) < 0$$

We already know that the sequence $(\alpha_t)_{t \in \mathbb{N}}$ is decreasing, so the above inequality is true, which corresponds to the intuitive idea that $s > b$ so that the resolution is non-trivial. Convexity is then proved by considering the sign of:

$$(\alpha_{t+2} - \alpha_{t+1}) - (\alpha_{t+1} - \alpha_t) = \frac{b}{s-b} (\alpha_{t+1} - \alpha_t)$$

which is negative because $\alpha_{t+1} - \alpha_t < 0$.

So the difference between two consecutive terms is negative and increasingly small, which in addition to the decrease establishes the convexity of the sequence $(\alpha_t)_{t \in \mathbb{N}}$.

3.B.2 Proof of proposition 6

Let \mathcal{C} be the space of continuous and bounded functions on $[0, 1]$. Let F be a function of \mathcal{C} , we define the application T as:

$$TF(x) = \max_{\gamma \in [0,1]} \left[u(x, \gamma) + \delta(1 - x\gamma) F\left(\frac{x(1-\gamma)}{1-x\gamma}\right) \right]$$

First, TF is defined for any function F of \mathcal{C} by extension by continuity, if u is defined for all $(x, \gamma) \in [0, 1]^2$, because for any function u , it may happen that the optimal γ is equal to 1 if x is equal to 1, and the ratio $\frac{x(1-\gamma)}{1-x\gamma}$ would then not be defined. But it is easy to prove that this ratio converges to 1 when γ converges to 1 if $x = 1$, and is thus extendable by continuity. We can extend T by continuity as well and define it for all x of $[0, 1]$. As a consequence of this definition, it is clear that $F\left(\frac{x(1-\gamma)}{1-x\gamma}\right)$ continuous on $[0, 1]^2$ then use the maximum theorem²⁵ to conclude that, if u is continuous and bounded on $[0, 1]^2$, then $TF(x)$ is continuous on $[0, 1]$ if F is, which proves that T is indeed an application of \mathcal{C} in \mathcal{C} .

It is clear that T satisfies Blackwell's sufficient conditions:

²⁵Stokey et al. (1989), *Recursive Methods in Economic Dynamics*, theorem 3.6, p. 62.

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Firstly, TF is defined for any function F in \mathcal{C} by continuous extension, as long as u is defined for all $(x, \gamma) \in [0, 1]^2$. For an arbitrary function u , it may happen that the optimal γ is equal to 1 if x is equal to 1, and the ratio $\frac{x(1-\gamma)}{1-x\gamma}$ would then not be defined. However, it is easy to prove that this ratio converges to 1 as γ converges to 1 if $x = 1$, and is thus continuously extendable. We can also extend T continuously and define it for all x in $[0, 1]$. As a consequence of this definition, it is clear that $F\left(\frac{x(1-\gamma)}{1-x\gamma}\right)$ is continuous on $[0, 1]^2$. We then use the maximum theorem²⁶ to conclude that if u is continuous and bounded on $[0, 1]^2$, then $TF(x)$ is continuous on $[0, 1]$ if F is, which proves that T is indeed an application from \mathcal{C} to \mathcal{C} . It is clear that T satisfies the sufficient conditions of Blackwell:

- i. Monotonicity: let $F, G \in \mathcal{C}$ be such that $G(x) \geq F(x) \forall x \in [0, 1]$. Then $TG(x) \geq TF(x) \forall x \in [0, 1]$.
- ii. Update: for any real $a \geq 0$, $T(F + a)(x) \leq TF(x) + \delta a$ with $\delta \in]0, 1[$.

Consequently, T is a contracting application of \mathcal{C} in \mathcal{C} .²⁷ Since \mathcal{C} is complete, the contracting application theorem asserts that T admits a unique fixed point V satisfying $TV = V$, which is thus the solution to the recursive problem (FE) .

Let us now consider the set of sequences $\{\alpha_n^*\}_{n \in \mathbb{N}}$ defined in the following way:

$$\alpha_n^* = \frac{\alpha_{n-1}^*(1 - \gamma_{n-1}^*)}{1 - x_{n-1}^* \gamma_{n-1}^*}$$

under the constraints $\gamma_n^* \in \operatorname{argmax}_{\gamma \in [0, 1]} \left[u(\alpha_n^*, \gamma) + \delta(1 - \alpha_n^* \gamma) V\left(\frac{\alpha_n^*(1-\gamma)}{1-\alpha_n^* \gamma}\right) \right]$ and $\alpha_0^* = \alpha_0$.

It is clear that the set of sequences $\{\alpha_n^*\}_{n \in \mathbb{N}}$ is defined by recurrence, even though it may not be composed of a unique sequence if for a given α_n^* the optimal γ is not unique. At this stage, we are not concerned with the uniqueness of the optimal sequence γ .

V is obviously a bounded function on $[0, 1]$ since it belongs to the space of continuous functions on the compact $[0, 1]$. Therefore, for any sequence $\{\alpha_n\}_{n \in \mathbb{N}}$ of $[0, 1]^{\mathbb{N}}$, and in particular for $\{\alpha_n^*\}_{n \in \mathbb{N}}$, we have:

²⁶Stokey et al. (1989), *Recursive Methods in Economic Dynamics*, theorem 3.6, p. 62.

²⁷Stokey et al. (1989), *Recursive Methods in Economic Dynamics*, theorem 3.3, p. 54.

$$\lim_{n \rightarrow +\infty} |\delta^n \mathbb{E}_{t=0}[V(\alpha_n)]| \leq \lim_{n \rightarrow +\infty} \delta^n |V(\alpha_n)| = 0$$

This concludes that V , unique solution to the problem (FE) , is also the unique solution to the problem (SP) , which concludes the demonstration.

3.B.3 Proof of proposition 7

We prove this proposition via the formulation (SP) , thus starting from $t = 0$. To generalise to any date, it suffices to consider that at any date t , the problem faced by the trader does not depend on past actions, just on the value of α_t at which they have arrived, and that the problem from date t is solved exactly like the problem from $t = 0$.

The first case is $\gamma_0^* = 0$. In this case, we have $\alpha_1^* = \alpha_0$. This means that the infinite horizon problem seen starting at period 1 is identical to the problem starting at period 0. The optimal manipulation intensity is the same, $\gamma_1^* = 0$. By recurrence, it is easy to prove that $\gamma_t^* = 0 \forall t \geq 1$ if $\gamma_0^* = 0$.

In the second case, we have $\alpha_1^* = 0$. If the intensity of the manipulation were such that the probability of a sanction is equal to 1, then, necessarily, all uncertainty disappears: the absence of a sanction implies that the trader is now sure that any sanction is impossible. In this case, whatever the trader's future decisions, we will always have $\alpha_t^* = 0$ for $t \geq 1$. The problem (SP) thus becomes:

$$V(\alpha_0) = u(\alpha_0, 1) + \sum_{t=1}^{\infty} \delta^t u(0, \gamma_t^*)$$

It is clear that the value is maximized by the sequence that maximizes utility at each date, i.e., by virtue of (H_1) , $\gamma_t^* = 1$ for $t \geq 1$.

Finally, if $\alpha_0 = 0$, the problem is simply:

$$V(0) = \sum_{t=0}^{\infty} \delta^t u(0, \gamma_t^*)$$

This implies, still by virtue of (H_1) , that $\gamma_t^* = 0$, for all $t \geq 0$, which ends the demonstration.

3.B.4 Proof of proposition 8

The use of (3.2.3) makes it possible to obtain immediately, for the case $\gamma = 1$:

$$V_h(\alpha) = u(\alpha, 1) + \delta(1 - \alpha)V_h(0)$$

It has already been proved in Proposition 7 that for $\alpha = 0$, under the hypothesis (H_1), the solution is « corner high ». We therefor have

$$V_h(0) = u(0, 1) + \delta V_h(0) \iff V_h(0) = \frac{u(0, 1)}{1 - \delta}$$

which concludes the proof.

In the « corner low » case, (3.2.3) is written

$$V_b(\alpha) = u(\alpha, 0) + \delta V_b(\alpha) \iff V_b(\alpha) = \frac{u(\alpha, 0)}{1 - \delta}.$$

The second part of the Proposition is easily demonstrated by observing that for any α , there is no reason why the sequence $\{\gamma_t = 1\}_{t \in \mathbb{N}}$ or the sequence $\{\gamma_t = 0\}_{t \in \mathbb{N}}$ should be the optimal sequence. $V(\alpha)$ must be greater than the value resulting from these two sequences.

3.B.5 Proof of proposition 10

We first show that if $F \in \mathcal{C}$ is decreasing, then TF is strictly decreasing under (H_2) - or decreasing under (H_2bis). If $\alpha_1 < \alpha_2$, we have

$$\begin{aligned} TF(\alpha_1) &= \max_{\gamma \in [0,1]} \left[u(\alpha_1, \gamma) + \delta(1 - \alpha_1\gamma)F\left(\frac{\alpha_1(1 - \gamma)}{1 - \alpha_1\gamma}\right) \right] \\ &= u(\alpha_1, \gamma^*(\alpha_1)) + \delta(1 - \alpha_1\gamma^*(\alpha_1))F\left(\frac{\alpha_1(1 - \gamma^*(\alpha_1))}{1 - \alpha_1\gamma^*(\alpha_1)}\right) \end{aligned}$$

where $\gamma^*(\alpha_1)$ denotes the value(s) of γ that maximize the function for α_1 . If $\alpha_1 < \alpha_2$, we have

$$1 - \alpha_1\gamma^*(\alpha_2) > 1 - \alpha_2\gamma^*(\alpha_2)$$

and

$$\frac{\alpha_1(1 - \gamma^*(\alpha_2))}{1 - \alpha_1\gamma^*(\alpha_2)} - \frac{\alpha_2(1 - \gamma^*(\alpha_2))}{1 - \alpha_2\gamma^*(\alpha_2)} = (1 - \gamma^*(\alpha_2)) \frac{\alpha_1 - \alpha_2}{(1 - \alpha_1\gamma^*(\alpha_2))(1 - \alpha_2\gamma^*(\alpha_2))} \leq 0$$

thus, by consequences,

$$(1 - \alpha_1\gamma^*(\alpha_2))F\left(\frac{\alpha_1(1 - \gamma^*(\alpha_2))}{1 - \alpha_1\gamma^*(\alpha_2)}\right) \geq (1 - \alpha_2\gamma^*(\alpha_2))F\left(\frac{\alpha_2(1 - \gamma^*(\alpha_2))}{1 - \alpha_2\gamma^*(\alpha_2)}\right)$$

By definition of the maximum, we have then

$$\begin{aligned} TF(\alpha_1) &\geq u(\alpha_1, \gamma^*(\alpha_2)) + \delta(1 - \alpha_1\gamma^*(\alpha_2))F\left(\frac{\alpha_1(1 - \gamma^*(\alpha_2))}{1 - \alpha_1\gamma^*(\alpha_2)}\right) \\ &> u(\alpha_2, \gamma^*(\alpha_2)) + \delta(1 - \alpha_1\gamma^*(\alpha_2))F\left(\frac{\alpha_1(1 - \gamma^*(\alpha_2))}{1 - \alpha_1\gamma^*(\alpha_2)}\right) \end{aligned}$$

In accordance with (H_2) , hence

$$TF(\alpha_1) > u(\alpha_2, \gamma^*(\alpha_2)) + \delta(1 - \alpha_2\gamma^*(\alpha_2))F\left(\frac{\alpha_2(1 - \gamma^*(\alpha_2))}{1 - \alpha_2\gamma^*(\alpha_2)}\right) = TF(\alpha_2)$$

Or, if we only have (H_2bis) :

$$TF(\alpha_1) \geq TF(\alpha_2)$$

We have proved that if $F \in \mathcal{C}$ is decreasing, TF is strictly decreasing under (H_2) - resp. decreasing under (H_2bis) . Now, T being contracting, V is the limit of the function sequence $(T^n V_0)_{n \in \mathbb{N}}$ for any function V_0 of \mathcal{C} . If we choose V_0 to be decreasing, this means that V is the limit of a strictly decreasing function sequence. The adherence of the space of strictly decreasing functions being the space of decreasing functions, V is necessarily decreasing, under (H_2) as under (H_2bis) . As $TV = V$, this implies that under (H_2) , V is strictly decreasing.

3.B.6 Proof of proposition 11

It is impossible to generalize directly to our problem the proofs of the differentiability of the value function for the usual recursive formulations (i.e. without probabilities with Bayesian updating). We proceed by reformulating the problem (FE) in a way that uses the usual results. The usual formulation expresses the recursive problem in terms

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of the state variable and the state variable at the next period. By noting this one α' , we can write, from the relation of bayesian updating:

$$\alpha' = \alpha \frac{1 - \gamma}{1 - \alpha\gamma} \iff \gamma = \frac{\alpha - \alpha'}{\alpha(1 - \alpha')} \quad \text{pour } \alpha \in]0, 1[\text{ and } \alpha' \in [0, \alpha]$$

The problem (FE) can then be reformulated as follows

$$V(\alpha) = \max_{\alpha' \in [0, \alpha]} \left[u \left(\alpha, \frac{\alpha - \alpha'}{\alpha(1 - \alpha')} \right) + \delta \frac{1 - \alpha}{1 - \alpha'} V(\alpha') \right]$$

or by introducing $W(\alpha) = \frac{V(\alpha)}{1 - \alpha}$:

$$W(\alpha) = \max_{\alpha' \in \Gamma(\alpha)} [\tilde{u}(\alpha, \alpha') + \delta W(\alpha')] \quad \text{s.t. } \Gamma(\alpha) = [0, \alpha] \quad (FE') \quad (3.B.1)$$

with $\tilde{u}(\alpha, \alpha') = \frac{1}{1 - \alpha} u \left(\alpha, \frac{\alpha - \alpha'}{\alpha(1 - \alpha')} \right)$.

This formulation is the usual formulation for recursive problems. However, it presents two problems. Firstly, W is not necessarily defined in $\alpha = 1$ (and even if it were, the expression of γ as a function of α' and α is not valid in $\alpha = 1$), and it is neither defined nor extendable by continuity in $\alpha = 0$ (it does not diverge, but is not continuous). Secondly, proving the existence of the W -value function by the contracting application theorem requires that \tilde{u} be bounded, which could be problematic in $\alpha = 1$ for a wide range of utility functions. We circumvent this problem by looking for the solution of (FE') on a compact $[a, b] \subset]0, 1[$. In this case, we bypass the two problems mentioned above by $\alpha = 0$ and $\alpha = 1$, and \tilde{u} is continuous and bounded on $[a, b]^2$ if u is on $[0, 1]^2$. Since Blackwell's sufficient conditions are necessarily satisfied for the application defined by (FE') , we conclude, by applying the contracting application theorem, that on $[a, b]$, (FE') admits a unique solution $W(\alpha)$. Now, if $V(\alpha)$ is the solution of (FE) it is necessarily a solution of (FE') son $[a, b]$. The uniqueness of the solution of $(FE)'$ thus guarantees that $V(\alpha) = (1 - \alpha)W(\alpha)$. It remains to prove that W solution of (FE') is derivable on all $[a, b] \subset]0, 1[$. We then apply a result due to [Benveniste and Scheinkman \(1979\)](#). If the following five conditions concerning \tilde{u} and α are verified, then W is derivable in α :

- i. the set of values taken by the state variable is a convex subset of \mathbb{R} , and $\Gamma(\alpha)$ is a non-empty, continuous and compact correspondence;

- ii. \tilde{u} is continuous and bounded;
- iii. \tilde{u} is strictly concave in α and α' ;
- iv. $\Gamma(\alpha)$ is convex and monotone in α ;
- v. α belongs to $]a, b[$ and α' is interior to $\Gamma(\alpha)$.

Since we are restricted to $\alpha \in [a, b] \subset]0, 1[$, and that $\Gamma(\alpha) = [0, \alpha]$, it is clear that (i.) and (iv.) are verified. Similarly, any utility function u continuous on $[0, 1]^2$ ensures that (ii.) is verified.

Finally, the cross derivative is written: as for (iii.), under (H_4) , by the very definition of the Hessian matrix, it is clear that \tilde{u} is strictly concave in its two arguments. Therefore, (H_4) implies (iii.).

If (H_4) is verified, the real difficulty lies in condition (v.): the need for an α' inside $\Gamma(\alpha)$ here really only amounts to having $\alpha' < \alpha$,²⁸ i.e. $\gamma > 0$, i.e. the solution must not be « corner low ».

We now characterize the values of α for which the solution is « corner low ». Under (H_3) , Proposition 7 says that $V(\alpha) = V_b(\alpha) = 0$ if the solution is « corner low ». If there exists $\alpha' \in]0, 1[$ for which the solution becomes « corner low », then $V(\alpha') = 0$. Let us suppose that there exists $\alpha'' > \alpha'$ for which $\gamma^*(\alpha'') > 0$. Definition 1 implies that if V is not in the « corner low » regime, we necessarily have $V(\alpha'') > V_b(\alpha'') = 0 = V(\alpha')$, otherwise, this means that $\gamma^* = 0$ also maximizes (FE) . Consequently, this implies that V is increasing on $] \alpha', \alpha'' [$, which contradicts Proposition 10. The solution « corner low » regime is necessarily of the form $] \alpha_b, 1 [$. We have thus proved that for all $[a, b] \subset]0, 1[$, V is derivable on $[a, b] \cap]0, \alpha_b [$. Moreover, when $\alpha \in] \alpha_b, 1 [$, the explicit form of V is known and this one is derivable if u is derivable with respect to α . Consequently, on $] \alpha_b, 1 [$, V is derivable, which ends the demonstration.

²⁸Benveniste proof requires that for a given α_0 , there exists a neighbourhood D of α_0 such that the optimal α'_0 (i.e. the optimal α' of α_0) is included in $\Gamma(x)$ for all $x \in D$. Now, here, $\alpha' = 0$ is included in $\Gamma(\alpha)$ for all α .

3.B.7 Proof of proposition 12

Let us suppose that $\alpha = 1$ is interior. We will give a condition such that this interior solution cannot lead to $\gamma^* = 0$. If this is the case, then the solution will never be « corner low », since it has been proved that we cannot return to an « interior » solution once V has entered the corner « corner low ». The (FE) problem in $\alpha = 1$ is rewritten:

$$V(1) = \max_{\gamma \in [0,1]} (u(1, \gamma) + \delta(1 - \gamma)V(1))$$

For γ^* to be optimal, we must have

$$\frac{\partial u}{\partial \gamma}(1, \gamma^*) = \delta V(1)$$

We reintroduce this FOC in the equation (FE) :

$$\frac{\partial u}{\partial \gamma}(1, \gamma^*) = \delta u(1, \gamma^*) + \delta(1 - \gamma^*) \frac{\partial u}{\partial \gamma}(1, \gamma^*)$$

or again:

$$\delta u(1, \gamma^*) - (1 - \delta + \delta \gamma^*) \frac{\partial u}{\partial \gamma}(1, \gamma^*) = 0 \quad (3.B.2)$$

If this condition is never verified for $\gamma^* = 0$, i.e. if

$$\delta u(1, 0) \neq (1 - \delta) \frac{\partial u}{\partial \gamma}(1, 0)$$

then there is never a « corner low » solution, which amounts to satisfying (H_5) if (H_3) is verified.

As for the second case, if (H_3) is verified, we necessarily have $V(1) = 0$ if there exists a « corner low » regime by virtue of Proposition 8. We never have a « corner low » regime if $V_h(1) = u(1, 1) > 0$.

3.B.8 Proof of proposition 13

Due to the upper semicontinuity of the correspondence of « policy functions », necessarily, $\gamma^* = 1$ in α_h . Moreover, the value function « jumps » $V_h(0)$ to $\gamma = 1$, and V_h is derivable if u is. Using the condition (FOC) of problem (FE) , we obtain:

$$0 = \frac{\partial u}{\partial \gamma}(\alpha_h, 1) - \delta \alpha_h V_h(0) - \delta \alpha_h V_h'(0) = \frac{\partial u}{\partial \gamma}(\alpha_h, 1) - \delta \alpha_h \left[u(0, 1) + \frac{\partial u}{\partial \alpha}(0, 1) \right] \quad (3.B.3)$$

We then provide sufficient conditions for the above equation to have a unique solution on $]0, 1]$. If $\alpha = 0$, the right-hand side is $\frac{\partial u}{\partial \gamma}(0, 1)$, which is positive by virtue of (H_1) . If $\alpha = 1$, the right-hand side is negative if:

$$\delta \left[u(0, 1) + \frac{\partial u}{\partial \alpha}(0, 1) \right] - \frac{\partial u}{\partial \gamma}(1, 1) > 0$$

which corresponds to H_7 . This condition guarantees that the FOC admits at least one solution. We can ensure the uniqueness of this solution by imposing that the derivative with respect to α of the right-hand side of (3.B.3) is strictly negative, i.e.

$$\delta \left[u(0, 1) + \frac{\partial u}{\partial \alpha}(0, 1) \right] - \frac{\partial^2 u}{\partial \gamma^2}(\alpha, 1) > 0 \quad \forall \alpha \in]0, 1]$$

which is the condition (H_8) .

The fact that the switching threshold is unique concludes that the « corner high » zone is of the form $[0, \alpha_h[$. Indeed, we know that 0 belongs to this zone by virtue of Proposition 7. Now suppose that this area is not of the form $[0, \alpha_h]$: then, since we know that the « corner low » area is of the form $] \alpha_b, 1]$, this means that there exists at least one subset of $[0, \alpha_h]$ such that the solution is interior. But then, because of the upper semicontinuity of γ^* , there must exist other values of α in $[0, \alpha_h]$ satisfying the CPO 3.B.3, which is impossible since the conditions imposed guarantee its uniqueness.

3.B.9 Proof of proposition 14

Rewriting the equation (3.B.3) in the case of quadratic utility simply leads to:

$$b - \alpha_h s - \delta \alpha_h \left(b - \frac{s}{2} \right) = 0$$

or

$$\alpha_h = \frac{b}{s + \delta \left(b - \frac{s}{2} \right)}$$

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Imposing $\alpha_h \leq 1$ clearly amounts to imposing (H_7) , which is rewritten as follows:

$$\frac{b}{s + \delta(b - \frac{s}{2})} \leq 1 \iff b \leq s \frac{1 - \frac{\delta}{2}}{1 - \delta}$$

3.B.10 Proof of proposition 15

With this choice of utility, (H_3) and (H_5) are satisfied, so the solution is not « corner low ». And if $b \leq s \frac{1 - \frac{\delta}{2}}{1 - \delta}$, the solution is no « corner high » either, so γ^* is interior in $\alpha = 1$. The differentiability of V is not required in $\alpha = 1$ to characterize the interior solution. γ^* verifies (3.B.2), which is rewritten:

$$\delta \left(b\gamma^* - s \frac{(\gamma^*)^2}{2} \right) - (1 - \delta + \delta\gamma^*)(b - s\gamma^*) = 0$$

or again:

$$\frac{\delta s}{2} (\gamma^*)^2 + (1 - \delta)s\gamma^* - (1 - \delta)b = 0$$

This equation of the second degree necessarily has two roots if $s > 0$ and $b > 0$, only one of which is positive, reported in (3.2.10). It is easy to check that $\gamma^*(1) \leq 1$ if $b \leq s \frac{1 - \frac{\delta}{2}}{1 - \delta}$.

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RÉSUMÉ

Cette thèse de doctorat en économie politique se compose de trois chapitres indépendants. Les deux premiers documentent le comportement verbal des députés européens. Leur originalité réside notamment dans la création d'une nouvelle base de données textuelles regroupant tous les discours prononcés au Parlement européen de juillet 1999 à novembre 2022, permettant l'utilisation d'approches de traitement du langage naturel comme mesures de résultat. Le dernier chapitre aborde un problème d'optimisation en étudiant le scandale du Libor dans un cadre bayésien.

Le premier chapitre se concentre sur les discours prononcés par les députés européens. Il présente les premières preuves de convergence au sein des groupes politiques européens. L'analyse démontre le développement de blocs idéologiques de plus en plus cohérents au Parlement, en particulier parmi les idéologies les plus radicales. Cependant, cette unité croissante au sein des groupes s'est faite au détriment de la proximité entre eux.

Le deuxième chapitre examine l'influence des interactions sociales entre les députés européens sur la similarité de leur langage. En utilisant l'allocation quasi-aléatoire des sièges au Parlement européen, je constate que le fait de siéger côte à côte augmente la similarité du langage de ces députés de 7% au sein du même groupe et de 4% entre différents groupes. Les effets de pairs au sein du même groupe sont également influencés par la convergence dans les sujets abordés et dans les expressions utilisées pour les aborder. En revanche, la convergence entre les groupes est uniquement due à une manière plus similaire d'aborder les sujets.

Le troisième chapitre étudie les dynamiques de la manipulation du Libor au moyen d'un modèle bayésien dans lequel un trader apprend l'intensité de la surveillance à laquelle il est soumis. Le superviseur peut être actif ou inactif, et le trader choisit une intensité de manipulation à chaque période qui génère un gain à court terme. Alors qu'un superviseur inactif permet au trader de tricher indéfiniment, un superviseur actif peut découvrir la manipulation. Il est donc plus susceptible de la détecter à mesure que l'ampleur de la manipulation augmente.

MOTS CLÉS

Économie politique, Parlement européen, TextAsData, Libor, Manipulation.

ABSTRACT

This PhD dissertation in political economy consists of three independent chapters. The first two document the speaking behaviour of members of the European Parliament (MEPs). Their originality lies in particular in the creation of a new textual database that gathers all the speeches made in the European Parliament from July 1999 to November 2022, allowing to use natural language processing approaches as outcome measures. The last chapter is an optimization problem studying the Libor scandal within a bayesian framework.

Chapter one focuses on the speeches given by members of the European Parliament and present the first evidence of convergence within European political groups. The baseline analysis shows the development of increasingly cohesive ideological blocs in the Parliament, particularly among the more radical ideologies. Yet, this increasing unity within groups has come at the expense of proximity between them.

Chapter two investigates the influence of social interactions among Members of the European Parliament on the similarity of language they speak. Using the quasi-random allocation of seats in the European Parliament, I find that sitting adjacently increases language similarity among MEPs by 7% within the same group and by 4% between different groups. Within-group peer effects are equally influenced by convergence in the topics discussed and in the phrases used to address them. In contrast, between-group convergence is driven solely by a more similar manner of addressing topics.

Chapter three studies the dynamics of Libor manipulation through the lens of a Bayesian model in which an agent learns the intensity of the supervision they are subject to. The supervisor can be active or inactive, and the agent chooses a manipulation intensity during each period that yields a short-term payoff. While an inactive supervisor lets the agent cheat indefinitely, an active supervisor can discover the manipulation. They are thus more likely to detect it as the extent of the manipulation increases.

KEYWORDS

Political economy, European parliament, TextAsData, Libor, Manipulation.

