

On the rule of k names

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Abstract

The rule of k names can be described as follows: given a set of candidates for office, a committee chooses k members from this set by voting, and makes a list with their names. Then a single individual from outside the committee selects one of the listed names for the office. Different variants of this method have been used since the distant past and are still used today in many countries and for different types of choices. After documenting this widespread use by means of actual examples, we provide a theoretical analysis. We concentrate on the plausible outcomes induced by the rule of k names when the agents involved act strategically. Our analysis shows how the parameter k , the screening rule and the nature of candidacies act as a means to balance the power of the committee with that of the chooser.

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1 Introduction

In the beginning of the sixth century, the clergy and the chief of the citizens of some Eastern European countries chose three names from whom the archbishop selected the bishop. Nowadays, several institutions around the world use variants of this system to fill public offices. For example, this system is known as the “rule of three names” in the United States, “regla de la terna” in Spain and “lista tríplice” in Brazil. Sometimes the list consists of more than three names. Since this does not complicate our analysis, we shall from now on refer to the “rule of k names”.

The rule of k names can be formally described as follows: given a set of candidates for office, a committee chooses k members from this set by voting, and makes a list with their names. Then a single individual from outside the committee selects one of the listed names for the office.

We emphasize that an important part of a rule of k names is the procedure used by the committee in order to screen out those k candidates that will be presented to the final chooser. A diversity of screening rules are actually used to select the k names. Because of this diversity, the “rule of k names” is in fact a family of different rules. Let us review some variants of the rule that have been used in the past and are used in the present.

In the Catholic Church, the bishops are appointed under the rule of three names. According the Code Canon Law #377, the Pope may accept one of the candidates in the list proposed by the Apostolic Nuncio (papal ambassador), or consult further. The list is made after consultation with the members of the ecclesiastical province. In many countries the list is decided by means of voting. In Ireland, each canon of the cathedral and parish priest can cast a vote for three candidates to bishop¹. In England, the canons vote three times, and select each time the most voted candidate. In both cases, the list is made with the three most voted candidates (see Catholic Encyclopedia and Code Canon Law #375, #376 and #377).

In the nomination of the rectors in Brazilian federal public universities, the university councils are permitted, since 1996, to consult their university communities. The law requires that during this consultation, each voter shall cast a vote for only one candidate,

¹Most of Brazilian states adopts this procedure to make the list in the choice of Prosecutor-General. The article 128 paragraph 3 of the Brazilian Constitution states that the governors of the states shall choose one name of those three names proposed by the members of the State Public Prosecute.

and that the three most voted candidates will form the list.² The President of the Republic shall select one of the listed names (see Decreto n°1916, May 23th, 1996, Brazil).

The committee that takes the final decision is in most of the cases a single individual and this is what we shall study here. But we could easily embed our definition of the rule of k names, with one committee and one chooser, into a larger class of procedures where both the screening and the choice are made by more than one agent. Here are two examples in which the first committee is smaller than the second committee. One is in the Article 76, par.5° of the Mexican Constitution that states that the President of the Republic shall propose three names to the Senate, which shall appoint one of them to become member of the Supreme Court of Justice. Another, is the Brazilian law of corporate finance, approved in 2001, that states that the preferred stockholders who hold at least 10% of the company capital stock shall choose one name among the three names listed by the controller of the company to become their representative on the company's board of administration (see Lei n° 10303, October 31th, 2001, Brasil).³

There are many variations of the rule of k names, involving more than two committees. In Chile, according to Article 75 of the Chilean Constitution, the members of the Superior Court of Justice are designated by the President of the Republic among those in the list with five names proposed by the Superior Court of Justice⁴, and must get the approval of two thirds of the Senate. If the Senate does not approve the proposal of the President, then the Superior Court must substitute the rejected name in the list, and the procedure is repeated until a presidential nominee is finally approved by the Senate. Another example also comes from Brazil. According to the Brazilian Constitution, one-third of the members of the Superior Court of Justice shall be chosen in equal parts among lawyers and members of the Public Prosecution nominated in a list of six names by the entities representing their respective classes. Upon receiving the nominations, the court shall organize a list of three names and send it to the President of the Republic, who selects one of the listed names for appointment.

²In additional, the sum of the weighted votes of teaching staff need to be a minimum of 70% of the total. In Brazil, before 1996, the list was made with six names proposed by the university council without consulting the university community (see Decreto-Lei n°5540, November 28th, 1968, Brazil).

³After 2006, the law states that there will be not such restriction.

⁴Each member of the Court cast a vote for three candidates, the list is made with the five most voted candidates.

Since two or more candidates may have the same number of votes during the preparation of the list, a tie-breaking criterion is often used. In some institutions ties are broken randomly and in others by some deterministic rule. For example, in the nomination of the minister of the Superior Court of Justice in Chile, ties are broken randomly, while in Brazil, the age and tenure in the public service of the candidates are used to break ties.

Let us mention that there are versions of the rule of k names in which one of the parties is supposed to be impartial regarding the alternatives. We have two examples and both come from the US. In the first example, the neutral party is the one who makes the list; in the second example, it is the one that makes the final choice.

For the first example, consider the following variant of the rule of three names, which the US Federal Government uses to recruit and select new employees. The US civil service law requires federal examining officers to assign each job applicant a numerical score, based on assessment tools, performance tests or by evaluations of her training and experience. Then a manager hiring people into the civil service must select one from among the top three candidates available (US Merit Systems Protection Board, 1995). Notice that this may be viewed as a variant of the rule of three names, but one where the list is not obtained by voting. Rather, the list must appear as being obtained by applying a neutral scoring test.

Let us turn to the second example. Under the 1993 Labor Reform, California's Labor Code 4065 states that the workers' compensation judge (WCJ) is constrained, in determining a permanent disability rating, to choose among the offers of one of the two parties. This procedure to settle disputes is referred to in the literature as the final-offer arbitration (FOA) (Neuhauser and Swezey, 1999). It is also known as "baseball arbitration" since US major baseball leagues used it to determine wages in disputed contracts. This system is often presented as an improvement over the conventional arbitration procedure, where the arbitrator is not constrained to choose only among the parties' offers. The final-offer arbitrage model was first proposed by Stevens (1966), who argued that it would induce convergence among the offers of the two parties, and presented this conjectured property as an advantage over the conventional arbitration scheme. However, the theoretical literature does not support this conjecture. Faber (1980), Chatterjee (1981), Crawford (1982), Whitman (1986) and Brams and Merrill (1983) show that the offers still diverge under FOA (Brams and Merrill, 1986). Whatever its formal properties, FOA can be interpreted

as a rule of 2 names, with the added qualification that the chooser is not guided by self interest, and is assumed to choose in the name of fairness.

Surprisingly, despite of the extensive economics and political science literature on voting, we do not know any article that is specifically devoted to study the rule of k names when both parties are not neutral regarding the alternatives. This paper is an attempt to fill this gap.

Many questions come to mind. Why are these rules used? What type of decisions are they well suited for? What could be the intentions and expectations of those who decided to set them up? Is there reason to believe that such expectations could be fulfilled? What is the type of strategic behavior that these rules induce on the different agents involved? Do these rules satisfy good properties that make them defensible in a public debate? Why choose three names in some cases, six in other occasions? We cannot give an answer to all of these questions, but we advance some hypothesis and then provide an analysis of different aspects relating to the rule. Hopefully, this analysis provides a first step toward a good understanding of the rule of k names and of its implications.

One of the most reasonable assumptions about the circumstances that recommend the use of the rule point to the existence of some balance between the ability to make decisions on the part of the committee and on the part of the final chooser. Indeed, if k was equal to one, this would amount to give all decisive power to the committee. At the other extreme, when k equals the number of alternatives, then no alternative is eliminated from the list, in which case the chooser decides everything. However, in order to be precise about the type of balances involved, we need a full game theoretic analysis of the rule. This is the main objective of this paper. We study what outcomes one may expect from applying the rule of k names, when agents act strategically and cooperatively. Our analysis shows how the parameter k , the screening rule and nature of candidacies act as a means to balance the power of the committee with that of the chooser.

2 An introductory example: The case of one proposer and one chooser

The rule of k names is definitely a procedure to balance the power of the committee and that of the chooser, though making this statement more precise will take some effort.

Before engaging in any complicated analysis, let us consider a simple and suggestive case involving only two agents: one of them, the proposer, selects a subset of k alternatives, from which the other agent has to choose one. This situation is reminiscent of the classical problem of how to cut a cake, though here we are dealing with a finite set of possibilities and we are not introducing any prior normative notion regarding the outcome.

So, let us consider two agents, 1 and 2, facing four alternatives a, b, c and d . Assume that their preferences over alternatives are as follows: $a \succ_1 b \succ_1 c \succ_1 d$ and $c \succ_2 b \succ_2 a \succ_2 d$ where $x \succ_i y$ means that agent i prefers x to y . Assume that agent 1 can propose k alternatives, from which agent 2 makes a final choice. Clearly, $k = 1$ is the case where 1's choice is final, and 2 has no influence, whereas, $k = 4$ gives all decision power to 2. What about the intermediate cases where $k = 2$ or $k = 3$? Let us informally discuss what outcomes we might expect under different strategic assumptions.

First, assume that the choice of strategies is sequential. So, using the language of game theory, 1's strategy is a list with k alternatives selected from the set $\{a, b, c, d\}$ and 2's strategy is a plan in advance regarding the alternative he will choose from every list which can be proposed by 1.

In this case, the only reasonable behavior for 2 is to choose the best alternative out of those proposed by 1. In practice, then, the only strategic player is 1. This is exactly the notion of backward induction equilibrium of this game. Since in any backward equilibrium strategy profile, 2's strategy prescribes the choice of 2's best alternative from every list which can be proposed by 1. Thus, when $k = 2$, the best strategy for 1 is to propose the set $\{a, d\}$, to let a be chosen by 2. When $k = 3$, a cannot be elected since either b or c will be in the list, so proposing a, b, d is 1's best strategy to let b be chosen by 2.

The set of backward induction equilibrium outcomes for different values of k is displayed in the table below:

Set of backward induction equilibrium outcomes

$k = 1$	$\{a\}$
$k = 2$	$\{a\}$
$k = 3$	$\{b\}$
$k = 4$	$\{c\}$

Let us now consider the case where both players choose strategies simultaneously. Now, 2's strategy is a choice rule that dictates the winning alternative from every list which can be proposed by 1. The reader could think that, given our description of the rule of k names as the result of a well defined sequence, where the proposer goes first and the chooser goes last, there is no point in considering this case. However, we think that it is worth studying, for the following reason. Our model of the interaction between the committee and the chooser is a very simple one. We do not model some important facts that will arise in real contexts, like the fact that the relationship among these main actors is a repeated one, and that the choice of alternatives is only a part of it. Since introducing these unmodelled aspects would complicate our analysis very much, we simply admit that threats from the chooser may sometimes be credible. Turning attention to the simultaneous game is the simplest device to study the consequences of such threats.

In this simultaneous game, a strictly Pareto dominated alternative can be the outcome of a Nash equilibrium. An alternative is strictly Pareto dominated if some other alternatives is considered better for both agents 1 and 2. To understand this point, let $k = 3$ and suppose that agents 1 and 2 have the same preferences over alternatives, $a \succ_i b \succ_i c \succ_i d$ for $i = 1, 2$. Given this preference profile a is the only alternative that is not Pareto dominated. It turns out that there exists a strategy profile that can sustain b as a Nash equilibrium outcome. Agent 1 proposes a list with b, c and d and agent 2 declares a choice rule $C(\cdot)$ such that $C(a, b, c) = C(a, b, d) = C(b, d, c) = b$ and $C(a, c, d) = c$. Notice that under this strategy profile, b is the winning alternative and it is a Nash equilibrium since no agent can profitably deviate, given that the other keeps its strategy unchanged. However both 1 and 2 would be better off if agent 1 substituted d by a in the proposed list, and 2 changed the choice rule from C to C' , so that $C'(B) = C(B)$ unless $B = \{a, b, d\}$, and $C'(B) = a$. In other words, the previous Nash equilibrium strategy is not a strong Nash equilibrium. A strategy profile is said to be a pure strategy strong Nash equilibrium of a game, if no coalition of players (maybe singletons) can profitably deviate from this strategy profile, given that the strategies of other players remain unchanged. Notice that, under this equilibrium concept, any Pareto dominated alternative is ruled out as an equilibrium outcome. This is basically the reason why we will study the strong Nash equilibria of the simultaneous game.

Let us go back to the previous preference profile where $a \succ_1 b \succ_1 c \succ_1 d$ and $c \succ_2 b \succ_2$

$a \succ_2 d$. Now, if $k = 2$, since the game is simultaneous, agent 2 can threaten 1 by pledging to choose d if $\{a, d\}$ is proposed. Under this threat, 1's best response would be to propose the set $\{a, b\}$ to let b be chosen by 2. The outcome b is now the result of a strong Nash equilibrium play. However, a is still the outcome of another strong equilibrium where 2 does not threaten and 1 proposes a and d . The table below presents the set of pure strong Nash equilibrium outcomes of the simultaneous game for different values of k .

Set of pure strong Nash equilibrium outcomes

$k = 1$	$\{a\}$
$k = 2$	$\{a, b\}$
$k = 3$	$\{c, b\}$
$k = 4$	$\{c\}$

Notice that the passage from $k = 2$ to $k = 3$ or $k = 4$ makes a difference. We can see that the case $k = 3$ still leaves room for 2 to get the preferred outcome c , while this is out of the question with $k = 1$ and $k = 2$.

This simple example suggests that one important concern of a careful study of rules of k names is precisely to assess the impact of the choice of k , from the point of view of the different parties involved. A second hint is that, in order to evaluate the likely consequences of establishing a rule of k names, we'll have to analyze the game that naturally arises, and that this analysis will be quite different depending on whether or not we think that the chooser can make credible threats. Because of that, in the sequel we analyze several games, and let the reader decide which one will suit each practical situation better. Notice that, in any case, the backward induction equilibrium outcome of the sequential game will be unique, and that it will coincide with agent 2's worst equilibrium outcome for the simultaneous game.

The consequences of the choice of k cannot be analyzed independently of the cardinality of the set of alternatives. Even the alternatives that no one likes play a role in the functioning of the rule: since numbers count, having an undesirable alternative is not the same as not having that alternative at all. To illustrate this simple point, let us go back to the previous example. Clearly, alternative d could never be a strong Nash equilibrium outcome since it is the last option for both agents. However its presence as an alternative makes a difference. Had it not been there, the set of equilibrium outcomes

of the simultaneous game for different values of k would have been as shown in the table below.

Set of pure strong Nash equilibrium outcomes

$$k = 1 \quad \{a\}$$

$$k = 2 \quad \{b\}$$

$$k = 3 \quad \{c\}$$

The reader can verify that the presence of d helps 1 and harms 2 for some k 's, but never the reverse. For $k = 2$, the presence of d is crucial for agent 1 because, without d , agent 1 will not be able to propose a list with two alternatives in which agent 2's best listed name is a . For $k = 3$, agent 2's favorite alternative c is elected in equilibrium if d is out. Yet, in the presence of d , b is chosen.

Since, for a given k , the number of alternatives affects the outcome, there is a lot of room to study how and why alternatives emerge. Adding undesirable alternatives to the contest, or introducing very similar alternatives (clones) to run are obvious forms to manipulate a rule of k names. We shall not pursue formally the related issue of strategic candidacies in the present paper.

Here is a last point regarding equilibria under the rule of k names, for the two games we have considered. We can express the equilibria as the result of a procedure where agent 2 takes the initiative of vetoing $k - 1$ alternatives and agent 1 chooses one out of those not vetoed for appointment. It turns out that, in terms of strong equilibrium outcomes, the rule of k names is equivalent to the rule of $k - 1$ vetoes where agent 2 is the one who has the right to veto.

The aim of the next section will be to extend our preceding remarks to the case where the proposer is not a single person, but a committee.

3 General results: Several proposers and one chooser

The case of one proposer and one chooser is interesting per se. Moreover it allows us to understand some interesting features of the rule of k names. However, our rules will involve, in general, not one but many proposers, whose interests may be at least partially

divergent. The choice of the best set to propose will then no longer be a matter of one agent, but the result of a collective decision.

Let us describe formally the rule of k names: given a finite set of candidates for office denoted by \mathbf{A} , a committee of proposers $\mathbf{N} = \{1, \dots, n\}$ chooses k members from \mathbf{A} by voting, and makes a list with their names. Then a single individual from outside the committee, called the chooser, selects one of the listed names for appointment.

3.1 Screening rules for k names

A screening rule for k names is a voting procedure that selects k alternatives from a given set, based on the actions of the proposers. These actions may consist of single votes, sequential votes, the submission of preference of rankings, the filling of ballots, etc...⁵ We have found six different screening rules that are actually used by institutions around the world. We divide them into two different groups depending on their properties. The first group we call majoritarian screening rules. The second consists of rules that are not majoritarian, but they still satisfy a weaker condition.

We say that a screening rule is majoritarian if and only if for any set with k candidates there exists an action such that every strict majority coalition of proposers can impose the choice of this set provided that all of its members choose this action. We say that a screening rule is weakly majoritarian if and only if for any candidate there exists an action such that every strict majority coalition of proposers can impose the inclusion of this candidate among the k chosen candidates provided that all of its members choose this action.⁶ Notice that by definition any majoritarian screening rule is weakly majoritarian.

Below we present two majoritarian screening rules.

- Each proposer votes for three candidates and the list has the names of the three most voted candidates, with a tie break when needed. It is used in the election of Irish Bishops and that of Prosecutor-General in Brazilian states.

⁵In other studies, procedures that select sets have been analyzed, but then they focus on the problem of selecting a committee of representatives of a fixed size. Fishburn (1981), Gehrlein (1985), Kaymak and Sanver (2003) discuss the Condorcet winner criterion for this type of rules. In Barberà, Sonnenschein and Zhou (1991), the sets that can be selected by the rule may be of variable size.

⁶In Appendix 1, we give exact definitions for these two properties.

- The list is made with the names of the winning candidates in three successive rounds of plurality voting, with a tie break when needed. It is used in the election of English Bishops.

Notice that these two rules above guarantee the election of any set of k names, provided that a strict majority votes for them (in the same order).

The following rules are only weakly majoritarian but not majoritarian.

- Each proposer votes for 3 candidates and the list has the names of the five most voted candidates, with a tie break when needed. It is used in the election of the members of the Superior Court of Justice in Chile.
- Each proposer votes for 2 candidates and the list has the names of the three most voted candidates, with a tie break when needed. It is used in the election of the members of the Court of Justice in Chile.
- Compute the plurality score of the candidates and include in the list the names of the three most voted candidates, with a tie break when needed. It is used in the election of rectors of public universities in Brazil.
- This is a sequential rule adopted by the Brazilian Superior Court of Justice to choose three names from a set with six names. At each stage there are twice as many candidate as there are positions to be filled in the list. Hence, if the list needs to have three names, we start by six candidates. Each proposer votes for one, and if there is an absolute majority winner, it has his name included in the list. Then, since there are two positions left, the candidate with less votes is eliminated, so as to leave four candidates to the next round. If the procedure keeps producing absolute majority winners, then the process is continued until three names are chosen. It may be that, at some stage (including the first one), no absolute majority winner arises. Then the voters are asked to reconsider their vote and vote again. Notice that, if they persist in their initial vote, the rule leads to stalemate. Equivalently, we could say that the rule is not completely defined. However, in practice, agents tend to reassess their votes on the basis of strategic cooperative actions.

Of course, many others screening rules are conceivable, with or without the properties described above. In what follows, our analysis is general, since we are not specific about

the exact form of the screening rule. The results, however, will depend on some of the properties of the screening rule that is used.

We now propose and analyze two games with complete information induced by the rule of k names.

3.2 A game theoretical analysis

In the first game, called the Sincere Chooser Game, it is assumed that the chooser is not a player. The strategy space of the players, i.e. the proposers, is the space of admissible messages associated with the screening rule used to select the k names. Based on these messages a list with k names is made and the winning candidate is the chooser's preferred listed name. It is assumed that the players only care about the identity of the winning candidate. This game is intended to reflect a two-stage process, where the chooser acts after the proposers have already decided whom to propose. It is a way to refine the strong Nash equilibria in the spirit of backward induction equilibria, by not allowing the chooser to send threats, which would be non-credible given the sequential nature of the play.

In the second game, called the Strategic Chooser Game, we assume that the chooser and the proposers play simultaneously. Chooser's strategy is a choice rule that dictates the winning alternative from every list which can be proposed by the committee. As a consequence, this game has more equilibria than the Sincere Chooser Game. In fact, the additional equilibria would not pass the test of backward induction if the chooser was playing last in the two-stage game. Such additional equilibria are based on the strategies by the chooser that reflect non-credible threats, within the context of the game. Why, then, do we study this second game? We do it because our model is a bit narrow, and we feel that knowing about these additional equilibria is interesting, because in real life, choosers are in a position to threaten. True, their possibility to threaten depends on aspects of the problem that are not modelled here: For example, the fact that these elections are embedded within a lasting set of relationships that allow the chooser to retaliate. Since modelling these further opportunities will complicate our model very much, we allow for simultaneous moves as the simplest way to include threats into our analysis.⁷

⁷See Appendix 1 for more formal descriptions of each game.

3.3 Strong Nash equilibrium outcomes

We investigate what are the equilibrium outcomes for these two games, when agents act strategically and cooperatively. More specifically, we study their pure strong Nash equilibrium outcomes when the screening rule used to select the k names is majoritarian.⁸ For simplicity, we assume that the number of proposers is odd and that all agents have strict preference over the set of candidates. Individual indifferences are ruled out. These two assumptions are convenient because they eliminate the necessity of specifying a tie-breaking criterion, if the screening rule is majoritarian.⁹

We provide a full characterization of the set of strong Nash equilibrium outcomes of the games when the screening rule is majoritarian. Our main result holds for each one of the games: All majoritarian screening rules generate the same set of strong Nash equilibrium outcomes.

Before introducing the characterization results, we need to provide three definitions. The first one is the standard definition of a Condorcet winner. A candidate $x \in \mathbf{B} \subseteq \mathbf{A}$ is the Condorcet winner over \mathbf{B} if $\#\{i \in \mathbf{N} | x \succ_i y\} > \#\{i \in \mathbf{N} | y \succ_i x\}$ for any $y \in \mathbf{B} \setminus \{x\}$ ¹⁰. In words, a candidate is the Condorcet Winner over a subset of \mathbf{A} if and only if it belongs to this subset and it defeats any other candidate in this subset in pairwise majority contests among proposers. It is important to note that the chooser's preferences over candidates are not taken into account in this definition. Notice also that there is at most one Condorcet winner over any set, and that such an alternative may not exist. In particular, if there is only one proposer, then the Condorcet winner over a set coincides with the proposer's preferred candidate in this set.

In the two following definitions, the preferences of the chooser will matter. A candidate is dominated if and only if there exists another candidate that is considered better by the chooser and by a strict majority of the proposers. A candidate is a chooser's ℓ -top

⁸See Appendix 1 for a formal definition of a pure strong Nash equilibrium for each one of the games.

⁹In Appendix 3, we present sufficient conditions for a candidate to be a strong Nash equilibrium outcome for each game provided that the screening rule is "unanimous". We also present the necessary conditions for a candidate to be a strong Nash equilibrium outcome for each game provided that the screening rule is "anonymous". In both cases we do not make any restriction whether the number of proposers is odd or even.

¹⁰Where $\#\{i \in \mathbf{N} | x \succ_i y\}$ stands for the cardinality of $\{i \in \mathbf{N} | x \succ_i y\}$ and $\mathbf{B} \subseteq \mathbf{A}$ means that B is contained in \mathbf{A} .

candidate if and only if he is among the ℓ best ranked candidates according to the chooser's preference. These two definitions are important because only those candidates that are undominated and $(\#\mathbf{A} - k + 1)$ -top candidates for the chooser can be strong equilibrium outcomes.

As we shall see later, even when the chooser is a player, the equilibrium conditions still require him to choose his truly preferred candidate among the k listed names. This remark is important because if a candidate is not a chooser's $(\#\mathbf{A} - k + 1)$ -top candidate then it cannot be the best listed name for the chooser in any list with k names. This is why only those candidates that are $(\#\mathbf{A} - k + 1)$ -top for the chooser can be strong equilibrium outcomes. Such outcomes need to be undominated, because any coalition formed by the chooser and by the strict majority of proposers is a winning coalition, i.e. are able to induce the election of any candidate.

Propositions 1 and 2 below characterize the pure strong Nash equilibrium outcomes of the Sincere Chooser Game and the Strategic Chooser Game, respectively.¹¹

Proposition 1 *A candidate is a strong Nash equilibrium outcome of the Sincere Chooser Game if and only if it is the Condorcet winner over the chooser's $(\#\mathbf{A} - k + 1)$ -top candidates.*

Notice that the Condorcet winner over the chooser's $(\#\mathbf{A} - k + 1)$ -top candidates is an undominated candidate.

The proofs of all propositions appear in Appendix 2.

Proposition 2 *A candidate is a strong Nash equilibrium outcome of the Strategic Chooser Game if and only if*

1. *it is an undominated and chooser's $(\#\mathbf{A} - k + 1)$ -top candidate, and*
2. *it is the Condorcet winner over some set of candidates with cardinality larger or equal than $\#\mathbf{A} - k + 1$.*

¹¹We follow closely the approach of Sertel and Sanver (2004). They consider a standard voting game where a committee elects a candidate for office, without any external interference. They show that the set of strong equilibrium outcomes of their voting game is the set of generalized Condorcet winners.

Hence, given a set of candidates, a preference profile over this set and a value for the parameter k , we can easily identify the set of strong Nash equilibrium outcomes of the games with the help of Propositions 1 and 2. The following example illustrate it.

Example 1 Let $\mathbf{A} = \{a, b, c, d\}$, $N = \{1, 2, 3\}$ and a majoritarian screening rule. The preferences of the chooser and the committee members are as follows:

<i>Preference Profile</i>			
<i>Proposer 1</i>	<i>Proposer 2</i>	<i>Proposer 3</i>	<i>Chooser</i>
<i>a</i>	<i>a</i>	<i>b</i>	<i>d</i>
<i>b</i>	<i>b</i>	<i>c</i>	<i>b</i>
<i>c</i>	<i>c</i>	<i>a</i>	<i>a</i>
<i>d</i>	<i>d</i>	<i>d</i>	<i>c</i>

Following Propositions 1 and 2, the first step in describing the equilibrium outcomes for each $k \in \{1, 2, 3, 4\}$, is to identify the set of undominated candidates. The second step is to find, for each undominated candidate, the largest set in which it is the Condorcet winner. The third and final step is to know the set of the chooser's $(\#A - k + 1)$ -top candidates.

Inspecting the preference profile above and recalling that $\#A = 4$, we have that:

1. The set of undominated candidates is $\{a, b, d\}$.
2. Candidate a is the Condorcet winner over $\{a, b, c, d\}$, candidate b is the Condorcet winner over $\{b, c, d\}$ and candidate d is the Condorcet winner over $\{d\}$.
3. The chooser's $(\#A - k - 1)$ -top candidates are: for $k = 1$, $\{a, b, c, d\}$, for $k = 2$, $\{a, b, d\}$, for $k = 3$, $\{b, d\}$ and for $k = 4$, $\{d\}$.

Combining the informations in steps 1-3 above and Propositions 1 and 2 we have the following:

For the Sincere Chooser Game, when $k = 1$ or $k = 2$, candidate a is the strong equilibrium outcome. The outcome is b when $k = 3$, and it is d when $k = 4$.

For the Strategic Chooser Game, the only change is that when $k = 2$, $\{a, b\}$ is the set of strong equilibrium outcomes.

Propositions 1 and 2 imply three corollaries. The first two refer to the existence and the number of strong equilibrium outcomes.

Corollary 1 *The set of strong Nash equilibrium outcomes of the Sincere Chooser Game is either a singleton or empty.*

Corollary 1 follows from Proposition 1 and from the fact that a Condorcet winner, if it exists, is unique. Since Condorcet winner may not exist, a strong equilibrium of the Sincere Chooser Game may not exist either.

Corollary 2 *The set of strong Nash equilibrium outcomes of the Strategic Chooser Game may be empty, and its cardinality cannot be higher than the minimum between k and $\#\mathbf{A} - k + 1$.*

Corollary 2 follows from Proposition 2, the uniqueness of a Condorcet winner and because there are at most k candidates that can be a Condorcet winner over some set with cardinality $\#\mathbf{A} - k + 1$ and, by definition, there are exactly $\#\mathbf{A} - k + 1$ candidates that are chooser's $(\#\mathbf{A} - k + 1)$ -top candidates.

The third corollary states the connection between the equilibrium outcomes of the two games we have studied.

Corollary 3 *If the strong Nash equilibrium outcome of the Sincere Chooser Game exists then it is the chooser's worst strong Nash equilibrium outcome of the Strategic Chooser Game.*

The example below shows that our characterization results are not valid when the screening rule is only weakly majoritarian.

Example 2 *Let $\mathbf{A} = \{a, b, c, d, e, f\}$ and let $N = \{1, 2, 3\}$. Assume that each proposer casts a vote for one candidate and the list is formed with the names of the three most voted candidates (a tie-breaking criterion is used when needed). So, this screening rule is only weakly majoritarian. The preferences of the chooser and the committee members are as follows:*

Preference Profile

<i>Proposer 1</i>	<i>Proposer 2</i>	<i>Proposer 3</i>	<i>Chooser</i>
<i>a</i>	<i>a</i>	<i>f</i>	<i>f</i>
<i>b</i>	<i>b</i>	<i>e</i>	<i>e</i>
<i>c</i>	<i>c</i>	<i>d</i>	<i>a</i>
<i>d</i>	<i>d</i>	<i>c</i>	<i>b</i>
<i>e</i>	<i>e</i>	<i>b</i>	<i>c</i>
<i>f</i>	<i>f</i>	<i>a</i>	<i>d</i>

Notice that, in both games, if the screening rule was majoritarian then candidate a would be the unique strong equilibrium outcome. However, the screening rule considered here is weakly majoritarian but not majoritarian. As can be verified, proposer 3 is able to force the inclusion of candidate f , his preferred candidate, in the chosen list independently of what the other proposers do. Notice that f is also the chooser's favorite candidate. Therefore candidate f is the unique strong Nash equilibrium outcome of both games.

We finish the presentation of the characterization results by admitting that, like in many others cases, our analysis of the strategic behavior of agents under the rule of k names is marred by the fact that strong equilibria may fail to exist. Since this is pervasive, we do not need to be apologetic about it. But we offer a simple example about how easy it is for existence to fail.

Example 3 *Let $\mathbf{A} = \{a, b, c, d, e\}$, $N = \{1, 2, 3\}$ and a majoritarian screening rule. The preferences of the chooser and the committee members are as follows:*

Preference Profile

<i>Proposer 1</i>	<i>Proposer 2</i>	<i>Proposer 3</i>	<i>Chooser</i>
<i>e</i>	<i>e</i>	<i>e</i>	<i>a</i>
<i>b</i>	<i>d</i>	<i>c</i>	<i>c</i>
<i>d</i>	<i>a</i>	<i>a</i>	<i>b</i>
<i>c</i>	<i>b</i>	<i>b</i>	<i>d</i>
<i>a</i>	<i>c</i>	<i>d</i>	<i>e</i>

After a quick inspection of the preference profile above we have that: The set of undominated candidates is $\{a, c, e\}$, candidates a , c and e are the Condorcet winners over $\{a, b\}$,

$\{a, c\}$ and $\{a, b, c, d, e\}$ respectively.

Applying Propositions 1 and 2, we have that the two games, for each k , share the same set of strong Nash equilibrium outcomes.

Set of strong Nash equilibrium outcomes

$$k=1 \quad \{e\}$$

$$k=2 \quad \{\emptyset\}$$

$$k=3 \quad \{\emptyset\}$$

$$k=4 \quad \{c\}$$

$$k=5 \quad \{a\}$$

The table above is interesting because we can examine the effects of changing the parameter k on the set of strong equilibrium outcomes. For a moment, consider only those rules for which an equilibrium exists. Those are the rules with $k = 1$, $k = 4$ and $k = 5$. According to the agents' preferences over candidates, the chooser prefers $k = 5$ to $k = 4$ and $k = 4$ to $k = 1$. All the proposers agree that the best scenario is when $k = 1$. However, proposers 1 and 2 prefer $k = 4$ to $k = 5$ while 3 prefers $k = 5$ to $k = 4$. So proposer 3 does not have monotonic preferences over k 's. It is easy to find a preference profile where one of the proposers always prefers a higher k . For instance, this may happen when one of the proposers shares with the chooser the same preferences over the candidates.

3.4 Comparative statics

Our purpose now is to examine the consequences of changing the parameter k , of adding undesirable candidates and of replacing a majoritarian screening rule by non-majoritarian screening rule. By knowing these consequences, we can infer the agent's preferences over different variants of the rule of k names. This can provide some insights into the questions raised in the introduction. Let us recall some of these questions: Why are these rules used? What could be the intentions and the expectations of those who decided to set them up? What is the type of strategic behavior that these rules induce on the different agents involved? Why choose three names in some cases, six in other occasions?

We have already discussed partially some of these issues for the one proposer case. Allowing several proposers complicates our analysis because the strong equilibrium may fail to exist. In the latter example, does the chooser prefer $k = 1$ to $k = 3$ or the reverse?

This is a difficult question since for $k = 3$ there is no equilibrium. We could partially avoid this problem by assuming that the preference profile satisfies single-peakedness¹², since under this assumption there is always a Condorcet winner and thus an equilibrium. Unfortunately, this assumption would not avoid the non existence of equilibrium when screening rules are not majoritarian. Thus it cannot help us to compare the performance of majoritarian screening rules with others that are only weakly majoritarian. Another drawback is the possibility of multiple equilibrium outcomes in the Strategic Chooser Game.

In what follows, and with this warning, we'll try to make our best in tackling with those added difficulties. We assume that the agents have preferences over sets of strong Nash equilibrium outcomes that satisfy two mild requirements: Let \mathbf{P} denote a generic individual strict preference relation on $2^A \equiv \{B \subseteq A | B \neq \{\emptyset\}\}$. Consider any $X, Y \in 2^A$ and $X \neq Y$. (1) If $X \subset Y$ then $X \mathbf{P}_i Y$ if $x \succ_i y$ for all $x \in X$ and for all $y \in Y \setminus X$. (2) If $X \not\subseteq Y$ then $X \mathbf{P}_i Y$ if $x \succ_i y$ for all $x \in X \setminus Y$ and for all $y \in Y$. Notice that if an agent i prefers x to y then condition (1) implies that $\{x\}$ is preferred to $\{x, y\}$ and condition (2) implies that $\{x\}$ and $\{x, y\}$ are preferred to $\{y\}$. These are very natural conditions since the elements of a set of strong Nash equilibrium outcomes are mutually exclusive alternatives (see Barbera, Bossert and Pattanaik, 2004).

Consider any of the two games. Let denote by $\mathbf{SET}(\mathbf{S}'; \mathbf{A}'; k')$ the set of strong Nash equilibrium outcomes of this game when $k = k'$, the set of candidates is \mathbf{A}' and the screening rule is \mathbf{S}' . We say that the agent i prefers the triple $(\mathbf{S}''; \mathbf{A}''; k'')$ to $(\mathbf{S}'; \mathbf{A}'; k')$ if and only if $\mathbf{SET}(\mathbf{S}''; \mathbf{A}''; k'') \mathbf{P}_i \mathbf{SET}(\mathbf{S}'; \mathbf{A}'; k')$.

In the context of the Sincere Chooser Game, we know by Corollary 1 that the set of equilibrium outcomes is singleton or empty. So, the condition above says that the agent i prefers the triple $(\mathbf{S}''; \mathbf{A}''; k'')$ to $(\mathbf{S}'; \mathbf{A}'; k')$ if and only if the strong equilibrium outcome under $(\mathbf{S}''; \mathbf{A}''; k'')$ is preferred to the respective outcome under $(\mathbf{S}'; \mathbf{A}'; k')$ according to agent i preferences over candidates.

The next proposition states that, in the context of the Sincere Chooser Game, if the chooser is asked to choose between a rule of k' names and of k'' names, and both rules

¹²We say that a preference profile satisfies single peakedness if and only if the elements of \mathbf{A} can be linearly ordered as $x_1 > x_2 > \dots > x_{\#A}$ such that for every $i \in N$ and $a, b \in A$ we have that if $b > a > \alpha(\mathbf{A}, \succ_i)$ or $\alpha(\mathbf{A}, \succ_i) > a > b$ then $a \succ_i b$, where $\alpha(\mathbf{A}, \succ_i)$ is i 's preferred candidate in \mathbf{A} .

use majoritarian screening rules then the chooser prefers the rule with the highest k .

Proposition 3 *For the Sincere Chooser Game the following statement holds:*

If $\{\emptyset\} \neq \text{SET}(\mathbf{S}''; \bar{\mathbf{A}}, k'') \neq \text{SET}(\mathbf{S}'; \bar{\mathbf{A}}, k') \neq \{\emptyset\}$, $k'' > k'$ and both \mathbf{S}' and \mathbf{S}'' are majoritarian then the chooser prefers the triple $(\mathbf{S}''; \bar{\mathbf{A}}, k'')$ to $(\mathbf{S}'; \bar{\mathbf{A}}, k')$.

Surprisingly, this proposition is not valid in the context of the Strategic Chooser Game. It can be seen in the following example.

Example 4 *Let $\mathbf{A} = \{a, b, c, d\}$, and let $N = \{1, 2, 3\}$. The preferences of the chooser and the committee members are as follows:*

<i>Preference Profile</i>			
<i>Proposer 1</i>	<i>Proposer 2</i>	<i>Proposer 3</i>	<i>Chooser</i>
<i>d</i>	<i>c</i>	<i>b</i>	<i>b</i>
<i>a</i>	<i>a</i>	<i>c</i>	<i>a</i>
<i>b</i>	<i>b</i>	<i>d</i>	<i>c</i>
<i>c</i>	<i>d</i>	<i>a</i>	<i>d</i>

Given the preference profile above, the set of undominated candidates is $\{a, b\}$, candidates a and b are the Condorcet winners over $\{a, b\}$, $\{b, c, d\}$ respectively.

Applying Proposition 2, we have the following equilibrium outcomes:

Set of strong Nash equilibrium outcomes

<i>Strategic Chooser Game</i>	
$k=1$	$\{\emptyset\}$
$k=2$	$\{b\}$
$k=3$	$\{a, b\}$
$k=4$	$\{b\}$

Examining the table above, we can see that the chooser prefers $k = 2$ to $k = 3$, while the majority of the proposers, 1 and 3, prefer $k = 3$ to $k = 2$.

Now, let us analyze the role of a candidacy that, at first glance, one could imagine that has no influence in the game. We say that a candidate is an undesirable candidate in \mathbf{A} if the chooser and all proposers dislike him more than any other candidate in \mathbf{A} .

The next results show that the withdrawal of an undesirable candidate has an effect similar to that of passing from k to $k + 1$.

Proposition 4 *For both games the following statement holds:*

If candidate u is an undesirable candidate of $\bar{\mathbf{A}}$ and both \mathbf{S}' and \mathbf{S}'' are majoritarian then $\mathbf{SET}(\mathbf{S}'; \bar{\mathbf{A}} \setminus \{u\}; k) \subseteq \mathbf{SET}(\mathbf{S}''; \bar{\mathbf{A}}; k + 1)$.

Corollary 4 *For the Sincere Chooser Game:*

If candidate u is an undesirable candidate of $\bar{\mathbf{A}}$, \mathbf{S}' is majoritarian and the proposers have single peaked preferences then $\mathbf{SET}(\mathbf{S}'; \bar{\mathbf{A}} \setminus \{u\}; k) = \mathbf{SET}(\mathbf{S}'; \bar{\mathbf{A}}; k + 1) \neq \{\emptyset\}$.

The next proposition states that the chooser cannot be worst off if an undesirable candidate decides to withdraw from the contest.

Proposition 5 *For both games the following statement holds:*

If $\{\emptyset\} \neq \mathbf{SET}(\mathbf{S}''; \bar{\mathbf{A}}; k) \neq \mathbf{SET}(\mathbf{S}'; \bar{\mathbf{A}} \setminus \{u\}; k) \neq \{\emptyset\}$, candidate u is an undesirable candidate of $\bar{\mathbf{A}}$ and both \mathbf{S}' and \mathbf{S}'' are majoritarian, then the chooser prefers the triple $(\mathbf{S}'; \bar{\mathbf{A}} \setminus \{u\}; k)$ to $(\mathbf{S}''; \bar{\mathbf{A}}; k)$.

How about the chooser's preferences over screening rules? This is a natural question since more than half of the screening rules that are actually used are not majoritarian. The next proposition tells us that, in the Sincere Chooser Game, the chooser cannot be worst off if a majoritarian screening rule is substituted by another that is only weakly majoritarian.

Proposition 6 *For the Sincere Chooser Game the following statement holds:*

If $\{\emptyset\} \neq \mathbf{SET}(\mathbf{S}''; \bar{\mathbf{A}}; k) \neq \mathbf{SET}(\mathbf{S}'; \bar{\mathbf{A}}; k) \neq \{\emptyset\}$, both \mathbf{S}' and \mathbf{S}'' are weakly majoritarian but only \mathbf{S}'' is majoritarian then the chooser prefers the triple $(\mathbf{S}'; \bar{\mathbf{A}}; k)$ to $(\mathbf{S}''; \bar{\mathbf{A}}; k)$.

The proposition above is not valid for the Strategic Chooser Game as proven by the following example.

Example 5 *Let $\mathbf{A} = \{a, b, c, d, e\}$, and let $N = \{1, 2, 3\}$. Consider the following screening rule: Each proposer casts a vote for list A or list B. List A is formed by candidates a, b and e and list B is formed by candidates b, c and d . The screened list is the most voted list. Notice that this screening rule is weakly majoritarian but not majoritarian.*

Preference Profile

<i>Proposer 1</i>	<i>Proposer 2</i>	<i>Proposer 3</i>	<i>Chooser</i>
<i>b</i>	<i>b</i>	<i>e</i>	<i>e</i>
<i>c</i>	<i>c</i>	<i>a</i>	<i>a</i>
<i>a</i>	<i>a</i>	<i>b</i>	<i>b</i>
<i>d</i>	<i>d</i>	<i>c</i>	<i>c</i>
<i>e</i>	<i>e</i>	<i>d</i>	<i>d</i>

For $k = 3$, under this screening rule, candidate b is the unique strong Nash equilibrium outcome of the Strategic Chooser Game. However under any majoritarian screening, $\{a, b\}$ is the set of strong Nash equilibrium outcomes of the Strategic Choose Game. Therefore, the chooser is better off under a majoritarian screening rules. Notice that the reverse can be said to the majority of the proposers.

3.5 Some voting paradoxes

In this subsection we formulate two axioms that express consistency properties of the election of outcomes from different bodies of proposers. These axioms are: (1) If there are two committee members who rank the candidates exactly as the chooser does then the chooser cannot be better off if these two members decide not to participate in the decision about the list. (2) If a committee member is substituted by an agent who ranks the candidates exactly as the chooser does, then the chooser cannot be worst off.

Notice that axioms 1 and 2 are closely related with two standard axioms of voting literature: Participation and reinforcement axioms (see Moulin, 1988, page 237).

The Sincere Chooser Game satisfies axioms 1 and 2. It turns out that the Strategic Chooser Game violates them as proven by the following example.

Example 6 *Let $k = 3$, $\mathbf{A} = \{a, b, c, d, e\}$, $N = \{1, 2, 3, 4, 5\}$, a majoritarian screening rule and the following preference profile:*

Preference Profile

<i>Proposer 1</i>	<i>Proposer 2</i>	<i>Proposer 3</i>	<i>Proposer 4</i>
<i>c</i>	<i>c</i>	<i>d</i>	<i>d</i>
<i>b</i>	<i>b</i>	<i>e</i>	<i>e</i>
<i>a</i>	<i>a</i>	<i>b</i>	<i>b</i>
<i>d</i>	<i>d</i>	<i>a</i>	<i>a</i>
<i>e</i>	<i>e</i>	<i>c</i>	<i>c</i>

<i>Proposer 5</i>	<i>Proposer 6</i>	<i>Proposer 7</i>	<i>Chooser</i>
<i>d</i>	<i>a</i>	<i>a</i>	<i>a</i>
<i>e</i>	<i>b</i>	<i>b</i>	<i>b</i>
<i>b</i>	<i>c</i>	<i>c</i>	<i>c</i>
<i>a</i>	<i>d</i>	<i>d</i>	<i>d</i>
<i>c</i>	<i>e</i>	<i>e</i>	<i>e</i>

Notice that proposers 6 and 7 and the chooser have the same preferences over the candidates. For $k=3$, the set of strong Nash equilibrium outcomes of the Strategic Chooser Game is $\{a, b\}$.

Now let us examine what would happen if proposers 6 and 7 decided not to participate. The preference profile without proposers 6 and 7's preferences is displayed below.

Preference Profile

<i>Proposer 1</i>	<i>Proposer 2</i>	<i>Proposer 3</i>	<i>Proposer 4</i>	<i>Proposer 5</i>	<i>Chooser</i>
<i>c</i>	<i>c</i>	<i>d</i>	<i>d</i>	<i>a</i>	<i>a</i>
<i>b</i>	<i>b</i>	<i>e</i>	<i>e</i>	<i>d</i>	<i>b</i>
<i>a</i>	<i>a</i>	<i>b</i>	<i>b</i>	<i>e</i>	<i>c</i>
<i>d</i>	<i>d</i>	<i>a</i>	<i>a</i>	<i>c</i>	<i>d</i>
<i>e</i>	<i>e</i>	<i>c</i>	<i>c</i>	<i>b</i>	<i>e</i>

Now, candidate a is the unique strong Nash equilibrium outcome of the Strategic Chooser Game. Thus both proposers 6 and 7 and the chooser are better off with this new situation. Suppose that proposer 5 is substituted by proposer 5', who ranks the candidates as the chooser does. The preference profile of this new committee is displayed below.

Preference Profile

<i>Proposer 1</i>	<i>Proposer 2</i>	<i>Proposer 3</i>	<i>Proposer 4</i>	<i>Proposer 5'</i>	<i>Chooser</i>
<i>c</i>	<i>c</i>	<i>d</i>	<i>d</i>	<i>a</i>	<i>a</i>
<i>b</i>	<i>b</i>	<i>e</i>	<i>e</i>	<i>b</i>	<i>b</i>
<i>a</i>	<i>a</i>	<i>b</i>	<i>b</i>	<i>c</i>	<i>c</i>
<i>d</i>	<i>d</i>	<i>a</i>	<i>a</i>	<i>d</i>	<i>d</i>
<i>e</i>	<i>e</i>	<i>c</i>	<i>c</i>	<i>e</i>	<i>e</i>

In this new situation, $\{a, b\}$ is the set of strong Nash equilibrium outcomes of the Strategic Chooser Game. Hence the chooser is worse off with the substitution of proposer 5 by someone who ranks the candidate as the chooser do.

3.6 The rule of q vetoes

As we said in the introduction, in Mexico, the President of the Republic shall propose three names to the Senate, which shall appoint one of them to become member of the Supreme Court of Justice. Since vetoing q names is equivalent to selecting $\#\mathbf{A} - q$ names, we can say that the Mexican president vetoes $\#\mathbf{A} - 3$ candidates, and then the Senate chooses one of the remaining candidates for appointment. This system is thus a member of the family of the “rules of q vetoes” that can be described as follows: given a set of candidates for office, a single individual vetoes q members from this set. Then a committee selects one candidate by plurality voting, among those not vetoed, for appointment.

Proposition 7 *In terms of strong Nash equilibrium outcomes of the Sincere Chooser Game, the rule of k names is equivalent to the rule of $k - 1$ vetoes whenever the sincere chooser is the one who vetoes.*

Proposition 8 *In terms of strong Nash equilibrium outcomes of the Strategic Chooser Game, the rule of k names is equivalent to the rule of $k - 1$ vetoes whenever the strategic chooser is the one who vetoes.*

A interesting implication of the propositions above is that the balance of power between the Mexican President and the Senate would not changed, if this nomination system was substituted by the rule of $\#\mathbf{A} - 2$ names where the Senate is the committee of proposers and the screening rule is majoritarian.

3.7 Remarks about the case where the number of proposers is even

If the number of proposers is even the set of strong Nash equilibrium outcomes may depend on how ties are broken. It can be seen in the following example.

Example 7 Let $\mathbf{A} = \{a, b, c, d\}$, and let $N = \{1, 2, 3, 4\}$. Assume that each proposer casts votes for two candidates, and that the list is formed with the names of the two most voted candidates with a tie breaking rule in case of need. Notice that this screening rule is majoritarian. The preferences of the chooser and the committee members are as follows:

Preference Profile

<i>Proposer 1</i>	<i>Proposer 2</i>	<i>Proposer 3</i>	<i>Proposer 4</i>	<i>Chooser</i>
<i>a</i>	<i>a</i>	<i>b</i>	<i>b</i>	<i>b</i>
<i>d</i>	<i>d</i>	<i>d</i>	<i>d</i>	<i>a</i>
<i>c</i>	<i>c</i>	<i>c</i>	<i>c</i>	<i>d</i>
<i>b</i>	<i>b</i>	<i>a</i>	<i>a</i>	<i>c</i>

The set of strong equilibrium outcomes of this game will depend on how ties are broken under this screening rule:

1) Suppose that the tie breaking criterion is as follows: $\{a, b\} \succ \{a, c\} \succ \{a, d\} \succ \{b, c\} \succ \{b, d\} \succ \{c, d\}$.

Notice that proposers 3 and proposer 4 are able to include in the chosen list their favorite candidate, which is b . Since candidate b is also the chooser's favorite candidate, there is no doubt that candidate b is the unique strong equilibrium outcome of the Sincere Chooser Game.

2) Suppose that the tie breaking criterion is as follows: $\{a, c\} \succ \{a, d\} \succ \{a, b\} \succ \{c, d\} \succ \{c, b\} \succ \{d, b\}$.

Now proposers 1 and 2 are able to guarantee the choice of the list formed by candidates a and c . If this list is chosen candidate a , which is proposers 1 and 2's preferred candidate will be elected, since he is the best listed name according to the chooser's preferences. Thus it is clear that candidate a is the unique strong equilibrium outcome of the Sincere Chooser Game.

If the number of proposers is even, the set of strong Nash equilibrium outcomes of the Strategic Chooser Game may not contain the set of strong Nash equilibrium outcomes of

the Sincere Chooser Game. See the example below.

Example 8 Let $\mathbf{A} = \{a, b, c, d\}$, and let $N = \{1, 2, 3, 4\}$. Consider the following majoritarian screening rule for two names: The chosen list of two names is $\{b, d\}$ unless the strict majority of the proposers agrees with another list. Notice that this screening rule is majoritarian. The preferences of the chooser and the committee members are as follows:

Preference Profile

<i>Proposer 1</i>	<i>Proposer 2</i>	<i>Proposer 3</i>	<i>Proposer 4</i>	<i>Chooser</i>
<i>a</i>	<i>a</i>	<i>b</i>	<i>b</i>	<i>d</i>
<i>b</i>	<i>b</i>	<i>a</i>	<i>a</i>	<i>b</i>
<i>c</i>	<i>c</i>	<i>c</i>	<i>c</i>	<i>a</i>
<i>d</i>	<i>d</i>	<i>d</i>	<i>d</i>	<i>c</i>

The set of strong Nash equilibrium outcomes of the Sincere Chooser Game is $\{a, b\}$. Notice that all the proposers announcing that they support $\{a, c\}$ is a strong Nash equilibrium outcome of the Sincere Chooser Game and it leads the victory of candidate a . All the proposers supporting $\{b, c\}$ is a strong equilibrium as well. In this equilibrium, candidate b is the winner.

However in the context of the Strategic Chooser Game, candidate b is the unique strong Nash equilibrium outcome. There exists no strategy profile that can sustain candidate a as a strong equilibrium outcome under this game because the coalition formed by the chooser and by proposers 3 and 4 can always find a profitable deviation.

4 Concluding remarks

As shown by our analysis the rule of k names is a method to balance the power of the two parties involved in decisions: the committee and the final chooser. We have provided examples of several institutions around the world that use the rule of k names to take decisions. We described six different screening rules that are actually used. Two of them are majoritarian and the others are only weakly majoritarian.

As part of our attempt to understand the widespread use of these rules, we have engaged in a game theoretical analysis of two games induced by them. We have shown that the choice of the screening procedure to select the k names is not too crucial when agents

act strategically and cooperatively. This is because rules of k names based on different majoritarian screening rules lead to the same sets of strong equilibrium outcomes. We characterized the set of strong equilibrium outcomes of these games under any majoritarian screening rules.

For both games, we determined the effects on the equilibria of increasing k , adding undesirable candidates and substituting a majoritarian screening rule for another not majoritarian. Knowing these effects, we were able to derive endogenously the agents' preferences over different variants of the rule of k names.

For both games, adding to the contest an undesirable candidate, i.e. a candidate that nobody likes, goes against the chooser's interests. For the Sincere Chooser Game, the chooser weakly prefers high k 's as well as any weakly majoritarian rule to any majoritarian screening rule. We showed with examples that the same cannot be said in the context of the Strategic Chooser Game. We provided an example where the chooser strictly prefers $k = 2$ to $k = 3$ while a majority of proposers strictly prefers $k = 3$ to $k = 2$. In another example, the chooser strictly prefers a weakly majoritarian screening to any majoritarian rule.

We have also shown the equivalence of rule of $k - 1$ vetoes with the rule of k names in terms of strong Nash equilibrium outcomes. In other words, we proved that the set of strong equilibrium outcomes would not change if instead of taking the final decision, the chooser vetoes $k - 1$ candidates and then let the committee select by plurality one of the remaining candidates for appointment.

We interpret our present work as a first step for understanding the implications of using such methods, and hope to generate interest in its further study.

5 Appendix

5.1 Appendix 1

Notation 1 Denote by W the set of all strict orders (transitive¹³, asymmetric¹⁴, irreflexive¹⁵ and complete¹⁶) on \mathbf{A} . Each member $i \in N \cup \{\text{chooser}\}$ has a strict preference $\succ_i \in W$. For any nonempty subset B of \mathbf{A} , $B \subseteq \mathbf{A} \setminus \{\emptyset\}$, we denote by $\alpha(B, \succ_i) \equiv \{x \in B \mid x \succ_i y \text{ for all } y \in B \setminus \{x\}\}$ the preferred candidate in B according to preference profile \succ_i . Denote by $\mathbf{A}_k \equiv \{B \subseteq \mathbf{A} \mid \#B = k\}$ the set of all possible subsets of \mathbf{A} with cardinality k where $\#B$ stands for the cardinality of B and $\mathbf{B} \subseteq \mathbf{A}$ means that B is contained in \mathbf{A} .

Definition 1 Let $M^N \equiv M_1 \times \dots \times M_n$ with $M_i = M_j = M$ for all $i, j \in N$ where M is the space of actions of a proposer in N . For example, if the actions in M^N are casting single votes then $M \equiv \mathbf{A}$. If the actions in M^N are submissions of strict preference relation then $M \equiv W$. Given $k \in \{1, 2, \dots, \#\mathbf{A}\}$, a **screening rule for k names** is a function $S_k : M^N \rightarrow \mathbf{A}_k$ associating to each action profile $m_N \equiv \{m_i\}_{i \in N} \in M^N$ the k -element set $S_k(m_N)$.

Definition 2 We say that a screening rule $S_k : M^N \rightarrow \mathbf{A}_k$ is **majoritarian** if and only if for every set $B \in \mathbf{A}_k$ there exists $m \in M$ such that for every strict majority coalition $C \subseteq N$ and every profile of the complementary coalition $m_{N \setminus C} \in M^{N \setminus C}$ we have that $S_k(m_{N \setminus C}, m_C) = B$ provided that $m_i = m$ for every $i \in C$.

Definition 3 We say that a screening rule $S_k : M^N \rightarrow \mathbf{A}_k$ is **weakly majoritarian** if and only if for every candidate $x \in \mathbf{A}$ there exists $m \in M$ such that for every strict majority coalition $C \subseteq N$ and every profile of the complementary coalition $m_{N \setminus C} \in M^{N \setminus C}$ we have that $x \in S_k(m_{N \setminus C}, m_C)$ provided that $m_i = m$ for every $i \in C$.

Definition 4 Given $k \in \{1, 2, \dots, \#\mathbf{A}\}$, a screening rule for k names $S_k : M^N \rightarrow \mathbf{A}_k$ and a preference profile $\succ \equiv \{\succ_i\}_{i \in N \cup \{\text{chooser}\}} \in W^{N+1}$, the **Sincere Chooser Game** can be described as follows: It is a simultaneous game with complete information where each player $i \in N$ chooses a strategy $m_i \in M_i$. Given $m_N \equiv \{m_i\}_{i \in N} \in M^N$, $S_k(m_N)$ is the chosen list with k names and the winning candidate is $\alpha(S_k(m), \succ_{\text{chooser}})$.

¹³Transitive: For all $x, y, z \in A : (x \succ y \text{ and } y \succ z)$ implies that $x \succ z$.

¹⁴Asymmetric: For all $x, y \in A : x \succ y$ implies that $\neg(y \succ x)$.

¹⁵Irreflexive: For all $x \in A, \neg(x \succ x)$.

¹⁶Complete: For all $x, y \in A : x \neq y$ implies that $(y \succ x \text{ or } x \succ y)$.

Definition 5 Given $k \in \{1, 2, \dots, \#\mathbf{A}\}$, a screening rule for k names $S_k : M^N \longrightarrow \mathbf{A}_k$ and a preference profile $\succ \equiv \{\succ_i\}_{i \in N \cup \{\text{chooser}\}} \in W^{N+1}$, a joint strategy $m_N \equiv \{m_i\}_{i \in N} \in M^N$ is a **pure strong Nash equilibrium of the Sincere Chooser Game** if and only if, given any coalition $C \subseteq N$, there is no $m'_N \equiv \{m'_i\}_{i \in N} \in M^N$ with $m'_j = m_j$ for every $j \in N \setminus C$ such that $\alpha(m'_N, \succ_{\text{chooser}}) \succ_i \alpha(m_N, \succ_{\text{chooser}})$ for each $i \in C$.

Definition 6 Given $k \in \{1, 2, \dots, \#\mathbf{A}\}$, a screening rule for k names $S_k : M^N \longrightarrow \mathbf{A}_k$ and a preference profile $\succ \equiv \{\succ_i\}_{i \in N \cup \{\text{chooser}\}} \in W^{N+1}$, the **Strategic Chooser Game** can be described as follows: It is a simultaneous game with complete information where each player i 's $\in N$ strategy space is M , while the chooser's strategy space is $M_{\text{chooser}} \equiv \{f : \mathbf{A}_k \longrightarrow \mathbf{A} \mid f(B) \in B \text{ for every } B \in \mathbf{A}_k\}$. Given $m_{N \cup \{\text{Chooser}\}} = (m_N \equiv \{m_i\}_{i \in N}, m_{\text{chooser}}) \in M^N \times M_{\text{chooser}}$, $S_k(m_N)$ is the chosen list with k names and the winning candidate is $m_{\text{chooser}}(S_k(m_N))$.

Definition 7 Given $k \in \{1, 2, \dots, \#\mathbf{A}\}$, a screening rule for k names $S_k : M^N \longrightarrow \mathbf{A}_k$ and a preference profile $\succ \equiv \{\succ_i\}_{i \in N \cup \{\text{chooser}\}} \in W^{N+1}$, a joint strategy $m_{N \cup \{\text{Chooser}\}} \equiv (m_N \equiv \{m_i\}_{i \in N}, m_{\text{chooser}}) \in M^N \times M_{\text{chooser}}$ is a **pure strong Nash equilibrium of the Strategic Chooser Game** if and only if, given any coalition $C \subseteq N \cup \{\text{chooser}\}$, there is no $m'_{N \cup \{\text{Chooser}\}} = (m'_N, m'_{\text{chooser}}) \in M^N \times M_{\text{chooser}}$ with $m'_j = m_j$ for every $j \in N \cup \{\text{chooser}\} \setminus C$ such that $m'_{N \cup \{\text{Chooser}\}}(S_k(m'_N)) \succ_i m_{N \cup \{\text{Chooser}\}}(S_k(m_N))$ for each $i \in C$.

5.2 Appendix 2

Proof of Proposition 1. Suppose that candidate x is the outcome of a strong equilibrium of the Sincere Chooser Game. In any strong Nash equilibrium where x is the outcome, the screened set is such that x is the best candidate in this set according to the chooser's preferences. So x is a chooser's $(\#\mathbf{A} - k + 1)$ -top candidate. Since the screening rule is majoritarian there exists no other chooser's $(\#\mathbf{A} - k + 1)$ -top candidate that is considered better than x by a strict majority of proposers. Otherwise this coalition could impose the choice of a set where this candidate would be the preferred candidate according to the chooser's preference. Therefore candidate x is the Condorcet winner over the set of chooser's $(\#\mathbf{A} - k + 1)$ -top candidates, and the first part of the proposition is proved. To complete the proof we need to show that if a candidate is the Condorcet winner over

the set of chooser's $(\#\mathbf{A} - k + 1)$ -top candidates then there exists a strategy profile that sustains him as a strong Nash equilibrium outcome. Let x be such a candidate. Take any set with k candidates contained in \mathbf{A} such that x is the chooser's best candidate in this set. Notice that this set exists, since candidate x is a chooser's $(\#\mathbf{A} - k + 1)$ -top candidate. Let B be such a set. Since the screening rule is majoritarian there exists an action such that every majority coalition of proposers can impose the choice of B provided that all of its members choose this action. Let m be such an action. Consider the strategy profile, where all proposers choose action m .

Then, candidate x will be elected since the screening rule is majoritarian. By this same reason, any coalition with less than half of the proposers cannot change the outcome. Notice also that any majoritarian coalition does not have any incentive to deviate, since there is no candidate among the chooser's $(\#\mathbf{A} - k + 1)$ -top candidate that is considered better than x by all proposers in the coalition (recall that only the chooser's $(\#\mathbf{A} - k + 1)$ -top candidates can be the chooser's best name among the candidates of a set with cardinality k). Otherwise x would not be a Condorcet winner over the set of the chooser's $(\#\mathbf{A} - k + 1)$ -top candidates. Therefore this strategy profile is a strong Nash equilibrium of the Sincere Chooser Game. ■

Proof of Proposition 2. Suppose that candidate x is the outcome of a strong equilibrium of the Strategic Chooser Game. In any strong Nash equilibrium where x is the outcome, the screened set is such that x is the best candidate in this set according to the chooser's preferences. Otherwise the chooser would have incentives to choose another name in this set. So x is a chooser's $(\#\mathbf{A} - k + 1)$ -top candidate. Since the screening rule is majoritarian there exists no other set with k names where all the candidates in this set are considered better than x by a strict majority of proposers. Otherwise this coalition would have incentives to impose the choice of this set. This is only true when candidate x is the Condorcet winner over some set of candidates with cardinality higher or equal than $\#\mathbf{A} - k + 1$. For this same reason there exists no candidate that is considered better than x by a strict majority of proposers and the chooser. This implies that candidate x is a undominated candidate. Therefore the first part of the proposition is proved.

To complete the proof we need to show that if a candidate is (1) undominated and chooser's $(\#\mathbf{A} - k + 1)$ -top candidate, and (2) Condorcet winner over some set of candidates with cardinality higher or equal than $\#\mathbf{A} - k + 1$ then there exists a strategy profile that sustains

him as a strong Nash equilibrium outcome. Let us call this candidate x . Take any set with k candidates contained in \mathbf{A} such that x is the chooser's best candidate in this set. Notice that this set exists, since candidate x is a chooser's $(\#\mathbf{A} - k + 1)$ -top candidate. Let B be such a set. Since the screening rule is majoritarian there exists an action such that every majority coalition of proposers can impose the choice of B provided that all of its members choose this action. Let m be such an action. Suppose the strategy profile where all proposers choose the action m . Let the chooser declare a choice rule such that if candidate x is in the screened set, x is the winning candidate. Otherwise, the winner is a candidate in the screened set that is considered worse than x by a strict majority of proposers (notice that this choice rule exists since x is the Condorcet winner over a set with cardinality $\#\mathbf{A} - k + 1$). Under this strategy profile, candidate x will be elected since the screening rule is majoritarian. Notice that the chooser's strategy eliminates any incentive of any majority coalition of proposers to deviate. Notice also that candidate x is the chooser's best candidate in the screened set, so that the chooser has no incentive to unilaterally deviate either. No coalition formed by a majority of proposers and the chooser has incentives to deviate either, since x is a undominated candidate. Therefore this strategy profile is a strong Nash equilibrium of the Strategic Chooser Game. Therefore the proof of the proposition is established. ■

Proof of Corollary 3. Let x be the strong equilibrium outcome of the Sincere Chooser Game and z be a strong equilibrium outcome of the Strategic Chooser Game. By Proposition 1, x is the Condorcet winner over the set of chooser's $(\#\mathbf{A} - k + 1)$ -top candidates. This information and Proposition 2 imply that x is also a strong equilibrium outcome of the Strategic Chooser Game. Again by Proposition 2, z is (1) undominated and chooser's $(\#\mathbf{A} - k + 1)$ -top candidate, and (2) the Condorcet winner over some set of candidates with cardinality higher or equal than $\#\mathbf{A} - k + 1$. Let us prove that the chooser does not prefer x to z . Suppose by contradiction that the chooser prefers x to z . This implies that the strict majority of proposers prefers z to x . Otherwise z would not be undominated. Since z is chooser's $(\#\mathbf{A} - k + 1)$ -top candidate, it implies that x is not the Condorcet winner over the set of chooser's $(\#\mathbf{A} - k + 1)$ -top candidates. This is a contradiction. ■

Proof of Proposition 3. Suppose $k'' > k'$, both \mathbf{S}' and \mathbf{S}'' are majoritarian screening rules and $\{\emptyset\} \neq \mathbf{SET}(\mathbf{S}''; \bar{\mathbf{A}}; k'') \neq \mathbf{SET}(\mathbf{S}'; \bar{\mathbf{A}}; k') \neq \{\emptyset\}$.

Let $x \in \mathbf{SET}(\mathbf{S}''; \bar{\mathbf{A}}; k'')$ and $y \in \mathbf{SET}(\mathbf{S}'; \bar{\mathbf{A}}; k')$. It will suffice to show that $x \succ_{\text{chooser}} y$. Suppose by contradiction that the chooser prefers y to x . By Proposition 1, we have that x is the Condorcet winner over the set of the chooser's $(\#\bar{\mathbf{A}} - k'' + 1)$ -top candidates. And y is the Condorcet winner over the of chooser $(\#\bar{\mathbf{A}} - k' + 1)$ -top candidates. Since x is one of the chooser's $(\#\bar{\mathbf{A}} - k'' + 1)$ -top candidate, the chooser prefers y to x and $k'' > k'$, we also have that y is a chooser's $(\#\bar{\mathbf{A}} - k'' + 1)$ -top candidate. But then this contradicts the fact that x is the Condorcet winner over the set of a chooser's $(\#\bar{\mathbf{A}} - k'' + 1)$ -top candidates. ■

Proof of Proposition 4. Consider first the Strategic Chooser Game. Let u be an undesirable candidate of $\bar{\mathbf{A}}$. It is easy to see that the set of the chooser's $(\#\bar{\mathbf{A}} \setminus \{u\} - k + 1)$ -top candidates is equal to the set of the chooser's $(\#\bar{\mathbf{A}} - (k + 1) + 1)$ -top candidates. Moreover, the set of undominated candidates does not change when the set of the candidates is $\bar{\mathbf{A}} \setminus \{u\}$ or $\bar{\mathbf{A}}$. We also have that the set of candidates that are Condorcet winners over some set with cardinality $\#\bar{\mathbf{A}} \setminus \{u\} - k + 1$ is contained in the set of candidates that are Condorcet winners over some set with cardinality $\#\bar{\mathbf{A}} - (k + 1) + 1$. By Proposition 2, these informations imply that $\mathbf{SET}(\mathbf{S}'; \bar{\mathbf{A}} \setminus \{u\}; k) \subseteq \mathbf{SET}(\mathbf{S}''; \bar{\mathbf{A}}; k + 1)$. For the Sincere Chooser Game, the proof requires a similar argument. For this reason it is omitted. ■

Proof of Proposition 5. Let u be the undesirable candidate of the set $\bar{\mathbf{A}}$ and $\{\emptyset\} \neq \mathbf{SET}(\mathbf{S}''; \bar{\mathbf{A}}; k) \neq \mathbf{SET}(\mathbf{S}'; \bar{\mathbf{A}} \setminus \{u\}; k) \neq \{\emptyset\}$.

First let us prove that the statement holds for the Strategic Chooser Game. Notice that the set of undominated candidates does not change whenever the set of candidates is $\bar{\mathbf{A}} \setminus \{u\}$ or $\bar{\mathbf{A}}$. We also have that the set of candidates that are Condorcet winners over some set with cardinality $\#\bar{\mathbf{A}} \setminus \{u\} - k + 1$ is equal to the set of candidates that are Condorcet winners over some set with cardinality $\#\bar{\mathbf{A}} - k + 1$. Moreover, any chooser's $(\#\bar{\mathbf{A}} \setminus \{u\} - k + 1)$ -top candidate is also chooser's $(\#\bar{\mathbf{A}} - k + 1)$ -top candidate. Therefore by Proposition 2, we have that $\mathbf{SET}(\mathbf{S}'; \bar{\mathbf{A}} \setminus \{u\}; k) \subset \mathbf{SET}(\mathbf{S}''; \bar{\mathbf{A}}; k)$. Thus it suffices to show that we have $x \succ_i y$ for all $x \in \mathbf{SET}(\mathbf{S}'; \bar{\mathbf{A}} \setminus \{u\}; k)$ and $y \in \mathbf{SET}(\mathbf{S}''; \bar{\mathbf{A}}; k) \setminus \mathbf{SET}(\mathbf{S}'; \bar{\mathbf{A}} \setminus \{u\}; k)$.

Suppose by contradiction that there is $y \in \mathbf{SET}(\mathbf{S}''; \bar{\mathbf{A}}; k) \setminus \mathbf{SET}(\mathbf{S}'; \bar{\mathbf{A}} \setminus \{u\}; k)$ and $x \in \mathbf{SET}(\mathbf{S}'; \bar{\mathbf{A}} \setminus \{u\}; k)$ such that the chooser prefers y to x . Notice that this information implies that y is a chooser's $(\#\bar{\mathbf{A}} \setminus \{u\} - k + 1)$ -top candidate. But then, we have y is undominated, chooser's $(\#\bar{\mathbf{A}} \setminus \{u\} - k + 1)$ -top candidate and the Condorcet winner of a set with

cardinality $\#\bar{\mathbf{A}} \setminus \{u\} - k + 1$. So, by Proposition 2, we have that $y \in \mathbf{SET}(\mathbf{S}'; \bar{\mathbf{A}} \setminus \{u\}; k)$. This is a contradiction, since we had assumed that $y \in \mathbf{SET}(\mathbf{S}''; \bar{\mathbf{A}}; k) \setminus \mathbf{SET}(\mathbf{S}'; \bar{\mathbf{A}} \setminus \{u\}; k)$. Now let us prove that the statement for the Sincere Chooser Game. By proposition 4, we have that $\mathbf{SET}(\mathbf{S}'; \bar{\mathbf{A}} \setminus \{u\}; k) = \mathbf{SET}(\mathbf{S}''; \bar{\mathbf{A}}; k + 1)$ since $\mathbf{SET}(\mathbf{S}'; \bar{\mathbf{A}} \setminus \{u\}; k) \neq \{\emptyset\}$. Hence, by Proposition 3, we have that the chooser prefers the triple $(\mathbf{S}'; \bar{\mathbf{A}} \setminus \{u\}; k)$ to $(\mathbf{S}''; \bar{\mathbf{A}}; k)$. ■

Proof of Proposition 6. First let us prove that if a screening rule is weakly majoritarian and x is an outcome of a strong equilibrium of the Sincere Chooser Game then x is undominated and chooser's $(\#\mathbf{A} - k + 1)$ -top candidate. Notice that in any strong Nash equilibrium in which x is the outcome, the screened set is such that x is the best candidate in this set according to the chooser's preferences. So x is a chooser's $(\#\mathbf{A} - k + 1)$ -top candidate. Since the screening rule is weakly majoritarian there exists no other candidate that is considered better than x by a strict majority of proposers and the chooser. Otherwise these proposers could impose the inclusion of this candidate in the screened set and this candidate would win. Therefore candidate x is undominated and chooser's $(\#\mathbf{A} - k + 1)$ -top candidate.

Let \mathbf{S}' and \mathbf{S}'' be weakly majoritarian screening rules but only \mathbf{S}'' is majoritarian such that $\{\emptyset\} \neq \mathbf{SET}(\mathbf{S}''; \bar{\mathbf{A}}; k) \neq \mathbf{SET}(\mathbf{S}'; \bar{\mathbf{A}}; k) \neq \{\emptyset\}$. Suppose by contradiction that $\mathbf{SET}(\mathbf{S}''; \bar{\mathbf{A}}; k) = \{y\}$ and $\mathbf{SET}(\mathbf{S}'; \bar{\mathbf{A}}; k) = \{x\}$ such that chooser prefers y to x . By the previous paragraph y and x are undominated and chooser's $(\#\bar{\mathbf{A}} - k + 1)$ -top candidates. We also know, by Proposition 1, that y is also the Condorcet winner over the set of chooser's $(\#\bar{\mathbf{A}} - k + 1)$ -top candidates.

Since the chooser prefers y to x , a strict majority of proposers prefers x to y . Otherwise x would not be undominated. Thus y is not the Condorcet winner over the set of chooser's $(\#\bar{\mathbf{A}} - k + 1)$ -top candidates. Therefore we have reached a contradiction. ■

Proof of Proposition 7. Since the chooser is always sincere (i.e. he is not a player), the vetoed candidates under rule of $k - 1$ are those that are not chooser's $(\#\mathbf{A} - k + 1)$ -top candidates. We know that under plurality voting the unique strong equilibrium outcome is the Condorcet winner (see Sertel and Sanver, 2004). Therefore, by Proposition 1, the strong equilibrium outcomes under rule of k names and rule $k - 1$ vetoes coincides and it is the Condorcet winner over the set of chooser's $(\#\mathbf{A} - k + 1)$ -top candidates. ■

Proof of Proposition 8. Here we assumed that the chooser is a player. So, by

Proposition 2, it suffices to show that a candidate is a strong equilibrium outcome under the rule of $k - 1$ vetoes if and only if it is (1) undominated and chooser's $(\#\mathbf{A} - k + 1)$ -top candidate, and (2) Condorcet winner over some set of candidates with cardinality higher or equal than $\#\mathbf{A} - k + 1$.

Suppose that candidate x is the outcome of a strong equilibrium outcome under rule of $k - 1$ vetoes. In any strong Nash equilibrium where x is the outcome, x is the Condorcet winner over the set of not vetoed candidates. Otherwise there would be a coalition formed by a majority of proposers that would have incentives in voting for another not vetoed candidate and this candidate would be elected. So x is the Condorcet winner over a set with cardinality $\#\mathbf{A} - k + 1$, since this is the cardinality of the set of available candidates after the veto made by the chooser. Notice that there exists no subset with cardinality $\#\mathbf{A} - k + 1$ where all candidates are considered better than x by the chooser. Otherwise the chooser would have an incentive to veto all but those in this subset. This is only true when x is a chooser's $(\#\mathbf{A} - k + 1)$ -top candidate. Since the proposers use plurality, there exists no other candidate that is considered better than x by a majority of proposers and by the chooser. Otherwise this coalition would be able to elect this candidate. This is only true when x is an undominated candidate. Thus we have proved that if a candidate is a strong equilibrium outcome under rule of $k - 1$ vetoes then it is (1) undominated and chooser's $(\#\mathbf{A} - k + 1)$ -top candidate, and (2) Condorcet winner over some set of candidates with cardinality higher or equal than $\#\mathbf{A} - k + 1$. So we have completed the first part of the proof.

To finish the proof we need to show that if a candidate is (1) undominated and chooser's $(\#\mathbf{A} - k + 1)$ -top candidate, and (2) Condorcet winner over some set of candidates with cardinality higher or equal than $\#\mathbf{A} - k + 1$ then there exists a strategy profile that sustains him as a strong Nash equilibrium outcome. Let x be such a candidate. Consider the following strategy profile: The chooser vetoes all candidates but the set with cardinality $\#\mathbf{A} - k + 1$ in which candidate x is the Condorcet winner (if there are more than one set with this characteristic choose one of them). All proposers unanimously cast a vote for candidate x if candidate x is a not vetoed; otherwise they vote for candidate considered worse than x according to the chooser's preference (this strategy is feasible since x is a chooser's $(\#\mathbf{A} - k + 1)$ -top candidate). Notice that under this strategy profile, candidate x will be elected. Notice that the proposers' threat eliminates any chooser's incentive in

unilaterally deviating. Notice that candidate x is the Condorcet winner over the set of not vetoed candidates. So the majority of proposers do not have incentive to deviate. Notice also that a coalition formed by a majority of the proposers and the chooser does not have any incentive to deviate either, since x is an undominated candidate. Thus this strategy profile is a strong equilibrium under rule of $k - 1$ vetoes. Therefore the proof of the proposition is established. ■

5.3 Appendix 3

In this appendix, we present sufficient conditions for a candidate to be a strong Nash equilibrium outcome for each of our games provided that the screening rule is "unanimous". We also present the necessary conditions for a candidate to be a strong Nash equilibrium outcome for each of our games provided that the screening rule is "anonymous".

Here, the number of proposers can be even and individual indifferences over the alternatives are not ruled out. We follow closely the approach of Sertel and Sanver (2004). They consider a standard voting game where a committee elects a candidate for office, without any external interference. In their voting game, the strategies of the voters are expressions of the agents' preferences regarding candidates. They provide a quasi-characterization of the set of strong equilibrium outcomes of their voting game under any anonymous and top-unanimous voting rule.

Notation 2 Denote by Θ the set of all reflexive¹⁷, transitive¹⁸ and complete¹⁹ orders on A . Each member $i \in N \cup \{\text{chooser}\}$ has a preference $\succsim_i \in \Theta$. Given any $i \in N \cup \{\text{chooser}\}$ and any $\succsim_i \in \Theta$, \succ_i stands the strict counterpart of \succsim_i . Denote by $\mathbf{A}_k \equiv \{B \subseteq \mathbf{A} \mid \#B = k\}$ the set of all possible subsets of \mathbf{A} with cardinality k .

Definition 8 Let $M^N \equiv M_1 \times \dots \times M_n$ with $M_i = M_j = M$ for all $i, j \in N$ where M is the space of actions of a proposer in N . For example, if the actions in M^N are casting single votes then $M \equiv A$. If the actions in M^N are submissions of strict preference relation then $M \equiv \Theta$. Given $k \in \{1, 2, \dots, \#A\}$, a **screening rule for k names** is a function $S_k : M^N \rightarrow \mathbf{A}_k$ associating to each action profile $m_N \equiv \{m_i\}_{i \in N} \in M^N$ the k -element set $S_k(m_N)$.

¹⁷Reflexive: For all $x \in A : x \succsim x$.

¹⁸Transitive: For all $x, y, z \in A : (x \succsim y \text{ and } y \succsim z) \text{ implies that } x \succsim z$.

¹⁹Complete: For all $x, y \in A : (x \neq y) \text{ implies } x \succsim y \text{ or } y \succsim x$.

Definition 9 We say that a screening rule $S_k : M^N \longrightarrow \mathbf{A}_k$ is **anonymous** if and only if given any permutation $\rho : N \rightarrow N$ of voters and any $(m_i)_{i \in N} \in M^N$, we have $S_k(\{m_i\}_{i \in N}) = S_k((m_{\rho(i)})_{i \in N})$.

All the six screening rules described in Subsection 3.1 are anonymous.

Definition 10 We say that a screening rule $S_k : M^N \longrightarrow \mathbf{A}_k$ is **unanimous** if and only if for every set $B \in \mathbf{A}_k$ there exists $m \in M$ such that $S_k(m_N) = B$ if $m_i = m$ for every $i \in N$.

Among all six screening rules described in Subsection 3.1 only the two majoritarian screening rules are unanimous.

Remark 1 A scoring screening rule for k names is characterized by a nondecreasing sequence of real numbers $s_0 \leq s_1 \leq \dots \leq s_{\#\mathbf{A}-1}$. Voters are required to rank the candidates, thus giving $s_{\#\mathbf{A}-1}$ points to the one ranked first, $s_{\#\mathbf{A}-2}$ to one ranked second, and so on. The selected list is formed by the candidates with the k highest total point score. Any scoring screening rule for k names characterized by a nondecreasing sequence of real numbers $s_0 \leq \dots \leq s_{\#\mathbf{A}-k-1} < s_{\#\mathbf{A}-k} \leq \dots \leq s_{\#\mathbf{A}-1}$ is unanimous and anonymous.

Before presenting the results, we need first to introduce several concepts of effectivity of a coalition. They are direct extensions of the concepts of effectivity functions studied by, among others, Peleg (1984), Abdou and Keiding (1991) and Sertel and Sanver (2004). These concepts of effectivity refer to the ability of agents to ensure an outcome, under the given rule.

Definition 11 Given a screening rule for k names $S_k : M^N \longrightarrow \mathbf{A}_k$ we say that a coalition $C \subseteq N$ of voters is β^+ -**effective** for $B \in \mathbf{A}_k$ if and only if there exists $m \in M$ such that for every profile of the complementary coalition $m_{N \setminus C} \in M^{N \setminus C}$ we have that $S_k(m_{N \setminus C}, m_C) = B$ provided that $m_i = m$ for every $i \in C$.

Notice that if C is β^+ -effective for B then all supersets of C are β^+ -effective for B . Denote the set of β^+ -effective coalitions for the set $B \in \mathbf{A}_k$ by $\beta^+s(B)$. Let $bs^+(B)$ stand for the cardinality of minimal coalition in $\beta^+s(B)$. By convention, set $bs^+(B) = n + 1$ whenever $\beta^+s(B)$ is empty.

Definition 12 Given $S_k : M^N \longrightarrow \mathbf{A}_k$, $bs_k^+ \equiv \max_{B \in \mathbf{A}_k} \{bs^+(B)\}$.

Definition 13 Given a screening rule for k names $S_k : M^N \longrightarrow \mathbf{A}_k$ we say that a coalition $C \subseteq N$ of voters is β^0 -**effective** for $x \in \mathbf{A}$ if and only if there exists $m \in M$ such that for every profile of the complementary coalition $m_{N \setminus C} \in M^{N \setminus C}$ we have that $x \in S_k(m_{N \setminus C}, m_C)$ provided that $m_i = m$ for every $i \in C$.

Notice that if C is β^0 -effective for B then all supersets of C are β^0 -effective for B . Denote the set of β^0 -effective coalitions for $x \in \mathbf{A}$ by $\beta^0 s(x)$. Let $bs^0(x)$ stand for the cardinality of minimal coalition in $\beta^0 s(x)$. By convention, set $bs_k^0(x) = n + 1$ whenever $\beta^0 s(x)$ is empty.

Definition 14 Given $S_k : M^N \longrightarrow \mathbf{A}_k$, $bs_k^0 \equiv \max_{x \in \mathbf{A}} \{bs^0(x)\}$.

Definition 15 Given a screening rule for k names $S_k : M^N \longrightarrow \mathbf{A}_k$, a coalition $C \subseteq N$ of voters is β^- -**effective** for $x \in \mathbf{A}$ if and only if for some set $D \in \{H \in \mathbf{A}_k \mid x \notin H\}$ and a $m' \in \{m \in M \mid S_k(\{m_i\}_{i \in N}) = D \text{ provided that } m_i = m \text{ for every } i \in N\}$, there exists a profile $m_C \in M^C$ such that $x \in S_k(m_C, m_{N \setminus C})$ given that $m_i = m'$ for every $i \in N \setminus C$.

Notice that if C is β^- -effective for B then all supersets of C are β^- -effective for B . Denote the set of β^- -effective coalitions for $x \in \mathbf{A}$ by $\beta^- s(x)$. Let $bs^-(x)$ stand for the cardinality of the minimal coalition belonging to $\beta^- s(x)$. By convention, set $bs^-(x) = n + 1$ whenever $\beta^- s(x)$ is empty.

Definition 16 Given $S_k : M^N \longrightarrow \mathbf{A}_k$, $bs_k^- \equiv \min_{x \in \mathbf{A}} \{bs^-(x)\}$.

Notice that for any screening rule for k names we have that $bs_k^+ \geq bs_k^0 \geq bs_k^-$.

Remark 2 Let $S_k : M^N \longrightarrow \mathbf{A}_k$ be an anonymous screening rule, if n is odd then $bs_k^+ \geq \frac{n+1}{2}$ otherwise $bs_k^+ \geq \frac{n}{2} + 1$.

Remark 3 Let S_k be a weakly majoritarian screening rule, if n is odd then $bs_k^+ \geq bs_k^0 \geq \frac{n+1}{2}$ otherwise $bs_k^+ \geq bs_k^0 \geq \frac{n}{2} + 1$.

Remark 4 Let $S_k : M^N \longrightarrow \mathbf{A}_k$ be a majoritarian screening rule, if n is odd then $bs_k^+ = bs_k^0 = bs_k^- = \frac{n+1}{2}$ otherwise $bs_k^+ = bs_k^0 = \frac{n}{2} + 1$ and $bs_k^- = \frac{n}{2}$.

Definition 17 Given $q \in \{1, \dots, n + 1\}$, we say that $x \in B \subseteq \mathbf{A}$ is a q -generalized Condorcet winner over B if and only if $\#\{i \in N | y \succ_i x\} < q$ for all $y \in B \setminus \{x\}$.

Definition 18 Given $q \in \{1, \dots, n + 1\}$, we say that $x \in \mathbf{A}$ is a q -undominated candidate if and only if there exists no $y \in \mathbf{A} \setminus \{x\}$ such that $\#\{i \in N | y \succ_i x\} \geq q$ and $y \succ_{\text{chooser}} x$.

Definition 19 Given $l \in \{1, \dots, \#A\}$, we say that $x \in \mathbf{A}$ is a chooser's l -top candidate if and only if $\#\{y \in \mathbf{A} \setminus \{x\} | x \succsim_i y\} \geq \mathbf{A} - q$.

Proposition 9 Let $S_k : M^N \rightarrow A_k$ be an anonymous screening rule for k names:

1. If a candidate x is a strong Nash equilibrium outcome of the Sincere Chooser Game then x is b_k^0 -undominated and b_k^+ -generalized Condorcet winner over the chooser's $(\#A - k + 1)$ -top candidates.
2. If a candidate x is a strong Nash equilibrium outcome of the Strategic Chooser Game then x is (1) bs_k^0 -undominated and chooser's $(\#A - k + 1)$ -top candidate, and (2) b_k^+ -generalized Condorcet winner over some set of candidates with cardinality larger or equal than $\#A - k + 1$.

Proof. Suppose that candidate x is the outcome of a strong equilibrium of the Sincere Chooser Game. In any strong Nash equilibrium where x is the outcome, the screened set is such that x is the best candidate in this set according to the chooser's preferences. So x is a chooser's $(\#\mathbf{A} - k + 1)$ -top candidate. Since the screening rule is anonymous, there exists no other chooser's $(\#\mathbf{A} - k + 1)$ -top candidate that is considered better than x by b_k^+ proposers or more. Otherwise these proposers could form a coalition to impose the choice of another set where this candidate would be the preferred candidate according to the chooser's preference. Hence candidate x is a b_k^+ -generalized Condorcet winner over the set of chooser's $(\#\mathbf{A} - k + 1)$ -top candidates. For this same reason there exists no candidate that is considered better than x by at least b_k^0 proposers and the chooser. Hence x is b_k^0 -undominated, and the first part of the proposition is proved.

Suppose that candidate x is the outcome of a strong equilibrium of the Strategic Chooser Game. In any strong Nash equilibrium where x is the outcome, the screened set is such that x is the best candidate in this set according to the chooser's preferences. Otherwise the chooser would have incentives to choose another candidate in this set. So x is a

chooser's $(\#\mathbf{A} - k + 1)$ -top candidate. Since the screening rule is anonymous, there exists no set with k candidates where all the candidates in this set are considered better than x by any coalition of proposers with cardinality higher or equal than b_k^+ . Otherwise this coalition would have incentives to impose this list. This is only true when candidate x is a b_k^+ -generalized Condorcet winner over some set of candidates with cardinality higher or equal than $\#\mathbf{A} - k + 1$. For this same reason there exists no candidate that is considered better than x by at least bs_k^0 proposers and the chooser. This implies that candidate x is a bs_k^0 -undominated candidate. Therefore the proof of the proposition is established. ■

Proposition 10 *Let $S_k : M^N \longrightarrow \mathbf{A}_k$ be an unanimous screening rule for k names:*

1. *If a candidate x is a b_k^- -generalized Condorcet winner over the chooser's $(\#\mathbf{A} - k + 1)$ -top candidates then x is a strong Nash equilibrium outcome of the Sincere Chooser Game.*
2. *If a candidate x is (1) b_k^- -undominated and chooser's $(\#\mathbf{A} - k + 1)$ -top candidate, and (2) b_k^- -generalized Condorcet winner over some set of candidates with cardinality larger or equal than $\#\mathbf{A} - k + 1$ then x is a strong Nash equilibrium outcome of the Strategic Chooser Game.*

Proof. First let us show that if a candidate is bs_k^- -undominated and b_k^- -generalized Condorcet winner over the chooser's $(\#\mathbf{A} - k + 1)$ -top candidates then x is a strong Nash equilibrium outcome of the Sincere Chooser Game. Let x be such a candidate. Take any set with k candidates contained in \mathbf{A} such that x is the chooser's best candidate in this set. Notice that this set exists, since candidate x is a chooser's $(\#\mathbf{A} - k + 1)$ -top candidate. Let B be such a set. Since the screening rule is unanimous there exists an action such that all proposers can impose the choice of B provided that all them choose this action. Let m be such an action. Consider the strategy profile where all proposers choose action m .

Then, candidate x will be elected since the screening rule is unanimous. Notice that there exists no coalition of players that can make a profitable deviation. Because any coalition of proposers with size higher or equal than b_k^- does not have incentive in deviating since there is no candidate among the chooser's $(\#\mathbf{A} - k + 1)$ -top candidate that is considered better than x by all proposers in the coalition (recall that only the chooser's $(\#\mathbf{A} - k + 1)$ -top

candidates can be the chooser's best name among the candidates of a set with cardinality k). Otherwise x would not be a b_k^- -generalized Condorcet winner over the set of the chooser's $(\#\mathbf{A} - k + 1)$ -top candidates. Therefore this strategy profile is a strong Nash equilibrium of the Sincere Chooser Game.

To finish the proof we need to show that if a candidate is (1) a bs_k^- -undominated and chooser's $(\#\mathbf{A} - k + 1)$ -top candidate, and (2) b_k^- -generalized Condorcet winner over some set of candidates with cardinality higher or equal than $\#\mathbf{A} - k + 1$ then there exists a strategy profile that sustains him as a strong Nash equilibrium outcome of the Strategic Chooser Game. Let us call this candidate x . Take any set with k candidates contained in \mathbf{A} such that x is the chooser's best candidate in this set. Notice that this set exists, since candidate x is a chooser's $(\#\mathbf{A} - k + 1)$ -top candidate. Let B be such a set. Since the screening rule is unanimous there exists an action such that all proposers can impose the choice of B provided that all of them choose this action. Let m be such an action. Consider the strategy profile where all proposers choose action m . Let the chooser declare a choice rule such that if candidate x is in the screened set, x is the winning candidate. Otherwise, the winner is a candidate in the screened set that is considered not better than x by more than $n - b_k^-$ proposers (notice that this choice rule exists since x is a b_k^- -generalized Condorcet winner over a set with cardinality $\#\mathbf{A} - k + 1$). Under this strategy profile, candidate x will be elected since the screening rule is unanimous. Notice that the chooser's strategy eliminates any incentive of any coalition of proposers with size higher or equal than bs_k^- to deviate. Notice also that candidate x is the chooser's best candidate in the screened set, so the chooser has no incentive to unilaterally deviate either. No coalition formed by at least bs_k^- proposers and the chooser has no incentive to deviate either since x is a bs_k^- -undominated candidate. Therefore this strategy profile is a strong Nash equilibrium of the Strategic Chooser Game. Therefore the proof of the proposition is established. ■

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