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Charles Louis-Sidois

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Institut d'études politiques de Paris  
Ecole doctorale de Sciences Po  
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Doctorat en sciences économiques

## TROIS ESSAIS EN ÉCONOMIE POLITIQUE

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soutenue le 2 juillet 2018

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# Introduction

Comment corrompre efficacement un jury ? Est-ce que la pression sociale peut influencer le résultat d'un scrutin à bulletins secrets ? Quelles sont les conséquences du service militaire sur les comportements politiques ? Cette thèse explore l'influence de facteurs extérieurs sur les interactions stratégiques propres au vote. Les articles proposés étant essentiellement théoriques, notre analyse s'applique à un grand nombre d'institutions prenant des décisions de façon collégiale. Parmi les applications potentielles, on peut mentionner les élections, les votes parlementaires, les référendums, le vote de jurys ou de comités. Identifier ce qui motive le vote des électeurs, députés ou jurés est complexe. Si les préférences intrinsèques pour les différentes alternatives soumises au vote jouent indéniablement un rôle, il existe de nombreux autres paramètres à prendre en compte. De par sa dimension collective, le vote engendre des considérations stratégiques sophistiquées. Des votants rationnels doivent entre autres anticiper les préférences et les stratégies des autres votants. Il en résulte une interdépendance entre les comportements électoraux des différents acteurs appelés à voter. Ces interactions en elles-mêmes sont relativement bien documentées par la littérature existante comme l'illustrent les quelques exemples proposés dans cette introduction. La contribution principale de cette thèse est d'étudier l'influence de facteurs extérieurs sur ces considérations. Dans le premier chapitre, nous montrons que manipuler la coordination entre les électeurs constitue une stratégie efficace pour influencer le résultat d'un vote. Le deuxième chapitre explore les interactions entre les normes sociales extérieures au vote et les stratégies des votants. Enfin, le dernier chapitre étudie les conséquences du service militaire obligatoire sur les comportements et les préférences politiques en France.

Nous profitons de cette introduction pour revenir sur quelques interactions stratégiques étudiées par la littérature. Nous avons choisi de détailler deux exemples particuliers : d'une part les enjeux de pivotalité et d'autre part l'agrégation d'informations car ces éléments constituent le socle théorique de cette thèse.

Le concept de pivotalité traduit l'impact potentiel d'un vote sur le résultat de

l'élection. Un vote n'est décisif que si les autres voix sont réparties de manière bien précise. Imaginons un comité de trois personnes votant à la majorité simple entre deux alternatives. Concentrons nous sur l'un des membres de ce comité. Son vote est déterminant si et seulement si les autres membres ne choisissent pas la même alternative (ou, si l'abstention est possible, s'ils se sont conjointement abstenus). Dans le cas contraire, une majorité est déjà dessinée et le vote n'a pas d'importance. Si le vote est simultané, les membres doivent anticiper la stratégie des autres pour savoir si leur vote peut faire basculer le résultat de l'élection. Si l'on considère une élection impliquant un grand nombre d'électeurs, un votant motivé uniquement par le résultat ne se sentira véritablement concerné que s'il anticipe une élection serrée (Ferejohn and Fiorina, 1974). Cette observation conduit notamment au paradoxe du vote : si l'on postule que les électeurs se préoccupent uniquement du résultat de l'élection et que l'action de voter présente des coûts (notamment le coût d'opportunité d'un déplacement aux urnes), alors des électeurs rationnels ne devraient quasiment jamais voter. Ce paradoxe est en général attribué à Downs (Downs, 1957) mais il s'agit en réalité d'un constat très ancien déjà mentionné par Condorcet. L'anticipation du comportement des autres joue donc un rôle clé dans la perception de l'importance du vote : afin d'estimer sa probabilité d'être pivot, un électeur doit former des hypothèses à la fois sur le taux d'abstention et sur les choix de ceux qui votent.

L'agrégation d'informations est un autre exemple d'interactions stratégiques entre électeurs. Introduite par Condorcet (1785), cette idée connaît récemment un regain d'intérêt suite aux travaux de Feddersen and Pesendorfer (1996) et Austen-Smith and Banks (1996). Cette théorie s'applique dans un univers où il existe une incertitude sur la qualité des alternatives proposées. Imaginons que chaque individu dispose d'informations sur la qualité des différentes alternatives et que ces informations ne puissent pas être partagées. Mis à part de rares exceptions, il s'avère que voter uniquement en fonction des informations dont chacun dispose va à l'encontre de la rationalité. Pour s'en convaincre, considérons un exemple proposé par Condorcet. Supposons qu'un jury doive se prononcer sur la culpabilité d'un accusé. Pour que l'accusé soit condamné, il faut que les membres du jury votent unanimement en ce sens. A priori, l'accusé a autant de chances d'être innocent que coupable. En étudiant le dossier les jurés apprennent des informations supplémentaires et forgent leur intime conviction. Ces opinions se forment indépendamment les unes des autres. Si les intimes convictions sont souvent correctes, il se peut que certains jurés se trompent. Admettons enfin que les jurés votent de façon simultanée et cherchent à prendre la bonne décision, c'est-à-dire à condamner l'accusé s'il est coupable et à l'acquitter s'il est innocent. Dans ce cadre, il s'avère que des jurés rationnels ne peuvent pas

tous voter selon leur intime conviction. En effet, supposons qu'un membre du jury pense d'une part que l'accusé est innocent et d'autre part anticipe que les autres jurés suivent leur intuition. S'il est rationnel, cet individu comprend que son vote n'est décisif que si tous les autres ont voté en faveur d'une condamnation, ce qui se produit uniquement si tous les autres pensent que l'accusé est coupable. Se sachant seul contre tous dans le seul cas où son vote importe, notre juré préfère alors voter à l'encontre de son intime conviction. Cet exemple illustre une idée plus générale : chaque votant doit prendre sa décision en imaginant que les conditions qui font de son bulletin un vote décisif sont réunies.

Il existe ainsi une multitude de mécanismes entremêlant les stratégies des électeurs. S'il est impossible de toutes les détailler ici, nous tenons à mentionner l'importance de la pression sociale, qui peut également influencer les pratiques électorales<sup>1</sup>. Enfin, les perspectives de carrières peuvent inciter les membres d'un comité d'experts à signaler qu'ils disposent d'une information précise sur la qualité des alternatives<sup>2</sup>. Notre second chapitre s'inscrit dans la continuité de ces travaux.

Si ces mécanismes en eux-mêmes sont relativement bien étudiés, peu d'articles considèrent l'influence de paramètres extérieurs sur les interactions stratégiques décrites ci-dessus. On peut tout de même souligner les contributions de Henry (2008) et Felgenhauer and Grüner (2008) qui montrent qu'un agent souhaitant corrompre un comité peut choisir les pots-de-vin de manière à manipuler l'agrégation d'informations. Dans une certaine mesure, Dal Bo (2007) présente également un modèle de corruption dans lequel un agent extérieur manipule la coordination entre les votants. Concernant les interactions entre le vote et les normes, Tyran and Feld (2006) proposent une expérience combinant une phase de vote et une phase de contribution à un bien public. Notre deuxième chapitre vise à réinterpréter cet environnement sous le prisme des travaux de Roland Bénabou et Jean Tirole sur les normes sociales<sup>3</sup>. Notre dernier article, essentiellement empirique, s'inscrit dans une littérature plus large étudiant l'influence d'expériences collectives sur le vote et les comportements politiques en général. À ce sujet, on peut entre autres citer les travaux de Madestam and Yanagizawa-Drott (2012) sur les conséquences des fêtes du 4 juillet aux États-Unis sur la participation électorale et les préférences politiques. Notre contribution permet d'apporter un éclairage détaché sur les conséquences politiques du service militaire, sujet qui fait encore aujourd'hui l'objet d'intenses débats en France.

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<sup>1</sup>Riker and Ordeshook (1968); Feddersen et al. (2009); Levine and Mattozzi (2017)

<sup>2</sup>Ottaviani and Sørensen (2001); Visser and Swank (2007); Levy (2007)

<sup>3</sup>Bénabou and Tirole (2003, 2006b, 2011)

# Résumé en français

## Chapitre 1

Le premier chapitre, co-écrit avec Leon Musolff, modélise la corruption au sein d'un comité. Le terme de comité est à interpréter au sens large et englobe tous types d'institutions prenant des décisions par un vote. Nous théorisons un mécanisme qui permet à un agent extérieur de corrompre le comité à moindre coût. L'agent extérieur peut représenter un lobby ou tout acteur susceptible de manipuler le vote du comité. Cet agent promet de payer un pot-de-vin à un certain nombre de membres du comité s'ils effectuent une action définie à l'avance, généralement voter en faveur de l'alternative favorable à l'agent. Nous postulons que les membres du comité votent en fonction du pot-de-vin qui leur est proposé ainsi que de leur impact potentiel sur le résultat de l'élection. Comme nous l'avons souligné plus haut, un vote n'est en effet décisif que si les autres voix sont réparties de manière bien précise. Dans ce cadre, nous montrons que l'agent extérieur a intérêt à corrompre un grand nombre de membres du comité. Paradoxalement, cette stratégie lui permet de faire accepter l'alternative qu'il soutient en déboursant une somme modique. En effet, lorsque le comité est largement corrompu, il est probable que l'alternative soutenue par l'agent extérieur sera plébiscitée par le comité. Chaque membre estime alors que son vote a peu de chances de faire basculer l'élection et préfère soutenir l'alternative défendue par l'agent extérieur afin de toucher son pot-de-vin, aussi maigre soit-il. En d'autres termes, l'agent extérieur cherche à convaincre les membres du comité que leur vote a peu de chance d'être décisif dans le résultat de l'élection.

Nous pensons que ce mécanisme possède de nombreuses applications. Par exemple, les contributions des lobbies à Bruxelles et aux Etats-Unis sont étonnamment faibles par rapport aux avantages obtenus par les secteurs qu'ils représentent. Il s'agit du paradoxe de Tullock, théorisé pour la première fois dans Buchanan et al. (1980). Notre théorie permet d'expliquer ce constat : il est possible de manipuler des institutions législatives à moindre coût lorsque les décisions sont prises collectivement. Soulignons ici que cela peut s'inscrire dans un cadre légal : les récompenses promises aux parlementaires peuvent prendre la forme de bénéfices pour la circonscription qu'ils représentent. D'autre part, une partie de la littérature théorique sur la corruption, initiée notamment par Groseclose and Snyder (1996) cherche à expliquer l'émergence de "super-majorités", dont l'existence est documentée par Mattila and Lane (2001)

et Fehrler and Schneider (2017). Ces articles constatent que les agents souhaitant influencer un comité se contentent rarement d'acheter le nombre minimum de votes requis pour remporter l'élection et préfèrent généralement s'assurer du soutien d'un grand nombre de membres du comité. Notre article propose un éclairage nouveau permettant d'expliquer ce phénomène, le coût d'une victoire écrasante peut s'avérer moins élevé que celui d'une majorité étriquée car les pots-de-vin proposés dans le premier cas sont moins onéreux. Enfin, la stratégie des partis au pouvoir dans certains pays semble également suivre cette logique. Comme le constatent Angeletos et al. (2007) et Edmond (2013), les résultats obtenus sont parfois bien supérieurs au minimum requis pour remporter l'élection. D'après notre modèle, ces taux de soutien s'auto-entretiennent : les opposants modérés n'ont pas intérêt à voter contre le régime s'ils anticipent que leur vote n'affectera pas le résultat de l'élection.

En formalisant le jeu décrit ci-dessus, nous caractérisons dans un premier temps la stratégie la plus efficace pour l'agent extérieur : nous déterminons le nombre optimal de membres qu'il faut corrompre ainsi que le montant du pot-de-vin qu'il faut leur proposer. Nous calculons également le montant total que l'agent doit dépenser pour faire basculer en sa faveur le vote du comité. Nous étudions ensuite comment ces résultats varient avec la structure du comité. En particulier, nous nous intéressons à l'impact de la taille du comité, à la règle de vote mise en place – c'est-à-dire à la majorité requise et au déroulement du vote – ainsi qu'au recrutement des membres. Enfin, en partant du principe que les pots-de-vin ne peuvent dépendre que des actions observées par l'agent extérieur, nous nous interrogeons sur la pertinence de la transparence du processus de vote.

Nous avons établi un certain nombre de prédictions. Tout d'abord, nous trouvons qu'augmenter la taille du comité peut avoir un effet ambigu sur la somme totale que l'agent doit déboursier. En effet, si le comité comporte un grand nombre de membres (on peut par exemple penser à un parlement), un vote a peu de chances de faire basculer l'élection. Les membres du comité sont alors plus enclins à vendre leur vote. Nous montrons qu'il existe des cas où augmenter le nombre de membres réduit strictement la somme que l'agent extérieur doit dépenser. À l'inverse, une règle de vote plus exigeante (c'est-à-dire requérir davantage de votes pour que l'alternative soutenue par l'agent extérieur soit acceptée) rend la corruption plus coûteuse. Le mécanisme n'est pas trivial, il se peut qu'augmenter le nombre de votes requis n'affecte pas le nombre de pots-de-vin distribués. L'augmentation du coût résulte alors d'un corollaire du mécanisme décrit ci-dessus : sachant que le comité est corrompu, renforcer la majorité requise augmente la probabilité qu'un vote fasse basculer le résultat de l'élection. L'agent extérieur doit donc revoir à la hausse la somme qu'il propose à

chaque membre du comité.

Concernant le déroulement du vote, nous considérons deux procédures différentes. Dans le modèle principal, les membres du comité votent de façon simultanée. Nous analysons également une variante du modèle dans laquelle les membres votent à tour de rôle. Cette procédure de vote est étudiée par exemple dans Spenkuch et al. (2015) et est notamment en vigueur au Sénat américain. Si les intuitions sont légèrement différentes, nous montrons que les résultats décrits plus haut sont inchangés.

À propos de la composition du comité, nous postulons que le recrutement affecte l'incertitude des préférences de ses membres. L'opinion sur l'alternative soutenue par l'agent extérieur peut en effet varier d'un membre à l'autre et il est plus difficile de prédire cette opinion lorsque les membres du comité proviennent d'horizons divers. Nous montrons qu'un recrutement diversifié augmente le nombre de pots-de-vin que l'agent extérieur doit promettre. En effet, une réaction plus aléatoire des autres membres du comité accentue la volatilité des votes. L'agent extérieur a alors intérêt à exploiter davantage cette incertitude en offrant un plus grand nombre de pots-de-vins. En revanche, les conséquences pour le coût sont en général ambiguës.

Enfin, nous montrons que la transparence du processus de vote augmente, peut-être paradoxalement, la capacité de corruption de l'agent extérieur. En effet, le mécanisme décrit ci-dessus suppose que le pot-de-vin peut être payé directement en échange d'un vote. Cependant, si les votes sont secrets, il n'est pas possible de vérifier l'alternative pour laquelle chaque membre a voté. Dans ce cas, on ne peut empêcher les membres du comité de voter comme bon leur semble tout en prétendant à l'agent extérieur qu'ils ont honoré leur parole. Il est alors impossible de corrompre le comité. Nous explorons également d'autres formes de contrat. Par exemple, si le nombre de votes en faveur de chaque proposition est rendu public, l'agent extérieur peut envisager de payer les pots-de-vin si son alternative a recueilli un certain nombre de votes. Nous montrons que cette stratégie permet théoriquement de s'assurer du soutien du comité.

## Chapitre 2

Le deuxième chapitre explore les interactions entre vote et normes sociales. Il s'agit d'une contribution essentiellement théorique co-écrite avec Emeric Henry. Nous étudions un environnement où les individus se préoccupent de leur image. Ils cherchent à manifester leur altruisme tout en étant contraints par leur environnement. Nous modélisons les interactions entre le vote et les normes sociales par un jeu en deux périodes. Dans un premier temps, un groupe d'agents vote sur une règle qui s'appliquera à la communauté. La seconde période est un jeu de bien public classique en tous points

similaire au modèle analysé dans Bénabou and Tirole (2011). Les agents choisissent de contribuer ou non à un bien public qui profite équitablement à tous. Contribuer est coûteux, mais certains individus retirent de leur contribution un bénéfice personnel que l'on peut interpréter comme de l'altruisme. L'utilité des agents dépend donc de considérations matérielles, quantité de bien public disponible et contribution personnelle, mais aussi de leur réputation. Cette réputation correspond à ce que les actions visibles de l'individu révèlent sur son paramètre d'altruisme. Par exemple, supposons que seule la phase de bien public est visible. La réputation est purement déterminée par la contribution de l'individu. Si seuls les plus altruistes contribuent, ces agents seront bien vus alors que les autres souffriront d'une mauvaise réputation. Pour compléter la description du modèle, la règle choisie en première période est une sanction financière punissant les passagers clandestins, c'est-à-dire les individus qui ne contribueront pas au bien public en deuxième période. Le montant de cette sanction est donné et les membres du groupe votent simultanément pour ou contre son adoption. La sanction est mise en place si un nombre suffisant d'individus ont voté en faveur.

Ce modèle permet d'étudier comment le comportement des individus dépend de la visibilité de leurs actions. Les agents n'ont que deux choix à effectuer, voter pour ou contre la sanction et contribuer ou non au bien public. Chacune de ces actions peut être effectuée secrètement ou à l'inverse être observée par tous. Nous avons donc quatre environnements possibles, les deux actions peuvent être secrètes, seule la contribution peut être observée, seul le vote peut être public et enfin les deux actions peuvent être publiques. Le cas adapté dépend de l'application. Par exemple, un référendum à bulletin secret portant sur la régulation d'un comportement éthique correspond à l'environnement vote secret, contribution publique. À l'inverse, si les députés se prononcent sur un comportement relevant de la sphère privée, le cadre vote public, contribution secrète sera approprié.

Pour donner un aperçu des prédictions obtenues, concentrons nous d'abord sur l'environnement où seule la contribution est visible. Afin de déterminer l'équilibre de ce type de modèle, il convient d'appliquer un raisonnement à rebours, on s'intéresse donc d'abord à la dernière période. La contribution au bien public est régie par deux types de considérations. D'une part, les individus prennent en compte les enjeux matériels, c'est-à-dire le coût de la contribution et le bénéfice qu'ils en retirent, modélisé par le paramètre d'altruisme. À l'équilibre, les agents contribuent si et seulement si leur altruisme est supérieur à un certain seuil. Ce seuil dépend du résultat du vote en première période : si la régulation est mise en place, contribuer permet également de ne pas payer la sanction. Les agents sont alors davantage incités

à contribuer, ce qui implique que le seuil est plus bas que dans un univers non régulé.

Nous pouvons désormais nous intéresser à la phase de vote. Les individus prennent en compte les conséquences sur le déroulement matériel du jeu. Mettre en place la sanction incite les autres à contribuer et augmente donc la quantité de bien public disponible. En revanche, la sanction constitue un coût direct pour certains individus. Les moins altruistes savent par exemple qu'ils ne contribueront pas au bien public et qu'ils seront amenés à subir la sanction. La nouveauté du modèle réside dans le fait que les enjeux de réputation entrent en compte dans la décision de vote même lorsque le scrutin est secret. En effet, la règle qui régit le comportement du groupe détermine les messages véhiculés par la décision de contribuer ou non. Par exemple, on peut imaginer qu'en l'absence de sanction, seuls quelques rares individus particulièrement altruistes contribueraient, ce qui leur permettrait de jouir d'une excellente réputation. Une fois la sanction mise en place, il se peut que la contribution devienne un comportement banal. Les plus altruistes ne peuvent alors plus être différenciés de ceux qui contribuent pour éviter de payer la sanction. Si les agents attachent beaucoup d'importance à leur réputation, nous obtenons donc un résultat quelque peu inattendu : les individus les plus altruistes s'opposent à la régulation afin de ne pas brouiller le signal envoyé par leur contribution.

Considérons désormais un environnement où seul le vote est visible. La contribution au bien public est purement régie par des considérations matérielles : les agents contribuent si le coût est inférieur à l'utilité qu'ils dégagent de leur contribution. Intéressons nous à première phase. La choix de vote a maintenant un impact direct sur la réputation des agents. À l'équilibre, il s'avère que les agents altruistes sont plus susceptibles de voter pour la régulation. Ces agents sont naturellement enclins à contribuer et la sanction affecte peu l'utilité retirée de la contribution en elle-même. À l'inverse des agents non altruistes seraient amenés à contribuer contre leur gré ou à subir la sanction. Un vote en faveur de la régulation est donc un signal positif sur l'altruisme. Lorsque les agents accordent une grande importance à leur réputation, ils tendent à voter en faveur de la régulation pour sauver les apparences, quand bien même cela nuit à leur bien-être matériel. Si le groupe est nombreux, on retrouve un mécanisme similaire à celui du premier chapitre car la probabilité qu'un vote donné change le résultat devient négligeable. Les agents vont donc se concentrer sur leur réputation, qui représente un gain certain. Si le groupe est suffisamment grand, cette considération devient prépondérante et les agents votent à l'unanimité en faveur de la régulation.

D'autre part, l'agrégation d'informations occupe une place majeure dans l'article. Dans notre modèle, l'effet de la régulation sur la quantité de bien public disponible

dépend de l'identité des membres du groupe. Il se peut par exemple que le groupe soit constitué uniquement d'individus très altruistes qui contribuent même en l'absence de la régulation. Dans ce cas, mettre en place la sanction n'affecte pas la quantité de bien public disponible. À l'inverse, si les individus sont modérément altruistes, la sanction peut se révéler décisive et provoquer une augmentation massive du nombre de contributions. A priori, un individu ne sait pas dans quel cas il se trouve lorsqu'il vote. Il dispose de croyances générales sur la distribution du paramètre d'altruisme mais ne connaît pas l'identité exacte des membres de son groupe. Comme nous l'avons vu dans l'introduction, un agent sophistiqué ne doit pas uniquement prendre en compte cette distribution générale car la phase de vote lui donne implicitement un indice supplémentaire sur l'altruisme réel des membres de son groupe. Pour clarifier ce phénomène, supposons que la régulation doive être acceptée à l'unanimité ; il suffit donc d'un unique opposant pour que la sanction ne soit pas mise en place. Les agents doivent donc conditionner leur vote sur les circonstances ayant permis la réalisation d'un tel événement. Dans ce cas particulier, le vote n'est décisif que si tous les autres membres sont suffisamment altruistes pour voter en faveur de la régulation, ce qui donne un indice sur leur réaction ultérieure à la sanction. De ces anticipations émergent des interactions complexes entre les stratégies des membres du groupe. Nous montrons notamment qu'il peut en résulter une multiplicité d'équilibres lors de la phase de vote.

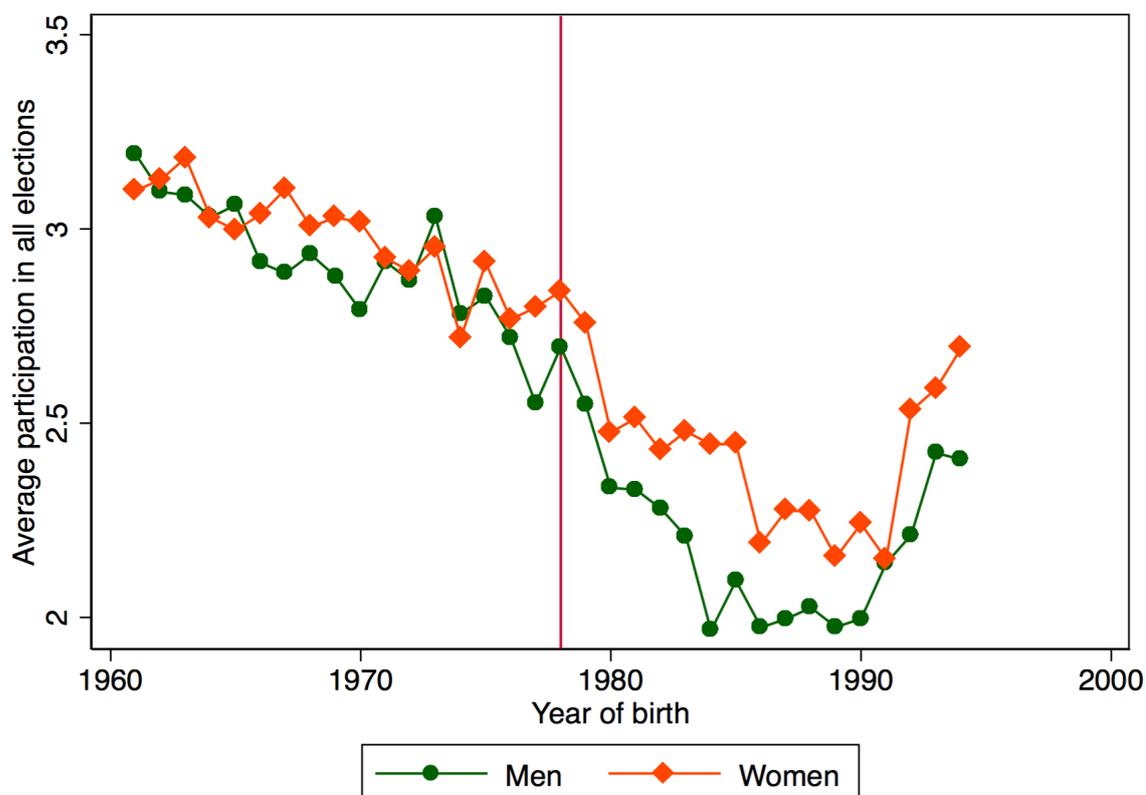
D'autres questions sont également abordées dans l'article. Nous analysons le cas où les deux décisions sont observées. Nous montrons que de nouvelles interactions stratégiques apparaissent alors entre les deux actions. Si l'analyse principale admet que le montant de la sanction est donné, il convient également de s'interroger sur la valeur optimale à soumettre au vote. Il faut d'abord prendre en compte la probabilité que la sanction soit acceptée, mais le modèle suggère une réponse plus complexe. En effet, un groupe accepte la régulation si et seulement si ses membres ont des attributs spécifiques, en général s'il y a assez d'individus suffisamment altruistes. La régulation n'aura donc d'effet que sur les groupes qui disposent de caractéristiques particulières. Une application possible concerne les accords d'entreprise. Au lieu d'imposer la même régulation à tous, l'État peut laisser à chaque entreprise le choix de réguler ou non différentes dimensions de la vie du groupe. En adaptant la législation proposée et le processus de décision au sein de chaque entreprise, le législateur peut faire en sorte que la régulation soit acceptée uniquement dans les cas où elle se révèle profitable. Il s'agit à notre connaissance d'un élément nouveau dans la littérature sur la régulation des biens publics.

## Chapitre 3

Le dernier volet de cette thèse porte sur les conséquences du service militaire sur les comportements politiques. L'article a été écrit avec Etienne Fize. À l'inverse des deux premiers chapitres, il s'agit d'un travail empirique. Nous nous concentrons sur le cas français et nous retenons de ce travail deux résultats majeurs. D'une part, le service militaire augmente la participation électorale de façon significative. Nous estimons que toutes choses égales par ailleurs, le taux de participation d'un individu ayant effectué son service est plus élevé de 4 à 5 points de pourcentage pour les élections présidentielles de 2012. L'effet est encore plus important pour les élections législatives, nous estimons que l'effet du service avoisine les 9 points de pourcentage pour le second tour. D'autre part, nous montrons que les individus ayant fait leur service sont plus conservateurs politiquement. En particulier, ils semblent plus enclins à soutenir le Front National.

Dans la première partie de l'article, nous identifions l'impact du service militaire obligatoire sur la participation électorale. Nous utilisons l'Enquête sur la Participation électorale (INSEE, 2012) qui collecte pour 40 000 individus la participation aux élections présidentielles et législatives de 2012. Ces données sont collectées directement dans les registres électoraux qui sont consultables dans les deux semaines suivant l'élection. L'échantillon étant tiré à partir des données du recensement, nous disposons d'un grand nombre de variables de contrôle. D'autre part, nous avons collecté auprès de la Direction du Service national des données relatives au service militaire. Nous avons ainsi calculé la probabilité que chaque individu ait effectué son service, cette information n'étant pas incluse dans le recensement. Nous utilisons cette probabilité pour estimer l'impact du service militaire sur la participation électorale. Nous admettons que la variation de cette probabilité est liée à des facteurs exogènes, principalement la décision prise par Jacques Chirac en 1996 de suspendre le service pour les hommes nés à partir de 1979.

La Figure 1 (discutée en détails dans l'article) illustre notre résultat. Cette figure représente le taux de participation à l'élection de 2012 par année de naissance pour les hommes et les femmes. On ne constate pas de différence de participation entre les sexes pour les cohortes nées avant la suspension du service militaire. En revanche, cette différence devient flagrante pour les cohortes nées après la suspension. Sachant que seuls les hommes étaient appelés sous les drapeaux, nous pensons que cette différence s'explique par la modification des obligations militaires. Nous testons cette intuition plus formellement dans l'article et nous trouvons que toutes choses égales par ailleurs, le service augmente la probabilité de voter de façon significative.



Note: L'année de naissance de la cohorte est indiquée en abscisse. L'ordonnée représente le nombre de suffrages exprimés en moyenne par les individus d'une cohorte, les individus pouvant théoriquement voter 4 fois (nous enlevons de l'échantillon les individus vivant dans une circonscription où un candidat a été élu au premier tour des élections législatives, nous montrons dans l'article que cette restriction n'altère pas les résultats).

Figure 1: Participation électorale par année de naissance

De plus, l'effet estimé se révèle plus important pour les élections législatives. Pour expliquer ce phénomène, nous montrons que le service tend davantage à intensifier la participation électorale des électeurs occasionnels qu'à créer de nouveaux électeurs. Ce résultat, combiné avec l'importance relative des élections présidentielles et législatives peut expliquer pourquoi l'effet du service est amplifié dans le second cas. En effet, le taux de participation avoisine les 80% pour les élections présidentielles et chute à moins de 60% pour les législatives. Les électeurs occasionnels se déplacent principalement pour les élections présidentielles mais peuvent s'abstenir lors des législatives. La baisse de participation entre les deux élections est cependant moins marquée chez les anciens conscrits, ces derniers étant des électeurs plus assidus.

Dans la deuxième partie de l'article, nous nous intéressons à l'effet du service sur les préférences politiques. Nous utilisons deux bases de données distinctes. D'une part, nous exploitons les Enquêtes interrégionales des phénomènes politiques réalisées entre

1988 et 1991 (OIP, 1988, 1989, 1990, 1991). D'autre part, nous analysons les données collectées en 2017 par Gougou and Sauger (2017). Ces deux sources contiennent des informations relatives au statut militaire des individus et nous disposons de nombreuses variables de contrôle. Si un quart de siècle s'est écoulé entre la collecte de ces données, les résultats obtenus à partir de ces deux sources sont cohérents et révèlent que les anciens conscrits sont davantage conservateurs. Les individus ayant fait leur service sont plus à droite sur l'échiquier politique, ce qui se traduit notamment par une préférence plus marquée pour le Front National en 2017.

## Introduction in English

Collective decision making, especially through voting, involves strategic interactions between agents. When a voter casts his vote, he will naturally consider his own preferences and information to take a decision. However, focusing only on those concerns would fail to account for the collective dimension of the process. Indeed, a rational voter must also take into account the expected behavior of other voters as well as their preferences or opinions. For instance, a voter should form expectations about how others vote in order to assess his probability to be pivotal in the election. This probability can affect the voter's decision for multiple reasons. If it is high, the voter has a strong incentive to support his favorite candidate. When it is low, the voter is less worried about the impact of his vote, which can induce him to abstain<sup>4</sup> or to vote insincerely if he can benefit from it, for example if another alternative is more ethical<sup>5</sup> or if he might sell his vote<sup>6</sup>.

In an environment where players receive private signals on the quality of the different alternatives submitted to the vote, the strategies of other voters must also be taken into account due to information aggregation<sup>7</sup>. A voter only observes his own signal, but since he can change the outcome of the vote solely if he is pivotal, he must only consider the distribution of others' signals that can make his vote decisive. Focusing on the cases where his vote is pivotal provides him with additional information about the quality of the different alternatives.

Pivotal considerations and information aggregation are just two examples that illustrate the rich interactions between voters' strategies. This thesis aims at studying the impact of outside elements on those interactions. More precisely, we investigate how additional stages, before or after the voting stage, may affect the strategic interactions that exist in the vote and in particular the calculus of pivotality.

Our papers provide multiple examples showing that the adjustments of strategic interactions have important consequences. In Chapter 1 we add a stage prior to the vote where a vote buyer proposes bribes to voters if they vote in a given way. We show that the vote buyer can choose the bribes in order to convince voters that they are not pivotal. Manipulating pivotal considerations allows the vote buyer to influence the outcome of the vote for a surprisingly small amount of money.

Furthermore, we add in Chapter 2 a stage that takes place after the vote. This second stage is a standard public good game. Players differ on their willingness to contribute to the public good. Each player knows his willingness to contribute but

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<sup>4</sup>Riker and Ordeshook (1968); Ferejohn and Fiorina (1974)

<sup>5</sup>Feddersen et al. (2009)

<sup>6</sup>Dal Bo (2007)

<sup>7</sup>Condorcet (1785); Feddersen and Pesendorfer (1996); Austen-Smith and Banks (1996)

does not observe the type of other agents. In the voting stage, agents decide whether or not to regulate the contribution to the public good. We show that the expected change in others' contribution induced by the regulation influences voting decisions through aggregation of information. More precisely, voters condition their vote on the event of being pivotal. Since voting decisions also depend in equilibrium on the willingness to contribute to the public good, being pivotal gives additional information on the distribution of others' type. This in turn provides information on how the regulation will impact others' contribution in the public good stage, which affects the incentives to support the regulation in the voting stage.

In the first chapter we show that a vote buyer can exploit pivotal considerations to bribe a committee for a surprisingly cheap cost. We analyze a setup where a committee votes on a proposal favorable to the vote buyer. Committee members care about the outcome of the vote and prefer the proposal to be rejected. However, they differ on how much they would be hurt if the proposal was implemented. The vote buyer approaches committee members and proposes to pay bribes depending on an outcome of the voting process. In most of the paper, we consider that payments depend on individual voting decisions, i.e. bribes are paid if committee members vote for the proposal supported by the vote buyer. This type of contract induces a tradeoff between a certain outcome (the bribe) and an uncertain impact on the result of the vote. Indeed, a committee member is pivotal if other votes are distributed in a specific way. Therefore, the relative importance of those two concerns depends on others' strategies and on the bribes offered.

We find that the vote buyer should bribe a supermajority in order to convince members that they are not pivotal. This turns out to be profitable because committee members are willing to accept smaller bribes when their colleagues are also corrupted. When a large number of members receive a bribe, the proposal supported by the vote buyer is likely to receive a majority of votes and members do not expect to be pivotal. As a result, they are willing to accept small bribes in exchange for they vote, even if they dislike the proposal. This is a typical example of an outsider intentionally manipulating the interactions between voters to affect the outcome of the vote.

We believe that this mechanism has many real world applications. For instance, it could be an explanation for the Tullock paradox<sup>8</sup>: the gains for the industries represented by lobbies generally outweigh the money spent on lobbying. This observation is consistent with our theory: collective decision making turns out to be surprisingly easy to manipulate when we account for pivotal considerations. Our setup also applies to a large number of institutions taking decisions through voting:

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<sup>8</sup>Buchanan et al. (1980)

juries, legislative committees, FIFA or International Olympic committee and even general elections. In order to embody the largest number of applications, we explore various formulations of the model including sequential voting, which is for instance the voting rule of the US Senate. We also vary the visibility of the voting process and analyze the consequences for the vote buyer.

Our paper has implications for the design of committees and we provide several policy recommendations. We study how the total amount that the vote buyer needs to spend in order to manipulate the vote depends on the structure of the committee. More precisely, we are interested in the number of members, in the voting process and in the recruitment of members. First, we show that increasing the size of the committee is generally not an efficient way to deter corruption, which might seem surprising at first glance. This result relies on pivotal considerations: committee members are less likely to be pivotal in a large committee and therefore accept smaller bribes in exchange for their vote. We even show that increasing the number of members without changing the majority requirement – i.e. the required number of votes in favor of the proposal to make it pass – can strictly decrease the cost for the vote buyer! With respect to the voting process, we show that more demanding majority requirements make the committee more expensive to buy. We derive those results for a committee voting simultaneously but we show that those predictions are qualitatively unaffected when the committee votes sequentially. However, in order to exploit the pivotal channel, the vote buyer needs to be able to condition the payment of bribes on individual voting decision. Arguably, this might only be feasible when the voting process is transparent. We consider alternative visibility setups and we find that disclosing less information can make the committee more robust to corruption. Finally, we claim that hiring committee members from different backgrounds combined with a demanding majority requirement increases the cost that the vote buyer needs to spend.

Our second chapter explores the interactions between voting and social norms. We analyze a setup where a group of agents vote on the rules that regulate their own behavior. This includes for instance workers voting on the rules of procedure of their firm, legislators voting on a law regulating their behavior (such as attendance in the Parliament) or citizens voting on a law submitted to a referendum. We model those applications by a two stages game. The second stage is a standard public good game where players care about their reputation in the spirit of Bénabou and Tirole (2011). Contribution to the public good is a binary decision and is equally costly for all agents. Utility is increasing in the number of contributions. Moreover, players derive a positive payoff that could be interpreted as altruism when they contribute.

This payoff – that we refer to as the type of a player – differs across agents and is privately drawn from a common knowledge distribution at the beginning of the game. Finally, players value their reputation, that we model as the expectation of a player’s type based on the actions that he takes and that are observed by all. Prior to the public good game, players vote on a regulation of contributions. This regulation takes the form of a sanction that committee members need to pay if they free ride in the second stage. Players vote simultaneously and the sanction is implemented if there is a sufficient number of votes in favor of the regulation.

This setup captures the interdependence between contributions and voting decisions. We show that the contribution stage affects the strategic interactions in the voting stage through several channels. We also investigate the impact of the visibility of the process. We explore several visibility setups: secret voting / public contribution, public voting / secret contribution, both decisions secret and both decisions public. Reputation is determined by the expectation of a player’s type conditional on the actions that are publicly observed. We show that players’ considerations are extremely different across the different visibility configurations. Therefore, the impact of the public good game on the voting stage depends on the environment we consider.

To get a preview of the results, let’s first consider the secret voting / public contribution setup. It is interesting to notice that even if the vote is not observed, image concerns need to be taken into account when we consider the voting stage. To see that, consider for instance a very altruistic individual who cares a lot about his reputation. Moreover, imagine that the public good induces a very high contribution cost, say for instance organ donation. In the unregulated environment, contributing sends a very strong signal about altruism and those who donate are perceived as extremely altruistic individuals. However, when the regulation is implemented, the signal is blurred because contributors cannot signal whether they contribute because they want to or because they have to. As a result, it turns out that even the most altruistic individual might oppose to the regulation in order to maintain his reputation!

We also investigate other forms of strategic interactions. For instance, aggregation of information plays a role through the expected increase in participation to the public good due to the regulation. In equilibrium, some types called swing participants contribute if and only if the sanction is implemented. The efficiency of the regulation therefore depends on the number of swing participants in the group. Given that a vote only matters if a player is pivotal, he must compute the expected number of swing participants conditional on the event of being pivotal. In this model, the aggregation of information is therefore shaped by the strategies in the public good game. The equilibrium of the voting stage is actually very sensitive to player’s beliefs

about the outcome of the public good game, which can even result in a multiplicity of equilibria.

Pivotal considerations also matter, especially in the setup public voting / secret contribution. In equilibrium, it turns out that altruistic individuals are more likely to vote for the regulation. A vote in favor therefore enhances reputation. Selfish agents can still oppose to the regulation not to be forced to contribute, but they only want do so if they are sufficiently likely to be decisive. Otherwise, they prefer to vote for the regulation to keep up appearances. This reasoning implies that when the group is large enough, players will support the regulation regardless of their type because the probability of being pivotal is small.

With respect to institutional arrangement, we study the problem of a planner choosing the level of sanction submitted to the vote. Our setup reveals a novelty in the literature on public good regulation. In the voting stage, only the groups that exhibit a specific distribution of types accept the sanction. When the planner is aware of the general distribution of types but does not know the actual draw, this selection effect could be used to let the group reject the sanction if it is detrimental and accept the regulation if it is beneficial. We believe that this argument provides a rationale for flexible forms of regulation, such as the "Accords d'entreprise" in France where the legislator decided to let each firm choose its own rules.

Finally, the last contribution investigates the impact of the French military service on political behaviors. This paper contributes to the literature showing that common experiences can have sizable and long term effects on the shaping of political behaviors. Especially, we show that former conscripts are significantly more likely to turnout. Moreover, we find that they exhibit more conservative political preferences, which translates into a higher support for the Front National (which is the main extreme-right party in France) in 2017.

This last paper is empirical and is less focused on the micro-foundations of voting decisions. Nevertheless, we exploit our dataset on elections, which includes individual data on turnout for the two rounds of presidential and legislative elections in France in 2012, to decompose the effect that we find on turnout. Especially, we want to disentangle the effect on the extensive margin, which would imply more people voting, from the effect on the intensive margin, which results in occasional voters turning out on a more regular basis. We use the sequence of votes and the relative importance of those elections to show that the impact of the military service on turnout is mostly driven by the intensive margin. In other words, doing the military service does not induce more citizens to vote but it makes those who vote more likely to do so on a regular basis.

Using survey data, we find that the military service induces a shift to the right of political preferences. We use this shift to test the expressive voting hypothesis<sup>9</sup>. If voters are more likely to vote when they can support a candidate close to their ideology, we expect the impact of military service on turnout to be larger when the right-wing political offer is large. We exploit the variation in the political offer across districts in the first round of the legislative election and we show that the effect of the military service is indeed larger when there are more candidates affiliated to the extreme-right.

We thus believe that this thesis sheds new light on the influence of external elements on voting. To our knowledge, only a handful of papers investigate the impact of outside considerations on the strategic interactions inherent to voting. Henry (2008) and Felgenhauer and Grüner (2008) show that a vote buyer can manipulate the aggregation of information in order to bribe a committee for a limited cost. Dal Bo (2007) also analyzes a mechanism that allows a vote buyer to break down the coordination between committee members through pivotal considerations. With respect to social norms, Tyran and Feld (2006) design a two stages experiment similar to the model we explore in the second chapter. We reinterpret this setup under the scope of the literature on social norms in the spirit of the contributions of Roland Bénabou and Jean Tirole<sup>10</sup>. Also related is Bénabou and Tirole (2006a) who study the mutual shaping of voting and attitudes towards fairness. We also need to mention the literature on constitutions where the decision making process involves multiple stages. For instance, Godefroy and Perez-Richet (2013) add a selection stage prior to the vote where agents decide whether the vote should take place. Finally, the last chapter of this thesis is related to the literature on the impact of national experiences on political behavior. We can mention for instance Madestam and Yanagizawa-Drott (2012) who study the impact of the fourth of July celebrations in the US on turnout and political ideology.

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<sup>9</sup>Brennan and Hamlin (1998)

<sup>10</sup>Bénabou and Tirole (2003, 2006b, 2011)

# Chapter 1

## Optimal vote buying

This chapter is co-authored with Leon Musolff (Princeton).

### **Abstract**

*We study the problem of a single vote buyer who wants to influence the vote of a committee. Prior to the vote, the vote buyer publicly announces a bribing scheme. When voting, committee members take into account the bribe as well as their impact on the outcome of the vote. We characterize the optimal bribing scheme of the vote buyer under different voting setups. We find that the vote buyer will generically seek the support of a supermajority; such a strategy allows the vote buyer to capture the committee at a smaller cost because committee members expect to be pivotal with a lower probability and accept smaller bribes.*

## 1.1 Introduction

When Robert Kennedy was appointed Attorney General in 1961, he waded into a campaign against organized crime. One of the main targets of this campaign was Jimmy Hoffa, a famous trade union leader involved in several illegal activities. Kennedy got personally involved in Hoffa's case and even gathered a "Get Hoffa" squad of prosecutors and investigators. In spite of those efforts, Hoffa managed to avoid conviction for several years. Before the 1962 trial, Kennedy was entirely sure that Hoffa would be convicted. When a reporter asked what he would do if Hoffa was acquitted, he answered "I'll jump off the Capitol". However, Hoffa managed to prove him wrong one more time and left the tribunal a free man. During the press conference after the trial, Hoffa's lawyer boldly declared "I'm going to send Bobby Kennedy a parachute" (Schlesinger 1978). Between 1957 and 1964, Hoffa successfully defended himself in a handful of trials in spite of overwhelming evidence against him. What was Hoffa's secret to avoid conviction? Ironically, he eventually went to jail for the very conduct that facilitated his prior acquittals: jury tampering. During this trial, Ed Partin – a former associate of Hoffa who testified against him – revealed how Hoffa corrupted a jury in a previous case. Partin's testimony reveals several striking patterns of Hoffa's strategy<sup>1</sup>. Firstly, Hoffa was trying to get to as many jurors as possible. Partin was just one of the middlemen used by Hoffa and he was asked to get in touch with several jurors. Secondly, the bribes proposed are not as high as one would expect. The amount at stake during the trial was at least several millions, but one juror considered the promise that Hoffa would support his promotion as sufficient payment for his vote. Finally, and perhaps most surprisingly, Hoffa did not seem to care much about the secrecy of his offers. He even kept making offers after one of the jurors reported that he had attempted to bribe him! If those elements are somewhat surprising, the following example unveils a mechanism that explains why Hoffa's strategy turned out to be so successful.

### A simple example

Suppose that a committee of three members votes on a proposal. The proposal is accepted if at least two members vote for it. Committee members dislike the proposal and get a payoff  $-v_i \sim U[0, 1]$  if the proposal is accepted. Payoffs are drawn independently and privately. Votes are observable and that a vote buyer (feminine pronoun) can commit to pay a bribe  $b_i$  to each member  $i$  if he votes for the proposal.

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<sup>1</sup>The case was brought to the Supreme Court and a summary can be found online on <https://supreme.justia.com/cases/federal/us/385/293/case.html>

For simplicity, the vote buyer proposes the same amount  $b_i = b$  to all bribed members. Moreover, suppose that the valuation of the proposal for the vote buyer is sufficiently high that she wants to ensure certain passage (though subject to certain passage she will of course try to minimize cost).

We compare two possible strategies for the vote buyer. First, suppose that she tries to bribe the minimal winning coalition. In such a case, she would offer  $b$  to two members of the committee. As long as  $b < 1$ , it is easy to see that there exists an equilibrium where players vote against the proposal if  $v_i$  is large enough; this is because players internalize the fact that their vote will influence the outcome. Indeed, the cheapest way to guarantee the support of a minimal winning coalition is to fully compensate the members who receive a bribe:  $b = 1$ . As a result, the cost for the vote buyer is 2.

Now, suppose that the vote buyer proposes a bribe to all three members. If  $b$  is small, members can coordinate on an equilibrium where they reject the proposal when their type is higher than a cutoff. However, when  $b$  is large enough, such an equilibrium cannot exist; in particular we show below that this is the case when  $b > \frac{8}{27}$ . When a voter casts his vote, he trades off a (certain) bribe against a potential impact on the outcome of the vote. The second concern will matter less if players anticipate that their vote is unlikely to determine the outcome of the vote, and it turns out that the vote buyer can lower players' assessment of their pivotal probability by offering bribes to more players. Thus, the vote buyer can guarantee that the 3 players will support the proposal for a total cost of  $\frac{8}{9}$ . In this example, buying an additional player turns out to be much cheaper for the vote buyer!

Our example uncovers the main mechanism of the paper: the vote buyer bribes supermajorities in order to prevent committee members from thinking that their vote could decide the outcome of the election. As a result, any bribed member will accept the bribe, even if he strongly dislikes the proposal, because he knows that his vote is unlikely to change the outcome of the vote. Going back to Hoffa's bribing strategy, our simple example helps us to understand why it was so successful. From Partin's testimony, it appears that Hoffa was actually trying to convince jurors that he had already bought the committee. This strategy requires the vote buyer to approach publicly as many jurors as possible to convey this message, which Hoffa did. Any juror was thus expecting his vote to be irrelevant for the final decision and preferred to accept Hoffa's offer.

Our setup primarily applies to any voting body that could be influenced by a vote buyer. It includes juries as in the above example or committees of experts (like FDA committees). Another example is that of party discipline: our mechanism suggests

that whips can impose party cohesion at a low cost when legislators do not expect to be decisive for the vote. Staying within the legislative realm, our results also provide an explanation for the Tullock paradox, first introduced in Buchanan et al. (1980). A vast body of evidence suggests that lobbying expenses are very small compared to the benefits associated with lobbying activities. Pivotal considerations in collective decision making can explain this paradox.

However, we believe that the mechanism we highlight is much more general. To begin with, it can explain why ruling parties are reelected with large majorities in non-democratic countries. Relying on a short majority would be expensive because each individual (or faction) can be decisive and thus the price of each vote would be large. Conversely, if people believe that the ruling party will be reelected with a large majority, they perceive themselves as having no chance of changing the outcome of the election and hence are willing to accept even small benefits in exchange for their votes. A related argument can be found in Angeletos et al. (2007) or in Edmond (2013), which have citizens playing a coordination game to overthrow a regime. Individual actions are strategic complements, which implies that the decision to overthrow the regime depends on players' beliefs about others' strategies. In those papers, the regime engages in propaganda to convey the message that it cannot be overthrown in order to prevent a potential coordination.

Moreover, our mechanism can be extended to various cooperation problems with two conflicting parties. Recasting votes as effort decisions by workers, our paper solves the optimal remuneration problem of a principal that can condition remuneration on effort but faces the problem of inducing agents with heterogeneous private costs of effort to cooperate. From an applied perspective, the optimal strategy amounts to a CEO trying to prevent a strike by conveying the message that the number of potential strikers is below the critical threshold to make it successful. In this context, our model provides a rationale for firms to purchase excess labour capacity as a tool to deter strikes.

We consider a setup where a committee votes on a proposal introduced by a vote buyer (feminine pronoun). The proposal favors the interests of the vote buyer and all committee members would prefer to reject it. Each member's distaste for the proposal is private information: members' valuations are secretly drawn at the beginning of the game from a common knowledge distribution. In order to manipulate the outcome, the vote buyer announces (and commits to) a bribing scheme before the vote takes place. The vote buyer wants to maximize the probability that the proposal is accepted and minimize the amount spent on bribes. The aim of this paper is to determine how the optimal strategy and the resulting cost for the vote buyer depend on the

parameters of the voting game. More specifically, we study the impact of the size of the committee, of the majority rule and of the dispersion of members' valuation. In most of the analysis, we assume that the vote buyer can condition the payment of bribes on individual votes. We discuss alternative setups where bribes are conditioned on the decision of the committee and on the number of votes in favor. Moreover, we investigate an extension of our model where voting is sequential.

First of all, we show that in most voting environments, the optimal strategy for the vote buyer consists in bribing a substantial supermajority. This reduces the amount spent on bribes insofar as committee members do not expect to be pivotal and accept smaller offers in exchange for their vote. We investigate how the design of the committee impacts the optimal strategy and the resulting cost for the vote buyer. When the payment of bribes depend on individual voting decisions, we find that increasing the number of members in the committee (weakly) decreases the cost. Intuitively, it is easier to manipulate pivotal considerations in a large committee. Conversely, increasing the majority requirement while keeping constant the number of voters unambiguously increases the cost for the vote buyer. Moreover, increasing simultaneously the size of the committee and the majority requirement raises the cost, but pivotal considerations mitigate this increase.

With respect to the voting process, we find that sequential voting rules lead to the same predictions: the vote buyer still bribes a large supermajority and the comparative statics with respect to the cost are qualitatively similar. However, other forms of contracts could lead to different predictions. For instance, if the vote buyer can only condition the payment of the bribes on the outcome of the vote, the pivotal channel is severed and her ability to manipulate the election is inhibited. Nevertheless, when bribes depend on the vote shares, we highlight a novel mechanism that allows the vote buyer to exploit pivotal considerations. Those alternative agreements can be justified by the visibility of the voting process: it could be hard for the vote buyer to contract on an outcome that is not publicly disclosed. This analysis suggests that a committee designer might want to keep the details of the vote secret in order to make the committee more robust to corruption.

Finally, we study the impact of the distribution of committee members' preferences. The vote buyer prefers to bribe larger supermajorities when voter's preferences are dispersed: this dispersion fosters the pivotal mechanism and encourages the vote buyer to bribe more members in order to fully exploit it. However, we find that the effect of dispersion on cost is ambiguous. On the one hand dispersion decreases pivotal probabilities, which has a negative impact on cost. On the other hand, members strongly opposed to the proposal are more likely to emerge when types are dispersed

(even if we consider mean preserving spreads) and this possibility leads the vote buyer to pay more. We show that for demanding majority requirements, the second effect dominates and the cost is increasing in dispersion. This last result is also of interest for a potential committee designer: large majority requirements – that typically yield higher bribing costs – combined with dispersion about committee members’ preferences make corruption more expensive. For instance, it could prove useful to renew committee members on a regular basis or to hire them from different backgrounds in order to increase the dispersion of their (dis)taste for the proposal supported by the vote buyer.

Our contribution relates first and foremost to the literature on vote buying in committees. Following Groseclose and Snyder (1996), a strand of the literature on vote buying has focused on two vote buyers moving sequentially. These papers include Banks (2000), Dekel et al. (2008), Morgan and Várdy (2011) and Iaryczower and Oliveros (2015). A key motivation of this literature is to explain why we observe supermajorities, as documented empirically in Mattila and Lane (2001) or experimentally in Fehrler and Schneider (2017). This literature shows that the first mover should bribe a large coalition in order to increase the cost for the follower to overbid her. In our model, we propose an alternative explanation for the existence of supermajorities: we show that a single vote buyer should also bribe a supermajority in order to exploit the pivotal channel to decrease her spending on bribes. Regarding the literature with a single vote buyer, Zápal (2017) analyzes a setup with dispersion in voters’ responses to the bribe. In his paper, the probability that a legislator votes in favor of the proposal is proportional to the bribe he receives.

However, all of these papers disregard the potential for strategic interactions between voters. For instance, a strand of the literature following the initial contributions of Feddersen and Pesendorfer (1996, 1997, 1998) and Austen-Smith and Banks (1996) shows how voters’ strategies interact through information aggregation. Other papers such as Ottaviani and Sørensen (2001), Levy (2007) and Midjord et al. (2017) consider careerist committee members and analyze the interactions between signaling strategies. In this paper we explore the tradeoff between a certain payoff (the bribe offered) and the uncertain impact of individual votes on the outcome of the vote. The relative saliency of the two elements depends on the pivotal probability, which is determined in equilibrium by the voting strategies of all players. A similar tradeoff has been documented in Feddersen et al. (2009): voters are more likely to support a (payoff decreasing) ethical outcome when they are unlikely to be pivotal.

A notable exception to this separation of strategic interactions and vote buying are Henry (2008) and Felgenhauer and Grüner (2008) who analyze how a vote

buyer can manipulate the process of information aggregation. In those papers, each member of the committee receives a signal about the quality of a common value proposal. In equilibrium, the vector of bribes determines the number of voters who vote informatively and shapes the inference drawn on others' signals when voters condition on being pivotal. In turn, those inferences affect the amount that voters are willing to accept in exchange for their vote.

Also close to our topic, Dal Bo (2007) proposes a model where a single vote buyer exploits pivotal considerations to reduce the amount spent on bribes. The main result of his paper is that costless capture will occur if the vote buyer can condition the bribe on the pivotal event: she will propose to pay an infinitesimal amount if voters are not pivotal and a large enough bribe if members turn out to be decisive. The vote buyer ends up paying almost nothing if she proposes this payment scheme to a supermajority. However, Dal Bo (2007) assumes that committee members' valuations for the proposal are common knowledge and his solution concept requires voting for the proposal to be a dominant strategy for a majority of players. As a result, when the vote buyer cannot condition the bribes on the pivotal event, he concludes that the vote buyer cannot do better than bribing the minimal winning coalition and offering a bribe equal to the disutility incurred by each member. We show that pivotal considerations can actually be exploited much more generally by a vote buyer. In particular, our main model is closest to the discussion of "Coarse Offers" in Dal Bo (2007) but our results crucially differ from the discussion there because we introduce uncertainty about players' valuations and show that the pivotal channel can still be used by the vote buyer when bribes are contingent on individual votes. This changes the optimal strategy and drastically reduces the cost spent on bribes. Moreover, we also provide a counterexample showing that pivotal considerations still matter when bribes are conditioned on the vote share; this result again differs from Dal Bo's conclusion. Our paper therefore enlarges the scope of Dal Bo (2007) as we show that pivotal considerations can be used by the vote buyer for a wide class of bribing schemes.

In the next section, we present the main model and we characterize the optimal bribing scheme as well as the resulting cost for the vote buyer. In Section 1.3, we consider several alternative specifications of the game. First, we analyze the problem of the vote buyer when voting is sequential. Then we discuss what the vote buyer should do when she can only contract on the outcome of the vote or on the vote share. For tractability, the model of the main text makes simplifying assumptions; in Section 1.4 we discuss the sensitivity of our results to these assumptions. In particular, we first extend our results to general uncertainty about members' disutility from the proposal.

We then discuss what happens if we allow the vote buyer to employ non-symmetric bribing schemes. Finally, we examine under which circumstances the vote buyer would want to induce certain passage of the proposal. Section 1.5 concludes.

## 1.2 General setup

We consider a committee of  $n$  members voting on a proposal favorable to the vote buyer. The proposal is accepted if at least  $m$  members vote for it. Committee member  $i$  privately draws the disutility  $v_i \stackrel{iid}{\sim} U[0, 1]$  he obtains if the proposal is accepted. This assumption is for ease of exposition. All of our proofs in the appendix are derived using a general class of distributions. We discuss the impact of the distribution and characterize the class of distributions for which our results hold in Section 1.4.1.

Prior to the voting stage, a vote buyer in favor of the proposal chooses a vector of bribes  $b = (b_1, \dots, b_n)$ . Bribes can be publicly announced or privately disclosed to each committee member. In the second case, each member knows his bribe but cannot observe the offers made to other members. We assume that individual voting decisions are public and that the vote buyer is able to commit<sup>2</sup> to pay the bribe  $b_i$  if and only if<sup>3</sup> member  $i$  votes for the proposal. We denote by  $k$  the number of members who receive a positive bribe. To keep the analysis tractable, we assume that the vote buyer proposes the same amount to all bribed members and we denote the common value of these bribes by  $b$ . We discuss the problem when we allow the vote buyer to offer different bribes in Section 1.4.2. Given our assumptions, a bribing scheme is a pair  $(k, b)$ : the vote buyer chooses how many members to bribe and how much they should each receive if they vote in favor of the proposal. If we denote by  $W$  the vote buyer's valuation of the proposal, she chooses  $(k, b)$  to maximize

$$U_{\text{VB}} = W \times \mathbb{P}(\text{proposal passed} \mid b \text{ offered to } k \text{ members}) - b \times (\# \text{votes for}).$$

Naturally, the voting game has multiple equilibria and the probability of passage depends on the equilibrium we consider. We make an *adversarial equilibrium selection* assumption, i.e. we focus on the equilibrium where the proposal is accepted with the smallest probability. This equilibrium maximizes the utility of committee members while minimizing the utility of the vote buyer; hence we are effectively assuming that the committee members choose to coordinate on their preferred equilibrium.

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<sup>2</sup>Modeling the commitment mechanism is beyond the scope of our paper. As in Rueda (2015), we could imagine that the committee and the vote buyer repeatedly interact.

<sup>3</sup>Note that assuming the vote buyer can condition his bribe on arbitrary events allows her to buy the committee at essentially zero cost (see Dal Bo 2007). We focus on the case where the vote buyer can condition her bribe to member  $i$  on  $i$ 's vote only.

At first glance, the solution to the vote buyers' optimization problem seems to require knowledge of the probability of passage for any combination  $(k, b)$ . However, the vote buyer will choose to ensure certain passage if  $W > \bar{W}$  for some  $\bar{W}$ . For most of the analysis, we assume that this condition is satisfied so that the vote buyer seeks to guarantee the approval of the proposal for the smallest possible cost. We discuss this assumption in Section 1.4.3.

To recap the timing of the game, the vote buyer moves first and proposes a bribing scheme  $(k, b)$ . Offers can be public or privately disclosed to each member. In a second stage, committee members learn the bribing scheme, privately observe their type and simultaneously choose whether to vote in favor or against the proposal. Finally, the proposal is implemented if at least  $m$  members have voted for it and the vote buyer pays  $b$  to the bribed members who have supported the proposal.

We want to study how the optimal strategy of the vote buyer and the corresponding cost of bribes depend on the voting process (number of committee members and required majority). We derive additional results on the shape of the distribution in Section 1.4.1.

## Main results

We solve the game backward and first consider the voting stage. We focus on players to whom the vote buyer proposes a positive bribe; unbribed players vote against the proposal in any equilibrium where their vote could change the result. Given a bribing strategy  $(b, k)$ , if a player is not pivotal the payoff difference between voting in favor and voting against is simply the value of the bribe offered to him. If his vote is pivotal, however, he also has to account for the fact that a vote in favor is causing the proposal to pass, which yields him disutility  $v_i$  compared to the outcome if he voted against. Thus, denoting by  $\pi_i$  the pivotal probability of committee member  $i$ , he will accept the bribe and vote for the proposal if and only if:

$$b \geq \pi_i v_i.$$

Our first lemma describes the outcome of the game if the vote buyer bribes the minimal winning coalition or uses private offers. We consider it as a benchmark and show below that she can pay a much lower cost.

**Lemma 1.** *If a vote buyer wants to ensure the support of a minimal winning coalition ( $k = m$ ) or if she privately communicates the bribes, she must offer a bribe equal to 1 to all bribed members and spend a total cost of  $m$ .*

When a minimal winning coalition is targeted, the strategic links between committee members decisions are severed and the pivotal channel is blocked: each bribed member behaves as if he were a dictator. If we were to assume such ‘naive’ behavior independently of the size of the bribed coalition, it would clearly be optimal to purchase a minimal winning coalition. Furthermore, this is indeed the optimal strategy in Dal Bo (2007), where the focus on dominant strategies and the assumption that players’ valuations are known ensure the pivotal channel cannot be exploited without employing bribes that are explicitly conditioned on the pivotal event. Thus, it comes as no surprise that Dal Bo (2007) concludes that the cost given in Lemma 1 is indeed the minimal cost to the vote buyer of ensuring passage.

Moreover, if the vote buyer chooses to make private offers, she also needs to offer a bribe of 1 to guarantee the passage of the proposal. To see this, notice that the strategy of bribing more than  $m$  voters cannot be part of an equilibrium: because committee members cannot monitor the number of bribes offered, the vote buyer has an incentive to deviate and propose a bribe to only  $m$  players if she expects them to vote for the proposal. Committee members would therefore anticipate such a deviation and expect the vote buyer to offer a number of bribes equal to the number of votes required to pass the proposal. Indeed, if the vote buyer wants to guarantee the passage of the proposal with private offers, the best strategy is to bribe the minimal winning coalition and propose to each member a bribe equal to his maximal possible valuation. Therefore, private offers do not allow credible exploitation of the pivotal channel. Going back to Hoffa’s case discussed in the introduction, there was clearly a risk in making such visible offers, but it was a necessary condition to credibly convey the message that jurors would not be pivotal, and this is probably why Hoffa took the risk of being caught.

We now consider offers where the vote buyer bribes publicly a supermajority. We restrict our attention to type-symmetric equilibria: given a bribing scheme  $(k, b)$  proposed by the vote buyer, all members who receive the same bribe and have the same type must choose the same strategy. We make this assumption to clarify the analysis, but we show below that it can be relaxed without impacting our results: it turns out that a bribing scheme that guarantees non-existence of interior type-symmetric equilibria (and hence ensures passage) also prevents committee members from coordinating on asymmetric equilibria.

For any  $k > m$ , Lemma 2 states that there are two potential types of equilibria of the voting game.

**Lemma 2.** *If  $k > m$ , in any type-symmetric equilibrium either*

1. all bribed members vote in favor of the proposal, or
2. bribed members vote for the proposal if and only if their type is smaller than a cutoff  $v^*$  that satisfies:

$$\pi(v^*)v^* = b, \tag{1.1}$$

where:

$$\pi(v) = \binom{k-1}{m-1} v^{m-1} (1-v)^{k-m}. \tag{1.2}$$

When  $k > m$ , the first type of equilibrium always exists. All members know that they are not pivotal and thus accept the bribe. In such a case, the proposal is accepted for sure. In the second type of equilibrium described in Lemma 2, bribed members vote for the proposal if and only if  $v_i \leq v^*$ ; as we assumed above that  $v_i \sim U[0, 1]$ , this means they are perceived by others to vote for the proposal with probability  $v^*$ . As a result, each member expects to be pivotal with a positive probability. Voting for the proposal guarantees a (certain) positive payoff from the bribe but could induce the committee to pass the proposal. Unlike the equilibrium of the first type, such equilibria do not necessarily exist. In particular, when  $b$  is large enough, committee members will not be able to coordinate on such an equilibrium.

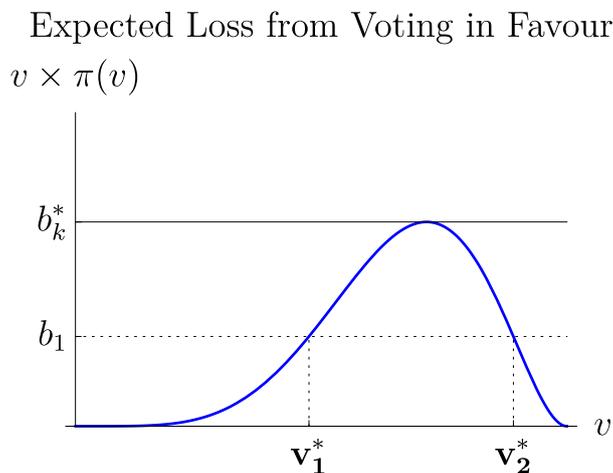
We now introduce a graphical interpretation of the problem. In Figure 1.1, we plot the function  $v \times \pi(v)$  for a given  $k$ . For small values of  $v$ ,  $\pi(v)$  is small: with all likelihood, only very few voters face distaste realizations  $v_i$  that are small enough to vote in favour given the low cutoff. This means that the probability that any given voter is pivotal is small. Similarly, if  $v$  is very large,  $\pi(v)$  is small again: in this situation, it is very likely that many voters will vote in favour of the proposal. Thus,  $\pi(v)$  itself is single-peaked, initially decreasing and eventually decreasing. Multiplying in  $v$  leads to the slightly skewed curve depicted in Figure 1.1.

From this graph, we see that there is no symmetric equilibrium of the second type if the bribe is larger than some value that we denote by  $b_k^*$ . For instance, when  $b = b_1$ , there exist two equilibrium cutoffs which are pinned down by the intersection of  $b_1$  with the function  $v\pi(v)$ . In such cases, our adversarial equilibrium selection assumption requires that the lowest cutoff is played. This cutoff is stable and increasing in  $b$ , which is not the case for the other cutoff<sup>4</sup>. As a result, in order to guarantee that no

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<sup>4</sup>So if the vote buyer expected the voters to coordinate on the other cutoff, she could ensure near-certain passage of the proposal by setting her bribe arbitrarily small; in particular, in this case the probability of the proposal being accepted would be decreasing in the bribe offered.

interior equilibrium exists, the vote buyer needs to offer more than the maximum of the function  $v \times \pi(v)$ . These observations are summarized in Lemma 3.



**Lemma 3.** *If  $k > m$ , there exist two type-symmetric equilibria of type (ii) if  $b < \max_v(v\pi(v))$ , one if  $b = \max_v(v\pi(v))$  and zero otherwise.*

We refer to the smallest value such that no type-symmetric equilibrium exists as  $b_k^*$ <sup>5</sup>. It remains to check that if the vote buyer offers at least  $b_k^*$  to  $k$  players, there is no possible coordination on an asymmetric equilibrium. As any equilibrium strategy must be a cutoff-strategy, an asymmetric equilibrium amounts to committee members choosing different voting cutoffs. We now show that this cannot be an equilibrium. Our proof relies on an iterated deletion of strictly dominated strategies. We define a function  $\pi_{max}(\underline{v})$  that represents the maximal pivotal probability of a player given that other cutoffs must lie above  $\underline{v}$ . This can thus be interpreted as the maximal expectation that a player can form about his pivotal probability given that cutoffs below  $\underline{v}$  have already been eliminated. Intuitively, member  $i$ 's pivotal probability is maximized if the others use two extreme cutoffs and split suitably between them. For instance, before the first iteration, we can maximize the pivotal probability by making  $m - 1$  other (bribed) players always accept (cutoff at 1) and  $k - m + 1$  always reject (cutoff at 0). In such a case, player  $i$  is pivotal for sure:  $\pi_{max}(0) = 1$ . The first iteration eliminates all cutoffs below  $b_k^*$ . Once those strategies have been eliminated, players cannot anticipate being pivotal with certainty:  $\pi_{max}(b_k^*) < 1$ . As a result, the

<sup>5</sup>This theoretically introduces open-set problems. These problems can be solved by assuming some minimum unit of currency  $\epsilon$ . The vote buyer would then offer  $b_k^* = \max_v(v\pi(v)) + \epsilon$  where  $\epsilon$  is arbitrarily small.

second iteration removes another set of cutoffs. This reasoning is illustrated in Figure 1.2: we plot the function

$$\underline{v}'(\underline{v}) = \frac{b_k^*}{\pi_{max}(\underline{v})}$$

as well as the 45 degree line. Given that cutoffs below  $\underline{v}$  have already been removed and that other strategies must lie in the remaining set of cutoffs,  $\underline{v}'(\underline{v})$  represents the lowest cutoff that could still be played. We show that the function  $\frac{\max_v \{v\pi(v)\}}{\pi_{max}(\underline{v})}$  is exactly tangent to the 45 degree line for  $\underline{v} = v^*$  and lies above elsewhere. As  $b_k^* > \max_v \{v\pi(v)\}$ ,  $\underline{v}'(\underline{v})$  is strictly above the 45 degree line, which implies that no cutoff below 1 is rationalizable.

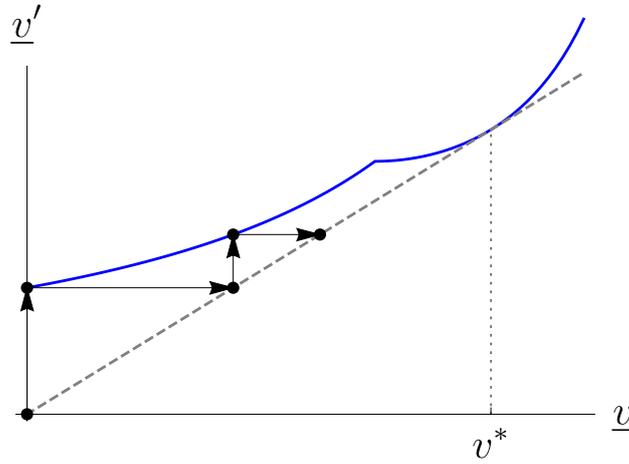


Figure 1.2: Iterated deletion of strictly dominated strategies

**Proposition 1.** *When the vote buyer offers  $b_k^*$  as defined in Lemma 3, the proposal is accepted with certainty in any equilibrium of the voting game.*

While Lemma 3 was true for any distribution of players' valuations, we need to emphasize that this proposition requires uncertainty to wash out asymmetric equilibria. Suppose for instance that all disutilities are equal to each other (say 1 for instance) as in Dal Bo (2007). If we focus on symmetric strategies, all bribed committee members will accept the bribe with a probability that we denote by  $x$ . This probability determines the pivotal probability  $\pi(x)$  and in equilibrium we must have  $\pi(x) = b$ . As the pivotal probability is maximized for  $x = \frac{m-1}{k-1}$ , the vote buyer should set  $b = \pi(\frac{m-1}{k-1}) + \epsilon$  in order to guarantee that no symmetric equilibrium exists where the proposal is rejected with a positive probability. However, as  $\pi(\frac{m-1}{k-1}) < 1$  if we relax the symmetry assumption we can build an equilibrium where  $m - 1$  players accept the proposal and others refuse. The first group has no impact on the outcome

while others are pivotal for sure, which ensures that this is an equilibrium. Proposition 1 shows that uncertainty makes such a coordination impossible.

We now turn to the problem of the vote buyer. Her objective is to choose the cheapest combination of  $k$  and  $b$  such that there is no equilibrium of the voting game where the proposal would be rejected with some probability. Obviously, the vote buyer cannot propose positive bribes to less than  $m$  members because the proposal would never be accepted. Moreover, if she chooses to bribe  $k$  members, she will propose exactly  $b_k^*$  to all of them. It remains to determine the actual size of the coalition that the vote buyer would like to bribe. The cost of bribing  $k$  members for the vote buyer is  $C(k) = b_k^* \times k$ . As explained in the introductory example, increasing  $k$  does not necessarily increase  $C(k)$  because it decreases the bribe that needs to be paid to each member. These trade-offs balance out to determine a unique (up to integer problems) size of the bribed coalition,  $k^*$ , that minimizes the vote-buyer's cost. When disutilities are drawn from a uniform distribution, it turns out that the pivotal channel is strong enough to guarantee that the vote buyer will bribe the full committee:

**Proposition 2.** *The optimal strategy for the vote buyer is to bribe the whole committee ( $k^* = n$ ).*

We discuss the robustness of this result to the distributional assumption in detail in Section 1.4.1: while we do show that the vote buyer can bribe a smaller coalition if the distribution is less dispersed, supermajorities are always optimal if we focus on symmetric strategies. In the appendix, we present a generalized version of this result and we show for any distribution and all combinations  $\{(n, m) : m < n\}$  that  $C(m) > C(m+1)$ , which implies that the vote buyer will always bribe a supermajority. Even when the distribution converges to a single point – we show below that this is the condition for the smallest supermajority to emerge – the vote buyer still bribes roughly  $\frac{3}{2}$  of the minimal winning coalition. However, if we remove uncertainty and allow for asymmetric equilibria, a minimal winning coalition is optimal: as discussed earlier, members can coordinate on an equilibrium where exactly  $m - 1$  members accept the bribe. Others are then pivotal and vote against the proposition if their disutility is larger than the bribe. As already noticed by Dal Bo (2007), the cheapest way to prevent this coordination is to offer their valuation to exactly  $m$  players. To summarize, we can generalize Proposition 2 as follows: if there exists enough uncertainty about members' valuations or if they cannot coordinate on an asymmetric equilibrium, the vote buyer can successfully exploit the pivotal channel and will bribe a supermajority.

It should also be noted that the optimal coalition would be smaller if members care about voting decisions per se. Indeed, many papers on vote buying such as Groseclose

and Snyder (1996) or Dekel et al. (2008) assume that members have only expressive preferences: they derive utility from their vote but do not take into account their impact on the outcome. This can be modeled by a fixed reputational or moral cost that each member incurs if he votes for the proposal. In a parliament for instance, legislators would be punished by their constituencies if they voted against public interests. Let us consider a mixed model where on top of the previous utility function we add a cost  $d$  for players who vote for the proposal<sup>6</sup>. Then  $d$  can be understood as a “sunk cost” that the vote buyer needs to pay in order to make a member vote for the proposal with a positive probability. For each possible coalition size, it is easy to see that the vote buyer should propose  $b_k^* + d$  to each member of the coalition to ensure the proposal’s acceptance. In this alternative formulation of the model, the pivotal channel is more expensive to exploit. As a result, the size of the optimal coalition is decreasing in the magnitude of the expressive voting cost. Eventually, if this cost is much larger than players’ preferences over the outcome, bribing the minimal winning coalition could be optimal.<sup>7</sup>

In the next proposition, we consider the impact of the design of the committee on the cost for the vote buyer:

**Proposition 3.** *The cost for the vote buyer is:*

1. *decreasing in the number of committee members  $n$ ,*
2. *increasing in the majority requirement  $m$ ,*
3. *increasing slower than linearly with committee scale, i.e. if both  $n$  and  $m$  are scaled by a factor  $s$ , the cost for the vote buyer is multiplied by less than  $s$ .*

The first point of Proposition 3 states that adding committee members without changing the majority requirement reduces the cost for the vote buyer. The cost is decreasing in the number of bribes and as we have seen in Proposition 2, she will always bribe the largest possible coalition. Therefore, adding new members allows her to exploit the pivotal channel even further, which decreases the cost. Moreover, notice that  $n$  has no impact on the pivotal probability so if we consider a variation of our setup where bribing the full committee is not optimal (see the discussion of Proposition 2), raising  $n$  does not affect the cost: the optimal coalition size remains unchanged and additional unbribed players have no impact on the game.

However, increasing  $m$  without changing  $n$  raises the cost for the vote buyer. Intuitively, manipulating pivotal considerations becomes harder with a more demanding

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<sup>6</sup>This cost differs across players in Groseclose and Snyder (1996). Midjord et al. (2017) propose a model of reputation where the cost is determined in equilibrium.

<sup>7</sup>In a similar extension, Dal Bo (2007) reaches this limit result but his setup does not allow studying the size of the optimal coalition.

majority requirement. For instance, if we set  $m = n$ , the vote buyer cannot do better than bribing the minimal winning coalition and pays the cost described in Lemma 1.

Instead of increasing  $n$  or  $m$  separately, a potential committee designer could consider multiplying both parameters by the same factor. This would result in a larger committee with the same ratio  $\frac{m}{n}$ . Even though the cost for the vote buyer would increase, the last point of Proposition 3 shows that pivotal considerations mitigate the impact of this strategy. Intuitively, members expect to be pivotal with a lower probability in a large committee which makes the pivotal channel easier to manipulate.

### 1.3 Other voting environments

We now investigate alternative voting setups. We first show that the vote buyer can still manipulate pivotal considerations if the committee votes sequentially. We then consider alternative payment schemes. When payments are conditioned on the outcome of the vote, our mechanism has no effect. However, when bribes depend on the vote share, we provide an example showing that pivotal considerations can still matter if the committee is large enough.

#### 1.3.1 Sequential voting

In the main section, we have assumed that committee members voted simultaneously. In many committees (for instance the US Senate), votes take place sequentially. We thus consider a variation of our model where the vote buyer still moves first and proposes a bribe  $b$  to  $k$  members. An ordering of members is then drawn at random and we assume that all orderings are equally likely. Finally, voters observe the ordering, announce their vote sequentially and the proposal is implemented if at least  $m$  members vote in favor.

We first consider the voting game. In such a voting process, committee members use backward induction to infer their pivotal probability as in Spenkuch et al. (2015). First of all, it is easy to see that in a subgame perfect Bayesian equilibrium, non bribed members will vote against the proposal in any subgame where the proposition can still be rejected. As a result, we can focus on the  $k$  members who receive a positive bribe. Define  $S_i(x, y)$  as the subgame where member  $i$  is to play,  $x$  votes are still needed to pass the proposal and  $y$  (bribed) players remain to play after  $i$ . Table 1.1 is a useful representation of the game where each cell represents a subgame. When a player votes for, the subgame located North-West along the diagonal is reached while if he votes against we move to the subgame just to the North. In each cell, we

write the subgame perfect Bayesian equilibrium strategy. A ‘+’ indicates that the member to play should accept the bribe regardless of his type. When a player uses a cutoff rule (i.e. votes for the proposal if his disutility is smaller than a cutoff), we simply display the cutoff used.

The first row is easy to fill: it represents the strategy of the last player to vote as a function of the number of votes in favor still needed to pass the proposal. Whenever  $x \neq 1$ , the last player is not pivotal and will accept the bribe. When  $x = 1$ , the last member to cast a vote will support the proposal if the bribe is larger than his disutility:  $b > v_i$ . This implies that from the perspective of other players, the last member will accept the proposal with probability  $b$  if he happens to be pivotal. Moving one row up, it turns out that the second to last player to vote will also accept if and only if there is only one vote needed to pass the proposal. To see that, first notice that if  $x < 1$  or  $x > 2$ , this player has no impact on the acceptance decision and will always accept. If  $x = 2$ , the player would get 0 if he votes against and

$$b - v_i \mathbb{P}(\text{proposal accepted} \mid \text{vote in favor at } (x, y) = (2, 1)) = b - bv_i$$

if he votes for. As  $v_i \leq 1$ , this player will accept regardless of his type<sup>8</sup>. Finally, in the subgame  $S(1, 1)$ , the member will accept if  $v_i < \frac{b}{1-b}$ . Iterating the reasoning, we show that the subgame perfect equilibrium of the voting game is the following:

**Lemma 4.** *A subgame perfect equilibrium of the sequential game must satisfy the following conditions:*

1. *In any subgame  $S_i(x, y)$  with  $x \neq 1$ , the member to play will vote in favor.*
2. *In any subgame  $S_i(1, y)$ , the member to play will accept if  $v_i < \min\{1, \frac{b}{1-yb}\}$ .*

We can now consider the problem of the vote buyer. She wants to choose the combination  $(b, k)$  which makes the proposal accepted with certainty for the minimal possible cost. The game begins at  $S(m, k - 1)$ ; thus, choosing  $k$  amounts to choosing the number of rows in Table 1.1. Given the equilibrium structure of the game, the  $m - 1$  first members will vote for the proposal until the subgame  $S(1, k - m)$  is reached. Once the game arrives at the first column, the proposal will be rejected with positive probability if for all  $S(1, y), y \leq k - m$ , some types reject the proposal. For the vote buyer, it is necessary and sufficient to choose  $b$  such that the player to move at  $S(1, k - m)$  accepts the proposal with certainty. This implies that when the vote buyer decides to bribe  $k$  players, she will offer a bribe  $b_k^* = \frac{1}{k-m+1}$ .

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<sup>8</sup>Member of type  $v_i = 1$  would be indifferent, but this event has 0-mass and can be neglected.

Table 1.1: Sequential voting.

	$x = 0$	$x = 1$	$x = 2$	$x = 3$	...	$x = m - 1$	$x = m$
$y = 0$	+	$\min\{b, 1\}$	+	+	...	+	+
$y = 1$	+	$\min\{\frac{b}{1-b}, 1\}$	+	+	...	+	+
$y = 2$	+	$\min\{\frac{b}{1-2b}, 1\}$	+	+	...	+	+
...			...				
$y = i$	+	$\min\{\frac{b}{1-ib}, 1\}$	+	+	...	+	+
...			...				
$y = k - 2$					...	+	+
$y = k - 1$					...		+

Note: Only bribed members are considered.  $x$  is the number of votes required to pass the proposal,  $y$  the number of players still to go. Each cell gives the SPNE strategy. We do not display all the subgames where the proposal is already accepted (i.e.  $x$  negative) as all bribed members will for sure accept. Greyed out cells correspond to nonexistent subgames.

To find the optimal  $k$ , notice that the total cost as a function of  $k$  is  $\frac{k}{k-m+1}$ , which is strictly decreasing in  $k$ . As a result, the vote buyer will always buy the full committee when the vote is sequential.

**Proposition 4.** *When voting is sequential, the vote buyer will bribe all committee members and offer them  $b_n^* = \frac{1}{n-m+1}$ .*

*The cost for the vote buyer is decreasing in the number of committee members  $n$ , increasing in the majority requirement  $m$  and increasing slower than linearly with committee scale.*

We can therefore conclude that the main mechanism of the paper also applies to sequential voting: the vote buyer will bribe a supermajority in order to make a pivotal event unlikely. By doing so, she makes sure that all members will support the proposal even if the bribes offered are small. Given that the vote buyer pays  $b_n^* = \frac{1}{n-m+1}$  to  $n$  members, the resulting cost is  $\frac{n}{n-m+1}$ . The comparative statics result from a direct inspection of this function and are qualitatively similar to the simultaneous voting case. In the main model, Proposition 3 stated that the cost was less than proportional to the size of the committee but grew unbounded. Interestingly, this is not the case here: if we fix the fraction  $z$  of the committee required to vote in favor for the proposal to pass and let  $m = zn$ , then the limit of the cost when the committee becomes arbitrarily large is  $\frac{1}{1-z}$ . As a result, the marginal effect of increasing the committee size on the cost goes to zero when the committee is large.

### 1.3.2 Other visibility setups

Until now we were assuming that the voting process was public and that the vote buyer could contract on the individual voting decisions. We now explore alternative mechanisms where the voting process is not fully transparent. More precisely, we first consider a committee where only the final decision is public. Furthermore, we also analyze a setup where the number of votes in favor is disclosed. In both cases, we assume that the vote buyer can only condition the payment of bribes on the information that is publicly disclosed after the vote.

#### Final decision

Suppose that the only information disclosed after the vote is the decision of the committee. In such a case, the vote buyer pays the bribes if the proposal is accepted. When we apply the same equilibrium concept, we have the following proposition:

**Proposition 5.** *When the vote buyer can only condition the bribes on the outcome of the vote, there is no bribing scheme that induces the proposal to be accepted in every equilibrium of the game.*

In such a setup, there always exists an equilibrium where all members refuse the proposal, even when the vote buyer offers large bribes. As a result, no one expects to be pivotal and players are indifferent. In our formulation of the model, this equilibrium involves weakly dominated strategies and is thus not robust to trembling hand perfection. Nevertheless, such a coordination becomes plausible in a version of the game where committee members derive a negative payoff if they vote for the proposal. When individual votes are secret, this payoff can be interpreted as moral concerns. Modifying payoffs to include those concerns would make stable an equilibrium in which all members turn down the bribe in this visibility setup.

#### Tally

Now let's suppose that the committee discloses the number of votes in favor of the proposal and that the vote buyer can condition the payment of bribes on this information. Other papers also analyze vote buying problems when the vote buyer conditions the payment of bribes on voting aggregates (Morgan and Várdy 2011, Smith and De Mesquita 2012, Gingerich and Medina 2013 and Rueda 2015, 2017). All those papers assume that the vote buyer commits to pay the bribe if the number of votes in favor reaches a given threshold. Such a strategy typically induces multiple equilibria and in order to stick to our equilibrium concept, we need to consider a

more sophisticated strategy. To see that, suppose that the vote buyer commits to pay  $b$  to some voters if there are more than  $k > 1$  votes in favor of the proposal. There exists an equilibrium where all members turn down the bribe: voting decisions are irrelevant and no one has an incentive to deviate. Paying the bribe if one member votes for the proposal is not a solution either: it is easy to see that such a bribing scheme cannot induce certain passage of the proposal. We therefore consider bribing schemes that consist of a number of bribed members  $k$  and a sequence of bribes  $\{b^1, b^2, \dots, b^m, \dots, b^k\}$  where  $b^p$  is the bribe that the vote buyer commits to pay to all  $k$  bribed members if  $p$  players vote in favor. We restrict our attention to symmetric proposals and type-symmetric equilibria. We also assume that the vote buyer cannot propose negative payments:  $b^p \geq 0$  for all  $p$ . We stick to the previous solution concept: the vote buyer wants to design the bribing scheme such that there is no equilibrium in which the proposal is accepted with a positive probability.

Because the bribe depends on the number of votes in favor, we potentially have  $k$  pivotal events: if  $p$  others have voted in favor, voting for the proposal increases the payoff to each member of the committee by  $b^{p+1} - b^p$ . As before, the incentive to vote for is decreasing in  $v_i$  and equilibria of the voting game will take a cutoff form. For a given voting cutoff  $v^*$ , we can express the different pivotal probabilities. We denote by  $\pi^p$  the probability that exactly  $p - 1$  others vote for the proposal. A player will take into account his impact on the bribe paid at all possible pivotal events. Moreover, when exactly  $m - 1$  other players vote for the proposal, he is decisive in the election and will make the proposal pass if he votes for. As a result, the expected gain from a vote in favor for a player of type  $v_i$  is

$$\Delta u_i = \sum_{p=1}^k \pi^p(v^*)(b^p - b^{p-1}) - v_i \times \pi^m(v^*),$$

which immediately implies that an interior cutoff must satisfy the following condition:

$$v^* = \frac{\sum_{p=1}^k \pi^p(v^*)(b^p - b^{p-1})}{\pi^m(v^*)}.$$

The vote buyer wants to propose a bribing scheme such that no interior equilibrium exists. To do so, she will make sure that for  $v^* \in [0, 1]$ , the right hand side of the above equation is strictly larger than  $v^*$ . As a result, all  $k$  bribed members will accept the proposal in the only equilibrium of the game and the vote buyer will pay a total cost  $k \times b^k$ . For a given  $k$ , the problem of the buyer is thus to minimize  $b^k$  such that there is no solution in  $[0, 1]$  to the above equation.

First of all, we observe that the vote buyer must propose  $b^1 > 0$ . This condition is needed to break down a possible coordination on a strategy profile where all members reject the proposal. Moreover, we notice that for all bribed members, the payoff when  $k$  players vote in favor must be larger than when  $k - 1$  do so. If this were not the case, the strategy profile where all players vote in favor with certainty would not be an equilibrium. This observation implies the following result:

**Lemma 5.** *Suppose that only the number of votes is disclosed. If the vote buyer wants to bribe the minimal winning coalition, she can propose  $b_m^* = \{\epsilon_1, \epsilon_2, \dots, \epsilon_{m-1}, 1 + \epsilon_m\}$  where  $\epsilon_1 > 0$  and all other  $\epsilon_k$  are arbitrarily small. She will pay a total cost arbitrarily close to  $C(m) = m$ .*

When she bribes the minimal winning coalition, the vote buyer must make sure that the highest type has no interest to deviate. As a result, she must propose a bribe such that  $b^m - b^{m-1} \geq 1$  in order to prevent  $v_i = 1$  from deviating. She must also satisfy  $b^1 > 0$  and the best she can do is to propose a small positive amount for all  $p < m$  in order to keep  $b^{m-1}$  close to zero. We observe that the resulting cost for the minimal winning coalition is the same as derived in the main section in Lemma 1. The following example reveals a surprising result that arises in this setup.

**Example 1.** *Suppose  $m = 2$  and  $n = 3$ . If the vote buyer proposes  $b_k^* = \{0, (\frac{2}{3})^2, \frac{2}{3}\}$ , she will pay a total cost  $C(3) = 2$  and in exchange every agent will vote in favor of her proposal.*

Example 1 states that in this visibility setup and for  $n = 3$  the vote buyer can bribe 2 or 3 players but will end up paying the same cost. The structure of the optimal bribing scheme is to propose a small amount up to  $b = m - 1$ , then raise the promised payoff at  $m - 1$  and  $m$  and finally keep it constant for  $p > m$ . Intuitively, the vote buyer targets two salient events in order to break down a potential coordination. Suppose that committee members try to coordinate on an interior equilibrium. The resulting interior cutoff  $v^*$  must make the decisive event salient enough to induce some members to vote against the proposal ( $\pi^m$  large). A natural try would be to target this event and propose a bribing scheme such that  $b^m - b^{m-1} = 1$  as in the minimal winning coalition case. However, it turns out that a better strategy is to propose a larger reward for switching from  $m$  to  $m + 1$  votes in favor. Indeed, when  $\pi^m$  is large, other pivotal probabilities and especially  $\pi^{m+1}$  need to be also large. For a given coalition size, it turns out that targeting this second event allows the vote buyer to prevent a potential coordination efficiently, but the cost is still the same as for the minimal winning coalition.

Can we generalize Example 1 to any committee size? The answer is positive only if we restrict our attention to increasing bribing schemes. However, for large committees, the vote buyer could save money over this strategy by successively lowering and then re-increasing the promised bribes for pivotal events occurring after the majority has been reached, i.e. for indexes  $p > m$ . This mechanism is illustrated by the following example:

**Example 2.** Suppose  $m = 4$  and  $n = 7$ . If the vote buyer proposes the bribing scheme depicted in Figure 1.3, she will pay a total cost  $3.86 < m$  and in exchange every agent will vote in favor of her proposal.

The intuition here is that the vote buyer can exploit the fact that close pivotal events become salient nearly simultaneously, i.e. whenever an agent places a high probability on being at a specific pivotal event she also places a high probability on being at nearby events. By exploiting these interactions between the pivotal events, it is possible for the vote buyer to progressively decrease the bribe and still prevent any potential coordination. As the expected utility gain from voting in favor is positive at all potential cutoffs  $v$ , the only type-symmetric equilibrium that survives is one in which all agents vote in favor of the proposal; yet the total cost to the vote buyer is a mere  $7b_7 \approx 3.86$ , which is less than the minimal winning cost of 4. Thus, we once again find that – at least for large committees – it is strictly better for the vote buyer to bribe a supermajority.

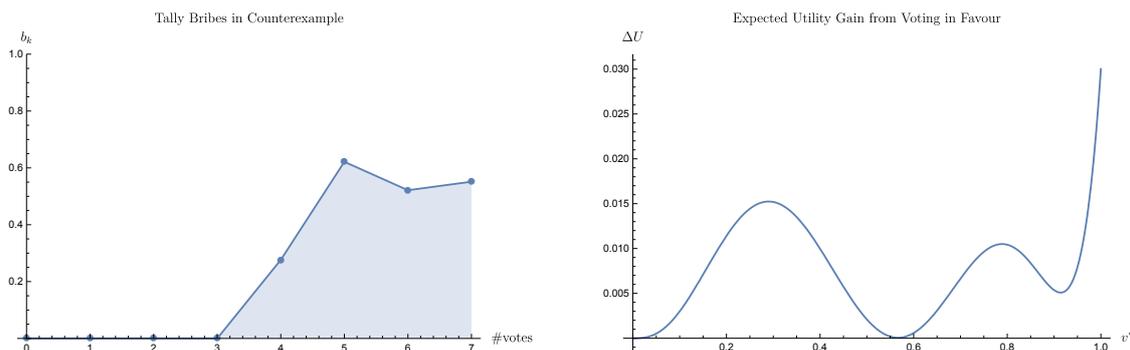


Figure 1.3: Example 2

It is clear from the figure that this result is achieved because the vote buyer sets  $b_6 < b_5$ . This decrease pushes agents towards not voting in favor of the proposal if they believe themselves to be pivotal in determining which of the two events occurs. However, whenever they find themselves in such a situation, they will also attach a high probability to the scenario in which they are pivotal of moving the outcome

from  $b_4$  to  $b_5$  or from  $b_6$  to  $b_7$ : as both of these are associated with increases in remuneration, they act as a counterweight to still ensure a net interest in passing the proposal. This counterexample is at odds with Dal Bo (2007) who concluded that the pivotal mechanism could not be exploited when only the share of votes was made public. It also contradicts one of the main predictions of Gingerich and Medina (2013) and Rueda (2015). In those papers, the vote buyer specifies a unique threshold and vote buying turns out to be easier when the number of voters is small. With large electorates, voters do not expect to be pivotal for the bribe and the offer of the vote buyer cannot affect individual decisions. Our model suggests that more sophisticated offers can reverse this prediction.

## 1.4 Discussion and extensions

In the following, we analyze how our results behave when we consider a more general distributions of types. Furthermore, up to here we were assuming that the vote buyer could only offer the same amount to all bribed members and that she had an arbitrarily large valuation for the proposal. We now discuss those assumptions and show that the main mechanisms and most of our results survive when we relax them.

### 1.4.1 Other distributions

We now relax the uniform assumption and we analyze how the shape of the distribution affects the size of the optimal coalition and the resulting cost. For a large class of distributions, the results derived in the main section are qualitatively valid. We refer the interested reader to the proof section where the exact conditions for each result to hold are explicitly stated. We consider a distribution with cumulative density function  $F(\cdot)$ . We denote by  $v_{max}$  the upper bound of this distribution<sup>9</sup>. We will also require the following technical assumption, which combines a differentiability requirement with the assumption that  $F(\cdot)$  has an increasing generalized failure rate<sup>10</sup>:

**Assumption 1.**  $F(\cdot)$  is continuously differentiable and  $\frac{\partial}{\partial v} \left( \frac{vF'(v)}{1-F(v)} \right) \geq 0$ .

The distribution of committee members' valuations for the proposal captures the uncertainty of their assessment. If we consider a committee where members have similar backgrounds, the assessment of players' valuation should be more accurate. Conversely, there will be more uncertainty in a committee where members come from different backgrounds and are renewed on a regular basis. Those elements are

<sup>9</sup>Note we do not exclude the case of  $v_{max} = \infty$ .

<sup>10</sup>Those distributions have been studied for instance in Lariviere (2006).

captured in the spread of the distribution and we will use the following definition of dispersion as a comparison criteria:

**Definition 1.** We say that  $\tilde{F}(\cdot)$  is more dispersed than  $F(\cdot)$  if  $\tilde{F} \leq_* F$ , i.e. if the ratio of the inverse CDFs, i.e.  $\frac{\tilde{F}^{-1}(p)}{F^{-1}(p)}$ , is nondecreasing in  $p$ .

We exhibit examples of distribution functions that can be ranked in the dispersion ranking in Figure 1.4 to illustrate the concept. For our purposes, note that the dispersion order when restricted to distributions with the same means is a strictly stronger order than second order stochastic dominance. For more technical details on this order, we refer the interested reader to Shaked and Shanthikumar (2007, p.213).

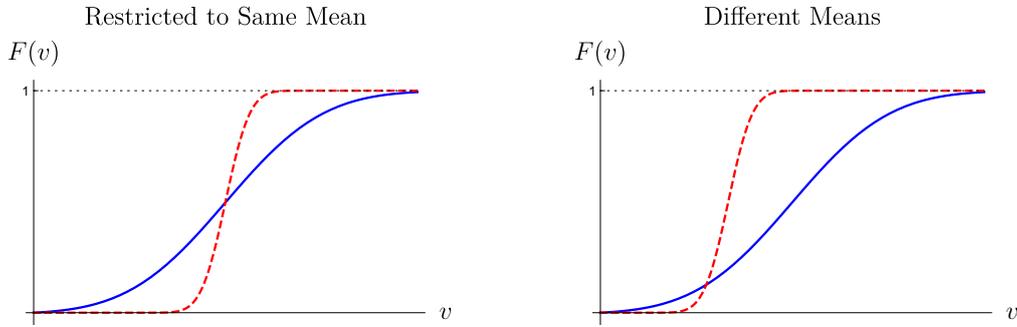


Figure 1.4: Dispersion Comparison:  $\tilde{F}(v)$  blue,  $F(v)$  red and dashed.

As discussed in the main section, our analysis requires either a sufficiently dispersed distribution to wash out asymmetric equilibria (see Proposition 1) or the direct assumption of type-symmetric strategies:

**Assumption 2.** We assume either

- (i)  $F(\cdot)$  is sufficiently dispersed to wash out asymmetric equilibria, or
- (ii) players play only type-symmetric strategies.

A sufficient (but not necessary) condition for  $F(\cdot)$  to be sufficiently dispersed is for it to be more dispersed than  $U[0, 1]$ ; for details see the proof section.

In the next result, we describe how the size of the optimal supermajority for the vote buyer depends on the dispersion of the distribution.

**Proposition 6.** The vote buyer will bribe a larger supermajority when the distribution is more dispersed (in the sense of Definition 1).

Intuitively, it is easier to manipulate members' beliefs about the pivotal probability when the distribution is dispersed. The vote buyer will therefore rely more on this channel when the dispersion is large, regardless of the fact that it implies paying a large number of bribes. However, even with little dispersion, the vote buyer will bribe a substantial supermajority if we focus on type-symmetric strategies. For instance, we can show that if we remove dispersion (i.e the distribution converges to a single mass point), the vote buyer still bribes a substantial supermajority equal to roughly  $\frac{3}{2}$  times the minimal winning coalition<sup>11</sup>.

Proposition 6 raises the question of how the vote buyers' cost responds to an increase in dispersion. So far, our analysis suggested that it was easier for the vote buyer to exploit the pivotal channel when dispersion was large. However, it turns out that the impact of dispersion on the cost is ambiguous. On the one hand, increasing dispersion makes coordination harder for committee members, which benefits the vote buyer. On the other hand, it also means that extreme types are more likely, which could make high cutoffs sustainable. As a result some  $b_k^*$  could be increasing in dispersion and the vote buyer could have to spend more for a given coalition size.

This tradeoff is illustrated in Figure 1.5, which depicts two cost functions where  $\tilde{C}(k)$  is associated with a more dispersed distribution. It is clear from the figure that if the vote buyer was unconstrained in his choice of coalition size, he would achieve a lower cost under the more dispersed distribution: as  $\tilde{C}(200) < C(k^*)$ , it is cheaper to bribe 200 committee members under the dispersed distribution than to bribe the optimal number under the less dispersed distribution. However, the vote buyer might be prohibited from employing this strategy by the size of the committee: e.g. if  $n = 100$ , any  $k$  in the grayed out area corresponds to bribing more committee members than actually exist. Under this constraint the vote buyer pays more in the more dispersed distribution.

We now identify sufficient conditions for the 'extreme values' channel to dominate, i.e. for dispersion to have a positive impact on cost. Let  $\alpha$  be such that, for two distributions  $F(v)$  and  $\tilde{F}(v)$  where the latter is more dispersed,  $\frac{\tilde{F}^{-1}(\alpha)}{F^{-1}(\alpha)} = 1$ . Thus,  $\alpha$  is the value of  $F(v)$  at the crossing of  $F(v)$  and  $\tilde{F}(v)$ . Given our definition of dispersion, this crossing needs to be unique.

**Proposition 7.** *Suppose  $\frac{m-1}{n-1} \geq \alpha$ . If  $\tilde{F}(\cdot)$  is more dispersed than  $F(\cdot)$ , then the cost for the vote buyer is larger under  $\tilde{F}(\cdot)$ .*

Dispersion will increase the cost when  $\frac{m-1}{n-1} \geq \alpha$ , which holds when  $m$  is large with respect to  $n$ , that is, for demanding majority requirements. In such cases, all

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<sup>11</sup>We do not have strict equality because of integer problems. If we set  $m = \alpha n$  for some  $\alpha$  and let  $n \rightarrow \infty$  (so that integer problems disappear), then  $k^*/n \rightarrow 3/2$ .

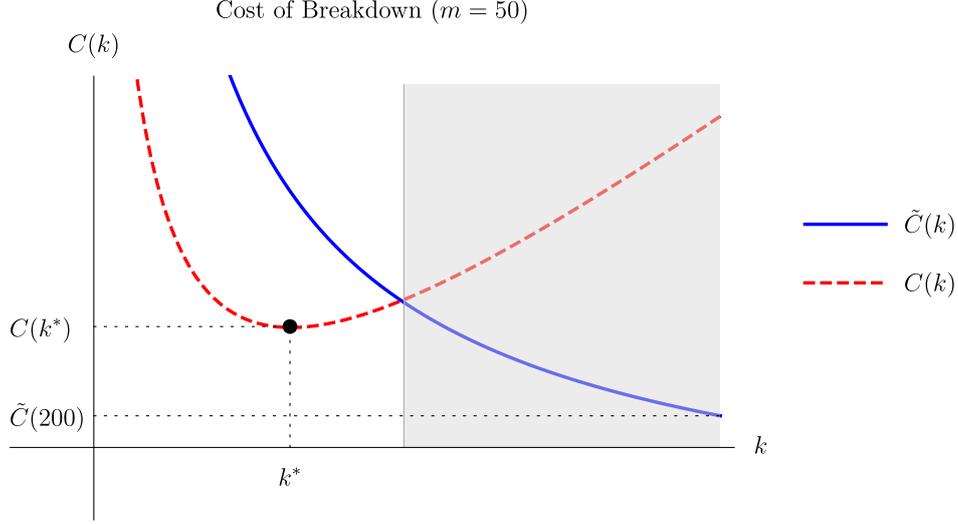


Figure 1.5: The impact of dispersion on cost is potentially ambiguous.

feasible coalitions are too small to fully exploit the pivotal channel. When dispersion increases, committee members with large disutility for the proposal are more likely to emerge, which makes high cutoffs easier to sustain. The vote buyer therefore needs to pay more to impede a possible coordination.

The proof relies on a graphical inspection of the pivotal probabilities. The idea is to show that for any  $k$ , the optimal bribe is larger when the distribution is more dispersed. Let  $\pi(v)$  and  $\tilde{\pi}(v)$  refer to the pivotal probabilities as a function of  $v$  (for given  $k, m$ ) corresponding to the distributions  $F(\cdot)$  and  $\tilde{F}(\cdot)$ . As plotted in Figure 1.6, we can show that the graph of  $\pi(v)$  and  $\tilde{\pi}(v)$  exhibit the following properties:

1. The two functions have the same value at their maximum,
2.  $\arg \max_v(\pi(v)) < \arg \max_v(\tilde{\pi}(v))$ ,
3. To the right of the maximum of  $\pi(v)$ , the two functions cross only once for a value  $\bar{v}$ ,
4.  $\tilde{\pi}(v)$  lies above  $\pi(v)$  for  $v > \bar{v}$ .

Now suppose that the optimal bribe when the distribution is  $F(\cdot)$  is  $b^* = v^* \pi(v^*)$ . To see that the optimal bribe is necessarily larger when the distribution is  $\tilde{F}(\cdot)$ , notice that there is (at least) one  $v' \geq v^*$  such that  $\tilde{\pi}(v') = \pi(v^*)$ . This implies that the optimal bribe when the distribution is  $\tilde{F}(\cdot)$  is at least  $v' \pi(v^*) \geq v^* \pi(v^*)$ . A similar reasoning implies that all  $b_k^*$  are larger under  $\tilde{F}(\cdot)$  than under  $F(\cdot)$ . As a result, the vote buyer has to pay more under  $\tilde{F}(\cdot)$ .

Whenever  $\frac{m-1}{n-1} \geq \alpha$ , our graphical proof allows us to conclude unambiguously on the impact of dispersion on the cost because we can clearly order the maximum of

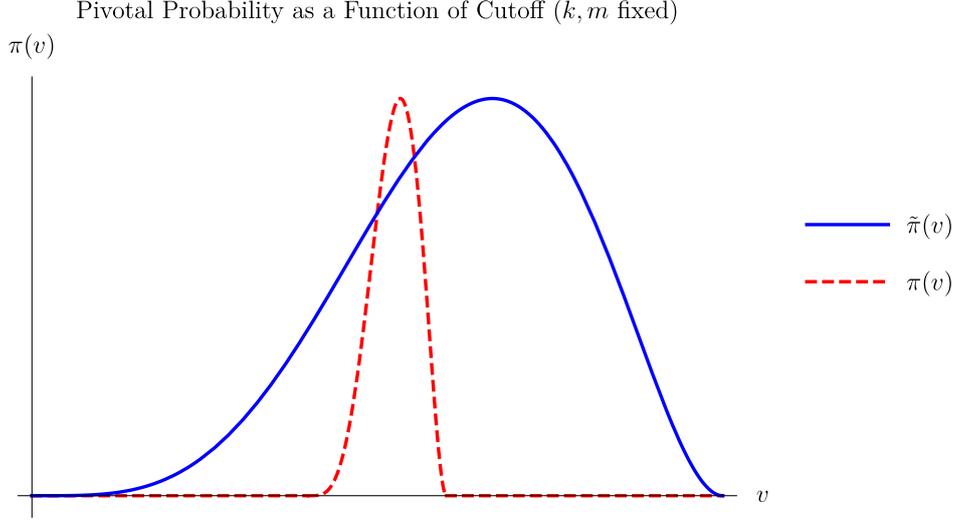


Figure 1.6: dispersion and optimal bribe

the pivotal probabilities for all possible  $k$  that the vote buyer could choose. When this condition does not hold, the graphical reasoning fails because we cannot order the maximums of the pivotal probabilities for every  $k$ . The impact of dispersion will then be ambiguous: the optimal  $k$  could vary between the two distributions and the ordering of some  $b_k^*$  between the two functions could be reversed.

### 1.4.2 Asymmetric bribes

Would the vote buyer be better off if she could propose different bribes? We relax the symmetry restriction and consider any vector of bribes  $(b_1, \dots, b_n)$ . As in the main model,  $v_i \sim U[0, 1]$  and the vote buyer wants to minimize the sum of bribes provided that the proposal is accepted with certainty.

Given a vector of bribes, an equilibrium is a vector of cutoffs  $(v_1^*, \dots, v_n^*)$  that satisfies

$$v_i^* = \min \left\{ \frac{b_i}{\pi_i(v_1^*, \dots, v_n^*)}, 1 \right\} \quad \forall i, \quad (1.3)$$

where pivotal probabilities depend on the cutoffs of all other members. By our adversarial equilibrium selection, the only way for the vote buyer to ensure passage of the proposal is by choosing a vector of bribes such that  $v_i^* = 1$  for all  $i$  is the unique solution to (1.3). Therefore, the vote buyer will choose the cheapest bribing scheme such that  $v_i^* = 1 \forall i$  is the unique solution.

Let us introduce the concept of *breakdown bribe*, which is the equivalent to  $\max_v(v \times \pi(v))$  when we allow the vote buyer to propose asymmetric bribes:

**Definition** A bribing scheme  $(b_1, \dots, b_n)$  is a breakdown bribe if:

1. There exists a vector of cutoffs  $(v_1^*, \dots, v_n^*)$  solving (1.3) such that the proposal is accepted with a positive probability,
2.  $v_i^* = 1 \forall i$  is the unique solution if we increase marginally some of the bribes.

In the symmetric case,  $\max_v(v \times \pi(v))$  was unique, but now there exists a continuum of breakdown bribes. To characterize them, we need to determine when it is possible to rearrange the cutoffs in order to increase some  $b_i = v_i^* \pi_i$  while keeping all other bribes constant. Intuitively,  $v_i^* \pi_i$  is the probability that player  $i$  is pivotal and votes for the proposal, which we can also interpret as the probability to end up with a minimal winning coalition (i.e exactly  $m$  players voting for the proposal) containing player  $i$ . The analogy with the symmetric case is instructive: when players receive the same bribe and play the same cutoff, maximizing the probability of a minimal winning coalition containing any player is equivalent to maximizing the probability of obtaining exactly  $m$  votes in favor. This probability is maximized when  $k \times v^* = m$  or  $v^* = \frac{m}{k}$  (where  $k$  is the number of bribes). When  $v^* < \frac{m}{k}$  and all members have the same cutoff, the probability to get exactly  $m$  votes in favor increases when we increase the cutoff. Conversely, when  $v^* > \frac{m}{k}$ , decreasing the cutoff would increase this probability. This tells us that  $b_k^* - \epsilon$  would induce an equilibrium cutoff  $v^* = \frac{m}{k}$ . To see that a similar intuition exists in the asymmetric case, it proves useful to sum up the bribes:

$$\begin{aligned}
\sum_{i=1}^n b_i &= \sum_{i=1}^n v_i^* \pi_i \\
&= \sum_{i=1}^n \mathbb{P}(i \text{ is pivotal and } i \text{ votes in favor}) \\
&= m \times P(m \text{ votes for}).
\end{aligned}$$

Thus, the sum of bribes is proportional to the same probability that  $v^*$  maximized in the symmetric case. However, it is not sufficient anymore to maximize the sum of the bribes; instead, given a vector  $(b_2, \dots, b_n)$  we can characterize the corresponding breakdown bribe  $(b_1^*(b_2, \dots, b_n), b_2, \dots, b_n)$  as solving

$$b_1^*(b_2, \dots, b_n) = \max_{v_1^*, \dots, v_n^*} \pi_1 v_1^* \quad \text{s.t.} \quad \pi_2 v_2^* \geq b_2, \quad \dots, \quad \pi_n v_n^* \geq b_n.$$

To solve this maximization problem, we use the Jacobian of the bribe vector  $(b_1(v_1, \dots, v_n), \dots, b_n(v_1, \dots, v_n))$ , which is here to be understood as a map from the space of potential cutoffs into the space of bribes that rationalize these cutoffs. Its

Jacobian is given by

$$\Pi := Db = \begin{pmatrix} \frac{\partial b_1}{\partial v_1^*} & \cdots & \frac{\partial b_1}{\partial v_n^*} \\ \vdots & & \vdots \\ \frac{\partial b_n}{\partial v_1^*} & \cdots & \frac{\partial b_n}{\partial v_n^*} \end{pmatrix}$$

Whenever this matrix is nonsingular, we can locally move about the cutoffs in order to get any desired change in the  $v_i^* \pi_i$ . Concretely, if the matrix is invertible, for any possible change in bribes  $(db_i)$ , it is possible to find a vector  $(dv_i^*) = (dv_1^*, \dots, dv_n^*)$  such that  $\Pi(dv_i^*) = (db_i)$ . This of course includes  $(db_i)$  with only (weakly) positive elements. As a result, if  $\Pi$  is invertible for a combination  $(v_1^*, \dots, v_n^*)$ , then the resulting bribe cannot be a breakdown bribe. In order to show that an equilibrium induced by a breakdown bribe needs to feature  $\sum_{i=1}^n v_i^* = m$ , it is therefore sufficient to show that  $\det(\Pi) = 0$  if and only if  $\sum_{i=1}^n v_i^* = m$ . In the appendix, we show it formally for  $(n = 3, m = 2)$ ,  $(n = 4, m = 2)$  and  $(n = 4, m = 3)$ . Unfortunately, we have been unable to provide a complete proof for any committee size. The following result is only valid when this property is satisfied:

**Proposition 8.** *Suppose that all equilibria induced by a breakdown bribe are characterized by  $\sum_{i=1}^n v_i^* = m$ . Then it is optimal for the vote buyer to propose the same bribe to all players.*

Given that the vote buyer wants to guarantee that the proposal is accepted, she will offer the cheapest breakdown bribe (or more exactly this bribe plus  $\epsilon$  for one player). Provided that equilibria induced by breakdown bribes satisfy  $\sum_{i=1}^n v_i^* = m$ , it is sufficient to show that  $v_i^* = \frac{m}{n} \forall i$  leads to the cheapest breakdown bribe. To see that, consider any combination  $(\{v_i^*\} : \sum_{i=1}^n v_i^* = m)$  where all  $v_i^*$  are not equal. The resulting distribution of votes in favor is maximized at exactly  $m$  and when this event occurs, members who vote for are pivotal. Keeping  $\sum_{i=1}^n v_i^* = m$ , we show that we can rearrange the cutoffs to decrease all  $b_i = v_i^* \pi_i$ . To do that, we can for instance increase the smallest cutoff and decrease the largest cutoff to compensate. This makes cutoffs more equal, which spreads the distribution of the number of successes. As a result, all players become less pivotal, which implies that all  $b_i$  are cheaper. This argument shows that given  $\sum_{i=1}^n v_i^* = m$ , more equal cutoffs lead to lower bribes. Therefore, offering the same bribe to all players turns out to be the cheapest solution for the vote buyer to guarantee that the proposal is always accepted. This suggests that the strategy described in the main text is actually optimal even if we allow for asymmetric bribes.

Interestingly, this reasoning provides a deeper understanding of Proposition 2. In the symmetric case, not offering a bribe to all members implies setting some cutoffs

at 0. In this section, we have seen that such a strategy cannot be optimal under the uniform assumption: the vote buyer would prefer to induce more equal cutoffs, which implies to pay more bribes. To see that, notice that  $b_k^* - \epsilon$  also induces  $v_k^* = \frac{m}{k}$ . The resulting cost is  $m \times \pi(\frac{m}{k})$ . From this expression, we see that it is always better to bribe more players: it decreases the pivotal probability, which reduces the cost of bribes.

### 1.4.3 Vote buyer's valuation

In the above analysis, we were assuming that the vote buyer always wanted to ensure certain passage of the proposal. We now relax this assumption and consider the general problem of the vote buyer. Recall that her objective function is

$$U_{\text{VB}} = W \times \mathbb{P}(\text{proposal passed} \mid b \text{ offered to } k \text{ members}) - b \times (\# \text{votes for}),$$

where  $W$  is the vote buyer's valuation of the proposal. In this section, the vote buyer may prefer to induce an interior equilibrium, i.e an equilibrium where bribed members have cutoffs smaller than 1 and where the proposal is rejected with a positive probability. To simplify the discussion, we assume that types are uniformly distributed and we focus on symmetric bribes and type-symmetric equilibria. Those restrictions are not innocuous anymore: when  $b$  is small enough, the iterated deletion proof used for Proposition 1 is not valid and there exist asymmetric equilibria. Going back to Figure 1.1, our adversarial equilibrium assumption implies that the lowest of the two possible cutoffs for a given  $b$  is played. When the vote buyer induces an interior equilibrium, the number of votes in favor is uncertain and follows a binomial distribution with  $k$  trials, each of which has a probability of success equal to the voting cutoff. The number of bribes to be paid is determined by the number of successes of this binomial distribution, which implies that the expected number of payments is  $k \times v^*$ , where  $v^*$  is the voting cutoff.

Because passage of the proposal is not certain anymore, the vote buyer could potentially have to pay bribes even if the proposal is rejected. When  $W$  is small, we could then imagine that the vote buyer would not bribe the committee at all: offering small bribes implies paying money to those who vote in favor while the probability of causing the proposal to be implemented is small. However it turns out that the vote buyer always wants to offer positive bribes even when her valuation for the proposal is small:

**Proposition 9.** *If  $W > 0$ , the vote buyer offers strictly positive bribes.*

This result is driven by pivotal considerations: when the bribes offered go to 0, committee members always reject the proposal and are never pivotal. They are thus ready to accept very small amount in exchange for their vote. The marginal impact of the bribes on the voting cutoffs – and thus on the probability of acceptance – is therefore very large when bribes are small. This appears in Figure 1: the function  $v^*\pi(v^*)$  increases very slowly for small  $v^*$  and small bribes can translate in non negligible probabilities of acceptance. As a result, the vote buyer will always offer positive bribes, even if her valuation for the proposal is small.

For any coalition size  $k$ , the probability of acceptance as well as the amount spent on bribes is increasing in  $b$ . Therefore, the sum of bribes proposed by the vote buyer is increasing in  $W$ . As we discussed above, there exists  $\bar{W}$  such that the vote buyer will make sure that the proposal is always accepted as she does in the main section. In our next result, we propose an upper bound for  $\bar{W}$ :

**Lemma 6.** *It is optimal for the vote buyer to guarantee certain acceptance if  $W > \bar{W}$  where  $\bar{W} < m + 1$ .*

To derive this result, we study the objective of the vote buyer as a function of the voting cutoff  $v^*$ . We plot this function in Figure 1.7. The condition  $W > m + 1$  is sufficient but not necessary: it guarantees that for any coalition size, the utility of the vote buyer is always increasing in  $v^*$ . In such a case, the vote buyer will of course choose the largest possible cutoff,  $v^* = 1$ . This condition is however not necessary: for some values of  $W$ , the derivative of the objective function with respect to  $v^*$  is not always positive but the vote buyer still wants to guarantee the support of the committee. There exists a mechanism that pushes the vote buyer to induce certain acceptance: the utility function of the vote buyer exhibits a discontinuity at  $v^* = \frac{m}{k}$ , as we can see in Figure 1.7. This point corresponds to the breakdown described in the main section: a marginal change in the bribes offered guarantees that no interior equilibrium exists and the probability of acceptance jumps to 1. This provides incentives to the vote buyer to use the breakdown strategy described in the main text. For instance, in the setup of our example from the introduction –  $n = 3, m = 2$  – we have  $\bar{W} \approx 1.14 < m + 1 = 3$ . The expression proposed in Lemma 6 is however the tightest bound on  $\bar{W}$  that we were able to characterize formally.

Let's now consider cases where  $W < \bar{W}$  so that the vote buyer wants to induce an interior equilibrium. With respect to the optimal number of bribes, the effect of an additional player is now ambiguous and the mechanism is different from the main model. To understand the intuition, suppose that the vote buyer spends a given amount that she splits between  $k$  players. Moreover, suppose that  $W$  is small so that bribes offered and cutoffs are small. What would happen if the vote buyer

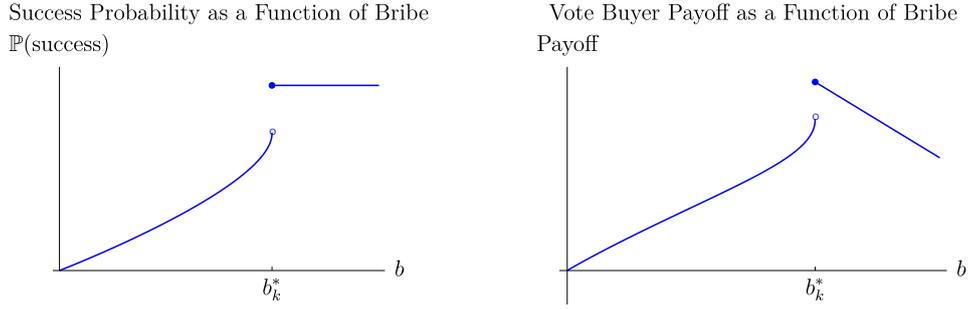


Figure 1.7: The General Vote Buyer's Problem

spent the same amount but split it between  $k + 1$  players? First of all, if we forget about pivotal probabilities, the direct effect of this move is to increase the spread of the distribution of the number of successes. This benefits to the vote buyer: when cutoffs are small, getting at least  $m$  votes in favor is unlikely. By making the number of successes more uncertain, the probability of obtaining a high enough number of votes for increases. However, there is now a countervailing effect: when we increase the dispersion of the distribution of the number of successes, we incidentally increase the pivotal probability. Because cutoffs are small, being pivotal can be seen as an extreme event. When we make the number of successes more uncertain, extreme events, including players being pivotal, become more likely. As a result, players are more reluctant to vote for the proposal and play lower cutoffs. When  $W$  is small enough, spreading the bribe to an additional player is therefore a double-edged sword: it increases the spread of the distribution of successes, which increases the probability of acceptance, but it also decreases the sum of cutoffs. Due to the second effect, bribing the whole committee is not necessarily the optimal strategy when the vote buyer wants to induce an interior equilibrium. Indeed, it is even possible to build an example where the vote buyer prefers to bribe  $m$  players than  $m + 1$ <sup>12</sup>.

## 1.5 Conclusion

Throughout the paper, we have shown how a vote buyer can shape committee members' assessment of their pivotal probability. While previous papers like Dal Bo (2007) have highlighted the role of pivotal concerns in vote buying, they relied on very specific bribing schemes and concluded that the pivotal channel could not be exploited in many of the environments we consider. We challenge this conclusion and show that, in most voting setups, the vote buyer can indeed manipulate pivotal considerations.

<sup>12</sup>For instance, if  $n = 17$  and  $W = 0.2$ .

When the vote buyer can condition the payment of bribes on individual voting decisions, the resulting ability to manipulate pivotal considerations induces the vote buyer to bribe a substantial supermajority in order to decrease the cost of the support of the committee. With respect to the design of the committee, increasing the number of members without changing the majority requirement can make the committee cheaper to buy, especially when the vote buyer wants to bribe the full committee. On the other hand, for a fixed number of members, more demanding majority rules increase the cost for the vote buyer. While the cost also increases when we raise  $m$  and  $n$  proportionally, pivotal considerations mitigate this increase. Moreover, we show that the vote buyer can also manipulate the pivotal channel efficiently when the committee votes sequentially.

A natural response to our concerns would be to render voting decisions secret. Indeed, such a change would dramatically lower the extent to which the vote buyer can exploit pivotality. However, we provide an example where the vote buyer can still propose a bribing scheme that exploits pivotal concerns even though only the share of votes in favor is public.

Finally, we discuss the impact of the distribution of members' preferences on our results. We show that the vote buyer will bribe a larger supermajority when the distribution is more dispersed. However, even if we can show that dispersion increases the cost for demanding majority requirements, the impact on the cost is generally ambiguous.

Our paper shows that exploiting the strategic interactions between the members of a voting body can be an efficient way to manipulate the decision making process. With the exception of Henry (2008), this topic has not yet been explored and we believe that there exists other mechanisms that could be used by an outsider to influence the committee. Introducing such concerns can radically modify the outcome: for instance, in the introductory example, a committee of three members turn out to be cheaper to bribe than a single decision maker with the same preferences due to pivotal considerations.

## 1.6 Appendix to chapter 1

*Note: For the main section, we first prove the results of the main text and then propose a general version of the results that does not rely on the uniform distribution assumption. For general distributions, we use the notation introduced in Section 1.4.1.*

For multiple proofs, we require Lemma 7:

**Lemma 7.** *Suppose  $\tilde{F}(\cdot)$  and  $F(\cdot)$  have increasing generalized failure rates. Suppose further that  $\tilde{F}(\cdot)$  is more dispersed than  $F(\cdot)$ . Then  $\tilde{F}(\tilde{v}^*) > F(v^*)$ , where  $\tilde{v}^*$  is the equilibrium cutoff if  $v_i \sim \tilde{F}(\cdot)$  and  $v^*$  is the equilibrium cutoff if  $v_i \sim F(\cdot)$ .*

*Proof.* To find the equation implicitly defining  $v^*$ , we solve

$$\max_v v \binom{k-1}{m-1} F(v)^{m-1} [1 - F(v)]^{k-m},$$

which yields the FOC defining  $v^*$ :

$$\frac{[F(v^*) - 1]F(v^*)}{v^*F'(v^*)} = (m-1) - (k-1)F(v^*). \quad (1.4)$$

We can rewrite (1.4) in terms of  $x = F(v)$  to yield

$$\frac{x-1}{F'(F^{-1}(x))F^{-1}(x)} = \frac{m-1}{x} - (k-1).$$

Now notice that the RHS is unambiguously decreasing. The LHS is increasing by our assumption of increasing generalized failure rates. Furthermore, as  $\tilde{F} \leq_* F$ , the LHS lies lower at  $\tilde{F}$  than at  $F$ :

$$\frac{x-1}{\tilde{F}'(\tilde{F}^{-1}(x))\tilde{F}^{-1}(x)} < \frac{x-1}{F'(F^{-1}(x))F^{-1}(x)} \iff \frac{\partial}{\partial x} \left( \frac{F^{-1}(x)}{\tilde{F}^{-1}(x)} \right) \geq 0.$$

But this must mean that  $\tilde{x} = \tilde{F}(\tilde{v}^*) > F(v^*) = x$ . □

### Proposition 1

*Proof.*

Consider at no loss of generality the strategy of (bribed) member 1 faced with a vector of cutoffs  $\mathbf{v}^1 = (v_2^*, \dots, v_k^*)$ . He will be pivotal if exactly  $m-1$  of the  $k-1$  bribed players vote in favor; in particular if  $S = \sum_{i=2}^k \text{Bernoulli}(F(v_i^*))$ , then his pivotal probability is given by

$$\begin{aligned} \pi(v_2^*, \dots, v_k^*) &= \mathbb{P}(S = m-1) \\ &= f_{k-1}(m-1; \mathbf{v}^1), \end{aligned}$$

where the last object is the PMF of a Poisson-Binomial random variable with  $k-1$  trials and success probability vector given by  $\mathbf{v}^1$ . We will define the maximum value

this object could take given that all cutoffs need to be above  $\underline{v}$ :

$$\pi_{max}(\underline{v}) := \max_{(v_2^*, \dots, v_k^*) \in [\underline{v}, v_{max}]^{k-1}} \pi(v_2^*, \dots, v_k^*). \quad (\star)$$

Now adopt the convention  $\mathbf{v}^{1i} = (v_2^*, \dots, v_{i-1}^*, v_{i+1}^*, \dots, v_k^*)$  and note that for any  $i$ ,

$$f_{k-1}(m-1; \mathbf{v}) = F(v_i^*) f_{k-2}(m-2; \mathbf{v}^{1i}) + (1 - F(v_i^*)) f_{k-2}(m-1; \mathbf{v}^{1i}),$$

whence  $\frac{\partial f_{k-1}}{\partial F(v_i^*)}$  is independent of  $F(v_i^*)$ . It immediately follows that there is a solution to  $(\star)$  in which  $v_i^* \in \{\underline{v}, 1\}$  for all  $i$ . In light of this, let  $\pi_h(\underline{v})$  be the value of the pivotal probability if exactly  $h$  of the  $k-1$  agents choose a cutoff of  $v_i^* = 1$  and  $k-1-h$  choose a cutoff of  $\underline{v}$ ; then  $\pi_{max}(\underline{v}) = \max_h \pi_h(\underline{v})$ .

For any  $h$ , we can derive a critical bribe  $b_h^*$  as in the main text that will satisfy  $\underline{v}\pi_h(\underline{v}) < b_h^*$  for all  $\underline{v}$  and is defined by

$$b_h^* = \max_v \left\{ v \underbrace{\binom{k-h-1}{m-h-1} [F(v)]^{m-1-h} [1-F(v)]^{k-m}}_{\pi_h(v)} \right\}.$$

To show that all cutoffs below 1 can be eliminated by IDSDS, we must show that  $\underline{v}\pi_{max}(\underline{v}) < b_k^*$  for all  $\underline{v} < v^*$ . But it will be sufficient to show that  $b_h^* < b_k^*$  for all  $h \in \{1, \dots, m\}$  (indeed, we have  $b_0^* = b_k^*$ ). We will do so by establishing

$$\begin{aligned} \frac{\partial b_h^*}{\partial h} &= -v \binom{k-h-1}{m-h-1} (1-F(v^*))^{k-m} F(v^*)^{m-h-1} \\ &\quad \times \{ \text{Log}[F(v^*)] + \psi^{(0)}(k-h) - \psi^{(0)}(m-h) \} < 0. \end{aligned} \quad (1.5)$$

If  $v_i \sim U[0, 1]$ , we have  $v^* = \frac{m-h}{k-h}$  and require

$$\log(m-h) - \psi^{(0)}(m-h) - [\log(k-h) - \psi^{(0)}(k-h)] \geq 0.$$

By Chen (2005), Theorem 1 we have  $\psi^{(1)}(x) > \frac{1}{x} + \frac{1}{2x^2}$ , whence we know that  $\frac{\partial}{\partial x}(\log(x) - \psi^{(0)}(x)) < 0$ ; but then as  $k-h > m-h$ , we are done for the uniform case. □

### Proposition 1, generalization

*Suppose that the distribution of types is more dispersed (in the sense of Definition 1) than  $U[0, 1]$  and that  $k \geq m$ . When the vote buyer offers  $b_k^*$  as defined in Lemma 3,*

the proposal is accepted with certainty in any equilibrium of the voting game.

*Proof.* To show that (1.5) also holds for more dispersed distributions, notice that  $\frac{\partial b_k^*}{\partial h}$  is decreasing in  $F(v)$ . Moreover, by Lemma 7,  $\tilde{F}(\tilde{v}^*) > F(v^*)$  if  $\tilde{F}(\cdot)$  is more dispersed than  $F(v)$ . It follows that ISDS will eliminate all strategies below  $v^*$  if  $F(v)$  is more dispersed than the uniform. □

## Proposition 2

*Proof.* We have  $C(k) = k \times b_k^*$  where  $b_k^* = \max_v v \pi_k(v)$ . As  $v_i \sim U[0, 1]$ , we have  $v_k^* = \frac{m}{k}$  (where  $v_k^* = \operatorname{argmax}_v \{v \pi_k(v)\}$ ) and thus:

$$C(k) = m \times \pi_k\left(\frac{m}{k}\right).$$

And we can show that  $\pi_k\left(\frac{m}{k}\right)$  is decreasing in  $k$ . □

## Proposition 2, generalization

If  $n > m$ , the vote buyer will always bribe a supermajority  $k^* > m$ .

*Proof.*

$$\begin{aligned} C(m+1) &= (m+1) \times \max_{v \in [0, v_{max}]} \{v \times m(F(v))^{m-1}(1-F(v))\} \\ &< (m+1) \times v_{max} \times \max_{v \in [0, v_{max}]} \{m(F(v))^{m-1}(1-F(v))\} \end{aligned}$$

Thus we have  $C(m) - C(m+1)$  bounded below by

$$\begin{aligned} Z &:= mv_{max} - (m+1)v_{max} \times \max_{v \in [0, v_{max}]} \{m \times (F(v))^{m-1}(1-F(v))\} \\ &= mv_{max} - (m+1)v_{max} \left(\frac{m-1}{m}\right)^{m-1} \end{aligned}$$

where the last line follows from solving the maximization problem. It is sufficient to show that  $Z > 0$ , which is true for  $m \geq 2$ . Thus,  $C(m) - C(m+1) > 0$ . □

**Proposition 3**

*Note: This proof is not specific to the uniform distribution. The proposition generalizes to all distributions except that the cost can be weakly decreasing in  $n$  if the vote buyer does not bribe the full committee. More precisely, an increase in  $n$  has no impact on cost if the optimal coalition size is smaller than  $n$  before and after the change.*

*Proof. i. The cost for the vote buyer is decreasing in the number of committee members  $n$ .*

We argue in the text that the cost is increasing in  $n$ .

*ii. The cost for the vote buyer is increasing in the majority requirement  $m$ .*

As regards  $m$ , we have

$$\hat{C}(m) = \min_k \left\{ k \times \max_v \left[ v \binom{k-1}{m-1} F(v)^{m-1} (1-F(v))^{k-m} \right] \right\}.$$

By the envelope theorem, we have  $\frac{dC(m)}{dm} = \frac{\partial C(m)}{\partial m}$  and hence algebra yields

$$\frac{dC(m)}{dm} \propto \log(F(v^*)) - \log(1-F(v^*)) + \psi^{(0)}(k^* - m + 1) - \psi^{(0)}(m), \quad (1.6)$$

where  $k^*$  and  $v^*$  are the relevant solutions in the nested optimization problems. Assume for now that  $v_i \sim U[0, 1]$ ; then  $v^* = \frac{m}{k}$  and

$$\frac{dC(m)}{dm} > 0 \text{ if } \log(m) - \log(k^* - m) + \psi^{(0)}(k^* - m + 1) - \psi^{(0)}(m) > 0$$

But from e.g. Qi and Guo (2016) we have  $\psi^{(0)}(m) - \log(m) < -1/(2m)$  and

$$\psi^{(0)}(k - m + 1) - \log(k - m) > \frac{1}{2(k - m)} - \frac{1}{12(k - m)^2}.$$

We can solve the resulting inequality to confirm<sup>13</sup> that  $\frac{dC(m)}{dm} > 0$ .

Finally note that from Lemma 7, we know that  $\tilde{F}(\tilde{v}^*) > \frac{m}{k}$  for any distribution  $\tilde{F}(\cdot)$  more dispersed than the uniform distribution. The required result follows immediately.

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<sup>13</sup>The specified bounds on  $\psi^{(0)}(\cdot)$  only allow us to conclude this if  $k > 3$ , but tighter bounds are easily available from the same paper.

iii. The cost for the vote buyer is increasing and sub-linear in committee scale, i.e. if both  $n$  and  $m$  are scaled by a factor  $s$ , the cost for the vote buyer is multiplied by less than  $s$ .

Consider a committee of size  $n$  with majority rule  $m$  and suppose that the vote buyer optimally offers  $b^*$  to  $k^*$  members. The cost for the vote buyer is:

$$C(k^*) = k^* \times b^*$$

Now take a committee of size  $s \times n$  with majority  $s \times m$  and suppose that the vote buyer wants to buy a coalition of size  $s \times k^*$ . Moreover, suppose that  $s \times n$ ,  $s \times m$  and  $s \times k^*$  are all integers. The new cost for the vote buyer would be

$$\bar{C}(s \times k^*) = (k^* \times s) \times \bar{b}^*,$$

where  $\bar{b}^*$  refers to the optimal bribe that the vote buyer should pay in this environment. We notice that this expression is an upper bound for the optimal cost because the vote buyer might prefer another coalition size. For our claim, it is sufficient to show that  $\bar{C}(s \times k^*) < s \times C(k^*)$ . To see that, let's focus on the optimal bribe in the scaled committee  $\bar{b}^*$ . Using the geometric characterization provided in the main text,  $\bar{b}^*$  can be seen as the largest rectangle in the plane  $(\bar{\pi}(v), v)$  where  $\bar{\pi}(v)$  is the pivotal probability in the new setup:

$$\bar{\pi}(v) = \binom{s \times k - 1}{s \times m - 1} F(v)^{s \times m - 1} (1 - F(v))^{s \times (k - m)}.$$

To complete the proof, we need to show that the pivotal probability is decreasing in  $s$  for all  $v \in [0, 1]$ . To see that, we use the following property of binomial distributions:

**Lemma 8.** *If  $x \sim \text{Binomial}(\alpha n, p)$ , then  $\mathbb{P}(x = \alpha k)$  is weakly decreasing for  $\alpha > 1$ .*

*Proof.* As  $\mathbb{P}(x = \alpha k) = \binom{\alpha n}{\alpha k} p^{\alpha k} (1 - p)^{\alpha(n - k)}$ , we have

$$\begin{aligned} \frac{\partial \mathbb{P}(x = \alpha k)}{\partial \alpha} &= -(1 - p)^{\alpha(n - k)} p^{\alpha k} \binom{\alpha n}{\alpha k} \left[ (n - k) \psi^{(0)}(\alpha(n - k) + 1) \right. \\ &\quad \left. + (k - n) \log(1 - p) - k \log(p) + k \psi^{(0)}(\alpha k + 1) - n \psi^{(0)}(\alpha n + 1) \right]. \end{aligned}$$

If the term in square brackets is always weakly positive, then we are done. But note

$$\frac{\partial[\cdot]}{\partial p} = \frac{n - k}{1 - p} - \frac{k}{p},$$

whence there is a unique local minimum of the square bracket term at  $p^* = \frac{k}{n}$  (SOC confirms this). Now if  $p \rightarrow 0$  or if  $p \rightarrow 1$ ,  $[\cdot] \rightarrow \infty$ ; thus, to ensure  $[\cdot] > 0$  everywhere it suffices to check the minimum. At  $p = \frac{k}{n}$  we have

$$[\cdot] = (n - k) \{ \psi^{(0)}(\alpha(n - k) + 1) - \log(n - k) \} \\ + k \{ \psi^{(0)}(\alpha k + 1) - \log(k) \} - n \{ \psi^{(0)}(\alpha n + 1) - \log(n) \}.$$

If we let  $f(x) = \psi^{(0)}(\alpha x + 1) - \log(x)$ , it suffices to show that

$$\frac{n}{k} \geq \frac{f(n - k) - f(k)}{f(n - k) - f(n)}$$

As  $f(\cdot) > 0$ ,  $f'(\cdot) < 0$ , we have  $\frac{f(n-k)-f(k)}{f(n-k)-f(n)} \leq 1$ ; thus, we are done. □

As a direct result of **Lemma 8**,  $\frac{\partial \bar{\pi}(v)}{\partial s} < 0$ . This result is intuitive: for any voting cutoff, the pivotal probability becomes smaller when we increase the size of the committee. We thus have  $\bar{\pi}(v) < \pi(v)$  which implies that  $\bar{b}^* < b^*$  according to the geometric characterization of the optimal bribe. Combining this with the expression of the cost, we have  $\bar{C}(s \times k^*) < s \times C(k^*)$  which proves the claim. □

#### Lemma 4

*Proof.* Consider Table 1.1.

- In any subgame where  $x \leq 0$ , the proposal will pass and any bribe must be accepted.
- In any subgame where  $x > y + 1$ , the proposal cannot pass and any bribe must be accepted.
- Consider the subgames where  $x = 1$ . Let  $P^+(y)$  be the probability that the proposal is accepted by the remaining members if he votes against it. The member to play at subgame  $S(1, y)$  faces the following arbitrage:

$$a = 1 \quad \rightarrow \quad b - v_i \\ a = 0 \quad \rightarrow \quad -v_i \times P^+(y)$$

He will thus accept if  $v_i < \min\{\frac{b}{1-P^+(y)}, 1\}$ . If  $\frac{b}{1-P^+(y)} > 1$ ,  $P^+(y+1) = 1$ : the member playing before knows that the proposal will be accepted for sure by the next player if he votes against. If  $P^+(y+1) < 1$  we have:

$$\begin{aligned} P^+(y+1) &= \frac{b}{1-P^+(y)} + \left(1 - \frac{b}{1-P^+(y)}\right) P^+(y) \\ &= P^+(y) + b \end{aligned}$$

We also know that  $P^+(1) = b$ . As a result,  $P^+(y) = yb$ . We can therefore reformulate the tradeoff at subgame  $S(1, y)$  and see that the member to play will accept if  $v < \min\{\frac{b}{1-yb}, 1\}$ .

- It remains to check that in any subgame  $S(x, y)$ ,  $1 < x < y$ , the member to play prefers to accept. Consider a subgame  $S(2, y)$  where  $P^+(y) < 1$ . Moreover, suppose that at  $S(2, y-1)$ , the player accepts for sure.

$$\begin{aligned} a = 1 &\rightarrow b - v_i \times P^+(y) \\ a = 0 &\rightarrow -v_i \times P^+(y-1) \end{aligned}$$

Substituting the value for  $P^+$ , it implies that the member to play at  $S(2, y)$  will accept if  $v < 1$ , which is true (potentially, type  $v = 1$  could mix but this event has 0-mass and can be neglected). It remains to check that the member to play at  $S(2, y-1)$  would accept. Notice that at  $S(2, 1)$ , the member to play would get  $b - v_i P^+(1) = b - v_i b$  if he votes for and 0 if he votes against (the proposal would be rejected for sure). As a result, he will vote for if  $v_i < 1$ , which is also true. Iterating this implies that any member to play in a subgame  $S(2, y)$  will vote for the proposal. The same argument applies to any subgame  $S(x, y)$ ,  $1 < x \leq y+1$  and the member to play must accept the proposal.

□

### Example 1

*Proof.* The vote buyer wants to minimize her payment subject to every agent voting in favor of her proposal; as before, every agent votes in favor of her proposal in any type-symmetric equilibrium as long as there is no cutoff  $v$  at which she is indifferent between voting in favor or against. Thus, the vote buyer solves

$$\min_{b_0, b_1, b_2, b_3} 3b_3 \text{ s.t. } \forall v : EU(v) > 0,$$

where

$$EU(v) = \binom{2}{2}v^2(b_3 - b_2) + \binom{2}{1}v(1-v)(-v - b_1 + b_2) + \binom{2}{0}(1-v)^2(b_1 - b_0)$$

is the expected benefit from voting in favor of the proposal over voting against. We can note immediately that  $b_0^* = 0$ .

We now check the stationary points of  $EU$  considered as a function of  $v$ ; simple algebra establishes that there is one maximum and one minimum. Thus, to ensure  $EU$  never crosses the x-axis, it suffices to ensure that  $EU$  lies above 0 at 0, at 1 and at its minimum: we require  $b_1 > 0$ ,  $b_3 > b_2$  and  $EU > 0$  at

$$v^* = \frac{1}{6} \left( \sqrt{(3b_1 - 3b_2 + b_3 - 2)^2 - 12(b_2 - 2b_1)} - 3b_1 + 3b_2 - b_3 + 2 \right).$$

Denote by  $EU^* = EU|_{v=v^*}$ . We can show that  $\frac{\partial EU^*}{\partial b_1} < 0$ , so we will set  $b_1 = \epsilon$  (as it needs to be positive). Plugging this back into  $EU^*$  we get

$$\begin{aligned} EU^* &= 3b_2 \left( \sqrt{9b_2^2 - 6b_2b_3 + (b_3 - 2)^2} + 3b_2 - 2b_3 - 4 \right) \\ &\quad - (b_3 - 2) \left( \sqrt{9b_2^2 - 6b_2b_3 + (b_3 - 2)^2} - b_3 + 2 \right) \end{aligned}$$

We can check that the derivative of  $EU^*$  wrt  $b_3$  is now negative; thus, given  $b_2$  we will set  $b_3$  such as to ensure  $EU^* = 0$ . We can thus solve  $EU^* = 0$  to find  $b_3$  as a function of  $b_2$ : this yields

$$b_3 = 2 - 4\sqrt{b_2} + 3b_2.$$

We finally minimize  $b_3$  with respect to  $b_2$  and we find  $b_2 = 4/9$ . Thus  $b_3 = 2/3$ .  $\square$

### Proposition 6

*Proof.* The optimal choice of  $k$  is the solution to:

$$\min_k \left\{ kv^* \binom{k-1}{m-1} F(v^*)^{m-1} [1 - F(v^*)]^{k-m} \right\}$$

where we consider  $v^*$  as an implicit variable of  $k$ . Using the envelope theorem, we can write a simplified FOC

$$1/k + \psi^{(0)}(k) - \psi^{(0)}(k - m + 1) + \text{Log}(1 - F(v^*)) = 0$$

where we have multiplied by strictly positive terms to eliminate their inverse. But now from Lemma 7 above we know that  $\tilde{F}(\tilde{v}^*) > F(v^*)$ . Thus, the FOC under the more dispersed distribution lies below the FOC under the old distribution at the (old) optimal  $k^*$ . Given that it can be verified that the cost function admits at most one local minimum, this is sufficient to conclude that the (new) optimal  $k^*$  needs to be larger. □

### Proposition 7

*Proof.* Most of the proof is in the main text. It remains to formally show that  $\pi(v)$  and  $\tilde{\pi}(v)$  exhibit the following properties:

1. The two functions have the same value at their maximum.

We have

$$\frac{\partial \pi(v)}{\partial F(v)} = \binom{k-1}{m-1} (F(v))^{m-2} (1-F(v))^{k-m-1} [m-1 + F(v)(1-k)].$$

For any distribution function, the pivotal probability is single peaked and is maximized for  $F(v) = \frac{m-1}{k-1}$ . For a given combination  $(k, m)$ , the value of  $\bar{\pi}$  at the maximum hence does not depend on the distribution function.

2. The maximum of  $\tilde{\pi}(v)$  is reached for a smaller  $v$  than the maximum of  $\pi(v)$ .  
The maximum of the  $\pi(\cdot)$  function is reached for  $F(v) = \frac{m-1}{k-1}$ . We necessarily have  $k \leq n$ . Given that  $\frac{m-1}{n-1} \geq \alpha$ , for any  $k \leq n$ ,  $F^{-1}\left(\frac{m-1}{k-1}\right) \leq \tilde{F}^{-1}\left(\frac{m-1}{k-1}\right)$ .
3. At the right of the maximum of  $\tilde{\pi}(v)$ , the two functions cross once at  $\bar{v}$ .  
Consider  $\pi(v)$  and  $\tilde{\pi}(v)$  between the maximums of the two functions.  $\pi(v)$  has value  $\bar{\pi}$  at the lower bound of the interval and is continuously decreasing.  $\tilde{\pi}(v)$  is continuously increasing and has value  $\bar{\pi}$  on the upper bound. By intermediate value theorem, the two functions cross exactly once between their respective maximum. The next point guarantees that there is no other crossing for larger  $v$ .
4.  $\pi(v)$  lies above  $\tilde{\pi}(v)$  for  $v > \bar{v}$ .  
To the right of the maximum of  $\tilde{\pi}(v)$ ,  $\tilde{\pi}(v) > \pi(v)$  because  $F(v) > \tilde{F}(v)$ .

□

**Proposition 8**

*Proof.* As we are in an interior equilibrium, we can write

$$\begin{aligned} v_1\pi_1 &= b_1, \\ &\vdots \\ v_n\pi_n &= b_n. \end{aligned}$$

Taking total derivatives yields:

$$\begin{aligned} dv_1\pi_1 + v_1 \sum_{s=1}^n \frac{\partial\pi_1}{\partial v_s} dv_s &= db_1, \\ &\vdots \\ dv_n\pi_n + v_n \sum_{s=1}^n \frac{\partial\pi_n}{\partial v_s} dv_s &= db_n. \end{aligned}$$

Now set  $dv_1 = -dv_n$ ,  $dv_k = 0$  for  $1 < k < n$  and sum all the equations; this yields

$$\sum_i db_i = dv_1 \left[ \pi_1 - \pi_n + \left( \sum_{j=1}^n v_j \left[ \frac{\partial\pi_j}{\partial v_1} - \frac{\partial\pi_j}{\partial v_n} \right] \right) \right]$$

However, note that

$$\begin{aligned} \sum_{j=1}^n v_j \frac{\partial\pi_j}{\partial v_1} &= \sum_{j=1}^n \left( v_j [f_{k-2}(m-2; v^{1j}) - f_{k-2}(m-1; v^{1j})] \right) \\ &= \sum_{j=1}^n \mathbb{P}(j \text{ votes } + \text{ and } \# \text{ votes w/o } 1 = m-1) \\ &\quad - \sum_{j=1}^n \mathbb{P}(j \text{ votes } + \text{ and } \# \text{ votes w/o } 1 = m) \\ &= (m-1)f_{k-1}(m-1; v^1) - mf_{k-1}(m; v^1) \end{aligned}$$

By a perfectly analogous argument we can find an expression for  $\sum_{j=1}^n v_j \frac{\partial\pi_j}{\partial v_n}$ ; putting everything together yields

$$\sum_i db_i = mdv_1 \left[ \left( f_{k-1}(m-1; v^1) - f_{k-1}(m; v^1) \right) - \left( f_{k-1}(m-1; v^n) - f_{k-1}(m; v^n) \right) \right].$$

But as long as  $\sum v_i = m$ , we can now employ Theorem 1 in Samuels (1965): we

immediately have

$$f_{k-1}(m-1; v^1) < f_{k-1}(m; v^1) \text{ and } f_{k-1}(m-1; v^n) > f_{k-1}(m; v^n).$$

We conclude that  $\sum db_i < 0$ . □

### Proposition 9

*Proof.* Suppose that the vote buyer offers positive bribes to exactly  $m$  players (bribing the minimal winning coalition is not necessarily the optimal strategy but the focus is sufficient for the proof). Her expected utility is:

$$U_{\text{VB}}(v) = W \times v^m - b(v) \times \mathbb{E}(\#\text{votes for} | v, m).$$

For the minimal winning coalition,  $b(v) = v\pi(v) = v^m$ .  $\mathbb{E}(\#\text{votes for} | v, m) = m \times v$  because it is the expected number of successes of a binomial variable with parameters  $m$  and  $v$ . Thus,

$$U_{\text{VB}}(v) = v^m \{W - m \times v\}$$

As a result, for any  $W > 0$ ,  $U_{\text{VB}}(v) > 0$  if  $v < \frac{W}{m}$ . This implies that not bribing at all can never be optimal for the vote buyer. □

### Lemma 6

*Proof.* We can write the VB objective function as

$$\begin{aligned} \Pi(v, k) &:= W \times \mathbb{P}(\text{proposal passed}) - kb^*(v) \times \mathbb{P}(\text{a bribed member votes in favour}) \\ &= W \sum_{x=m}^n \binom{k}{x} v^x (1-v)^{k-x} - kv^2 \binom{k-1}{m-1} v^{m-1} (1-v)^{k-m}. \end{aligned}$$

Taking the first-order conditions wrt  $v$  yields local extrema at

$$v^* = \frac{m+1+W \pm \sqrt{-4(1+k)W + (m+1+W)^2}}{2(1+k)}.$$

The sign of  $\frac{\partial \Pi}{\partial v}$  does not depend on  $v$  if the discriminant is negative. Thus, as long as

$$W \in \left[ 1 + 2k - m - 2\sqrt{k + k^2 - m - km}, 1 + 2k - m + 2\sqrt{k + k^2 - m - km} \right],$$

the vote buyer will either not want to bribe at all or bribe breakdown. Furthermore, if the lower of the  $v^*$  exceeds  $\frac{m}{k}$ , again the derivative never changes sign on the region of interest. This happens if

$$W > 1 + 2k - m + 2\sqrt{k + k^2 - m - km},$$

whence we can conclude that  $W > 1 + 2k - m - 2\sqrt{k + k^2 - m - km}$  is sufficient for the vote buyer to employ a breakdown strategy conditional on bribing at all. We have to check this inequality separately for each  $k$  to ensure that for no  $k$  does the vote buyer prefer an interior strategy. Thus, the true lower bound is the maximum of the RHS of the inequality wrt  $k$ . It is easy to show that the RHS is strictly decreasing in  $k$ ; the lowest admissible  $k$  is  $m$ . Thus, we obtain the desired result. □



## Chapter 2

# Voting and contributing when the group is watching

This chapter is co-authored with Emeric Henry (Sciences Po)

### Abstract

*Members of groups and organizations often have to decide on rules that regulate their contributions to common tasks. They typically differ in their propensity to contribute and often care about the image they project, in particular want to be perceived by other group members as being high contributors. In such environments we study the interaction between the way members vote on rules and their subsequent contribution decisions. We show that multiple norms can emerge. We characterize the socially optimal level of sanctions to be submitted to a vote by the social planner and discuss optimal voting rules.*

## 2.1 Introduction

In May 2009, the elected members of the French *Assemblée Nationale* (French Parliament) voted a law imposing sanctions for those among them not attending weekly meetings of committees. Even without sanctions, some legislators would have attended, driven by an individual sense of duty or a concern for the image the group, and potentially the electorate, has of them. Sanctions nevertheless significantly increased attendance: from an average of 7 meetings attended per year, it jumped to 19 meetings. Moreover there appeared to be a systematic link between the way parliamentaries voted on sanctions and the way they behaved after that.

Similarly, most members of groups and organizations (firms, NGOs, academic departments...) choose the rules that govern their interactions, in particular those regulating tasks with group externalities, such as attending meetings, writing reports or participating in team work. One important driver of contributions to common tasks are image concerns, i.e caring about how the group perceives you. For instance Ariely et al. (2009) show that efforts made to contribute to a good cause are much higher when individuals are observed by others.

In the presence of image concerns, we study how group members vote on rules and subsequently behave. There is a close interaction between voting behavior and contribution decisions. A sanction, by increasing overall contributions, decreases the honor derived from being seen contributing. Thus voting affects the calculus of reputation. In turn, when votes are public, concern for image will affect voting behavior. Uncovering the subtle interactions inherent in these environments is the object of this paper and allows us to draw policy implications in terms of socially optimal level of sanctions to be submitted to a vote and optimal voting rules.

Specifically, we study a model that includes two stages involving the same group of players. In the second stage players simultaneously choose whether to contribute or not to a public good. Each individual contribution provides a positive externality  $e$  shared among the rest of the group. In the first stage, the same players vote on a given sanction  $s$  to be imposed in the second stage to non contributors. Group members are heterogenous in their intrinsic propensity to contribute, what we call their type, but all members want the group to perceive them as having a high type, i.e they have image concerns. These inferences made by the group are based on observed actions. In most of the paper, we consider situations where the vote is secret and the action observed by others is the contribution decision. Later in the paper, we examine instances where only the vote is public and the inferences of others are based exclusively on voting behavior. Finally we discuss the case where both decisions are

public<sup>1</sup>.

In the public good contribution stage, for a given level of sanction  $s$ , three categories of members emerge. Those with a high type, called always-participants, contribute regardless of whether the sanction was voted or not. Those with a low type, called never-participants, never contribute. Finally those with intermediate values, called swing-participants, contribute if and only if the sanction was voted.

In the voting phase, the members of these three groups have different incentives. We first show that it can be a dominant strategy for always participants to vote against the sanction, even though the sanction will never apply to them. Indeed, even though these members gain from a sanction because other group members increase their contribution and thus impose a positive externality, they however lose in reputation as taking the action is no longer so rare that it signals a high intrinsic value. If the sensitivity to reputation is sufficiently high, these members will vote against the sanction. If the externality gain is big enough they will however vote in favor.

Furthermore we show that, in spite of the very different motivations of the three categories of members, always participants necessarily have higher incentives to vote in favor than the swing participants who themselves have higher incentives than the never participants. We thus find that the equilibrium in pure and symmetric strategies is of the cutoff form where members vote for the sanction if and only if their type is above a cutoff value  $V^*$ . We show that there can exist several equilibria, that can be interpreted as corresponding to different norms of behavior: some with a high  $V^*$ , i.e groups tending to vote against sanctions under the self realized expectation that the gain in additional public good is low and norms with a low  $V^*$  where group members are more likely to vote for sanctions as they expect higher benefits.

Technically, the multiplicity is linked to the information aggregated when voters consider the case where their vote is pivotal. The gain from a sanction comes from the additional public good provided in the second stage. The only types that change their actions depending on the sanction are the swing participants. Thus, to evaluate the benefit of the sanction, individuals need to estimate the number of swing participants in the group. We find that the information aggregated on the proportion of swing participants in the group can generate the multiplicity of equilibria mentioned above.

We then turn to the characterization of the socially optimal level of sanctions. Consider a benchmark case where the sanction proposed by the social planner is not submitted to a vote. In this case the first best can be achieved by setting a sanction  $s$  equal to  $e$ , to force contributors to internalize the externality. When voting is introduced, it can be optimal to deviate from that level of sanction: there is of

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<sup>1</sup>We also examine in Supplementary Appendix B3 a setup where everything is secret.

course an ex post loss in the contribution phase, but a potential ex ante gain, if the probability of acceptance can be increased by changing  $s$ .

In the case without image concerns and when sanctions are submitted to a vote, we show that the socially optimal level of sanctions is weakly above  $e$  and strictly so in most cases. Indeed in this case the probability of acceptance is increasing in the sanction: an increase in the sanction, raises the expected positive externality voters expect from having the sanction in place and thus makes them more inclined to vote in favor. On the contrary, when group members have image concerns, the optimal level of sanctions is below the level without voting if image concerns are high enough. In this case, higher sanctions make group members less inclined to vote in favor since the honor derived from contributing will then be lower. Thus, the social planner has an incentive to set the sanction below the level optimal without voting.

We then turn to the case where the individual votes are public, but the contributions are kept secret. There is then a reputation payoff attached to the vote (regardless of whether the member is pivotal or not) that has to be traded off against the probability of being pivotal. We find that the voting equilibrium is again characterized by a cutoff, since the members with a higher type have more to gain from the sanction. We show also that as the size of the group increases, sanctions will tend to be approved regardless of their size: the probability of being pivotal goes to zero and the only motivation that remains is to vote in the way sanctioned by the social norm. This is consistent with a large body of anecdotal evidence suggesting that the shift from secret to public evidence increases the consensus in voting (for instance Elster (2015) case of the EU council of ministers discussed in section 5).

We finally examine the case where both votes and contributions are observable. We show that the equilibrium is no longer necessarily of the cutoff type, given that the members now have two ways of signaling their type. It is possible that low types vote against and don't contribute, intermediate types vote for and don't contribute while high types vote against and contribute.

Bénabou and Tirole (2011) is the paper closest to ours. They examine a public good problem, very similar to the second stage of our model, and show how the calculus of honor and stigma can be derived. Their key focus is on how an informed principal can optimally set incentives. They also examine the case where the choice of the principal reveals information about the societies values. We take a different stance and examine instances where the rules are endogenously determined by the group, not set by a principal. Such situations are of high practical relevance and furthermore lead to subtle theoretical interactions. We show how the law can shape the calculus of honor and how in turn social norms can influence voting. We derive

## *Chapter 2. Voting and contributing when the group is watching*

predictions on the effect of different institutional features.

There is in fact quite a large experimental literature examining the difference between exogenously and endogenously set sanctions on future behavior. Part of the literature (Galbiati and Vertova, 2008 and Galbiati et al., 2013) examines the case where the designer who decides on the sanction is informed, contrary to our setting, which relates to the expressive nature of the law that motivates Bénabou and Tirole (2011). Tyran and Feld (2006) consider an experimental setting closer to our model and show that if the group votes for the sanction (rather than have a sanction exogenously imposed), it is followed by higher contributions. We return to that evidence in the conclusion.

Our paper is also closely related to the literature on strategic voting and information aggregation in voting, where the initial motivation was to revisit the Condorcet jury theorem when including strategic concerns (Austen-Smith and Banks, 1996, Feddersen and Pesendorfer, 1996, 1997, 1998). To the best of our knowledge, in all the papers in this literature, the benefits of the law submitted to a vote is exogenously given (but not publicly observed). In our public good setting, the benefit of the sanction is endogenously determined by how voters react to it. This leads to a multiplicity of equilibria not present in the rest of the literature.<sup>2</sup>

There is also a growing literature on aggregation of information in committees when individuals have career concerns. The key distinction between our environment and the type of setups the career concern literature (Ottaviani and Sørensen, 2001, Visser and Swank, 2007) is that our model can be seen as a first model where agents take initial actions in order to enhance the reputational value of future actions. For instance in Midjord et al. (2017), privately informed agents vote on an approval decision and get a negative reputation payoff (of fixed value) if the outcome is to approve and the state was in fact bad. They show that this will lead the committee to be overly cautious and in the limit when the size is large, will lead to sure rejection. This relates to our result in the case of public voting, where we show that for large organizations sanctions are always adopted, except that in our case the reputation payoff is endogenously determined.

In a related paper, Godefroy and Perez-Richet (2013) consider a sequence of two votes in a committee with privately informed voters, the first to select the issue to be submitted to a vote and a second to vote on approval of this issue versus status quo. They focus on the effect of the supermajority requirement in the selection stage on

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<sup>2</sup>One exception is Callander (2008) who examines a model where privately informed voter want to elect the best candidate but also want to vote for the winner. The source of multiplicity is very different: if the rest of the group is more likely to vote against their signal, it also makes sense to do so as there is a desire to be on the winning side.

voting behavior and show that a more conservative rule implies more conservative voting behavior. Similarly, in section 4.2, we show that in our very different setting, the supermajority requirement in the first stage can have unexpected implications on voting behavior due to information aggregation properties, but the mechanics of information aggregation are quite different. In fact, in our setting we find that a more stringent rule can make voters more inclined to vote for the sanction. Even more surprisingly, a more conservative rule can make overall approval more likely.

One of the key elements of the model is the fact that individuals care about the image others have of them, what has been coined image concerns. Many papers, in the lab or in the field, establish empirically the importance of these image concerns. Ariely et al. (2009) for instance compare effort levels in treatments that varied in three dimensions: subjects were either observed or unobserved, received monetary incentives or not and contributed either to a “good cause” (Red Cross) or a “bad one” (NRA). They find that being observed increased effort levels only when subjects did not receive monetary incentives or when they volunteered for a good cause. DellaVigna et al. (2012) show that notifying residents in advance of the exact time of solicitation in a door to door fundraiser significantly decreases the share of households opening doors, one possible interpretation being that image concerned individuals attempt to avoid the pressure.<sup>3</sup>

There is also extensive laboratory experiment. Andreoni and Petrie (2004) find that contributions in a public goods game increased when the players were not anonymous. Dana et al. (2006) offer participants a costly option to opt out of a dictator game and show that giving in the dictator game is in part motivated by participants not wanting to appear selfish. In the same spirit, other contributions (Rege and Telle, 2004, Samek and Sheremeta, 2014), find that providing options for the participants to overcome their moral dilemmas significantly lowers transfers.

The rest of the paper is organized as follows. In section 2 we present the model, in section 3 we derive results for the case of a secret vote but an observable contribution. We discuss the social optimal choice of the sanction in section 4. In section 5 we examine other visibility setups. Finally we discuss empirical implications in section 6 and conclude.

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<sup>3</sup>Henry and Louis-Sidois (2015) propose an experimental game to measure individual sensitivity to image concerns and show that image concerned individuals often try to avoid situation where their reputation is at risk. Note that there are also instances where image concerns don't seem to play a role, such as Gill et al. (2015).

## 2.2 Model

We consider a two stage game involving  $2N + 1$  players. In the first stage, a rule (or law in certain contexts) is submitted to a vote. The rule specifies a sanction  $s > 0$  (given to the group) that will be imposed in case of free riding in the public good stage that follows.<sup>4</sup>

All players cast their vote simultaneously. The voting decision of individual  $i$  is denoted  $b_i \in \{0, 1\}$  (where  $b$  stands for ballot). If strictly more than  $K$  voters vote in favor, the sanction is adopted. For most of the paper we consider the case of majority rule, i.e  $K = N$ . The outcome of the vote is publicly revealed and the players then simultaneously decide, in a second stage of the game, whether to contribute or not to the public good. Individual  $i$ 's contribution is denoted  $a_i$ , where  $a_i \in \{0, 1\}$ .

For a given approved sanction  $s$  and a given vector of contributions to the public good  $a = \{a_1, a_2, \dots, a_{2N+1}\}$ , the utility of player  $i$  is given by:

$$U_i = (v_i - c)a_i - s(1 - a_i) + e^{\frac{\sum_{j \neq i} a_j}{2N}} + \mu E[v_i | y_i]$$

Individual  $i$  gets an intrinsic benefit of contributing to the public good, denoted  $v_i$ , which characterizes the type of the individual. This intrinsic motivation (as in Bénabou and Tirole, 2011) can in particular be linked to the player's level of altruism, since all contributions benefit others.<sup>5</sup> There is also a cost of contribution  $c$  common to the whole population. If a sanction is in place, there will be an additional cost for those not contributing  $s(1 - a_i)$ .<sup>6</sup> In addition, there is an externality gain derived from the contributions of others  $e^{\frac{\sum_{j \neq i} a_j}{2N}}$ .<sup>7</sup>

Finally, the utility contains a less standard term,  $\mu E[v_i | y_i]$ , which corresponds to a reputation or image concern.<sup>8</sup> Actions reveal information on the underlying value of  $v_i$ , the intrinsic motivation of each agent. Individuals privately observe their  $v_i$ , what we will call their type. Specifically  $v_i$  are i.i.d. drawn from the distribution of

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<sup>4</sup>Note that the case of a bonus for contributing would lead to very similar results (discussed in the supplementary appendix).

<sup>5</sup>It could also represent the efficiency of the individual in providing the public good. The only important feature for us is that a higher value of  $v_i$  is viewed positively by the rest of the group.

<sup>6</sup>From the point of view of group members, the sanctions is a pure loss, in particular is not redistributed to the group. We did not want to add this extra consideration that would make our message less clear. In the planner section, we consider that the sanctions are redistributed to the rest of society without deadweight loss so that paying the sanction is welfare neutral but group members never consider the impact of their actions on redistribution.

<sup>7</sup>We consider in the Supplementary Appendix the case where the production of the public good involves complementarities.

<sup>8</sup>Group members can value reputation per se because they care about the perception others have of them, or this reputation might have future consequences not explicitly specified in the model, as in the case of politicians and voters.

types  $f(v)$  with support  $[v_{min}, v_{max}]$ , continuously differentiable with  $f(v) > 0$ . The reputation term  $E[v_i|y_i]$  is thus the expected value of  $v_i$  given action  $y_i$  using the distribution of types  $f$ .<sup>9</sup> Agents want to be perceived as intrinsically motivated.

For most of the paper we consider the case where the vote is secret but the contribution is observable, i.e  $y_i = a_i$ , an environment we call *public contributions*. We discuss in section 2.5 the case where individual votes are revealed but the individual contributions are kept secret, i.e  $y_i = b_i$ , which we call *public vote*. Finally we consider the case where both votes and contributions are publicly revealed  $y_i = (a_i, b_i)$ , in Supplementary Appendix B4.

The timing of the game is thus the following:

1. Types are drawn and privately observed.
2. Players vote on the rule with no abstention. The outcome of the vote is publicly revealed.
3. Players then simultaneously decide on their contribution decision.

We focus on symmetric Perfect Bayesian Nash equilibria (where players with the same type choose the same strategy).

## 2.3 Voting on sanctions: secret votes

In most organizations and for most public goods, contributions are directly observable by all group members (for instance participation to meetings, preparation of reports...). The organization might however have in place secret voting. We therefore consider such situations where individual votes are secret, but contributions are publicly observed, what we call the *public contributions* environment.

### 2.3.1 Contribution stage

In the second stage, all players observe whether the sanction was voted or not in the first stage and decide on their contribution to the public good. For a given sanction

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<sup>9</sup>Note that we assume that the expectation is taken with respect to the prior distribution  $f$ . As in Levy (2007), information could in fact be obtained about individual votes from the aggregate result of the vote. The voters could thus update their belief about the type distribution. This would significantly complicate the resolution and increase the multiplicity of equilibria. We thus assume that the expectation is conditioned only on individual observable actions. It appears to us to be a reasonable assumption for this term which in any case is a behavioral component of the utility function: other members do not use the aggregate result to base their belief about individual types when the individual actions are so salient.

$s$  (where  $s = 0$  corresponds to the case where voters turned down the sanction), contributing yields intrinsic benefits and costs as well as the honor of doing the right thing:

$$v_i - c + \mu E[v_i | a_i = 1].$$

Not contributing on the contrary exposes individual  $i$  to a sanction and to the stigma of not contributing:

$$-s + \mu E[v_i | a_i = 0].$$

As in Bénabou and Tirole (2011), using the notation  $\Delta(v_s) = E[v | v > v_s] - E[v | v < v_s]$ , the equilibrium of the voting game is characterized by the following lemma:

**Lemma 1.** *If  $1 + \mu\Delta'(v) > 0$ , in the contribution stage, the unique symmetric Perfect Bayesian Nash equilibrium is such that player  $i$  contributes if and only if  $v_i \geq v_s^*$  where the cutoff is defined by*

$$v_s^* = c - s - \mu\Delta(v_s^*). \quad (2.1)$$

*The cutoff is increasing in  $c$ , decreasing in  $s$  and  $\mu$ .*

The cutoff is increasing in  $c$ , as a more costly contribution reduces the incentives to participate. The cutoff also decreases with the visibility of contribution (or taste for reputation)  $\mu$ , since more pressure worsens the impact the stigma attached to free-riding and thus provides incentives to contribute. Finally, the voting cutoff is decreasing in  $s$  as a higher sanction raises the material cost of free-riding. For the rest of the text, we impose the condition  $1 + \mu\Delta'(v) > 0$ .

### 2.3.2 Voting stage

In the first stage, players have to vote whether or not to approve a given sanction  $s$ . If there is a majority of votes in favor, sanction  $s$  is implemented and players use in the contribution phase a strategy with cutoff  $v_s^*$ , as derived above. On the contrary if a majority votes against the sanction, the players use in equilibrium a strategy with cutoff denoted  $v_0^*$ .<sup>10</sup> According to Lemma 1,  $v_s^* < v_0^*$ .

Given the equilibrium behavior in the public good stage, players can be grouped in three categories:

- *Never-participants* who do not contribute regardless of the outcome of the vote: members with  $v_i < v_s^*$ .

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<sup>10</sup>This cutoff is also defined by equation (2.1) with  $s = 0$ .

- *Swing-participants* who contribute if and only if the sanction is voted: members with  $v_s^* \leq v_i \leq v_0^*$ .
- *Always-participants* who always contribute regardless of the outcome of the vote: members with  $v_i > v_0^*$ .

These different types of individuals have different motivations in voting. One common factor is that they all benefit from a positive externality if the sanction is approved: more players contribute in the second stage under the threat of a sanction, thus providing a benefit for the whole group. Secondly, the never participants can anticipate that, if the sanction is implemented, this will directly decrease their payoff since they will need to pay the sanction.

There is a third factor that determines voting in equilibrium: whether a sanction is voted or not shapes social norms. For those who always contribute, a sanction decreases the honor they derive from doing the right thing since more types will contribute in equilibrium. On the contrary, for the never participants, a sanction increases the stigma attached to not contributing. We now uncover how these different effects interact.

Consider first the always participants (i.e. players with  $v_i > v_0^*$ ). By definition of this category, the outcome of the vote will not affect their own behavior, since regardless of their particular type  $v_i$ , they participate. When considering their voting decision, they thus simply tradeoff the externality gain that a sanction would bring against the decrease in the reputation payoff they obtain from doing an honorable act. It turns out that if  $e$  is low enough, the second effect dominates and they actually have an incentive to vote against the sanction.

**Proposition 1.** *For any sanction  $s$ , there exists a value  $\bar{e}(s)$  such that if  $e \leq \bar{e}(s)$ , it is a weakly dominant strategy for the always-participants to vote against the sanction.*

Proposition 1 shows that group members who in any case contribute to the public good, have an incentive to vote against a sanction that would force the others to participate as well. This is the case if the loss in reputation dominates the gains from increased contributions of the rest of the group. From a policy perspective this result is important. Note that even if the conditions for Proposition 1 are not met, the fact that these individuals always suffer from a loss of reputation if the sanction is passed, means that they have fewer incentives to lobby for regulation than what could be expected at first sight.<sup>11</sup>

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<sup>11</sup>In our model there is of course no lobbying phase or stage where players can exert effort to influence legislation. If we added such a stage, the always-participants might have in fact little incentive to lobby for the regulation.

## Chapter 2. Voting and contributing when the group is watching

However, when  $e$  is larger ( $e > \bar{e}(s)$ ), the always participants have an incentive to vote in favor of the sanction. We now examine more in detail the voting decision, to determine which category of group members is most likely to support the sanction.

The never participants do not change their contribution decision even if the sanction is in place. However a sanction, not only implies for them a financial cost  $s$ , it also creates a loss in reputation from the increased stigma of not contributing ( $\mu(E[v_i|v_i < v_s^*] - E[v_i|v_i < v_0^*])$ ), which is negative since  $v_s^* < v_0^*$ . They however benefit from the expected externality gain obtained if the sanction is approved that we denote  $G$ . This externality gain is the difference between the externality obtained with a sanction and that obtained without:

$$G = e \frac{\mathbb{E} \left[ \sum_{j \neq i} a_j | s > 0 \right]}{2N} - e \frac{\mathbb{E} \left[ \sum_{j \neq i} a_j | s = 0 \right]}{2N}.$$

In equilibrium, the expected externality  $G$  is the same for all group members, regardless of their type (i.e. the same for a never, always or swing participant). Indeed, the types of other players are i.i.d and therefore the expectation about other players actions  $a_j, j \neq i$  are independent of  $i$ 's type. We describe later in this section the exact calculation of  $G$  in equilibrium.

Overall, we find that for the never participants, the difference in expected utility comparing the situation with a sanction to the one without, that we denote  $D(v_i)$ , is given by:

$$D(v_i) = \underbrace{\mu(E[v_i|v_i < v_s^*] - E[v_i|v_i < v_0^*])}_{\text{reputation loss } < 0} - s + G.$$

For the always participants, as explained above, they suffer a loss of reputation that they need to tradeoff against the externality gain. Thus for the always participants, the difference in expected utility  $D(v_i)$ , is given by:

$$D(v_i) = \underbrace{\mu(E[v_i|v_i > v_s^*] - E[v_i|v_i > v_0^*])}_{\text{reputation loss } < 0} + G.$$

Finally, for the swing participants, the decision involves an additional consideration. By definition swing participants contribute if and only if the sanction is in place. Therefore the actual type  $v_i$  will play a role. For this group we find:

$$D(v_i) = \mu(E[v_i|v_i > v_s^*] - E[v_i|v_i < v_0^*]) + v_i - c + G$$

We see that for all types, the difference in utilities  $D(v_i)$  expressed in the above conditions can be written as  $D(v_i) \equiv \mathcal{R}(v_i) + G$ , where  $\mathcal{R}(v_i)$  is the difference in

reputation cost and in direct financial costs, between the case with a sanction and the case without.

Which group has the most incentives to vote in favor of the sanction? the answer is not straightforward. Consider for instance the comparison between the never and always participants. It could a priori be the case that the loss in reputation for the always-participants be greater than for the never participants. This would be the case if  $\Delta(v)$  was increasing in  $v$ , what Bénabou and Tirole (2011) describe as the case of strategic complements. We however show that in equilibrium, even if that were the case, the difference in reputation could not be greater than  $s$ .

**Lemma 2.** *In all symmetric perfect bayesian equilibria:*

1. *If some of the never participants vote in favor of the sanction then all the swing participants and always participants vote in favor.*
2. *If some of the swing participants vote in favor of the sanction, then all the always participants vote in favor.*
3. *If a swing participant of type  $v_i$  votes in favor of the sanction, then all swing participants with type  $v'_i > v_i$  vote in favor.*

Lemma 2 reflects the fact that the function  $\mathcal{R}(v_i)$  is weakly decreasing in  $v_i$ . Types with a higher  $v_i$  have a relatively lower cost of having the sanction accepted. In Figure 1 we plot  $-\mathcal{R}(v_i)$ . The function  $-\mathcal{R}(v_i)$  is flat for always and never participants and strictly decreasing for swing participants.

The result of Lemma 2, strongly suggests that symmetric perfect bayesian equilibria should be of the cutoff form, i.e equilibria characterized by a cutoff  $V^*$  such that a type  $v_i$  votes in favor if and only if  $v_i \geq V^*$ . This is in fact correct only with a small additional constraint that we introduce below. Indeed there can exist other types of equilibria, due to the fact that all never participants (and always participants) face the same tradeoff in voting regardless of their particular type  $v_i$ . Without further constraints, there could therefore exist equilibria where all never participants are indifferent between voting in favor or against, some vote in favor and others against (and all swing and always participants vote in favor). In such an equilibrium the identity of those never participants who vote against is not a priori uniquely pinned down.<sup>12</sup> We thus impose the following additional restriction that states that if two types are indifferent in their voting decision then, if the lower type votes in favor, so does the higher type.

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<sup>12</sup>The specific types of never participants that vote against can be chosen freely under the constraint that the condition of indifference between voting for and against is indeed satisfied.

## Chapter 2. Voting and contributing when the group is watching

**Restriction A (tie breaking):** *If in equilibrium two types  $v_i > v'_i$  are indifferent between voting in favor or against the sanction, then if type  $v'_i$  votes in favor, so does type  $v_i$ .*

Under this minor restriction we obtain the following result:

**Proposition 2.** *Under Restriction A,*

1. *All symmetric perfect bayesian equilibria are cutoff equilibria, characterized by a cutoff  $V^*$ .*
2. *There is at most one equilibrium where the cutoff belongs to the never participants group (resp. always participant group), i.e  $V^* < v_s^*$  (resp  $V^* > v_0^*$ ).*

To understand better the shape of equilibria and the potential multiplicity, we describe what determines the expected externality gain  $G$  in equilibrium. As explained above, for a given equilibrium with cutoff  $V^*$ ,  $G$  takes a unique value, identical for all groups. However, this value  $G$  is not necessarily monotonic in  $V^*$ .

As in the literature on information aggregation in voting (Austen-Smith and Banks, 1996, Feddersen and Pesendorfer, 1996), voters consider only the case where their vote is pivotal. In equilibrium a pivotal voter can infer additional information about the distribution of types.<sup>13</sup> In the simple majority voting case, a player is pivotal when there are exactly  $N$  yes-voters and  $N$  no-voters among the  $2N$  other players. Recall however that to determine the expected externality gain  $G$  from having a sanction, each voter only needs to determine the expected number of swing participants. Indeed they are the only types who change behavior based on whether the sanction is approved or not and they thus determine the added value of having a sanction in place.

Consider the case where the cutoff is among the never participants, i.e  $V^* \leq v_s^*$ . In this case, the no-voters are necessarily never participants, while some of the yes-voters are going to be swing participants. In fact this proportion is the expected probability of being a swing participant  $F(v_0^*) - F(v_s^*)$  conditional on being a yes voter, probability  $1 - F(V^*)$ . Thus for a given cutoff  $V^*$ , given that exactly 1/2 of other group members are yes voters in the case where the vote is pivotal, the expected externality is given by:

$$G(V^*) = \frac{1}{2} e \left[ \frac{F(v_0^*) - F(v_s^*)}{1 - F(V^*)} \right].$$

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<sup>13</sup>A recent experimental literature including Battaglini et al. (2008) and Battaglini et al. (2010) has confirmed that people indeed aggregate information when they vote.

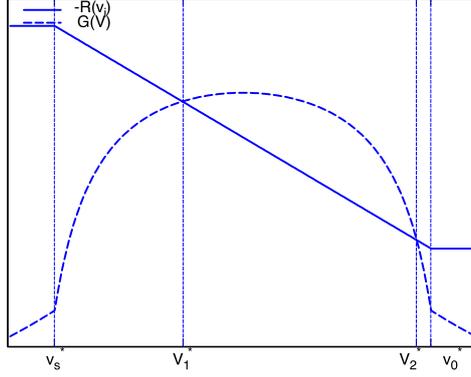


Figure 2.1: Multiple equilibria

This expected externality is strictly increasing in  $V^*$ : indeed, if the cutoff is higher, it becomes more likely that the yes voters are indeed swing participants. This implies the result in Proposition 2 that there can be only one equilibrium in this zone (since  $\mathcal{R}(v_i)$  is flat in this zone as illustrated in Figure 1).

If the cutoff is in the swing participant group, the calculation of  $G$  is slightly more intricate. No-voters can in this case either be swing participants or never participants. Specifically, given a voting cutoff  $V^*$ , the probability that a no voter is a swing participant is given by  $\frac{F(V^*)-F(v_s^*)}{F(V^*)}$ . As  $V^*$  increases, it becomes more likely that a no voter is in fact a swing participant. On the other hand, the probability that a yes voter is a swing participant (and not an always participant), is given by  $\frac{F(v_0^*)-F(V^*)}{1-F(V^*)}$ . As  $V^*$  increases, it becomes less likely that the yes voter is a swing participant. Overall, the expected externality gain is thus given by the following expression:

$$G(V^*) = \frac{1}{2}e \left[ \left( \frac{F(V^*)-F(v_s^*)}{F(V^*)} \right) + \left( \frac{F(v_0^*)-F(V^*)}{1-F(V^*)} \right) \right].$$

The effect of an increase in  $V^*$  on the expected externality gain is ambiguous when  $V^*$  belongs to the swing participant group. As  $V^*$  increases, it becomes more likely that no voters are swing participants but less likely for yes voters, leading to an ambiguous conclusion on the expected number of swing participants, and thus on the size of the externality. This mechanism can generate multiple equilibria with  $V^* \in (v_s^*, v_0^*)$ , i.e the cutoff is among the swing-participants. We call equilibria in this zone *interior equilibria*.

We illustrate this in Figure 1 where we plot both the decreasing function  $-\mathcal{R}(v_i)$  and the function  $G(V^*)$  for the case where  $f$  is uniform.<sup>14</sup> There are two equilibria with cutoffs  $V_1$  and  $V_2$  that corresponds to the intersection of function  $-\mathcal{R}(v_i)$  and

<sup>14</sup>Note that the  $x$  axis is  $v_i$  for  $\mathcal{R}$  and  $V^*$  for  $G$ .

the function  $G(V^*)$ . Indeed the cutoff is characterized by the fact that the cutoff type  $V^*$  is such that  $\mathcal{R}(V^*) + G(V^*) = 0$ . In equilibrium with cutoff  $V_1$ , the pivotal voter expects a large portion of yes voters (to the right of  $V_1$ ) and of no voters (to the left of  $V_1$ ) to be swing participants. The expected externality is thus large and justifies the low voting cutoff. On the contrary in the case of  $V_2$ , it is very unlikely that the yes voters are swing participants, the expected externality is thus lower, justifying the higher cutoff.<sup>15</sup>

These different equilibria can be understood as corresponding to different norms of voting. A norm of opposition to sanctions (high cutoff) might prevail and would be based on a self realized expectation of low externality gain. There could also exist norms of voting more favorable to sanctions (lower cutoff) based on an expectation of a high externality gain. Both these norms would be self sustained due to the mechanisms of information aggregation described above.

Figure 1 shows a case with two equilibria but the multiplicity can be larger in general. We present below conditions (satisfied in the case of the uniform distribution presented in Figure 1), where this multiplicity is reduced.

**Proposition 3.** *Under Restriction A, if  $\frac{f}{1-F}(v)$  is weakly increasing and  $\frac{f}{F}(v)$  is weakly decreasing:*

1. *there are at most two symmetric perfect bayesian equilibria,*
2. *there is a unique stable interior equilibrium.*

The conditions  $\frac{f}{1-F}(v)$  is weakly increasing and  $\frac{f}{F}(v)$  is weakly decreasing, guarantee that the externality gain  $G(V^*)$  is a weakly concave function on the interval  $(v_s^*, v_0^*)$ . Thus there can be at most two equilibria. Furthermore, an interior equilibrium (defined above as  $V^* \in (v_s^*, v_0^*)$ ) is stable if and only if  $G(V)$  is increasing at the equilibrium cutoff.

## 2.4 Planner problem

Having characterized the equilibrium, we discuss in this section the problem faced by the planner if she can choose the sanction. We consider sanctions that create no

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<sup>15</sup>This outcome with multiple equilibria is an interesting feature of our model and, to the best of our knowledge, is not present in the literature on aggregation of information in voting. Consider the classic case where voters get information on an underlying state of the world and the expected payoff is increasing in this state. The type of a voter is the signal he obtains, and like in our model the equilibrium will take the form of a cutoff strategy. In this case, the expected payoff is increasing in the cutoff: a higher cutoff means the information obtained when pivotal indicates a higher state of the world. In our model there can be non monotonicities as suggested above.

deadweight loss and require no enforcement costs, to focus on the main tradeoffs.

Consider first the benchmark of a planner who does not observe the individual types of group members and chooses the sanction without submitting it to a vote. This is a classic problem of regulation of an externality. Each individual contribution creates a positive externality of level  $e$  for the group. The first best requires that a group member  $i$  contributes if and only if  $v_i + e \geq c$  and can thus be implemented in the decentralized equilibrium without voting using a sanction  $s = e$ . The sanction also affects the reputation of the different types, but this does not impact overall expected welfare since reputation is a zero-sum game, as explained for instance in Bénabou and Tirole (2011).

When the planner needs to submit the sanction to a vote, the choice of the socially optimal sanction is affected in two ways. First, the level of the sanction affects the probability of approval. Second, conditional on acceptance, the expected composition of the group and thus the expected effect of sanction on welfare depends on the level of  $s$ . We discuss in the next sections the socially optimal level of sanctions submitted to a vote. In this case with no deadweight loss of sanctions, submitting the sanction to a vote weakly decreases welfare. Note however that if there was a deadweight loss of sanctions, voting could have benefits due to a selection effect, since only groups with higher types, less likely to pay the sanction, would approve them in the voting stage.<sup>16</sup>

### 2.4.1 Case without image concern

To understand better these effects, we first consider the case with  $\mu = 0$ , i.e. no reputation. The results of the previous section applied to this case imply that  $v_s^* = c - s$  and  $v_0^* = c$  and that the voting cutoff  $V^*$  is either among the swing or the never participants since the always participants no longer suffer a disutility from a loss of reputation. In fact, if the sanction is set at the socially optimal level without voting,  $s = e$ , we can show that the voting cutoff is necessarily among the swing participants. Indeed, the expected externality gain  $G$  can never be greater than  $e$ , so the swing participant with the lowest type  $v_i = v_s^* = c - e$  will necessarily vote against the sanction.

In terms of welfare, setting a sanction different from  $e$  imposes an “ex post” cost in the contribution phase as it deviates from the socially optimal level without voting.<sup>17</sup> However from an “ex ante” point of view, setting a sanction different from  $s$  may be

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<sup>16</sup>We can construct examples where having a vote strictly increases welfare, but this question is outside the scope of the current paper.

<sup>17</sup>If  $s > e$ , some group members will inefficiently contribute, while if  $s < e$  some group members don’t contribute when they optimally should.

beneficial as it affects the probability of acceptance. It turns out that the probability of acceptance is increasing in  $s$  since a higher  $s$  increases the expected externality gain  $G$  as more group members are expected to contribute if the sanction is approved. A direct consequence is that the optimal sanction in this case is necessarily weakly greater than  $e$ , the optimal level without voting.

In the case of unanimity rule, we show that the optimal sanction is in fact strictly greater. Given that unanimity is required, if the sanction is approved, the group has to be such that all members have a type greater than  $V^*$ . Since  $V^* > c - e$ , there is therefore no ex post cost from setting a higher sanction: those who would inefficiently contribute in the ex post phase because the sanction is set higher than  $e$  will vote against the sanction in the ex ante phase and thus can never be part of a group that approves. It follows that setting a sanction strictly higher than  $e$  is socially optimal. A similar logic should apply as long as the majority required is sufficiently large.

**Proposition 4.** *In the absence of image concerns ( $\mu = 0$ ):*

1. *If  $s = e$ , the voting cutoff is among the swing participants  $v_s^* \equiv c - e < V^* \leq v_0^* \equiv c$ .*
2. *The probability of approval of a sanction  $s$  is increasing in  $s$ .*
3. *The socially optimal sanction is always weakly higher than the optimal level without voting:  $s^* \geq e$ . Under unanimity rule, it is strictly higher  $s^* > e$ .*

## 2.4.2 Case with image concerns

We now consider our model when players have image concerns. We show that reputation changes the way the level of sanctions affects the voting outcome.

As in the case without reputation, an increase in  $s$  increases contributions in the second phase and thus increases the expected externality gain in the voting phase. Reputation creates a countervailing effect: increasing  $s$  decreases the honor derived from contributing and increases the stigma from not doing so. This effect on reputation decreases incentives to vote in favor of the sanction when the sanction is higher. Overall, the balance between these two effects is determined by the size of the externality  $e$ , as reflected in the following result. If  $e$  is small, decreasing the sanction increases the probability of acceptance and the socially optimal level of sanctions is then chosen below the socially optimal choice without voting.

**Proposition 5.** *When players are image concerned ( $\mu > 0$ ), there exists a benchmark  $\bar{e}$  such that:*

1. in all stable and interior equilibria, the voting cutoff in equilibrium  $V^*$  is decreasing in the level of sanction  $s$  if and only if  $e \geq \bar{e}$ .
2. if  $e \leq \bar{e}$ , the socially optimal sanction is lower than the optimal level without voting:  $s^* \leq e$ .

To conclude this section, we examine whether the planner could want to change the voting rule and in particular the majority required for approval. Up till now we have considered the case of majority rule. We now consider institutions that use different rules and require strictly more than  $K$  votes in favor to approve the sanction.

The required majority does not impact the contribution stage or the general structure of the equilibrium in the voting phase. It however affects the information aggregated when an individual is pivotal. This yields the following result:

**Proposition 6.** *There exists  $\tilde{e}$  such that, in all stable equilibria, the voting cutoff  $V^*$  is decreasing in  $K$  if and only if  $e \geq \tilde{e}$ .*

Consider an equilibrium such that  $V^* < v_s^*$ , in other words the pivotal voter is a never-participant. This pivotal voter, to calculate the expected externality, needs to build an expectation on the number of swing participants. Only the yes-voters can be swing participants in such an equilibrium. As  $K$  is increased, the number of yes voters is higher when pivotal and thus the expected size of the externality is higher, which makes the pivotal voter more inclined to vote in favor (i.e  $V^*$  decreases). In this case a more stringent voting rule, namely an increase in the supermajority rule, makes people more inclined to vote in favor. These cases occur when  $V^*$  is initially small, or equivalently  $e$  is high.

*In fact there are instances where increasing the supermajority rule can increase the probability of approval.* We present such a case in Supplementary Appendix B2 for a uniform distribution where increasing the number of votes necessary for approval can in fact facilitate approval. In such a situation, for any given level of  $s$ , the socially optimal voting rule would be a strict supermajority since it would increase the probability of approval and have no effect on the contribution phase.

## 2.5 Other visibility setups

### 2.5.1 Public voting, private contributions

We now consider the *public vote* environments, i.e situations where the individual votes are public but the contribution decisions are not observed by the group members. This could be the case if the individual contribution to the public good are hard to

identify, which is often the case when it is the outcome of team work. Of course, to impose the sanctions, the designer/manager will have to observe individual actions. We thus consider cases where he commits or is unable to credibly make the actions public. Note that in the case of bonuses in firms, which is typically a reward corresponding to a team work, individual bonuses are not revealed to other members. Groups can be opposed to the public disclosure of sanctions or bonuses.

In these cases, the reputation of individuals will therefore be based on their votes.<sup>18</sup> In the contribution phase, given a sanction  $s$ , individual  $i$  contributes if and only if  $v_i > c - s$ . As in the previous sections, there will be three categories in equilibrium, always participants, swing participants and never participants. However the cutoffs between these categories do not include a reputation component anymore:  $v_0^* = c$  and  $v_s^* = c - s$ .

The voter cares not only about the event where her vote is pivotal, but also about the other events since her vote will always be observed, and other players will make inferences on her type based on it. All voters care in the same way about reputation, so would vote the same way if they knew they were not pivotal. However, in the pivotal case, those with lower  $v_i$  will have higher incentives to vote against the sanction.

We denote  $Piv$  the event of being pivotal when voting and  $\Delta^* \equiv E[v_i|b_i = 1] - E[v_i|b_i = 0]$  the reputation derived in equilibrium from voting in favor of the sanction rather than against. Both these measures are determined in equilibrium and do not depend on the individual types of players.

In equilibrium, the net benefit of the never participants to vote in favor of the sanction is given by:

$$\mu\Delta^* + P[Piv](-s + G)$$

for swing participants

$$\mu\Delta^* + P[Piv](v_i - c + G)$$

and for always participants

$$\mu\Delta^* + P[Piv](G)$$

where  $G$  is the expected externality gain from the sanction, conditional on the event of being pivotal. As in the environments studied in the previous sections, under

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<sup>18</sup>We consider the case of majority voting.

Restriction A, all symmetric perfect bayesian equilibria are of the cutoff form.

**Lemma 3.** *Under Restriction A, all symmetric perfect bayesian equilibria are cutoff equilibria, characterized by a cutoff  $V^*$ .*

Lemma 3 reveals that under the same minor restriction as before, all symmetric equilibria are of the cutoff form. As in the case of observable actions and unobservable votes, the problem is characterized by a multiplicity of equilibria. As in the case of *public contributions*, one of the sources of multiplicity is the fact that the expected externality gain  $G$  is not necessarily a monotonic function of  $V^*$ . There are however in this setting additional sources of multiplicity.

The first is due to the reputation term  $\Delta^*$ . Given that we are faced with cutoff equilibria, this term can be written  $\Delta^* = E[v_i|v_i > V^*] - E[v_i|v_i < V^*] \equiv \Delta(V^*)$ . As described in detail in Benabou and Tirole, the function  $\Delta(V)$  is not necessarily monotonic. These nonmonotonicities are the first source of additional multiplicity of equilibria.

The second is more interesting and is present even when we abstract from the externality effect. Consider the case where  $e = 0$ . For a given  $N$ , the probability of being pivotal is non monotonic in  $V^*$ . For  $V^*$  lower than the median, the probability of being pivotal is increasing in  $V^*$  while it is decreasing otherwise. There could thus be two potential equilibria: one where  $V^*$  is low and one where it is close to median. In the first case, players have high incentives to vote in favor because the probability of being pivotal is low and the reputation effect dominates, thus justifying the low  $V^*$ . This is a self sustaining norm of general support for sanctions, self sustained because the chance of pivotal is small if everyone votes in the same way. In the second equilibrium (different norm), players have more incentives to vote against (higher  $V^*$ ) as this higher  $V^*$  is coherent with a higher probability of being pivotal.

We have shown that the key tradeoff in the case of public voting is between the reputation derived from voting in favor and the effect of the vote on the outcome in the event the vote is pivotal. It is thus natural to ask the question of what occurs for large organizations when the chance of being pivotal decreases. We find that any level of sanction will be adopted in equilibrium for large assemblies. We need to focus on sequential equilibria to eliminate the unreasonable equilibrium where everyone votes against the sanction and the belief, off the equilibrium path when someone votes in favor, is that the deviator has a very low type (i.e  $\Delta^* < 0$ ).<sup>19</sup>

**Proposition 7.** *In the public vote environment:*

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<sup>19</sup>Such an equilibrium is not sequential since if voting in favor happens with some probability on the equilibrium path, then given that the incentives to vote in favor are increasing in the type, the reputation  $\Delta^*$  attached to a yes-vote should necessarily be positive.

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1. if  $\Delta(V^*)$  is decreasing in  $V^*$ , then an increase in the size of the organization  $N$  will decrease the probability of acceptance,
2. when  $N \rightarrow +\infty$ , in all sequential equilibria of the game where only votes are observable, any sanction  $s > 0$  is approved with probability converging to one.

However, when  $N \rightarrow +\infty$ , in all sequential equilibria of the game where only votes are observable, any sanction  $s > 0$  is approved with probability converging to one.

The intuition when  $N$  becomes very large is quite clear. Low types vote against the sanction when the probability of being pivotal is high enough that it compensates for the loss of reputation. When  $N$  becomes large, the probability of being pivotal goes to zero and the proportion of people ready to vote against shrinks. Note that this is independent of the level of the sanction and in particular, it could well be the case that the sanction decreases total welfare. This result generalizes the result of Feddersen et al. (2009) who consider the case where one alternative is exogenously given as the ethical outcome.

The first result of Proposition 7 however shows that this is only a limit result, and in a sense qualifies the finding of Feddersen et al. (2009). Increasing  $N$  can actually decrease the probability of acceptance of the sanction in the case where  $\Delta(V)$  is a decreasing function at  $V^*$ .

The discussion of whether individual votes should be made public or kept secret is a long standing one, in particular for political assemblies. Some have highlighted that publicity can have perverse effects. Taking the case of the EU council of ministers, Elster (2015) highlights that “the publication of votes, which was supposed to increase the accountability of ministers, actually became an additional incentive for opponents to silence themselves and join the majority” (p. 163, chapter by Novak). The authors suggest that those in the minority voted as the majority, first to avoid being on the losing side (motivation related to image concerns), but also to possibly avoid retaliation. In our case, publicity of votes can indeed be welfare reducing if it leads to the imposition of excessive sanctions.<sup>20</sup>

### 2.5.2 Observing votes and contributions

In small committees it is often the case that the contribution decision is observable, or as discussed in the previous section, that the designer is unable or unwilling to keep the contributions secret. Therefore, if the institutional choice was to choose

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<sup>20</sup>In Gradwohl (2017), secret voting can be superior to public voting since under certain conditions, sincere voting is the only equilibrium and the voters do not incur the privacy cost.

public voting, the inferences made by other group members about an individual's type, will be based both on her vote and contribution choices.

To clarify the forces at play, we focus on the case where the sanction  $s$  submitted to a vote is large,  $s > v_{min} - c$ , so that if the sanction is voted, all types participate. Consider the case where the sanction was not voted in the first stage of the game. The behavior of the players will depend on the way they voted in the first phase. Conditional on a vote, the players will choose a cutoff strategy. We denote the cutoff  $v_0(1)$  for the players who voted in favor of the sanction in the first phase and  $v_0(0)$  for those who voted against.

Using the notation  $E_0(b, a) = E[v_i | (b_i = b) \cap (a_i = a) \cap (s = 0)]$  (for instance  $E_0(1, 0)$  is the expected value of  $v$  given that the player voted for the sanction, the sanction was not passed and he did not participate), the cutoff is defined by

$$v_0(i) = c - \mu [E_0[i, 1] - E_0[i, 0]]$$

There is no clear ordering between  $v_0(0)$  and  $v_0(1)$ . On the one hand, those who already sent a bad signal by voting against the sanction, might have little to lose by not participating. On the other hand, those who already voted for the sanction, can afford to send a bad signal of not participating. The ranking will depend on inferences made in equilibrium.

Proposition 8 below presents properties of equilibria such that certain types vote in favor of the sanction and some against. The full set of equilibria is described in the proof. The first key property is that the voting strategy is not necessarily of the cutoff form. In particular there is an equilibrium where low types vote against and do not participate, intermediate types vote for and do not participate and high types vote against and participate. In this equilibrium, the low types do not want to vote in favor because contributing is too costly and they consider the case where their vote can be pivotal. The intermediate types are ready to take the risk of voting in favor and potentially losing if pivotal, to benefit from the increased reputation. They however do not want to deviate to action (0,1) since contributing is still too costly.

**Proposition 8.** *In the voting phase:*

1. *There exist equilibria where  $v_0(0) < v_0(1)$  and others where the ordering is reversed*
2. *The equilibrium voting strategy is not necessarily a cutoff strategy. In particular there exists an equilibrium with two cutoffs  $\underline{v}$  and  $\bar{v}$  such that:*

- for  $v < \underline{v}$ , players vote against the sanction and do not participate, i.e. choose  $(0,0)$
- for  $\underline{v} \leq v \leq \bar{v}$ , players vote for the sanction and do not participate  $(1,0)$
- for  $v > \bar{v}$ , players vote against the sanction and participate  $(0,1)$

## 2.6 Discussion and examples

We conclude by discussing potential avenues for testing empirically our results, both with field and lab data, and incidentally give some further examples of applications of our setup.

We first return to the case, mentioned in the introduction, of the French *Assemblée Nationale* voting for a law imposing sanctions for not attending.<sup>21</sup> Following the vote and the introduction of the sanction, participation significantly increased: from an average of 7 meetings attended per year, it jumped to 19 meetings. There was, however, a large heterogeneity in reactions. Some people still did not participate. The maximum fine imposed was 4615 euros for someone failing to attend a single meeting.

This setting with elected members of parliament voting on rules that regulate their activity appears to be a very good environment to test our theoretical results. Data is available: for instance we can observe both voting and contribution behaviors. Furthermore, the level of observability evolved. Initially in 2010, the members did not expect their presence to be publicly revealed, but an independent association, called *Regards Citoyens*, decided to make public the information. The participation behavior can thus initially be considered as partially secret since the parliamentaries were not aware that the data would be published. Finally we point out that politicians might care in this environment, not only about their image within the group, but also in the eyes of their electorate.

One challenge however is that there is a tendency, particular strong in France, for parliamentaries to follow party lines, making it harder to identify individual decisions. We thus code a party member abstaining or not coming to vote as someone voting against the party line. For instance in this particular case, the right wing party (UMP) called to vote in favor of the proposal, while the left called to vote against. We consider those UMP members who did not vote as voting against the proposal.<sup>22</sup>

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<sup>21</sup>If they missed more than 2 sessions per month, their compensation for these meetings would be reduced by 25 percent (representing more or less 353 euros).

<sup>22</sup>In fact, the final result turned out to be quite close, with 312 voting in favor when a majority of 266 was required.

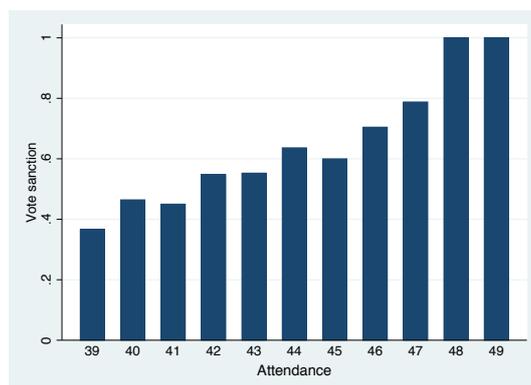


Figure 2.2: Attendance and voting on sanctions

Among the top 7 shirkers in 2010, 3 voted against the sanction and out of the four UMP ranking in the top 7, three were not present on voting day.

We can go further and examine the link between voting behavior and attendance in the general assembly. This is presented in Figure 2.2. As an indicator of  $v_i$ , we consider attendance in the general assembly in the 2009-2010 parliamentary session. We see a clearly increasing trend indicating that those with a higher  $v_i$  are more likely to vote against the sanction, consistent with our result that equilibria will be of the cutoff form.

This example suggests one possible avenue for testing some of our results. Ideally data could also be obtained from the behavior of smaller groups where the image concern would only be relevant within the group. A different direction would be to use experimental data.<sup>23</sup>

In fact our paper can inform some of the existing experimental evidence in the literature, in particular the results in Tyran and Feld (2006). The authors examine a two stage game very similar to ours, involving 3 players. The second stage is a public good provision game. In some treatments a sanction for free riding is exogenously imposed, while in others it is voted by the group. We focus on the results they obtain in the mild sanction case, i.e a sanction that would not deter a purely rational player from free riding.

The authors show that contributions in the public good games are significantly higher following a sanction endogenously chosen compared to situations where the sanction is exogenously imposed. They suggest one explanation based on selection: if participants vary in their generosity (i.e our  $v_i$ ), those cases where the sanction is adopted are cases where the group is overall more generous. They discard this

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<sup>23</sup>There are now new procedures to measure individual sensitivity to image concerns.

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explanation based on the following two additional results.<sup>24</sup> Yes and no voters contribute more or less in the same way in the public good game that follows. Yes and no voters contribute significantly less if the sanction is rejected than if it is accepted. The authors claim that if selection was an issue, yes voters should contribute the same regardless of whether they are in a group that accepted vs rejected the sanction.

Our analysis suggests a more nuanced view. Consider the case where most subjects in the lab are swing participants. If that were the case, by definition of swing participants, they would behave differently if the group adopted or rejected the sanction. Moreover, both yes and no voter if they are swing participants, even though they vote differently, would behave in the same way later on. The two facts mentioned above are thus not incompatible with selection. However, if most subjects are actually swing participants, we should not observe a significant difference between exogenous and endogenous sanctions, which might point to the fact that additional forces as those proposed by Tyran and Feld might be at play, including conditional cooperation. Understanding how this modifications of preferences affects our results, could be the object of interesting future work.

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<sup>24</sup>Shown in Table 3 of their paper.

## 2.7 Appendix to chapter 2

### Appendix A: Proofs

#### Lemma 1

As derived in the main text, the contribution cutoff for a given sanction  $s$  is given by:

$$v_s^* = c - s - \mu\Delta(v_s^*)$$

with  $\Delta(v_s) \equiv E[v|v > v_s] - E[v|v < v_s]$ .

Let  $F(v) = \mu\Delta(v) + v - c + s$ . The equation characterizing  $v_s^*$  can be rewritten  $F(v_s^*) = 0$ . Furthermore, we have  $F'(v) = 1 + \mu\Delta'(v)$ . Thus, the condition  $1 + \mu\Delta'(v) > 0$  guarantees the unicity of the equilibrium as in Bénabou and Tirole (2011).

To prove the comparative statics, we use the implicit function theorem, yielding:

$$\begin{aligned}\frac{\partial v_s^*}{\partial s} &= -\frac{1}{1 + \mu\Delta'(v_s^*)} < 0, \\ \frac{\partial v_s^*}{\partial c} &= \frac{1}{1 + \mu\Delta'(v_s^*)} > 0, \\ \frac{\partial v_s^*}{\partial \mu} &= -\frac{\Delta(v)}{1 + \mu\Delta'(v_s^*)} < 0.\end{aligned}$$

#### Proposition 1

Denoting  $G_s$  the expected externality obtained if the sanction is approved and  $G_0$  the expected externality obtained if the sanction is not approved, we denote  $G = G_s - G_0$  as in the main text, the expected externality gain from sanctions, which is the same for all players regardless of their type.

The expected payoff of always participants if the sanction is approved is:

$$v_i - c + \mu(E[v_i|v_i > v_s^*]) + G_s,$$

and if it is rejected:

$$v_i - c + \mu(E[v_i|v_i > v_0^*]) + G_0.$$

The difference between the payoffs is thus:

$$D(v_i) = \mu(E[v_i|v_i > v_s^*] - E[v_i|v_i > v_0^*]) + G. \quad (2.2)$$

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$D(v_i)$  is independent of the particular value of  $v_i$  and furthermore we have  $E[v_i|v_i > v_s^*] - E[v_i|v_i > v_0^*] < 0$  since  $v_s^* < v_0^*$ . In other words, more players participate following the sanction so there is less value of reputation from participating.

The maximum value for  $G$  is achieved when all other players contribute if and only if the sanction is passed, i.e  $G_s = G = e$  and  $G_0 = 0$ . Therefore, rewriting equation (2.2) using the fact established above that  $G \leq e$ , we have:

$$D(v_i) \leq \mu(E[v_i|v_i > v_s^*] - E[v_i|v_i > v_0^*]) + e.$$

For a given  $s$ , define  $\bar{e}(s)$  as:

$$\bar{e}(s) = -\mu(E[v_i|v_i > v_s^*] - E[v_i|v_i > v_0^*]).$$

We thus conclude that for all  $e \leq \bar{e}(s)$  it is a best response for the always participants to vote against the sanction, even if the externality gain is at its maximum. We thus conclude that for  $e \leq \bar{e}(s)$ , voting for the sanction is a weakly dominated strategy.

**Lemma 2**

As derived in the main text, in equilibrium, never participants vote in favor of the sanction if and only if:

$$\mu(E[v_i|v_i < v_s^*] - E[v_i|v_i < v_0^*]) + G - s \geq 0, \tag{2.3}$$

swing participants vote in favor if and only if:

$$\mu(E[v_i|v_i > v_s^*] - E[v_i|v_i < v_0^*]) + G + v_i - c \geq 0, \tag{2.4}$$

and always participants vote in favor if and only if:

$$\mu(E[v_i|v_i > v_s^*] - E[v_i|v_i > v_0^*]) + G \geq 0. \tag{2.5}$$

Taking the difference between the left-hand side of condition (2.4) and (2.3), we find that this difference equals:

$$\begin{aligned} & \mu(E[v_i|v_i > v_s^*] - E[v_i|v_i < v_s^*]) + v_i - c + s \\ = & \mu\Delta(v_s^*) + v_i - c + s. \end{aligned}$$

Since  $v_i$  corresponds to the type of swing-participants, we have  $v_i \geq v_s^*$  and by

definition of  $v_s^*$  given in Proposition 1, we have  $v_i \geq c - s - \mu\Delta(v_s^*)$ . So that

$$\mu\Delta(v_s^*) + v_i - c + s \geq 0.$$

We thus conclude that if condition (2.3) is satisfied then condition (2.4) will also be satisfied.

Similarly, using the fact that  $v_i$  for swing participants is such that  $v_i \leq v_0^*$ , we can show that if condition (2.4) is satisfied then condition (2.5) will also be satisfied. This establishes the first two points of the lemma. The last point directly follows using the fact that for the swing participants, the incentive to vote in favor of the sanction is strictly increasing in  $v_i$  (i.e the left hand side of condition (2.4) is increasing in  $v_i$ ).

### Proposition 2

1. Result 1 of Proposition 2 directly follows from Lemma 2 and using in addition restriction A to guarantee that if a never participant (resp. always participant) votes in favor, then all never participants (resp. always participant) with higher types also vote in favor.

2. The second result directly follows from the derivations in the main text. For  $V < v_s^*$ , we have that  $\mathcal{R}(V)$  is constant and  $G(V)$  is strictly increasing. An equilibrium is characterized by the intersection of  $-\mathcal{R}(V)$  and  $G(V)$ . Thus, there is at most one equilibrium where  $V^* < v_s^*$ . The same reasoning applies for the always participants.

### Proposition 3

We first show that under the conditions of Proposition 3,  $G(V)$  is concave for  $V \in (v_s^*, v_0^*)$ . In this region, we have

$$G(V) = \frac{1}{2}e \left[ \left( \frac{F(V) - F(v_s^*)}{F(V)} \right) + \left( \frac{F(v_0^*) - F(V)}{1 - F(V)} \right) \right].$$

Thus, the derivative is given by

$$G'(V) = \frac{1}{2}e \left[ \left( \frac{f(V)F(V) - f(V)(F(V) - F(v_s^*))}{(F(V))^2} \right) + \left( \frac{-f(V)(1 - F(V)) + f(V)(F(v_0^*) - F(V))}{(1 - F(V))^2} \right) \right].$$

Looking at the second derivative, we have

$$G''(V) = \frac{1}{2}e \left[ \left( \frac{F(v_s^*)F(V)(f'(V)F(V) - 2(f(V))^2)}{(F(V))^4} \right) + \left( \frac{(1 - F(v_0^*))(1 - F(V))(-f'(V)(1 - F(V)) - 2(f(V))^2)}{(1 - F(V))^4} \right) \right].$$

Thus, a sufficient condition to establish  $G''(V) < 0$  is that

$$f'(V)F(V) - 2(f(V))^2 \leq 0, \tag{2.6}$$

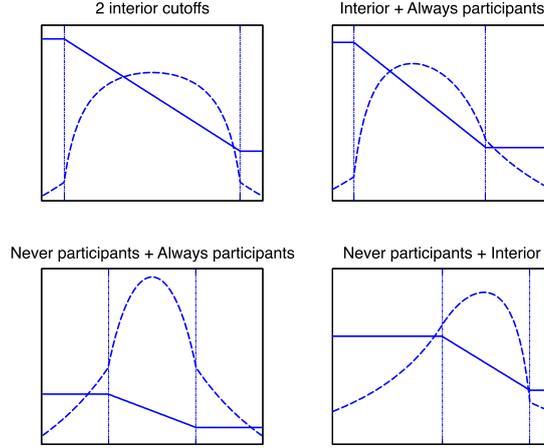


Figure 2.3: Four possible outcomes

and

$$-f'(V)(1 - F(V)) - 2(f(V))^2 \leq 0. \quad (2.7)$$

These two conditions are implied by the conditions introduced in Proposition 2 namely  $\frac{f}{1-F}(v)$  is weakly increasing implies condition (2.7) and  $\frac{f}{F}(v)$  is weakly decreasing implies condition (2.6) .

We thus establish that under these conditions,  $G(V)$  is concave in  $V$  in the interval  $(v_s^*, v_0^*)$ . This implies that there are at most two perfect bayesian equilibria. The four cases are illustrated in Figure 2.3.

- Suppose  $G$  and  $-\mathcal{R}$  intersect for  $V < v_s^*$  and for  $v_s^* < V < v_0^*$ . By result 2 of Proposition 2, there cannot be another intersection with  $V < v_s^*$ . Moreover, because of the concavity of  $G(V)$ , there cannot be another intersection for  $V$  such that  $v_s^* < V < v_0^*$ . Finally there cannot then be an intersection with  $V > v_0^*$  since  $G$  is decreasing on that interval while  $\mathcal{R}$  is linear and at  $v_0^*$  we have  $G(v_0^*) < \mathcal{R}(v_0^*)$ . This corresponds to the case “Never participants+interior” in Figure 2.3.
- Similar reasoning implies that if there is an intersection for  $V < v_s^*$  and for  $V > v_0^*$ , then there cannot be an intersection for  $v_s^* < V < v_0^*$ . This corresponds to the case “Never participants+always participants” in Figure 2.3.
- Similarly, if there are two intersections for  $v_s^* < V < v_0^*$  there cannot be another intersection. This corresponds to the case “2 interior cutoffs” in Figure 2.5.
- The last case is one where there are two intersections, one with  $v_s^* < V < v_0^*$  and one with  $V > v_0^*$ . This corresponds to the case “Interior+always participants”

in Figure 2.3.

**Proposition 4**

1. Lemma 1 for  $\mu = 0$  implies that  $v_s^* = c - s$  and  $v_0^* = c$ .

As discussed in the main text, we necessarily have  $V^* \leq v_0^*$  since always participants with no image concern have strict incentives to vote in favor of the sanction. Consider the difference in expected utility comparing the situation with a sanction to the one without, that we denote  $D(v_i)$ , for the swing participants, as described in the main, for  $\mu = 0$ :

$$D(v_i) = v_i - c + G,$$

where

$$G(V^*) = \frac{1}{2}e \left[ \frac{F(v_0^*) - F(v_s^*)}{1 - F(V^*)} \right].$$

We have that  $G(V^*) < e$  so that for  $s = e$ , type  $v_s^* = c - e$  has strict incentives to vote against the sanction.

2. Given that the voting cutoff is in the swing voter category, we can examine how the incentives to vote in favor of the sanction change when  $s$  increases. An increase in  $s$  decreases  $v_s^*$  and thus increases  $G$ . This implies that  $D(v_i)$  is strictly decreasing in  $s$  and so is the voting cutoff  $V$ . This implies that  $V^* > v_s^*$ .

3. Choosing  $s^* < e$  strictly decreases the probability of acceptance according to result 2. Moreover, in the contribution phase, regardless of the composition of the group, having  $s = e$  leads to higher welfare. Thus choosing  $s^* < e$  always leads to lower welfare than choosing exactly  $e$ .

We now show that for unanimity rule, it is optimal to choose a sanction strictly greater than  $e$ . According to result 2, it strictly increases the probability of acceptance. Furthermore, the ex post cost is zero since the proposal is accepted only if all group members have  $v_i \geq V^* > c - e$ .

**Proposition 5**

1. We examine the case of interior equilibria (where  $V^*$  is the swing-participant group). In this case  $V^*$  is implicitly defined by:

$$\mu(E[v_i|v_i > v_s^*] - E[v_i|v_i < v_0^*]) + V^* - c + G = 0$$

with

$$G = \frac{1}{2}e \left[ \left( \frac{F(V^*) - F(v_s^*)}{F(V^*)} \right) + \left( \frac{F(v_0^*) - F(V^*)}{1 - F(V^*)} \right) \right]$$

We use the implicit function theorem

$$\frac{\partial V^*}{\partial s} = - \frac{1}{1 + \frac{e}{2}f(V^*) \left[ \frac{F(v_s^*)}{(F(V^*))^2} + \frac{F(v_0^*)-1}{(1-F(V^*))^2} \right]} \left( -\frac{e}{2} \frac{f(v_s^*)}{F(V^*)} + \mu \frac{\partial E[v_i|v_i > v_s^*]}{\partial v_s^*} \right) \left( \frac{\partial v_s^*}{\partial s} \right)$$

In stable equilibria,  $G(V)$  needs to be increasing in  $V$ . This guarantees that  $\left[ \frac{F(v_s^*)}{(F(V^*))^2} + \frac{F(v_0^*)-1}{(1-F(V^*))^2} \right]$  is positive.

Thus, since  $\frac{\partial v_s^*}{\partial s} < 0$  we have that  $V^*$  is increasing in  $s$  if and only if:

$$-\frac{e}{2} \frac{f(v_s^*)}{F(V^*)} + \mu \frac{\partial E[v_i|v_i > v_s^*]}{\partial v_s^*} > 0. \quad (2.8)$$

Given that  $E[v_i|v_i > v_s^*] = \int_{v_s^*}^{v_{max}} \frac{vf(v)}{1-F(v_s^*)} dv$ , we have:

$$\begin{aligned} \frac{\partial E[v_i|v_i > v_s^*]}{\partial v_s^*} &= \frac{-v_s^* f(v_s^*)(1 - F(v_s^*)) + f(v_s^*) \int_{v_s^*}^{v_{max}} vf(v)}{(1 - F(v_s^*))^2} \\ &= \frac{f(v_s^*)}{1 - F(v_s^*)} (E[v_i|v_i > v_s^*] - v_s^*). \end{aligned}$$

Overall condition (2.8) can be rewritten as:

$$\frac{e}{F(V^*)} < 2 \frac{\mu}{(1 - F(v_s^*))} (E[v_i|v_i > v_s^*] - v_s^*).$$

The right hand side is positive and does not depend on  $e$ . The left hand side must be (strictly) increasing in  $e$  because  $V^*$  is decreasing in  $e$ . Moreover, it goes to 0 when  $e$  goes to 0 and to infinity when  $e$  becomes large ( $V^*$  goes to 0). By the intermediate value theorem, there exists a unique value of  $\bar{e}$  such that equation (2.8) holds ( $V^*$  is increasing in  $s$ ) if and only if  $e > \bar{e}$ .

**2.** If  $e \leq \bar{e}$ , according to result 1, choosing  $s^* > e$  decreases the probability of approval. Furthermore it imposes an ex post loss since it deviates from the socially optimal level ex post. Finally, in terms of reputation, it decreases the reputation of those who voted in favor.

### Proposition 6

We first consider the case where  $V^*$  belongs to the swing participant group.

As specified in the main text, when a supermajority of  $K$  votes is required to pass the law, the indifference condition characterizing the cutoff is given by:

$$\begin{aligned} V^* + e & \left[ \frac{K}{2N} \times \frac{F(v_0^*) - F(V^*)}{1 - F(V^*)} + \frac{2N - K}{2N} \times \frac{F(V^*) - F(v_s^*)}{F(V^*)} \right] \\ & = c - \mu(E[v_i|v_i > v_s^*] - E[v_i|v_i < v_0^*]). \end{aligned}$$

Considering  $K$  as a continuous variable, we can apply the implicit function theorem:

$$\frac{\partial V^*}{\partial K} = - \frac{1}{1 + \frac{e}{2N} f(V^*) \left[ (2N - K) \frac{F(v_s^*)}{(F(V^*))^2} + K \frac{F(v_0^*) - 1}{(1 - F(V^*))^2} \right]} \frac{e}{2N} \left[ \frac{F(v_0^*) - F(V^*)}{1 - F(V^*)} - \frac{F(V^*) - F(v_s^*)}{F(V^*)} \right]$$

Given that in stable equilibria, the denominator will be positive, we have that  $\frac{\partial V^*}{\partial K}$  is thus of the same sign as  $\frac{F(V^*) - F(v_s^*)}{F(V^*)} - \frac{F(v_0^*) - F(V^*)}{1 - F(V^*)}$ , which is an increasing function of  $V^*$ , negative at  $v_s^*$  and positive at  $v_0^*$ . There is a unique value  $\widehat{V}$  defined by

$$\frac{F(\widehat{V}) - F(v_s^*)}{F(\widehat{V})} = \frac{F(v_0^*) - F(\widehat{V})}{1 - F(\widehat{V})}, \quad (2.9)$$

such that for interior equilibria, if  $V^* \leq \widehat{V}$ ,  $V^*$  is decreasing in  $K$  and the opposite for  $V^* > \widehat{V}$

Furthermore we have, as explained in the main text, that for  $V^* < v_s^*$ ,  $V^*$  is decreasing in  $K$ , while equilibria such that  $V^* > v_0^*$  are not stable.

We thus have the result of that there exists  $\widehat{V} \in (v_s^*, v_0^*)$ , with  $\widehat{V}$  defined by equation (2.9), such that the voting cutoff  $V^*$  is decreasing in  $K$  if  $V^* \leq \widehat{V}$  and increasing in  $K$  if  $V^* \geq \widehat{V}$ .

Since  $V^*$  is decreasing in  $e$  for stable equilibria, we can find  $\tilde{e}$  such that for  $e = \tilde{e}$ ,  $V^* = \widehat{V}$ , so that the result above can be reexpressed as: the voting cutoff  $V^*$  is decreasing in  $K$  if  $e \geq \tilde{e}$  and increasing in  $K$  if  $e \leq \tilde{e}$ .

### Lemma 3

As stated in the main text, the incentive to vote in favor of the sanction is, for the never participants, given by:

$$\mu \Delta^* + P[Piv](-s + G),$$

for swing participants

$$\mu \Delta^* + P[Piv](v_i - c + G),$$

and for always participants

$$\mu\Delta^* + P[Piv](G).$$

The incentive is weakly increasing in  $v_i$ . Restriction A then implies that all symmetric perfect equilibria are cutoff equilibria as in Proposition 2.

**Proposition 7**

1. For all intervals, the indifference condition characterizing the equilibrium is of the form

$$\mu\Delta^* = P[Piv]\Lambda,$$

where  $\Lambda$  can take different values depending on which interval the equilibrium belongs to.

An increase in  $N$ , for a given  $V^*$  decreases  $P[Piv]$ . Thus, if  $\Delta^*$  is decreasing in  $V^*$ , we see that an increase in  $N$  will lead to an increase in  $V^*$  (i.e decrease in probability of acceptance).

2. To establish the second result, we first show that the equilibrium where all types vote against the sanction is not a sequential equilibrium. Indeed for all totally mixed strategies, it has to be the case that  $E[v|b_i = 1] - E[v|b_i = 0] \geq 0$ , because of the cutoff property. So in all sequential equilibria, always participants will always have an incentive to vote in favor of the sanction to benefit from the expected externality and since a vote in favor cannot bring a bad reputation.

We now show that when  $N \rightarrow +\infty$  the probability that there is a vote against the sanction goes to zero.

Never participants are those who have the least incentives to vote in favor of the sanction. In equilibrium, the net benefit of the never participants to vote in favor of the sanction are given by:

$$\mu [E[v|b_i = 1] - E[v|b_i = 0]] + P[Piv](-s + G).$$

We have that  $-s + G$  is bounded and  $P[Piv]$  converges to zero, so that in equilibrium, if some individuals vote against the sanction, it has to be the case that  $[E[v|b_i = 1] - E[v|b_i = 0]]$  converges to zero. This implies that the proportion of those voting against converges to zero.

**Proposition 8**

As indicated in the main text, in the public good stage, players will use cutoff strategies conditional on their voting behavior in the first stage. There are therefore two relevant cutoff:  $v_0(0)$  and  $v_0(1)$ .

Conditional on a particular equilibrium, denote  $P_p$  the probability that the sanction is adopted independently of individual  $i$ 's vote,  $P_r$  the probability that the sanction is rejected independently of individual  $i$ 's vote, and  $P_{piv}$  the probability that the individual is pivotal. All these probabilities are independent of the player's actual type.

We also use the notation  $E_0(b, a) = E[v|(b_i = b) \cap (a_i = a) \cap (s = 0)]$ . For instance  $E_0(1, 0)$  is the expected value of  $v$  given that the player voted for the sanction, the sanction was not passed and he did not participate

*Consider group members with  $v_i < \min(v_0(0), v_0(1))$ .* If he votes in favor, his expected benefit is:

$$P_p(\mu E_s[1, 1] + v_i - c + G_s) + P_r(\mu E_0[1, 0] + G_0) + P_{piv}(\mu E_s[1, 1] + v_i - c + G_s),$$

where  $G_s$  (resp.  $G_0$ ) denotes as before the expected externality gain when the sanction is passed (resp. not passed).

If the group member votes against, his expected benefit is:

$$P_p(\mu E_s[0, 1] + v_i - c + eG_s) + P_r(\mu E_0[0, 0] + eG_0) + P_{piv}(\mu E_0[0, 0] + eG_0).$$

The net benefit of voting in favor for that individual is thus

$$D(v_i) = P_p\mu(E_s[1, 1] - E_s[0, 1]) + P_r\mu(E_0[1, 0] - E_0[0, 0]) + P_{piv}(\mu(E_s[1, 1] - E_0[0, 0]) + v_i - c + G)$$

$D(v_i)$  is increasing in  $v_i$  on that interval.

Similarly, if  $v_i > \max(v_0(0), v_0(1))$ , the net benefit of voting in favor is given by

$$D(v_i) = P_p\mu(E_s[1, 1] - E_s[0, 1]) + P_r\mu(E_0[1, 1] - E_0[0, 1]) + P_{piv}(\mu(E_s[1, 1] - E_0[0, 1]) + G) \quad (2.10)$$

which is independent of  $v_i$ .

We now consider the intermediate regions.

Suppose first  $v_0(0) < v_0(1)$  and consider the case  $v_0(0) < v_i < v_0(1)$ . Such a group member participates when the sanction did not pass, if and only if he voted against the sanction.

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If he votes in favor, his expected benefit is:

$$P_p(\mu E_s[1, 1] + v_i - c + G_s) + P_r(\mu E_0[1, 0] + G_0) + P_{piv}(\mu E_s[1, 1] + v_i - c + G_s)$$

If he votes against, his expected benefit is:

$$P_p(\mu E_s[0, 1] + v_i - c + G_s) + P_r(\mu E_0[0, 1] + v_i - c + G_0) + P_{piv}(\mu E_0[0, 1] + v_i - c + G_0)$$

The net benefit of voting in favor for that individual is thus

$$\begin{aligned} D(v_i) &= P_p\mu(E_s[1, 1] - E_s[0, 1]) + P_r(\mu(E_0[1, 0] - E_0[0, 1]) - (v_i - c)) \\ &+ P_{piv}(\mu(E_s[1, 1] - E_0[0, 1]) + G). \end{aligned}$$

$D(v_i)$  is then decreasing in  $v_i$  on that interval.

Suppose on the contrary that  $v_0(1) < v_0(0)$  and consider types with  $v_0(1) < v_i < v_0(0)$ , then the net benefit of voting in favor for that individual is thus

$$\begin{aligned} D(v_i) &= P_p\mu(E_s[1, 1] - E_s[0, 1]) + P_r\mu(E_0[1, 1] - E_0[0, 0]) + (v_i - c) \\ &+ P_{piv}(\mu(E_s[1, 1] - E_0[0, 0]) + (v_i - c) + G), \end{aligned}$$

which is increasing in  $v_i$

*Consider case A:  $v_0(1) < v_0(0)$ .*

In this case as shown above, if we impose restriction A as before, the voting strategy is a cutoff strategy with cutoff  $V^*$  since the net benefit function  $D(v_i)$  is weakly increasing in  $v_i$  on all intervals and continuous. There are three situations

- $V^* < v_0(1)$  then there are three zones with respective outcomes (0,0), (1,0) and (1,1),
- $v_0(1) < V^* < v_0(0)$  with two zones: (0,0) and (1,1),
- $V^* > v_0(0)$  with three zones (0,0), (0,1) and (1,1).

We now check whether these equilibria are compatible with the condition  $v_0(1) < v_0(0)$ . We have

$$\begin{aligned} v_0(0) &= c - \mu(E[0, 1] - E[0, 0]), \\ v_0(1) &= c - \mu(E[1, 1] - E[1, 0]). \end{aligned}$$

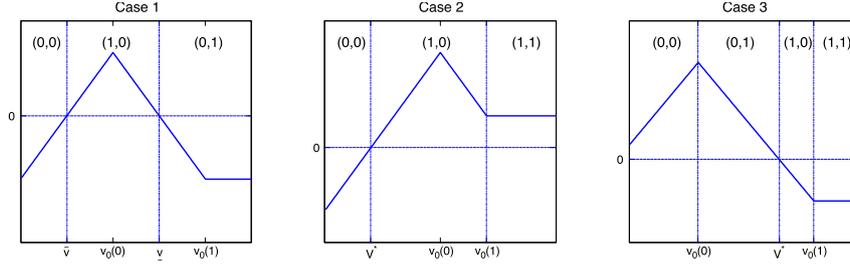


Figure 2.4: Comparing the cases *both secret* and *secret vote*

So that  $v_0(1) < v_0(0)$  is equivalent to:

$$E[1, 1] - E[1, 0] > E[0, 1] - E[0, 0]. \quad (2.11)$$

Only that values  $E[1, 1]$ ,  $E[0, 0]$  and  $E[1, 0]$  (in the second equilibrium) are pinned down in equilibrium, and thus  $E[0, 1]$  can be chosen low enough to guarantee that condition (2.11) is satisfied.

*Consider case B:*  $v_0(0) < v_0(1)$ . In this case as shown above, the voting strategy is no longer necessarily a cutoff strategy since the net benefit curve  $D(v_i)$  first increases in  $v_i$  then decreases. There are then potentially three cases for an equilibrium with some types voting in favor and some against.

Consider the case  $e = 0$ , then there exists a value of  $\mu$  such that  $D(v_i)$  intersects the zero line twice and you thus have outcomes (0,0) for low values of  $v_i$ , outcomes (1,0) for intermediate values and (0,1) for high values, as indicated in the result of the Proposition. This is represented in case 1 in Figure 2.4.

Suppose now that  $D(v_i)$  intersects the zero line once for  $v < v_0(0)$  (case 2 in Figure 2.4). Agents will then choose (0,0) for low values, (1,0) for intermediate values and (1,1) for high values.

Finally, if  $D(v_i)$  intersects the zero line once for  $v_0(0) < v < v_0(1)$  (case 3 in Figure 2.4), there are four zones (0,0), (0,1), (1,0) and (1,1).

Note furthermore that the condition  $v_0(0) < v_0(1)$  is equivalent to

$$E[1, 1] - E[1, 0] < E[0, 1] - E[0, 0]. \quad (2.12)$$

We can again find beliefs that will imply condition (2.12).

## Appendix B: Supplementary Material

### B1: complementarities

Consider the contribution stage and fix the contributions  $a_{-i}$  of other group members. If individual  $i$  contributes, he gets,

$$v_i - c + \mu E[v_i | a = 1] + eg(1, a_{-i}).$$

Not contributing yields

$$-s + \mu E[v_i | a = 0] + eg(0, a_{-i}).$$

So contribution behavior is going to be characterized by a cutoff, as in the main model. However, the exact determination of the cutoff is more involved for two reasons. First,  $a_{-i}$ , the contribution of others, is an equilibrium choice and thus a function of the equilibrium cutoff. Second, the outcome of the vote in the first phase, gives information about the distribution of types in the population and therefore affects the expectation of  $a_{-i}$ . We restrict our attention to cases where only the aggregate result of the vote is revealed.

In spite of these differences, the results of Proposition 2 and Lemma 2 are preserved. In particular the shape of the equilibrium is unaffected.

**Proposition 9.** • *For the case of substitutes, if  $1 + \mu\Delta'(v) > 0$  and  $e < \tilde{e}$ , the contribution stage is characterized by two cutoffs  $\tilde{v}_0 > \tilde{v}_s$  such that group member  $i$  contributes if and only if  $v_i > \tilde{v}_0$  if there is no sanction and  $v_i > \tilde{v}_s$  with a sanction.*

- *For the case of complements, if  $1 + \mu\Delta'(v) > 0$  and  $e < \tilde{e}$ , there exists a bound  $\epsilon$  such that if  $\frac{\partial(g(1, a_{-i}) - g(0, a_{-i}))}{\partial a_j} < \epsilon$ , then the contribution stage is characterized by two cutoffs  $\tilde{v}_0 > \tilde{v}_s$  such that group member  $i$  contributes if and only if  $v_i > \tilde{v}_0$  if there is no sanction and  $v_i > \tilde{v}_s$  with a sanction.*
- *Under Restriction A, all symmetric perfect bayesian equilibria are cutoff equilibria at the voting stage.*

### Proof

The aggregate result of the vote (pass or fail), allows the group members to update on the type distribution. We denote  $f_s(v)$  the updated belief over the types of other

group members (vector  $v$  of size  $2N$ ) given that the sanction was passed in the first phase and  $f_0(v)$  the updated belief given that the sanction was rejected.

Consider the case where the sanction was adopted. Not contributing yields

$$v_i - c + \mu E[v_i|a = 1] + eE_s[g(1, a_{-i}^*)].$$

Not contributing yields

$$-s + \mu E[v_i|a = 0] + eE_s[g(0, a_{-i}^*)],$$

where

$$E_s[g(1, a_{-i}^*)] = \int g(1, a_{-i}^*(v)) f_s(v) dv.$$

is the expected value of the public good, given belief  $f_s$  over types and given that the relation in equilibrium between type and action,  $a_j^*(v_j)$ .

The net incentive to vote in favor is thus given by:

$$v_i - c + s + \mu (E[v_i|a = 1] - E[v_i|a = 0]) + e (E_s[g(1, a_{-i}^*)] - E_s[g(0, a_{-i}^*)]).$$

So the contribution behavior is going to be characterized by a cutoff. The cutoff is defined by:

$$v_s^* - c + s + \mu \Delta(v_s^*) + e (E_s[g(1, a_{-i}^*)|v_s^*] - E_s[g(0, a_{-i}^*)|v_s^*]) = 0$$

where  $a_{-i}^*$  depends on the cutoff  $v_s^*$  used in equilibrium.

We reexpress this equation as  $F(v) = 0$ . The implicit function theorem

$$\begin{aligned} \frac{\partial v_s^*}{\partial s} &= - \frac{\frac{\partial F}{\partial s}}{\frac{\partial F}{\partial v_s^*}} \\ &= - \frac{1 + \frac{\partial e (E_s[g(1, a_{-i}^*)|v_s^*] - E_s[g(0, a_{-i}^*)|v_s^*])}{\partial s}}{\frac{\partial F}{\partial v_s^*}}. \end{aligned}$$

$E_s[g(1, a_{-i}^*)|v_s^*]$  depends on  $s$  through the changes in  $f_s$ . The numerator is thus negative, provided  $e$  is low enough.

The denominator is given by:

$$1 + \mu \Delta'(v_s^*) + e \sum_{j \neq i} \frac{\partial a_j}{\partial v_s^*} \frac{\partial (E_s[g(1, a_{-i}^*)] - E_s[g(0, a_{-i}^*)])}{\partial a_j}.$$

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We have  $\frac{\partial a_j}{\partial v_s^*} < 0$ . In the case of substitutes  $\frac{\partial(E_s[g(1, a_{-i})] - E_s[g(0, a_{-i})])}{\partial a_j} < 0$  so the condition  $1 + \mu \Delta'(v) > 0$  is sufficient to guarantee that the overall  $\frac{\partial v_s^*}{\partial s} < 0$ .

For the case of complements  $\frac{\partial(E_s[g(1, a_{-i})] - E_s[g(0, a_{-i})])}{\partial a_j} > 0$ , so the extra constraint is required to guarantee that the left hand side is increasing:

$$\frac{\partial (g(1, a_{-i}) - g(0, a_{-i}))}{\partial a_j} < \epsilon.$$

This establishes the first two results of the Proposition.

So in the second stage the same three categories emerge as in our main model: never-participants, swing-participants and always-participants. The same derivations as those used for Lemma 1 apply, in particular the calculations in equations defining  $D(v_i)$  for the different groups in the main text. The only difference involves the calculation of  $G$ , but since  $G$  is identical for all groups, Lemma 1 and the first result of Proposition 3 follow directly.

### B2: changing supermajority rule

*We present a particular example where the sanction is more likely to be implemented when we increase the supermajority requirement.*

We consider a case where the type distribution  $f$  is a uniform distribution on  $(0,1)$  and we restrict our attention to a group with 3 members. Participation cutoffs simplify to

$$\begin{aligned} v_0 &= c - \frac{\mu}{2}, \\ v_s &= c - \frac{\mu}{2} - s. \end{aligned}$$

We use the following parameters:  $c = 3$ ,  $s = 0.5$ ,  $\mu = 4$  and  $e = 1.5$ . It implies that  $v_0 = 1$  and  $v_s = 0.5$ . All yes voters are swing participants.

Suppose that majority is required ( $K=2$ ) Voting cutoff if interior is determined by:

$$\mu \left( \frac{v_s + 1}{2} - \frac{v_0}{2} \right) + V^* - c + \frac{1}{2}e \times \left[ \frac{V - v_s}{V} + 1 \right] = 0.$$

Plugging the parameters, the voting cutoff that satisfies this equation is  $V_2 \simeq 0.91$ .

Because of the simple majority assumption, the probability that the sanction is accepted is:

$$\begin{aligned}
P(\text{sanction is accepted}) &= P(3 \text{ votes for}) + P(2 \text{ votes for}) \\
&= (1 - V_2)^3 + V_2 \times (1 - V_2)^2 \times 3 \\
&\simeq 0.02.
\end{aligned}$$

Now suppose that unanimity is required. If a voter is pivotal, the other two must have voted for the sanction and thus are swing participants. If he votes for, pivotal player will therefore convince all others to contribute. The equation defining the cutoff becomes:

$$\mu\left(\frac{v_s + 1}{2} - \frac{v_0}{2}\right) + V^* + e = 0.$$

And the voting cutoff is the smallest possible interior cutoff:  $V_3 = v_s = 0.5$ . This cutoff is much smaller than before because in our example, being pivotal when unanimity is required increases a lot the expected externality gain.

As a result, we have:

$$\begin{aligned}
P(\text{sanction is accepted}) &= P(3 \text{ votes for}) \\
&= (1 - V_3)^3 \\
&= \frac{1}{8}.
\end{aligned}$$

Overall, the sanction is more likely to be implemented when we increase the supermajority in this example.

### B3: Contributions and vote secret

In this appendix, we compare our main setup where only contributions are public to an environment where both actions are secret. To clarify the comparison, we focus on the case where types are uniformly distributed over  $(0, 1)$ . In the public good stage, members use higher cutoffs than when contributions are public,  $\hat{v}_s = c - s > v_s^*$  and  $\hat{v}_0 = c > v_0^*$ .

In the voting stage, the tradeoff is very similar to the one expressed above: the voters tradeoff the cost of contributing (that we denote  $-\hat{\mathcal{R}}(v_i)$ ) against the expected externality gain  $\hat{G}(v_i)$ . The functions  $-\mathcal{R}$ ,  $-\hat{\mathcal{R}}$ ,  $G$  and  $\hat{G}$  are plotted in Figure 2.5. The financial and reputational cost is higher for always and never participants to vote in favor in the *public contributions* environment compared to the *both secret* (i.e at the extremities, for  $v < v_s^*$  or  $v > \hat{v}_0$ ,  $-\mathcal{R}$  is above  $-\hat{\mathcal{R}}$ ). Consider for instance the case of never participants: by voting in favor they will not only incur the financial cost  $s$  but will also suffer from the increased bad reputation, a concern not present when contributions are kept secret. For the intermediate zone, and in particular in the

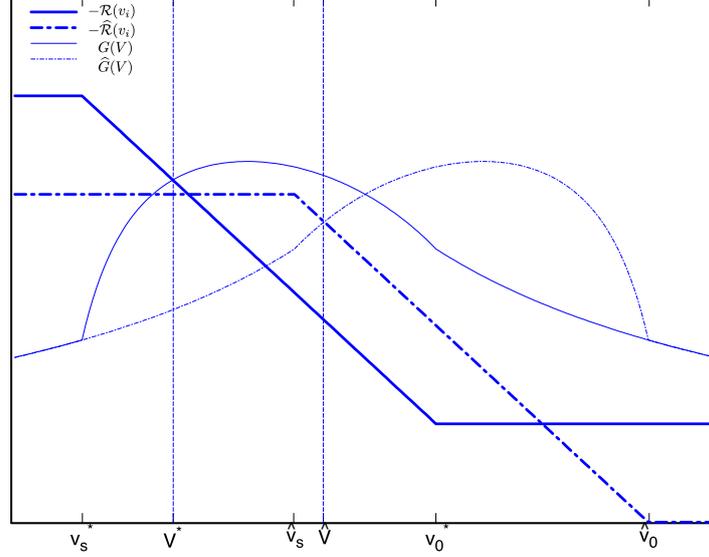


Figure 2.5: Comparing the cases *both secret* and *public contributions*

zone of swing-participants for both (i.e  $V \in (\hat{v}_s, v_0)$ ),<sup>25</sup> the cost is higher in the *both secret* environment. Indeed image concerns make swing participants more inclined to vote in favor as they benefit from the good reputation of contributing when the sanction is passed.

We now compare the expected externality gains  $G$  and  $\hat{G}$ . We see a pattern emerge in Figure 2.5. For low values of  $V < v_s^*$ , where types are never participants in both cases,  $G(V) = \hat{G}(V)$ , and similarly for high values  $V > \hat{v}_0$ . Then for  $V$  slightly above  $v_s^*$ ,  $G(V)$  starts increasing faster, as some of the no voters can now be swing participants in the *secret vote* environment. It eventually decreases as  $V$  approaches  $v_0^*$ , while  $\hat{G}(V)$  starts increasing. We find that in the uniform case, there is a single intersection between the two curves:

**Lemma 4.** *If  $f$  is uniformly distributed over  $(0, 1)$  and if  $\hat{v}_s < \frac{1}{2} < v_0^*$ , then if  $V < \frac{1}{2}$ ,  $G(V) \geq \hat{G}(V)$  and if  $V > \frac{1}{2}$ ,  $G(V) \leq \hat{G}(V)$*

**Proof:** For  $f$  uniform over  $(0, 1)$ , we have that  $\Delta(v)$  is constant, so that

$$v_0^* - v_s^* = \hat{v}_s - \hat{v}_0. \quad (2.13)$$

Using equation (2.13), for  $V < v_s^*$

$$G(V) = \hat{G}(V) = \frac{1}{2} e \left[ \frac{v_0^* - v_s^*}{1 - V} \right].$$

<sup>25</sup>This zone does not necessarily exist, in particular if  $\mu$  is high enough, we will have  $v_0 < \hat{v}_s$ .

For  $v_s^* < V < \hat{v}_s$

$$G(V) = \frac{1}{2}e \left[ \frac{V - v_s^*}{V} + \frac{v_0^* - V}{1 - V} \right] > \hat{G}(V) = \frac{1}{2}e \left[ \frac{v_0^* - v_s^*}{1 - V} \right],$$

the inequality derives from the fact that on this interval  $V < \frac{1}{2}$ .

For  $\hat{v}_s < V < v_0^*$ , we have:

$$\begin{aligned} G(V) &= \frac{1}{2}e \left[ \frac{V - v_s^*}{V} + \frac{v_0^* - V}{1 - V} \right] \\ \hat{G}(V) &= \frac{1}{2}e \left[ \frac{V - \hat{v}_s}{V} + \frac{\hat{v}_0 - V}{1 - V} \right]. \end{aligned}$$

So that  $G(V) = \hat{G}(V) \Leftrightarrow V = \frac{1}{2}$ .

The comparison of  $G(V)$  and  $\hat{G}(V)$  is then symmetric for  $V > \frac{1}{2}$ .  $\square$

We can now conclude on the impact of keeping contributions secret on the voting cutoff. In Figure 2.5 we illustrate a case where  $V^* < \hat{V}$ . We provide in the next proposition general conditions for this pattern to emerge.

**Proposition 10.** *If  $f$  is uniformly distributed over  $(0, 1)$  and if  $\hat{v}_s < \frac{1}{2} < v_0^*$ , there exists  $e_l$  and  $e_h$ , such that if  $e \in (e_l, e_h)$ , the sanction is more likely to be adopted under public contributions than under both secret, i.e  $V^* < \tilde{V}$ .*

**Proof:**

Lemma 4 establishes that for  $V < \frac{1}{2}$ ,  $G(V)$  is above  $\hat{G}(V)$ . Changing the value of  $e$  shifts  $G(V)$  and  $\hat{G}(V)$  without affecting  $\mathcal{R}$  or  $\hat{\mathcal{R}}$ . Thus for  $e$  not too high,  $G$  and  $-\mathcal{R}$  will intersect for lower values of  $V$  than  $\hat{G}$  and  $-\hat{\mathcal{R}}$ , as visible in Figure 2. If  $e$  is sufficiently high, so that  $\hat{G}(0) > \hat{\mathcal{R}}(0)$ , then the cutoff will be zero for the *both secret* case. There is therefore an upper bound  $e_h$  on  $e$  for the result to hold. Similarly, if  $e$  is very low, the unique equilibrium in the *secret vote* environment is for all types to vote against the sanction. There is therefore a lower bound  $e_l$  on  $e$  for the result to hold.

## Chapter 3

# Military service and political participation

This chapter is co-authored with Etienne Fize (Sciences Po).

### Abstract

*We investigate the impact of compulsory military service on turnout and political preferences. Exploiting the suspension of mandatory conscription for French men, we find a significant and positive impact of military service on turnout. This effect ranges from 3.6 percentage points for the first round of the presidential election of 2012 to 8.9 percentage points for the second round of the legislative elections. We also investigate the impact of conscription on political preferences and we find that former conscripts are significantly more nationalist and conservative. Especially, we show that they are more likely to support and vote for the Front National, which is the main far-right party in France.*

## 3.1 Introduction

*"[...] re-establishing a compulsory national service is absolutely necessary, not only to teach citizens how to adapt to the [terrorist] threat, but also to strengthen national cohesion."*

Emmanuel Macron, April 18th 2017

We have observed during the past few years a renewed interest in national services. For instance, Lithuania and Ukraine reintroduced the military service in 2015. In France, the implementation of a new form of national service was a campaign promise of the recently elected President Emmanuel Macron. One of the main arguments in favor of the reintroduction of national services is the shaping of civic and political preferences. "The [2015] Paris attacks were attributed in some parts to a lack of intermixing between social milieus, with republican values no longer being promoted throughout society by way of the armed forces. According to opinion polls, 60 to 80 per cent of respondents would support the reintroduction of the draft." (Bieri, 2015). The fundamental question of the effects of the service on political behaviors has often been raised in the public debate but to our knowledge no in-depth analysis has been conducted. We use the suspension of the military service in France to identify the impact of mandatory military service on turnout and political preferences.

The French conscription differs from the other forms of military service that have been studied in the literature, especially in the United States. First, we consider mandatory and peace-time conscription: during the period we study, no conscript directly participated in a conflict. Therefore, the results that we find are driven by the institution per se and not by combat exposure. Moreover, all French men had to complete the service. In principle the selection was solely based on medical criteria and conscription was a stepping stone in the life of all male individuals. What we can learn from the French service is nevertheless instructive because many other institutions share the same characteristics. Some countries maintained conscription while relying mostly on a professional army for military purposes and, most of all, the new forms of national service that are considered (in France for instance) are also mandatory for all citizens and less military oriented. Our paper is the first study that investigates formally the political consequences of such a national experiment.

In the first part of the paper, we consider the impact of the military service on turnout. Using data collected from electoral rolls, we find that the military service led to a significant increase in turnout. Our main identification strategy consists in

using the variation in compliance to the military service across cohorts. This variation is mostly driven by the suspension of mandatory conscription announced in 1996: individuals born in 1979 and after were not required anymore to do their service while it was compulsory for all males born before this date. We show that a cohort where all individuals have done the service would exhibit a higher turnout than a cohort where no one has done it. We estimate that this effect ranges from 3.6 percentage points for the first round of the presidential election to 8.9 percentage points for the second round of the legislative elections. We show that this impact is mostly driven by a change in the intensive margin. More precisely, the military service does not increase the likelihood that a non-voter casts his first vote but it makes occasional voters more likely to participate in all elections.

Since only men had to fulfill their military obligations, women are not affected by the suspension of the military service. This allows us to control for potential confounding factors like age and cohort effect. We also explore alternative identification strategies. We consider similar data on turnout for the 2002 elections in order to show that the patterns we observe are not driven by age. Those two independent identification strategies allow us to clearly disentangle the impact of military service from the effect of age and from potential cohort-specific characteristics.

The second part of the paper investigates the effect of conscription on political preferences. We use two different sources to examine how the preferences of former conscripts differ from the rest of the population. First, we use a survey conducted in 2017 where we introduced a question on military service in order to identify former conscripts. We also exploit a series of surveys conducted between 1988 and 1991. We find that former conscripts are significantly more likely to report nationalist and conservative political preferences. This result is valid in both data sources, which indicates that the military service modifies political preferences in the long run. Moreover, using the data collected in 2017, we show that former conscripts report more positive attitudes towards the Front National, which is the main nationalist party in France, and towards its leader Marine Le Pen. For instance, we estimate that an individual who has done the military service is twice more likely to state that he has voted for Marine Le Pen in 2012 than a non conscript.

## **Literature review**

Starting with Angrist (1990), consequent literature has studied the impact of veteran status in the US on education and earnings<sup>1</sup>. Using the natural experiment of the

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<sup>1</sup>Although our paper focuses on the impact of peace-time mandatory conscription, we review the literature on veteran status more broadly.

draft lottery during the Vietnam war, he shows that veterans earn 15 percent less than comparable nonveterans. The same impact has been found in Angrist and Krueger (1994). Nevertheless, Angrist et al. (2011) and Grenet et al. (2011) show that this result erodes over time, suggesting that the earning gap is only due to the loss in experience on the labour market.

Similar research has been done on mandatory non-professional military service. Imbens and Van Der Klaauw (1995) reached the same conclusion as Angrist (1990) in the Netherlands. Card and Cardoso (2012) find opposite results on wages in Portugal and show that military service raises wages, especially for low-income groups. Similarly, both Maurin and Xenogiani (2007) for France and Torun and Tumen (2015) for Turkey find that the service raised both education and earnings. They explain their results by the incentives to stay in school in order to delay military service, as documented in Card and Lemieux (2001) in the US and in Di Pietro (2013) in Italy.

A small number of papers have studied the link between military experience and civic behaviors. Galiani et al. (2011) have studied the impact of military service on crime in Argentina and found a positive relation. A similar result has been found in Hjalmarsson and Lindquist (2016). They find that military service in Sweden significantly increases post-service crime, which questions the civic virtues of conscription. Those results can be partly driven by the positive effect of combat exposure on crime highlighted by Rohlfs (2010).

A few papers look at the impact of veteran status on political behaviors. This literature focuses on voluntary militaries in the US and not on mandatory peace-time military service. Teigen (2006) studies the impact of veteran status on voting turnout and finds a positive impact in the US. This result can be explained by the willingness of veterans to affect the policy in their favor and also by candidacies of other military veterans like John McCain. Nesbit and Reingold (2011) show that veterans are more likely to volunteer in associations. On the contrary, Bishin and Incantalupo (2008) look at similar questions and find that veterans do not vote cohesively. Also related to this literature, Erikson and Stoker (2011) show that low draft numbers during the Vietnam War – associated to a higher likelihood to be drafted – resulted in more antiwar and more liberal preferences. It also increased the probability to vote for the Democrats. To our knowledge, our paper is the first to investigate the impact of mandatory peace-time military service on turnout and political preferences.

In the next section, we present the context and the data that we use. We then discuss our main results: Section 3 analyzes the impact of military service on turnout and Section 4 investigates the effects on political preferences. Section 5 concludes.

## **3.2 Context and Data**

### **3.2.1 The French military service**

Conscription exists in France since 1798. Over the years, the form and the length of the military service have fluctuated a lot depending on the needs of the army. For the period we are interested in, the service lasted 12 months from 1970 to 1992 and was reduced to 10 months afterwards. Nuclear weapons reduced the need of draftees and non-professional militaries were eventually a burden in a modern army. During the Gulf war, draftees were not directly involved in the conflict. President Jacques Chirac finally announced the suspension of the military service in 1996. In October 1997, young men born after 1978 were officially released from their military duties. Those born before this date still had the obligation to do their service and actually did so up to 2001, even though the rate of compliance was lower for the last cohorts.

However, suspending the military service was far from being a consensual decision. Those who were in favor of conscription claimed that it was a stepping stone in political and civic education. Since the suspension, the reintroduction of a national service has often been discussed. For instance, it was a campaign promise of the recently elected President Emmanuel Macron. Those projects are often less military oriented: other forms of national services, such as the civic service, are considered.

In principle, military service was mandatory for all French men. Nevertheless, young men could avoid the military service for two reasons. First, dispensations were granted in some circumstances. For instance, sole breadwinners did not have to serve. Such dispensations were granted to 5 percent of a birth cohort. Moreover, medically unfit individuals were exempted. For a detailed discussion on the selection process, we refer the interested reader to the dedicated section in the appendix where we report the differences between conscripts and non-conscripts. In Figure 1 we plot the share of individuals who did the service by birth cohort. For cohorts born before 1973, the share of young men who did their service is around 70 percent. This share declines for cohorts born in 1974 and later. After the announcement of the suspension of the military service, it became easier and easier to avoid it. Finally, cohorts born in 1979 and after are not treated.<sup>2</sup>

[Figure 1 about here]

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<sup>2</sup>Voluntary enrollment in the military is beyond the scope of our paper and we do not consider it. We do not look at voluntary civic service because the rate of enrollment is negligible for the period we consider.

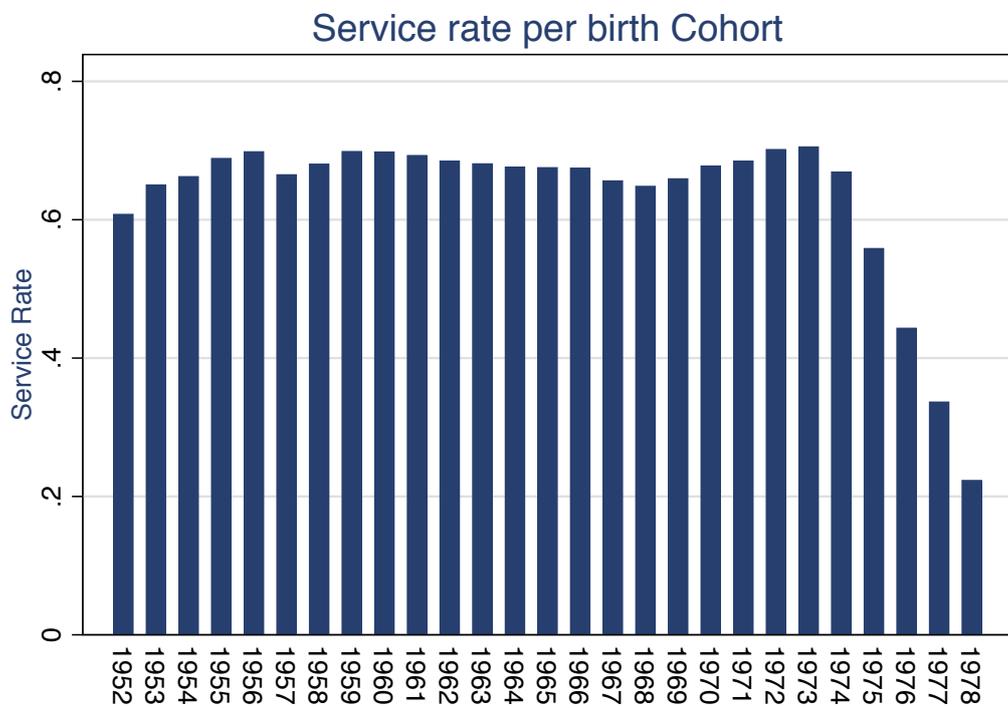


Figure 3.1: Probability of doing the service by birth cohort

### **3.2.2 2012 elections**

For our analysis, we focus on the elections that took place in 2012 in France. This period includes the presidential and the legislative elections. French citizens can vote if they are more than 18 at the time of the election. As a result, those born at the beginning of 1994 and before were allowed to vote.

France has a two-round system for presidential elections. The President is the most important character of the French Vth Republic and his election is considered as the main event of the French political cycle. Turnout is thus much higher than for other elections. For example, 80 percent of French citizens voted in 2012 in contrast with only 50 percent for the local elections that took place in 2015 (“departementales” and “regionales”). The two candidates who gather the largest number of votes in the first round qualify to compete in the second round. The two rounds took place in April 22nd and May 6th. The two candidates of the largest parties qualified for the second round, namely the incumbent Nicolas Sarkozy for l’Union pour un Mouvement Populaire (right-wing) and Francois Hollande for the Parti Socialiste (left-wing). The latter was finally elected with 51.6 percent of votes.

Legislative elections are also held following a two-round system. They took place on June 10th and June 17th. Each of the 577 constituencies elects one MP who later sits at the lower chamber of the Parliament. The outcome of these elections determines the political orientation of the government. Turnout was however much lower than for the presidential election (57 percent for the first round and 55 for the second). In 36 districts, one candidate gathered more than 50 percent of voters in the first round and was thus directly elected. In those cases no second round was held. The left-wing party gathered a large of 331 seats.

### **3.2.3 Turnout**

Our data on turnout is the INSEE dataset “Study on Electoral Participation” of 2012<sup>3</sup>. This dataset was collected by the French Statistical Institution (INSEE) during the electoral period of 2012. A representative sample of 40,000 individuals was first drawn from the census. Our data includes information on individual characteristics from the census (sex, age, education, occupation, marital status...). However, this database does not include whether or not individuals have completed the military service. For each individual in the survey, INSEE directly collected turnout in the voting records. Our data is therefore not biased by misreporting issues (See Harbaugh 1996 for a discussion on misreporting of political preferences).

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<sup>3</sup>INSEE (2012)

Similar data were collected for the presidential and legislative elections of 2002<sup>4</sup> and 2007. For the elections of 2017, the data has not been released yet. We also use the data of 2002 to confirm our results. We could not use the 2007 database because it does not include the age of individuals. Such data are not collected for local elections in France and the access to voting records is only permitted within ten days after the election. As a result, we are not able to extend our analysis to other elections.

### 3.2.4 Service rate

Since the turnout dataset does not include information on military service, we look at the share of individuals who did the service by cohort. We collected data from the archives of the office of the French Ministry of Defense in charge of the military service (Direction du service national). This data includes detailed yearly information on the young men who completed the military service. We were able to collect data on the age of the draftees from 1970 to 2001. We merged this data with the census in order to compute the share of each birth cohort which actually did the service. As a result, we could compute the probability of doing the service for males born in 1952 and after. Those findings are reported in Figure 1.

### 3.2.5 Political preferences

Very few surveys include both data on political preferences and on the military service. After the suspension, all sources collecting data on political behaviors stopped including questions on the military service. Therefore, we introduced a question on this topic in the French Electoral Survey conducted in 2017 by Gougou and Sauger (2017). This survey consists in 1,830 face-to-face interviews and includes a wide range of questions related to political preferences. Roughly one fourth of all respondents have done the military service.

We also use four surveys (Interregional Study on Political Behaviors) conducted each year from 1988 to 1991<sup>5</sup> by the French “Interregional Political Observatory”. Each wave includes around 150 questions and 12,600 observations. The sample is renewed for each wave.

Those two surveys are to our knowledge the only databases that include both information on political preferences and on the military service for France. The time difference between the two sources is useful because we can observe data collected before and after the suspension. In the appendix, we report the translation of the

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<sup>4</sup>INSEE (2002)

<sup>5</sup>OIP (1988),OIP (1989),OIP (1990),OIP (1991)

questions that we include in the analysis.

### 3.3 Military service and turnout

In this section, we show that military service had a large and positive impact on turnout. We focus on the elections of 2012 because for the first time we can observe the voting decisions of a large number of cohorts who were supposed to do the service (born in 1978 and earlier) as well as cohorts who were not treated (1979 to those born at the beginning of 1994).

Figure 3.2 provides a graphical intuition of the main result of the paper. In order to plot this graph, we first compute the sum of the ballots cast by each individual for the elections of 2012. As a result, our variable takes values ranging from 0 if the individual abstained for all elections to 4 if he always voted<sup>6</sup>. We then plot the average of this variable by sex and birth cohort in Figure 3.2. The red vertical line represents the last cohort for which all men had to fulfill military obligations (1978 cohort). Women, on the other hand, never had to fulfill military obligations and can be used as a control group.

[Figure 3.2 about here]

We observe that for cohorts born before 1979 there is no obvious difference in turnout between men and women. At that time, men had to complete the military service. For the later cohorts, not affected by the military service, we observe however that men's turnout is much lower than for women of a same cohort. An explanation to Figure 3.2 is that women are on average more likely to vote and that the military service had a positive impact on men's turnout that compensated for this gender bias.<sup>7</sup> In the following subsections, we test this graphical intuition formally.

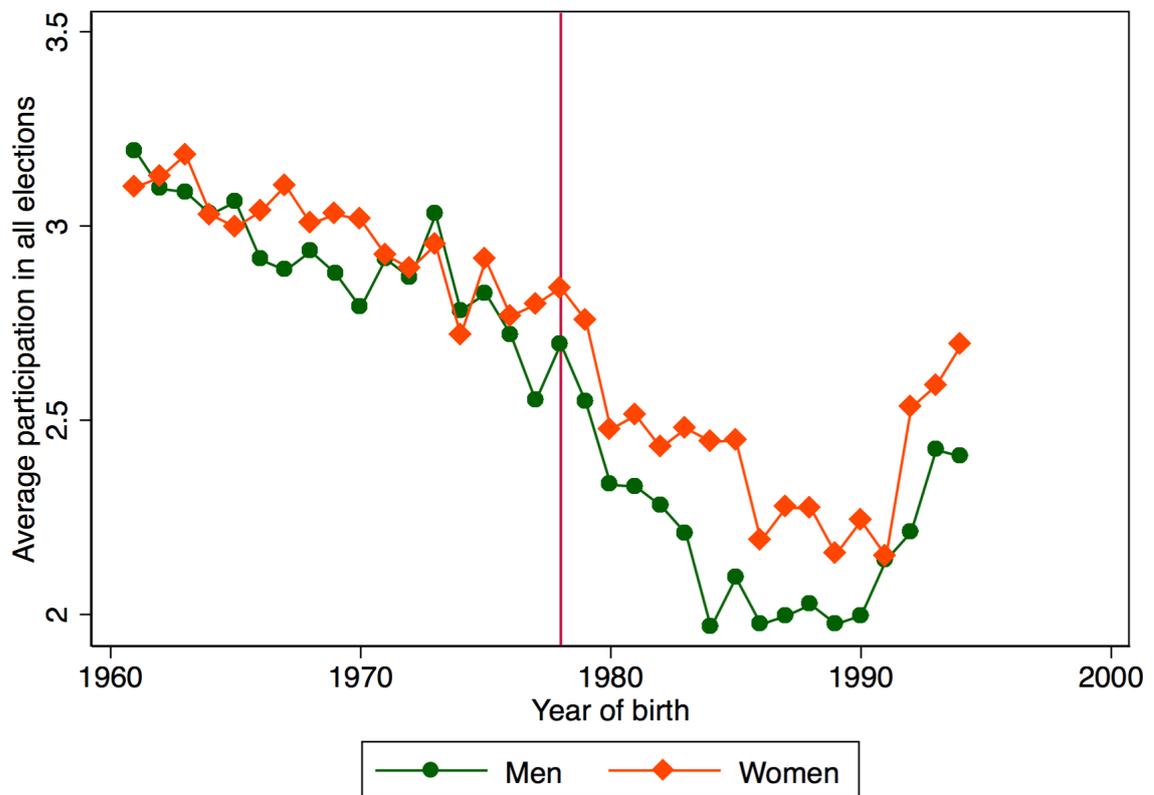
#### 3.3.1 Empirical strategy

In order to estimate the impact of military service on voting turnout, we use a method similar to Imbens and Van Der Klaauw (1995). As explained in their paper, we do not need to observe individual compliance to the service in order to estimate the impact

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<sup>6</sup>We drop the individuals who live in districts where a candidate was elected in the first round in order to keep only those who could vote four times. In Figure 3.2bis (in the appendix), we observe the same pattern when we keep all individuals and use their turnout rate.

<sup>7</sup>Early literature such as Merriam and Gosnell (1924) reported that women used to vote less than men in the first half of the 20th century because of social pressure. Heckelman (1995) points out that this bias is not likely to exist anymore. Turnout by sex for the 2008 elections in the US even suggests that the bias is now reversed (US census bureau).



Note: The variable on the x-axis is the year of birth. The y-axis is the average number of votes cast in 2012 by sex and by cohort. The orange line with diamond symbol is for women and the green one with circles for men. We only keep individuals who could vote 4 times, we show the results for all individuals in Figure 3.2bis.

Figure 3.2: Average turnout by birth cohort

on turnout. Instead, it is sufficient to observe the variation in the aggregate rate of compliance to the military service between birth cohorts.

The change in compliance rate across cohorts is driven by exogenous political decisions. Those decisions could only have impacted turnout through the change in the participation rate to the military service. The main variation in the compliance rate is due to the suspension of military service, which led to a gradual decrease in the rate of conscription for cohorts born between 1975 and 1978. This decline therefore results from an exogenous political reform.

Before this date, the share of young men who did the service each year depended on the needs of the army and on the number of males in that cohort. Because the service was supposed to be done by all French males, the ministry of defense had to adjust the medical criteria required to enter the army in order to regulate the number of admissions. Before incorporation, young men were submitted to a medical examination. They were given six grades based on different criteria.<sup>8</sup> The government set a threshold for each criteria and those who had at least one grade below the threshold were exempted. This procedure allowed the Ministry to raise the threshold in order to reduce the number of incorporations when the army needed less conscripts or for too numerous cohorts. This process was eventually used to match the number of incorporations with the human and financial requirements. A report of the Army stated that “exemptions were used to get rid of unfit individuals, but also, in case of excess human resource, adjust the supply to meet the budget constraint.”<sup>9</sup> This report claims that such adjustments were done at least in 1975, 1978 and 1983. The small variation in the compliance rate for cohorts born before 1975 is therefore also driven by exogenous political adjustments.

As a result, we consider that the variation in the aggregate share of enrollment in the military service is exogenous and we estimate the following model:

$$y_{i,c} = \alpha + \beta ProbaService_c + \delta_1 Age_i + \delta_2 Male_i + \gamma X_i + \epsilon_i \quad (3.1)$$

Where  $y_i$  is a binary variable equal to 1 if the individual has voted.  $ProbaService_c$  is the proportion of the birth cohort  $c$  of individual  $i$  who completed the military service. We implicitly assume that the probability that an individual born in cohort  $c$  has done his service is equal to the share of cohort  $c$  that has done the service. The share of compliance by cohort is reported in Figure 1. We were able to compute those shares for cohorts born between 1952 and 1978 and we assume that the compliance

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<sup>8</sup>The “SIGYCOP” grading system (upper body, lower body, general state, eyes/vision, color blindness, hearing and mental health).

<sup>9</sup>Rapport sur les conditions d’exécution du service militaire, Ministère de la Défense (1989).

rate is 0 afterwards. We had to drop the individuals born before 1952. We end up with 26,662 individuals for whom we can observe turnout for each round of the 2012 elections.<sup>10</sup>

Moreover,  $X_i$  is a vector of control variables including age, sex, marital status, education and profession dummies as in Wolfinger and Rosenstone (1980), Alvarez et al. (2011) or Burden et al. (2014)<sup>11</sup>. In the appendix, we show that our results do not change when we add further controls.

### 3.3.2 Increase in turnout

[Table 3.1 about here]

In Table 3.1, we estimate the model above with a logistic specification. In Column 1, the dependent variable is the turnout for the first round of the presidential election. Columns 2, 3 and 4 report the marginal effects for the other elections. The regressions confirm the graphical intuition we discussed above. For all elections, we find a positive and significant impact of military service. Our estimation suggests that changing the probability of doing the service from 0 to 1 would change the probability to turn out by 3.6 percentage points for the first round of presidential elections and by 8.9 percentage points for the second round of legislative elections.

In the appendix, we show that those results hold when we change the empirical specification. The estimates are similar when we run OLS or probit regressions. We also use a pseudo-difference-in-differences approach where we consider women as the control group. Our results are also robust to the introduction of further controls and to the exclusion of the 1975-1978 cohorts for which we observe a gradual decrease in the treatment rate.

We also find a positive and significant impact of age on turnout. The effect of military service is therefore clearly disentangled from the impact of age. This regression confirms that males vote less than women. The gender gap is about 4 percentage points, which is of the same order of magnitude than the impact we have found for the military service.

In relation to the literature on turnout, the effect of service is comparable to the impact of door-to-door canvassing found in the US by Gerber and Green (2000).

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<sup>10</sup>Because in some constituencies a candidate was elected at the first round, this number drops to 25,014 for the second round of legislative elections.

<sup>11</sup>Other studies also include age squared in the regression. The coefficient for this variable is usually negative and represents the decline in turnout for the oldest age groups. Because we have dropped individuals who are more than 60 in 2012 this effect should not exist in our data and we assume that the effect of age is linear.

Table 3.1: Logit Marginal effects for turnout

	(1)	(2)	(3)	(4)
	Presidential		Legislative	
	First	Second	First	Second
Service Rate	0.0358** (0.0167)	0.0504*** (0.0149)	0.0672*** (0.0228)	0.0894*** (0.0209)
Age	0.0037*** (0.0005)	0.0038*** (0.0004)	0.0091*** (0.0006)	0.0092*** (0.0005)
Sex	-0.0348*** (0.0087)	-0.0361*** (0.0069)	-0.0376*** (0.0103)	-0.0428*** (0.0103)
$N$	26662	26662	26662	25014
$R^2$	0.04	0.06	0.07	0.07

\*  $p < 0.1$ , \*\*  $p < 0.05$ , \*\*\*  $p < 0.01$

Note: Estimates are logit regressions, we display the average marginal effects. We control for marital status, education and profession. Representative INSEE weights are used. The outcome is individual turnout at each of the four elections. *Service Rate* is the proportion of male individuals who did their military service per birth cohort, the variable takes the value of 0 for women. Standard errors in parentheses are clustered at cohort level.

They report an increase in turnout by 9 percentage points when individuals are contacted in person by a canvasser who reminds them of the vote. Also in the US, Madestam and Yanagizawa-Drott (2012) study the impact of attendance to 4th July celebrations. Using rainfall on July 4th as an instrument, they predict the number of celebrations attended in childhood. They find that attending one additional celebration in childhood raises turnout by 0.88 percentage points at age 39.

Even if Table 3.1 indicates an impact of military service on turnout, we cannot yet rule out that the effect is explained by a difference in age trend between sexes. In order to test whether our results are driven by such an explanation, we compare the 2012 elections with the 2002 elections. An alternative method is to add an interaction between age and gender in the main model. We test this specification as a robustness check in Table 1ter in the appendix. The main result is not altered and we even find a larger estimate for the impact of military service. However, this is not our preferred specification because the interaction term is highly correlated with other control variables. Similar data on turnout has been collected in the “Study on Electoral Participation” of 2002. We merge the 2002 and 2012 turnout data and test if we observe a similar age trend for the two elections. If the effect found in Table 3.1 is driven by the military service, we expect to find a significantly higher turnout for age groups that did the service in 2002 than for the same age groups that did not do it in 2012.

We do not consider presidential elections because an extreme right candidate (Jean-Marie Le Pen) managed to qualify for the second round in 2002. This outcome was unexpected and abstention dropped by 8 percentage points between the two rounds. These special circumstances are likely to introduce noise so we exclude this election from our analysis. For each individual, we generate a variable equal to the sum of votes cast for the two rounds of the legislative elections and take it as the dependent variable. We focus on districts where there was a second round. We estimate the following empirical specification:

$$y_i = \alpha + \beta_1 Age_i + \beta_2 2002 + \beta_3 Age_i * 2002 + \epsilon_i \quad (3.2)$$

2002 is a dummy variable that indicates if the observation is for the 2002 election. This variable accounts for the global difference in turnout between the two elections. We also control for age and include an interaction of the 2002 dummy with age.  $\beta_3$  therefore indicates if the impact of age differs between the two elections.

[Table 3.2 about here]

In Column 1, we focus on men between 25 and 34. For those age cohorts, males

Table 3.2: Comparison 2012-2002

	(1)	(2)	(3)	(4)
	Comparative sample		Placebos	
	Men 25-34	Women 25-34	Men>34	Men<24
2002	0.9982*** (0.2455)	0.3721 (0.2436)	0.0824* (0.0433)	-0.2743 (0.3372)
Interaction age 2002	-0.0282*** (0.0083)	-0.0088 (0.0082)	-0.0008 (0.0007)	0.0231 (0.0157)
Age	0.0456*** (0.0063)	0.0299*** (0.0062)	0.0073*** (0.0005)	-0.0548*** (0.0115)
Constant	-0.5359*** (0.1896)	0.0173 (0.1898)	0.8807*** (0.0347)	1.9693*** (0.2497)
$N$	5303	5317	24698	4175
$R^2$	0.033	0.023	0.021	0.032

\*  $p < 0.1$ , \*\*  $p < 0.05$ , \*\*\*  $p < 0.01$

Note: Estimates are obtained with OLS regressions. We have regional (department) fixed effects. The outcome is the sum of individual turnout at each of the two rounds of legislative elections. *2002* is a dummy for election year 2002. The first column is the column of interest where we compared two generations, one affected by the mandatory service, the other not. The other columns are placebos. Standard errors in parentheses are clustered at cohort level.

had to complete the military service in 2002 while those of the same age in 2012 did not have to. Looking at equation (2),  $\beta_2$  could be interpreted as the net impact of service provided that individuals of this age group do not differ on other characteristics between the two elections. We include regional fixed effects. Unfortunately, the 2002 database on electoral participation does not include the control variables we used in the previous section and we cannot account for further differences. The regression shows that  $\beta_2$  is positive and significant (Column 1). This reveals that the level of participation was significantly lower in 2012 than in 2002 for this particular age group, which indicates a military service effect.

To confirm our results, the other columns are placebo regressions of model (2) on the groups for whom service conditions have not changed between 2002 and 2012. Our placebo regressions reveal a smaller difference in turnout between 2002 and 2012 for groups not impacted by the change in service conditions. The fact that we see no significant difference in women's level of turnout (Column 2) for the same age group (25 to 34) reveals that the result is specific to males and not driven by an election or generation effect. Column 3 displays the results for men above 34. This difference is only significant at the 10% level and the point estimate is about ten times smaller. Those men have done the military service in both elections. In Column 4, we focus on men below 24 who did the service neither in 2012 nor in 2002. This confirms that the results of Column 1 are driven by the suspension of the military service.

The comparison between those two election raises the question of the persistence of the impact of the service: is the effect long lasting or does it vanish over time? We investigate this question in a dedicated section in the appendix. Our analysis shows that the impact is quite persistent.

[Table 3.3 about here]

Finally, the data on turnout has not been released for the 2017 election but we can use the French Electoral Study conducted in 2017 to infer the impact on turnout. The sample is much smaller and the data is declarative. As it includes a question on military service, we can regress turnout on a binary variable equal to 1 if the individual has done the service and on a set of controls. This estimation could be affected by a selection bias if enrollment in the military service was driven by unobservable variables for which we cannot control. A section in the appendix is dedicated to the selection effect: we control for most variables that impacted the enrollment into the military service. The estimation strategy is therefore very different from what we have done for the 2012 data. Yet, we find a positive and significant impact of conscription on turnout. Moreover, the magnitude of this effect is similar to what we found for the

Table 3.3: Turnout for 2017 (FES)

	(1)	(2)	(3)
	Presidential	Presidential	Legislative
	First	Second	First
Service	0.101*** (0.028)	0.065** (0.028)	0.080*** (0.027)
Age	0.011*** (0.003)	0.012*** (0.003)	0.013*** (0.003)
Age <sup>2</sup>	-0.000*** (0.000)	-0.000*** (0.000)	-0.000*** (0.000)
Male	-0.090*** (0.024)	-0.090*** (0.027)	-0.070*** (0.023)
N	1,717	1,717	1,717
R2	0.07	0.07	0.08

\*  $p < 0.1$ , \*\*  $p < 0.05$ , \*\*\*  $p < 0.01$

Note: Estimates are obtained from OLS regressions. For each election, the dependent variables is equal to 1 if the individual declares that he has voted. Since the survey was conducted before the legislative election, the last column relies on a prospective statement. *Service* is a dummy variable with value 1 if the individual did his military service. We control for age, age squared, sex, income, education and profession fixed effects. Standard errors in parentheses are clustered at cohort level.

2012 election, which confirms that the impact of the military service on turnout is persistent.

### 3.3.3 Extensive/Intensive margin

We now investigate which type of voters was most impacted by the military service. More specifically, does conscription increase the probability of never voters to turn out at least once, or does it increase the probability of occasional voters to vote more? We refer to the first effect as the extensive margin effect and to second effect as the intensive margin.

In order to tackle this extensive/intensive margin question we generate three additional binary variables. The first takes the value of 1 if the individual has voted once or more, the second takes the value of 1 if he has voted three times or more and the last one indicates if the individual has voted for all elections. We focus on districts where there was a second round in the legislative elections in order to keep individuals who could have voted four times. To give an order of magnitude 91% of voters voted at least once, 65% at least three times and 47% voted to all four elections.

In Table 3.4, we regress those dummy variables on the probability of service and on the usual controls. Column 1 shows that military service is unlikely to make a never-voter vote once. On the other hand, Column 2 and 3 show that military service makes occasional voters vote more systematically. We can conclude that most of the impact of the military service goes through the intensive margin.

[Table 3.4 about here]

The impact on the intensive margin explains why we find a stronger effect for legislative elections. Knowing that an individual has voted at the first round of the legislative election, this individual had voted for the first round of the presidential election with a .95 probability. However, an individual who did not vote at the presidential election has only a probability of .15 to vote at the first round of the legislative election. The impact on the intensive margin will therefore make individuals who would only have voted for the presidential also turn out for the legislative election.

This explanation is confirmed by Table 3.5. We separately consider individuals who voted for the first round of the presidential and those who did not. We chose this election because it occurred first and because it received the most media attention. In the first three columns, we consider voters who voted in the first round of the presidential election. We test the model of equation (1) with turnout for the three other elections as the dependent variable. In Columns 4, 5 and 6, we replicate the same method on the subsample of individuals who did not vote in the first round

Table 3.4: Extensive/Intensive margin

	(1)	(2)	(3)
	One or more	Three or more	Four
Service Rate	0.0086 (0.0126)	0.0810*** (0.0226)	0.0928*** (0.0193)
Age	0.0029*** (0.0004)	0.0087*** (0.0005)	0.0081*** (0.0005)
Male	-0.0162*** (0.0059)	-0.0416*** (0.0095)	-0.0515*** (0.0100)
<i>N</i>	26662	26662	26662
<i>R2</i>	0.07	0.07	0.05

\*  $p < 0.1$ , \*\*  $p < 0.05$ , \*\*\*  $p < 0.01$

Note: Estimates are logit regressions, we report the marginal effects. We control for marital status, education and profession. Representative INSEE weights are used. The outcome is a dummy variable with value 1 if the individual voted once or more for the first column, three times or more for the second and to all four in the last one. Service Rate is the proportion of male individual who did their military service per birth cohort, the variable takes the value of 0 for women. Standard errors in parentheses are clustered at cohort level.

Table 3.5: Extensive/Intensive margin : using election timing

	(1)	(2)	(3)	(4)	(5)	(6)
	Voted at first election			Did not vote at first election		
	2nd Pres	1st Legis	2st Legis	2nd Pres	1st Legis	2st Legis
Service Rate	0.0397*** (0.0128)	0.0573** (0.0233)	0.0888*** (0.0170)	-0.0150 (0.0509)	-0.0079 (0.0438)	-0.0175 (0.0617)
Age	0.0016*** (0.0004)	0.0084*** (0.0006)	0.0084*** (0.0005)	0.0022** (0.0010)	0.0044*** (0.0011)	0.0049*** (0.0013)
Male	-0.0181*** (0.0070)	-0.0224** (0.0112)	-0.0397*** (0.0091)	-0.0163 (0.0177)	-0.0013 (0.0231)	0.0372 (0.0363)
<i>N</i>	22610	22610	21197	4052	4052	3817
<i>R2</i>	0.03	0.05	0.05	0.05	0.09	0.09

\*  $p < 0.1$ , \*\*  $p < 0.05$ , \*\*\*  $p < 0.01$

Note: Estimates are logit regressions, we report the marginal effects. We control for marital status, education and profession. Representative INSEE weights are used. The first three column are regressions on the sample of individuals who voted in the first elections, the outcome variables are individual turnout for the other elections. The second part looks at individuals who did not vote at the first election. Service Rate is the proportion of male individual who did their military service per birth cohort, the variable takes the value of 0 for women. Standard errors in parentheses are clustered at cohort level.

of the presidential election. The military service does not affect the participation rate of citizens who did not participate in the first round of the presidential election, but it does increase the probability to vote to the other elections for those who did. This finding confirms that the military service has mostly an impact on the intensive margin.

[Table 3.5 about here]

## **3.4 Political preferences**

In addition to the effects that we found on turnout in the previous section, did the military service modify other political behaviors? In this section, we focus on political preferences. We find that former conscripts are more nationalist, more conservatives and that they are more likely to support the French far-right party.

### **3.4.1 Empirical strategy**

We use two different sources to investigate the impact of the military service on political preferences. First, we exploit the French Electoral Study, hereafter FES, conducted in 2017 by Gougou and Sauger (2017). This study consists in 1,830 face to face interviews. Respondents had to answer a large list of questions on political behaviors. This survey includes a question on conscription status. In the sample, 436 respondents have done the military service. This is to our knowledge the only dataset in France released after the suspension of the military service that includes a question on it. We also use a series of surveys conducted from 1988 to 1991: "Interregional Study on Political Behaviors", hereafter ISPB. Those surveys also include data on conscription status as well as a wide range of questions on political preferences and moral values. Each year 12,600 individuals were surveyed and the sample was renewed every year.

We report our results with the FES dataset in Table 3.6 and for the ISPB databases in Table 3.7. For most questions, individuals had to choose among several ordered answers, generally ranged from "Strongly agree" to "Strongly disagree". We therefore regress the preferences reported on a dummy variable equal to 1 if the individual has done the service and on a set of controls. The list of variables differs between the two datasets, we discuss the details of the estimation strategy in the table notes. We report the translation of the questions that we use in the appendix.

A major concern for this estimation is the selection bias. If some individuals are more likely to avoid conscription because of unobserved characteristics for which we

cannot control that also impact the answer to the questions we study, our results would be biased. The solution proposed by Angrist (1990) would be to instrument the indicator variable for the military service by the probability of doing the service (computed as the share of the birth cohort which did the service). Unfortunately, this instrument is too weak because there is not enough variation in this proportion for the years covered in the ISPB surveys.

We provide a detailed discussion of the selection in the appendix. Especially, we see in Table 3.9 that former conscripts are better educated and more healthy. Moreover, sons of immigrants are less likely to have done the service. We include control variables that account for this selection effect. Unfortunately, we do not have a proxy for health in the databases that we use. The results of this section could thus be biased if health had an impact on the dependent variables that did not only go through the change in compliance to the military service and for which we cannot control.

### 3.4.2 Military service and extreme-right ideology

[Table 3.6 about here]

Our results clearly point towards a shift in political preferences of former conscripts. In the two tables, we find that those who did the service are more nationalist, more conservative and are more likely to support and vote for the Front National, which is the main far-right party in France. In the FES survey, respondents were asked about their feelings towards political parties. In Column 1, we find that former conscripts are significantly more likely to declare that they have voted for Marine Le Pen – the candidate of the main nationalist party (Front National) – for the first round of the 2012 presidential election. The odds ratio reveals that a former conscript is twice more likely to state that he has voted for Marine Le Pen. The second and third columns confirm the increased support for the Front National: in Column 2, we find that those who have done the service are more likely to state that they could vote for this party one day and in Column 3, we see that former conscripts have a better opinion of the Front National. We cannot express the odds ratio because the respondents had to answer on a scale. Those results are not driven by more positive feelings towards politicians in general: we do not observe such a pattern when we consider other political parties and other politicians. We include the average feelings towards political parties in the regressions to control for this effect. Finally, we find in the last column that they also report more negative feelings towards immigrants.

Table 3.6: French Electoral Study 2017

	(1)	(2)	(3)	(4)
	Le Pen 2012	Vote FN	Support FN -	Xenophobic
Service	2.343** (0.801)	0.211** (0.098)	0.253*** (0.097)	0.233*** (0.087)
Age	0.983 (0.033)	-0.013 (0.010)	-0.019** (0.009)	-0.008 (0.009)
Age <sup>2</sup>	1.000 (0.000)	-0.000 (0.000)	0.000 (0.000)	0.000 (0.000)
Male	0.407*** (0.123)	-0.054 (0.084)	-0.060 (0.083)	-0.122 (0.075)
N	1,239	1,658	1,658	1,454
Pseudo-R2	0.12	0.05	0.04	0.03

Standard errors in parentheses

\*  $p < 0.1$ , \*\*  $p < 0.05$ , \*\*\*  $p < 0.01$

Note: The first column is the odds-ratio of a logit regression. The other estimates are ordered probit regressions, these are not the marginal effects. *Service* is a dummy variable with value 1 if the individual did his military service. We control for age, age squared, sex, income, education and profession fixed effects and for the country of origin of the parents. In the first column, the dependent variable is equal to 1 if the respondent declares to have voted for Marine Le Pen in 2012. The second column is the reported likelihood to vote for the Front National in general. The third column variables in the sympathy for the Front National. The last variable is a summary of several questions related to attitudes towards immigrants. The translation of the questions is reported in the appendix.

Table 3.7: ISPB 1988-1991

	(1)	(2)	(3)	(4)
	Right	Patriot	Xenophobic	Tax
Service	0.1655*** (0.0304)	0.0945*** (0.0308)	0.1242* (0.0726)	-0.1841*** (0.0309)
Age	0.0028 (0.0024)	-0.0075*** (0.0025)	0.0241*** (0.0063)	0.0090*** (0.0025)
Age <sup>2</sup>	0.0000 (0.0000)	0.0001*** (0.0000)	-0.0002*** (0.0001)	-0.0001*** (0.0000)
Male	0.1421*** (0.0211)	-0.0004 (0.0215)	0.2309*** (0.0491)	-0.1823*** (0.0216)
N	46,034	46,034	10,933	33,366
Nb years	4	4	1	3
Pseudo-R2	0.05	0.01	0.09	0.02

Standard errors in parentheses

\*  $p < 0.1$ , \*\*  $p < 0.05$ , \*\*\*  $p < 0.01$

Note: Estimates are ordered probit regressions (or probit for the first and second column), these are not the marginal effects. We control for age, age squared, income, education and survey fixed effects and for the country of origin of the father. *Service* is a dummy variable with value 1 if the individual did his military service. We also introduce a variable accounting for the fading of the effect over time, defined as Age-20, which is roughly the number of years since the service. When questions are identical accros surveys, we pool the observations (the sample was renewed every year). *Nb years* indicates the number of years the question was asked. The variable *Right* takes a value of 1 if the individuals reports right-wing political preferences on a scaled left-right spectrum. The variable *Patriot* is equal to 1 if the individual identifies France as his primary group of belonging. The variable *Xenophobic* is equal to 1 when the individuals thinks that there are too many immigrants in France. The question was only asked in 1990. The *Tax* variable indicates on a scale from 0 to 3 whether the individual is willing to pay more taxes.

[Table 3.7 about here]

The ISPB database confirms and reinforces the previous results. Respondents had to indicate their ideological position on a right-left scale. In Column 1, we run an ordered probit regression taking the dichotomized right-left position as the dependent variable<sup>12</sup>. There is a significant correlation between military service and the likelihood to report rightist political preferences. In the second column, we can see that they are more likely to report themselves as patriot. The third column confirms the negative impact on attitudes towards immigrants that we found in Table 3.6.

Finally, we find in Column 4 of Table 3.7 that former conscripts prefer lower taxation rates. In line with Shayo (2009), this can also indicate a shift in patriotic values. This author proposes a model where individuals vote for the level of redistribution that maximizes the social status of the group they identify with. When people identify with their social group, the poor will support a high redistribution rate because this reduces the gap with the rich. Conversely, when they identify with their nation, they prefer a lower redistribution rate because it makes their nation perform better than other nations. In tables 3.6 and 3.7, we find that military service enhanced patriotic values and as one would expect from Shayo (2009), we also find that former conscripts support lower taxes.

Our data do not allow us to investigate formally the mechanisms through which the ideological shift that we document occurs. One explanation could be the exposure of young men to professional militaries during their service. This group is known to be conservative and nationalist as explained in Rouban (2007) and Rouban (2013). The interactions between conscripts and professional militaries could have had an influence on the shaping of political preferences of young men.

In the spirit of the citation of President Macron in the introduction, it was commonly said that military service promoted civicness through social mixing. The findings on immigrants questions this idea. Allport (1954) and Pettigrew and Tropp (2000) have highlighted that intergroup contacts can improve the relations between the groups only under certain conditions, including an equal status for all groups. This was indeed not the case in the military service because educated conscripts served in better conditions and were given different tasks that required specific skills. To some extent, this unequal treatment could have exacerbated social tensions and might explain why we observe an ambiguous effect on former conscripts.

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<sup>12</sup>We dichotomize because the scale varies across surveys (5 possible answers in 1988 and 10 in 1991). In Table 8bis in the appendix, we display the results with the different samples separated.

### 3.4.3 Shift in preferences and expressive voting

According to the expressive voting theory (Brennan and Hamlin, 1998), the shift to the right of political preferences could be a mechanism that reinforces the positive impact of military service on turnout for the 2012 elections. The French political campaign of 2012 was largely focused on nationalist debates, such as immigration or “*identité nationale*” (Martin, 2012). Citizens with conservative preferences could therefore have been more interested in the elections than others. To test this effect, we use the INSEE data on turnout that we exploited in the previous section. We focus on the first round of legislative elections of 2012 because it is the only election covered by our data where there is a sufficient ideological variation in the platforms proposed to voters. We recovered the political offer in the 577 electoral districts for the legislative election. We aim to test whether a larger nationalist political offer implies a larger effect of military service on turnout. We exploit the variation in the number of extreme right candidates, who generally campaign on nationalist and conservative platforms. There was at least one extreme right candidate in all districts. In our sample, 13 percent of voters live in a district where there is more than one extreme-right candidate. We test if this additional choice implies a larger impact of the military service on turnout. We estimate the following model in Table 3.8:

$$y_{i,c} = \alpha + \beta_1 ProbaService_c + \beta_2 ProbaService_c * ExtremeRight_i + \delta X_i + \epsilon_i \quad (3.3)$$

Where  $ExtremeRight_i$  is equal to 1 if there are more than one extreme right candidate in the electoral district of voter  $i$ . The dependent variable is individual turnout for the first round of the legislative elections and  $X_i$  is the set of control variables.

The positive and significant coefficient of the interaction between the probability of service and the number of extreme right candidates indicates that military service raises turnout by a larger magnitude when the extreme right political offer is large. This finding supports the expressive voting theory: former conscripts are willing to support conservative and nationalist candidates so they are more likely to vote when they face a large right-wing political offer in their district. Naturally, we cannot conclude that this is the only mechanism that explains our result on turnout. However, we expect a larger impact of conscription when the political debate is focused on topics associated to the extreme right.

[Table 3.8 about here]

Table 3.8: Extreme Right

	(1) First round legislative
Service Rate	0.3401*** (0.0978)
Extreme Right	0.0816 (0.0723)
Service $\times$ Extreme Right	0.9239** (0.4000)
Age	0.0408*** (0.0029)
Male	-0.1718*** (0.0430)
$N$	24451
$R^2$	0.07

\*  $p < 0.1$ , \*\*  $p < 0.05$ , \*\*\*  $p < 0.01$

Note: Estimates are logit regressions, these are not the marginal effects. We control for total number of candidates, total right-wing candidates, marital status, education and profession. We define a fading variable as Age-20, which is roughly the number of years since the service. We interact this variable with the controls depending on the service to account for the fading of the effects over time. Representative INSEE weights are used. The outcome is individual turnout at the first round of legislative election. Service Rate is the proportion of male individuals who did their military service per birth cohort, the variable takes the value of 0 for women. Standard errors in parentheses are clustered at cohort level.

## 3.5 Conclusion

This paper investigates the impact of mandatory peace-time military service on political behaviors. We exploit the natural experiment of the suspension of the military service in France at the end of the 1990's to estimate the impact of conscription on turnout. We use the difference in treatment between men and women and between men of different cohorts to identify our effect. We also explore additional identification strategies to validate our results. Especially, we use data collected during previous elections to show that the patterns we highlight are specific to the cohorts affected by the discontinuity. We conclude that military service enhanced political participation. We have found a significant and positive effect on turnout for the 2012 elections. The magnitude of this effect is very large (up to 8.9 percentage points).

We then investigate the impact of the military service on political preferences. We show that former conscripts are more conservative and nationalist. They are more likely to support the Front National, which is the main far-right party in France, and its leader Marine Le Pen. They report more positive attitudes towards this party and they are more likely to vote for it.

To conclude, we show that institutions such as the military service can shape political behaviors on the long-term. Given that national services still exist all around the world and that many countries consider to reimplement it, it is crucial to understand better how it may affect people. Especially, if the literature has focused on economic outcomes, many other dimensions should be impacted by such institutions and deserve to be studied as well.

## **3.6 Appendix to chapter 3**

### **Selection**

[Table 3.9 about here]

We test in Table 3.9 whether participation in the military service was correlated with individual characteristics. We use data collected by the French Statistical Institution (“Study on Youth in the Labour Market” INSEE 1997) to investigate the determinants of compliance to the military service. This study surveyed individuals born between 1952 and 1979. The survey embodies many questions on individual characteristics including military service and labour market outcomes. Table 3.9 shows that former conscripts come from slightly higher socio economic backgrounds. It was commonly said that educated individuals could simulate mental illness in order to avoid the service. Even if such cases have existed, the military report cited in Footnote 9 claims that this fraud was not statistically significant. It is supported by the fact that 3.5 percent of college graduates were reformed for psychological reasons in 1987 instead of 10.8 percent for those with minimal education. Mother education is on average 0.25 years higher for individuals who did the service. They are also slightly more educated and have higher wages. Although all individuals we consider for our regression are French, sons of immigrants are less likely to do the service in France probably due to agreements with their country of origin. For example, young men with Algerian parents could do the service in Algeria.

### **Robustness checks**

Our main results discussed in section 3 are robust to other specifications and to the introduction of further controls. For the sake of clarity, we now consider each possible vote as one observation (i.e. for each individual, we consider the 3 to 4 elections for which he could have voted as different observations and take the full sample of those observations). We end up with a sample of around 100,000 observations.

Table 1bis compares the results of different specifications used in the literature. Both OLS and logistic regressions are commonly used to estimate turnout models. Blais et al. (2011) use OLS while Burden et al. (2014) and Alvarez et al. (2011) prefer the logistic regression. Beck (2011) refers to this double standard as a “Folk theorem”. Using Monte Carlo simulations, he shows that for normally distributed data, OLS and logistic regressions are almost equivalent for estimating marginal effects.

Table 3.9: Selection

	Mean No Service	Mean Service	Difference	T-Stat
Education	10.60	10.79	-.19	-1.94
Salary	9175	9517	-342	-2.16
First Salary	3652	3744	-92.30	-1.25
Foreign Father	.23	.14	.09	9.87
Foreign Mother	.16	.1	.06	7.63

Note: We report differences between treated and untreated individuals (where treatment is the military service). *Education* is in years, *Salary* is expressed in Francs, the *Foreign* variable takes the value of 1 if the individual was born outside of France. If individuals are too young, they might not have done the service yet so we drop individuals who are below 24.

### *Chapter 3. Military service and political participation*

In Table 1bis Column 1, we use the same specification as in Table 3.1 on the pooled sample adding a dummy for each election. Column 2 and 3 show the estimation using OLS and probit regressions. Probit and logistic regressions lead to similar results. We observe that the impact of military service is slightly higher when we use a linear specification.

In Column 4, we use a pseudo-difference-in-differences approach. We consider males as the treatment group and women as the control group. Treated individuals are men born before 1978. We consider the binary variable Service Dummy, which takes the value of 1 for males born before 1978 and 0 for other men and all women. The coefficient of Service Dummy estimates the change in the difference of participation rate between men and women after and before the end of conscription. We find a point estimate similar to the one we found in the previous estimation.

Column 5 shows the result of our baseline logistic regression when we exclude the cohorts born between 1975 and 1978. For these cohorts, we observe a downward trend in the conscription rate, which could be driven by the anticipation of the end of military service. This could bias our results if individuals with specific characteristics are more likely to have avoided the service during the last years. Column 5 shows that the exclusion of those cohorts has almost no impact on the results.

[Table 1bis about here]

In Table 1ter, we introduce additional control variables. In Column 1, we add an interaction between sex and age. This specification allows to get a different effect of age across sexes. The effect of military service becomes larger and remains significant. The impact of age on turnout is higher for women (negative coefficient on the interaction). Adding this interaction can only strengthen our result. This confirms that the effect of conscription is not driven by a natural difference in age trend across sexes. We decided however not to keep this interaction in our main regression because this variable is highly correlated with other control variables (age, sex and service rate) and therefore the estimation is likely to be noisy.

In Column 2, we find that our coefficients are not affected when we introduce additional geographical controls. Finally, Column 3 shows the results when we exclude the 1975-1978 cohorts with the largest set of control variables. This specification does not alter our results.

[Table 1ter about here]

Table 1bis: Robustness to estimation methods and sample

	(1)	(2)	(3)	(4)	(5)
	Vote	Vote	Vote	Vote	Vote
Service Rate	0.0598*** (0.0141)	0.0788*** (0.0148)	0.0615*** (0.0143)		0.0595*** (0.0144)
Service Dummy				0.0672*** (0.00525)	
Age	0.0065*** (0.0004)	0.0064*** (0.0005)	0.0063*** (0.0004)		0.0064*** (0.0004)
Male	-0.0373*** (0.0062)	-0.0483*** (0.0075)	-0.0400*** (0.0064)	-0.0667*** (0.0046)	-0.0362*** (0.0063)
_cons		0.6132*** (0.0272)		13.7963*** (0.2774)	
N	105,000	105,000	105,000	105,028	96,370
$R^2$	0.13	0.15	0.13	0.05	0.13
Estimation	Logit	OLS	Probit	DiD	Logit
Sample	Full	Full	Full	Full	Cut

Note: We display marginal effects. We control for marital status, education, profession and election fixed effects. Representative INSEE weights are used. The outcome is turnout for all elections the individual faced (3 or 4). In the last column, we exclude from the sample people born between 1975 and 1978. Service Rate is the proportion of male individuals who did their military service per birth cohort, the variable takes the value of 0 for women. Service Dummy is only used for the difference-in-difference estimation, it is a dummy that takes 1 for men born before 1979. Standard errors in parentheses are clustered at cohort level and results don't significantly change if we cluster by individual.

Table 1ter: Robustness to more control variables

	(1)	(2)	(3)	(4)
	Vote	Vote	Vote	Vote
Service Rate	0.1002*** (0.0252)	0.0581*** (0.0143)	0.0963*** (0.0252)	0.0983*** (0.0267)
Age	0.0067*** (0.0005)	0.0064*** (0.0004)	0.0067*** (0.0005)	0.0066*** (0.0005)
Male	0.0033 (0.0219)	-0.0360*** (0.0065)	0.0024 (0.0215)	0.0060 (0.0222)
Interaction Male Age	-0.0015* (0.0008)		-0.0014* (0.0007)	-0.0015* (0.0008)
N	105,000	104,924	104,924	96,294
$R^2$	0.13	0.14	0.14	0.14
Location FE	No	Yes	Yes	Yes
Sample	Full	Full	Full	Cut

Note: Estimates are logit marginal effects each time. We control for marital status, education, profession and election fixed effects. Representative INSEE weights are used. The outcome is turnout for all elections the individual faced (3 or 4). For the last three columns we include very specific geographical controls: department fixed effect and dummies for different type of dwelling situations (rural, small city, suburbs, big city...). In the last column, we exclude from the sample people born between 1975 and 1978. Service Rate is the proportion of male individuals who did their military service per birth cohort, the variable takes the value of 0 for women. Interaction Male Age allows for a different effect of age for both genders. Standard errors in parentheses are clustered at cohort level. Results do not significantly change if we cluster by individual.

## Persistence of the impact on turnout

Does the impact on turnout persist over time? Madestam and Yanagizawa-Drott (2012) also study the persistence of the impact of attendance to 4th July celebrations. Their methodology creates intra cohort variation in the probability of treatment, which allows them to test if the impact erodes over time. Somewhat surprisingly, they find that the effect of attending celebrations in childhood reinforces over time. Our data does not allow us to compute intra-cohort variation and we have to assign the same probability of doing the service to all the individuals of a birth cohort. Another approach would have been to collect data at a regional level in order to create intra-cohort variation. We have data on the number of conscripts each year by region but those data do not include the birth cohorts and therefore we were unable to use the same methodology than what we did at the national level.

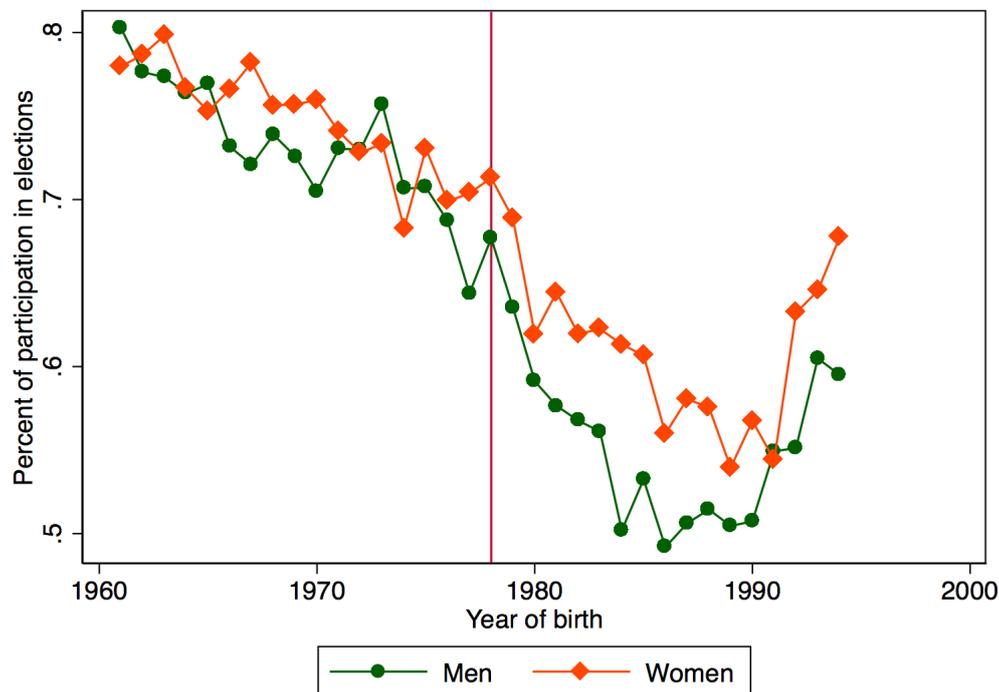
We use Table 3.2 and the comparison with the 2002 election to study the persistence of the impact of military service on turnout. We claim that the difference in turnout between men from 24 to 34 is mostly due to the difference in military requirements. We use the evolution of this difference to study the persistence of the effect of military service. If the effect of service was persistent, the difference should be constant. Conversely, if the effect was decreasing, we should observe a larger difference in turnout for younger cohorts because the impact on previous generations has faded.

In order to test this persistence we use the interaction of age and the 2002 year dummy written as  $\beta_3$  in equation (2). In Table 3.2, this term is negative and significant only in Column 1, which is precisely the column which focuses on age cohorts treated in 2002 and not in 2012. It implies that the difference in turnout between the two elections is stronger for the younger cohorts than for the older ones. If this suggests that the effect of the service fades over time, the magnitude of this coefficient is small enough that we cannot rule out the possibility that the effect persists over the lifetime of treated individuals.

## Additional material

[Figure 3.2bis about here]

[Table 7bis about here]



Note: The variable on the x-axis is the year of birth. The y-axis is the average participation rate in 2012. We first compute the participation rate of each individual as the number of votes cast divided by the number of ballots she could have cast (3 if a candidate has been elected at the first round of the legislative election, 4 otherwise). We then average this measure by year and by cohort. The orange line with diamond symbol is for women and the green one with circles for men.

Figure 2bis: Average turnout by birth cohort

Table 7bis: More right wing regressions

	(1)	(2)	(3)
	Right 89-91	Right 88	Right 90
Service	0.212*** (.0373419)	0.125** (.0627127)	0.390*** (.0535147)
Fading	-0.00352**** (.000941)	-0.00256 (.00157)	-0.00480*** (.00134)
Age	0.00652** (.00303)	0.009* (.00511)	0.00307 (.00433)
Age <sup>2</sup>	0.00000238 (.0000294)	-0.0000207 (.0000503)	0.0000340 (.0000421)
Male	0.135*** (.0255)	0.121*** (.0458)	0.283*** (.0365)
Nb Years	2	1	1
<i>N</i>	18729	7755	9672
<i>R</i> <sup>2</sup>	0.01	0.01	0.01

\*  $p < 0.1$ , \*\*  $p < 0.05$ , \*\*\*  $p < 0.01$

Note: Estimates are ordered probit regressions, these are not marginal effects. We control for income, education and survey fixed effects. Nb years refers to the number of years the question was asked. Service is a dummy variable with value 1 if the individual did his military service. Standard errors in parentheses.

## Questions (translated from French)

### Questions Table 3.6, survey FES

#### Le Pen 2012

- Could you rate these political figures, on a scale from 0 to 10, 0 being that you really dislike this politician and 10 meaning you really like him/her. (Question asked for many several candidates for the presidential election, we focus on Marine Le Pen).

#### Vote FN

- Could you give us your opinion on these political forces, on a scale from 0 to 10, 0 being not at all possible that I would vote for this political party one day and 10 being that you are very likely to vote for this party.

#### Support FN

- Could you rate these political forces, on a scale from 0 to 10, 0 being that you really dislike the political party and 10 meaning you really like it.

#### Xenophobic

- This variable was constructed from a compilation of seven questions about immigrants. All rated from 1 to 5, 1 being “I totally disagree” and 5 “I totally agree”.
  - Minorities should adapt to French traditions and customs.
  - The will of the majority should always win, even if it infringes the rights of the minorities.
  - Immigrants are a bad thing for the economy.
  - In general, the French culture is threatened by the immigrants.
  - Immigrants are rising the criminality rate.
  - Many immigrants come to France only to take advantage of the social security system.
  - There are too many immigrants in France.

## Questions Table 3.7, survey ISPB

### Right

- We usually divide people on a right-left scale. How would you assess your personal position?
  - 5 choices from “Extreme Left” to “Extreme Right” in 1988
  - 10 choices from “Extreme Left” to “Extreme Right” in 1989
  - 7 choices from “Extreme Left” to “Extreme Right” in 1990
  - 10 choices from “Extreme Left” to “Extreme Right” in 1991

### Patriot

- To which place do you belong to?
  - Your city
  - Your department
  - Your region
  - France
  - None
  - No answer

### Xenophobic

- Do you believe that there are too many immigrants in France?
  - Yes
  - No
  - Does not know

### Taxes

- Would you agree to pay more taxes for the economic development of your region?

*Chapter 3. Military service and political participation*

- Yes for sure
- Probably
- Probably not
- No
- No answer



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