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VOTING OVER MATCHES: AN ADOPTION MARKET

ISAAC BERNARDO LARA NÚÑEZ

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ASESOR:

DAVID CANTALA

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Abstract

The National System for Integral Family Development (SNDIF, by its Spanish acronym) is a public institution in Mexico that performs child-adoption matching procedures. It does so through a committee integrated by civil servants who act as voters in a voting procedure conducted during committee sessions to approve matches. We call this mechanism Voting over Matches (VM) and propose an algorithm to model it. Under two consistency restrictions on voters' preferences, we find this algorithm to be agenda-dependent. In particular, the cardinality of its output matching depends on the inputted agenda. Associated with each of our two consistency axioms holding, we find a class of agendas such that, if we input any agenda in this class into the VM algorithm, it produces as many matches as if we input any other agenda. We discuss the policy implications of our results.

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1 Introduction

According to the Social Assistance Centers Census (*Censo de Alojamientos de Asistencia Social*) conducted by the National Institute of Statistics and Geography (*Instituto Nacional de Estadística y Geografía*, n.d.) in 2015 , there were 25,667 minors living in 879 social assistance centers, out of which approximately 11% were public shelters and the rest of them private ones (in this paper's context: social assistance centers, shelters and residential institutions are considered equivalent). Amador (2018) warns that these data underestimate the number of minors residing in institutions, she says there are at least 30,000 of these minors, 80% living in private shelters .

Most minors in social assistance centers are not legally adoptable. According to Gómez (2018b), between May and June of 2017, of the approximately 30,000 children in shelters only about 1,168 were known to be legally adoptable. From 2012 to May 2017, 5,432 adoptions were registered in the country. Menchaca (2018) reports that 48% of the legally adoptable children have remained at least 5 years under the custody of the Integral Family Development (*Desarrollo Integral de la Familia* [DIF]) and 68% of the legally adoptable children have remained at least 3 years under this institution's custody.

Whenever a child lives in a social assistance center it is said to be institutionalized. The institutionalization of children is a way in which the State provides care to protect minors whose right to live in a family has been violated. The General Law on the Rights of Children (*Ley General de los Derechos de Niñas, Niños y Adolescentes* [LGDNNA]; *Diario Oficial de la Federación de México*, 2014), refers to institutionalization as residential care and defines it as the one provided by social assistance centers as a special subsidiary protection measure, which will be of last resort and for the shortest possible time, prioritizing care options in a family environment.

According to the Latin American Foster Care Network (*Red Latinoamericana de Acogimiento Familiar*) and the United Nations Children's Fund (2015) family care is the most appropriate environment for a child to develop. In addition, Williamson and Greenberg (2010) state that institutionalization has very negative effects on child development, which are different for children of different ages. For instance, it is very difficult for an institutionalized young child to develop attachment with an adult caregiver because of the high ratio of children to staff in a shelter and the high frequency of staff turnover. In addition, residential institutions typically have a harsh environment not prone to basic socialization. Consequently, it is common for children in institutions to have difficulties initiating and maintaining relationships through all their lives. Moreover, these authors claim that for every three months that a child stays in residential care, he/she loses one month of development.

Williamson and Greenberg (2010) also assert that institutionalization may impose a burden on a country's development. They report the results of a research carried out in Russia which found

that one out of three children that lived in a residential institution ends up in street situation; one in five acquires a criminal record; and one in ten commits suicide. Moreover, according to a meta-analysis of 75 studies involving 3,800 minors in 19 countries cited by these authors, children raised in a residential institution had, on average, an IQ 20 points less than the ones in foster care.

Despite having adverse effects on child development, institutionalization is the main way in which the Mexican State protects children who have been separated from their family. In an interview for the journalistic project *Aging out: The adoption in Mexico* (my own translation of this project's title: *Crecer en la espera: la adopción en México*), the Federal Attorney for the Protection of Children (*Procurador Federal de Protección de Niños, Niñas y Adolescentes*) Luis Enrique Guerra García said: "Today the best alternative is the shelter, the residential institution, because it is the only administrative structure we have" (Gómez, 2018b).

Considering the importance that the LGDNNA (*Diario Oficial de la Federación de México*, 2014) confers to prioritizing family care options, and that among these options it establishes the adoption and foster care, we study the adoption market in Mexico. There are several institutions, both public and private, performing different adoption procedures in this market. For the purpose of this paper we model the one used by the National System for Integral Family Development (*Sistema Nacional para el Desarrollo Integral de la Familia* or *Sistema Nacional* DIF [SNDIF]) i.e., the mechanism it uses to assign children to parents. The SNDIF carries out its matching process through a committee integrated by civil servants. Committee members act as voters in a voting procedure conducted during committee sessions to approve matches. We call this procedure Voting over Matches (VM) algorithm. The objective of this paper is to assess, through our model, this mechanism in terms of the quantity of matches it produces. We find that the quantity of matches produced by the VM algorithm is agenda-dependent even under two consistency restrictions on voters' preferences. One of these axioms says that if any voter considers acceptable to match a child with a parent, then it is also acceptable, for that voter, to match that same child with a parent with more parental capacity. The other axiom says that if any voter considers acceptable to match a child with a parent, then it is also acceptable, for that voter, to match that same parent with a less needs child. Associated with each of these consistency axioms holding, we find a class of agendas such that, whenever we input any agenda in this class into the VM algorithm, it produces as many matches as if we input any other agenda.

This paper is organized in the following manner. First, we briefly discuss how this paper is related to the literature about the design of adoption markets. Second, we point out the main features and flaws of the adoption market in Mexico to contextualize our analysis. Third, we describe SNDIF's adoption procedure. Fourth, we present our model and its results. Finally, we provide conclusions.

1.1 Related Literature

This paper is embedded in the incipient literature on the design of adoption markets. According to Baccara, Collard-Wexler, Felli, and Yariv (2014, p. 136), "despite the scope of the adoption industry in terms of volume of children and annual revenues, as well as the unique matching mechanisms it employs, adoption has, thus far, received little attention in the economics literature". These authors found empirical evidence on the preference of potential adoptive parents in favor of girls and against African American children. Slaugh, Akan, Kesten, and Ünver (2016) explicitly approach the adoption market from a market design perspective. They helped Pennsylvania Adoption Exchange (PAE), which recommends prospective adoption families to case workers representing children in state custody, to redesign its match recommendation process. Moreover, these authors viewed PAE as a two-sided matching market and relied on the market design literature to guide their design efforts. We view SNDIF as a three-sided matching market (children, parents, voters), but we do not model neither parents' preferences nor children's preferences. Instead, we model voters' preferences because in the case of SNDIF, a first stage in the matching process depends solely on these preferences. Yet, it is true that in a second stage, when the matches are determined by SNDF's committee, parents and children have to accept or consent their mutual assignment for the matching process to continue. For now, allow us just to consider the stage in the matching process in which the relevant preferences are the ones of voters. In this sense our model could be cataloged as a computational social choice one. Specifically, our problem might be framed as one of voting in combinatorial domains. In this type of problems one has to deal with preference aggregation and voting when the set of alternatives posses a combinatorial structure: "a Cartesian product (or a subset of the Cartesian product) of finite domain values, each corresponding to an issue, a variable, or an attribute" (see, Lang & Xia, 2016, p. 197). In our case the set of alternatives is a set of subsets of the Cartesian product of finite sets of children and parents. Our algorithm structure is partially based on the Sequential Voting Protocol proposed by Lang and Xia (2016). In our model voting is conducted over the approval of matches and the outcome of the voting procedure is a matching, which is a subset of the Cartesian product of finite sets of children and parents (such that there is no child or parent in two different matches that belong to that subset).

1.2 The Adoption Market in Mexico

The journalistic project *Aging out: The adoption in Mexico* conducted by Horizontal (2018), with the support of the non-governmental organization Information Group on Reproductive Choice (*Grupo de Información en Reproducción Elegida* [GIRE]), coordinated by Thelma Gómez Durán, researched on the relevant data regarding adoptions in Mexico; described the adoption process; and carried out an analysis of the legal framework.

The adoption as a legal figure has been recognized in Mexico since 1928 and belongs to the field of civil law (Gómez, 2018b). Consequently, it is regulated by each federal entity's Civil or Family Code (*Código Civil o Familiar*; in Mexico, the federal entities are the states and Mexico City), local laws on children protection, the Federal Civil Code (*Código Civil Federal*), the LGDNNA, and some local laws on adoption which some states have established (GIRE, 2018). As a result, each federal entity sets different requirements for adoptive parents to satisfy, different adoption procedures, even different adoption types (Gómez, 2018b). The SNDIF and the federal entities' DIFs carry out adoption procedures. Furthermore, there are both secular and religious non-governmental organizations that perform adoption procedures with their own requirements and criteria that establishes who can adopt a child. Gómez (2018b) reports that some of these organizations accomplish more adoptions than some states' DIFs.

Article 13, section IV of the LGDNNA (*Diario Oficial de la Federación de México*, 2014) states that minors have the right to live in a family. When this right is violated, one way the State can restore it is through adoption; however, before taking this measure, the State must seek for the reincorporation of the minor with his immediate family. If this is impossible, then the reincorporation of the child with his extended family (grandparents, uncles, aunts, etc.) must be tried. Only if both attempts fail, a termination of parental rights trial can start.

On the one hand, Gómez (2018b) warns that negligence on part of the competent authorities can prolong indefinitely the time spent trying to reincorporate the child to its immediate or extensive family. In response, some states have established a cap of 6 months for this process to take place. On the other hand, a termination of parental rights trial, which is required for a child to be legally adoptable, typically lasts for 3 months to 2 years, according to the Monterrey DIF Coordinator for Childhood, Adolescence and Family (*Coordinador de Infancia, Adolescencia y Familia del* DIF *Monterrey*), Alejandro Morton (Gómez, 2018b). There is also a chance that this trial is never solved and the minor stays in a shelter until he/she reaches the age of majority. Because of the slowness of these two processes, it takes a lot of time for institutionalized children to become legally adoptable and, therefore, they end up growing in shelters.

According to Gómez (2018b), of the approximately 1,168 adoptable minors in social assistance centers, 90.7% are six years old or older and the average age is 11.5. These numbers raise a problem because, in general, parents prefer to adopt babies or young children. In line with this, in an interview conducted for this thesis, the Head of the General Directorate for the Representation of Children (*Titular de la Dirección General de Representación de Niñas, Niños y Adolescentes*; personal communication, October 17, 2018) said that as of October 2018 there were 170 children in shelters of the SNDIF, of which 31 were adoptable, and of these 24 were teenagers; however, from 2014 until today there have been no adoptions of teenagers in the SNDIF (SNDIF, n.d.). From January 2014 to June 2018, the SNDIF carried out nineteen national adoptions for children

between 0 and 4 years old; eleven for children between 5 and 8 years old; and eight for children between 9 and 12 years old. For the same period, the SNDIF accomplished two international adoptions for children between 5 and 8 years old and only one for a child between 9 and 12 years old. Since most parents prefer to adopt babies and young children, it is reasonable to think that the more time a minor spends in a residential institution, the lower his probability of being adopted.

The fact that potential adoptive parents prefer young children, while older children predominate, could be encouraging adoption between individuals or through private instances, that is where the State has minor or no interference. The Committee on the Rights of the Child of the United Nations Organization (2015) expresses its concern since the LGDNNA does not expressly prohibit this kind of adoptions in Mexico, implying the possibility of unacceptable financial benefits related with the sale of minors for adoption.

Negligence, slow justice and the preference of adoptive parents for babies and young children are not the only obstacles to adoption in Mexico. According to GIRE (2018), while the LGDNNA tried to standardize rules and procedures regarding adoption, there are still a wide variety of criteria and regulations regarding adoption. For example, the laws of some states contemplate two types of adoption, simple and full adoption, but most federal entities and federal's legislation consider only full adoption. Whereas full adoption has the same legal effect as filiation by consanguinity, it extends to the family of the adoptive parents and it is irrevocable; on the other hand, simple adoption only transfers parental authority and custody to the adoptive parents, in addition to being revocable. Moreover, federal and local laws establish different requirements for people trying to adopt a child. The minimum age required for the adoptive parent varies from 18 to 30 years, between federal entities' legislations, and some regulations specify a maximum age. In almost all federal entities a minimum age difference between adoptive parent and adopted child is requested, but this difference varies between states from 10 to 25 years. In some legislations, this last requirement can be ignored if the adoption applicant has a relationship of kinship with the minor susceptible of being adopted or if he/she is in a situation of abandonment. Regarding the maximum age difference between adoptive parent and child, the state of Hidalgo establishes the age of 45 years.

GIRE (2018) asserts that marriage or cohabitation requirements for adoption also differ by federal entity. In several states, single people can adopt; however, certain types of adoption are reserved only for either spouses or partners, such is the modality of full adoption in the states of Campeche, Chiapas, Guerrero, Jalisco, Sonora, Tabasco and Tlaxcala. In Jalisco, only marriages formed by a man and a woman can fully adopt. In Chiapas and Tabasco, a full adoption requires a heterosexual couple that although does not need to be married, must not have any impediment to get married. In the case of Durango, marriage is required for full adoption by a couple (*Sistema para el Desarrollo Integral de la Familia en el Estado de Durango*, n.d.).

Local legislations contain other requirements that are source of great variability (GIRE, 2018);

the potential adoptive parent may be required to have enough resources to ensure the subsistence of the adoptee and his education; however, "enough resources" might mean something different among federal entities. It may be required that the adoptive parents have an honest way of living; physical and psychological health, among other different demands. For example, in Michoacán the adoption applicant is required to have moral aptitude. Furthermore, Gómez (2018b) reports that civil associations which carry out adoptions impose discretionary requirements for candidates to adopt. Most of these associations require that adoption applicants take certain courses, whose price ranges from 5,000 to 10,000 pesos. Some of these organizations require these courses to be taken with them, while others allow to take them with specialized organizations recognized by local DIFs. Most civil associations ask for donations and only integrate heterosexual couples, married couples and/or devout Catholics into their parent lists. For example, the civil association Vifac requires adoption applicants to be married by the Church for at least 5 years (Gómez, 2018a). In addition, this association asks that those interested in adopting prove to be active Catholics through letters written by priests.

According to GIRE (2018), some federal entities require children of certain age to consent to be adopted by their potential adoptive parents, but, depending on the federal entity, this age varies between six and fourteen. While in Durango and Puebla children from six years can decide, in most federal entities and at Federal level this age is twelve or fourteen. Regardless of whether the minor's consent is required, his or her opinion must be considered throughout the adoption process, according to national legislation and national and international jurisprudence on human rights of children (GIRE, 2018).

In summary, the number of adoptions in Mexico can be affected by several factors. First, negligence on the side of competent authorities in the reintegration processes to immediate or extended family; second, the slowness of the trial of loss of parental authority. These two factors may explain why so few children are susceptible to adoption. Third, the preference of adoption applicants for young children and babies could adversely affect the number of adoptions made since most of the children in adoptability are older than 6 years, with an average age of 11.5. A fourth factor is diversity of requirements, resulting both from heterogeneity of regulations between the Federation and the federal entities and from the diversity of public and private institutions involved in adoption procedures. The factors that hinder adoption make respective market so complicated that they could be hindering its use by potential parents, leading perhaps even to disqualify many people who want and could adopt.

In addition to such a context, the adoption mechanisms used by either public or private institutions might have problems on its own. In particular, we want to know how these mechanisms perform in terms of the number of adoptions (matches) they produce. To do so, we study the SNDIF's adoption procedure and, in particular, its assignment mechanism of children to parents, applied

during committee sessions of the Technical Adoption Committee (*Comité Técnico de Adopción*, from now on Committee) of the SNDIF. The purpose of this work is to evaluate this mechanism in terms of the number of assignments of minors to parents.

1.3 The Adoption Mechanism of the SNDIF

The SNDIF carries out domestic and international adoption procedures (SNDIF, n.d.). The former is the one that does not entail a child to be adopted in a country other than its origin country. The international adoption is the one in which a minor leaves his home country to be adopted in another one. In this paper we focus on the domestic adoption procedure conducted by the SNDIF.

The domestic adoption procedure consists of the following steps (SNDIF, n.d.):

1. Persons intending to adopt must integrate a file with several requirements: A certificate of attendance to an introductory course on adoption given by the Federal Attorney's Office for the Protection of Children (*Procuraduría Federal de Portección de Niñas, Niños y Adolescentes*); a letter addressed to the SNDIF, specifying their desired profile for the child they want to adopt (sex, age, etc.); their birth certificate; the birth certificate of any son or daughter they already have; marriage certificate or cohabitation agreement; two recommendation letters; medical certificate; drug test results; certificate of employment; proof of address; proof of no criminal record; photographs of their property and of family gatherings.

2. Applicants undergo psychological and social diagnoses carried out by SNDIF's specialists and a psychosocial report results from these evaluations.

3. The Committee of the SNDIF uses this report to decide whether an applicant qualifies as an adoptive parent or not. If it does, the Committee issues a Suitability Certificate (*Certificado de Idoneidad*) for the applicant. Else, the application is reconsidered or rejected.

4. If this certificate is issued, then the applicant in question enters a waiting list for the assignment of a minor.

5. A child is matched to a parent in the waiting list during a committee session. The Committee attempts to match a child with a parent with enough parental capacity to satisfy his/her needs. In any given committee session, the Committee seeks to match all legally adoptable children under SNDIF's custody to parents in the waiting list.

6. Once such a session is finished, the assignments are communicated to the parents and they have to accept or reject their assigned child. To take this decision they are given the minor's

Adoption Report (*Informe de Adoptabilidad*) which contains the medical, legal, psychological, social and pedagogical situation of the minor in question. If a parent accepts his/her assigned child and if the child consents, a first meeting between them is arranged.

7. Then a series of gatherings between the parent and the child begins. Firstly, these gatherings take place at the shelter where the minor lives, and then outside of it. The purpose of this is to evaluate the degree of compatibility between them. If the gatherings turn out to be successful, the legal process of Adoption Finalization begins.

8. A judge assesses whether the applicants meet the requirements established in the current legislation or not based on the presented evidence. If they do, the adoption is consummated and the judge sends an official letter to the Civil Registration for them to issue the minor's new birth certificate.

9. After an adoption is completed, the post-adoption follow-up begins in order to assess how well the child adapts to his new family and environment, as well as to observe its development in all senses. These follow-ups are carried out every six months, for 2 years.

In this paper we propose a model for step 5 of the SNDIF adoption procedure. This is, we model the matching mechanism used by the Committee to assign children to parents in the waiting list in a given committee session. What we care about in this paper is how this mechanism performs in terms of the quantity of matches it produces in a given committee session. Before proceeding to the model, we describe this mechanism. To do so, we use the SNDIF's Guidelines on Adoption (*Lineamientos en materia de Adopción del* SNDIF; *Diario Oficial de la Federación de México*, 2016). However, these guidelines do not describe this mechanism in a detailed way. Therefore, for the purposes of this research, and through information requests to the National Institute of Transparency, Access to Information and Protection of Personal Data (*Instituto Nacional de Transparencia, Acceso a la Información y Protección de Datos Personales*), an interview was held with a member of the SNDIF's Committee, in October 2018, and written information was obtained. Using these sources, we proceed to describe this mechanism.

The assignment of children is performed by the Committee by way of a sequential voting procedure with the Committee's permanent members being the voters. The Committee has six permanent members who are SNDIF's high officials. Two of them are the Head of the SNDIF (*Titular del* SNDIF) and the Head of the Federal Attorney's Office for the Protection of Children (*Titular de la Procuraduría Federal de Protección de Niñas, Niños y Adolescentes*). The former is the Committee's Chairman (*Presidente*), the latter is the Technical Secretary (*Secretario Técnico*). These members have voice and vote in committee sessions. Furthermore, there are permanent and extraordinary guests to committee sessions without vote, but with voice. The Committee meets

twice a month in an ordinary manner but can also hold extraordinary sessions any time. Committee's decisions are taken by majority of its permanent members, and if there is no consensus, the Chairman has casting vote. There is quorum whenever there is a majority of the permanent members in a session.

The Committee decides which legally adoptable children are matched to which parents in the waiting list. To do so, the only criteria is that a parent has to have enough parental capacity to satisfy the child's needs. Parental capacity is measured through the psychological and social diagnoses conducted by the SNDIF's experts, and the child's needs are presumably known by the SNDIF. Assignments are carried out both in ordinary and extraordinary committee sessions. In any given session, the Committee tries to clear the pool of legally adoptable children. To assign a child to a parent (without considering the parent's position in this list), the Technical Secretary proposes their match and permanent members vote in favor or against the match in question. The decision is made according to what the majority says and in case of a tie the Chairman has casting vote.

When modelling this mechanism, we make the following assumption:

1. There is no voter with casting vote.

2. For a match to be approved a simple majority is required and in case of a tie the match is rejected.

3. Voting is conducted over all possible matches, not only over the ones proposed by the Technical Secretary. Moreover, there is no voter who proposes matches in a certain order, they are voted in an exogenous order.

4. Voters do not behave strategically: any voter votes in favor of a match if and only if it is an acceptable match to him/her.

5. As we mentioned in the description of the adoption market in Mexico, different public and private institutions impose different requirements for the adoptive parents. A criterion that is different across federal entities and the federation is the minimal age difference between the adoptive parent and the adopted child. In SNDIF this difference is of 17 years. Hence, we assume that the younger parent considered in our model is at least 17 years older than the oldest minor. Therefore, there are no parent and child that cannot be matched because of an age difference requirement.

A last remark before modelling: previously, we said that an applicant to be an adoptive parent specifies his desired profile for the child he wants to adopt. For example, an applicant can ask for a 3 to 7 years old girl. In an interview with a Committee member (personal communication, October 17, 2018), she said that parents' preferences over certain characteristics are considered by

the Committee but do not constraint any assignment, i.e. the Committee might assign an 8 years old boy to the parent in our example. Hence, parents' preferences only matter through voters' preferences.

2 Model

2.1 Matches, Matchings and Preferences

There are finite and disjoint sets of children, $C = \{c_1, ..., c_k\}$; parents, $P = \{p_1, ..., p_m\}$; and voters $N = \{1, ..., n\}$. The set of all possible matches is $C \times P$. A **match** is an element $(c, p) \in C \times P$. For convenience, (c, p) is denoted cp. A **matching** is an element $\mu \in 2^{C \times P}$ such that, if $c^1p^1, c^2p^2 \in \mu$ and $c^1p^1 \neq c^2p^2$, then $c^1 \neq c^2$ and $p^1 \neq p^2$. Let $p \in P$ ($c \in C$). We say that a parent p (child c) **participates** in a matching $\mu \in 2^{C \times P}$ if there is a child $c \in C$ (parent $p \in P$) such that $cp \in \mu$.

Each voter $i \in N$ has a rational preference relation $\succeq_i$ on $X = (C \times P) \cup \{\emptyset\}$, this means that $\succeq_i$ is complete and transitive. Let $x, y \in X$. $x \succeq_i y$ means "x is at least as good as y for voter i". $x \succ_i y$ means "x is (strictly) preferred to y for voter i". $x \sim_i y$ means "voter i is indifferent between x and y". If $x \succ_i \emptyset$ then we say x is **acceptable** for i. If $\emptyset \succ_i x$ then we say x is **unacceptable** for i. A **voter preference profile** is an n-tuple $(\succeq_i)_{i \in N}$ of rational preferences on X, one per voter.

2.1.1 Restrictions on Voters' Preferences

No-abstentions axiom: $\forall i \in N, \forall x \in C \times P, x \succ_i \emptyset$ or $\emptyset \succ_i x$. This axiom says that for every voter $i \in N$, matching a certain child with a certain parent is either acceptable or unacceptable. We maintain this axiom from now on, so when stating any result, we assume it holds without further mention.

Assume a linear order $>_c$ on C such that, for every $c^1, c^2 \in C$, $c^1 >_c c^2$ means "child c^1 has less needs than child c^2". We write $c^1 \geq_c c^2$ if and only if $c^1 >_c c^2$ or $c^1 = c^2$. Also assume a linear order $>_p$ on P such that, for every $p^1, p^2 \in P$, $p^1 >_p p^2$ means "parent p^1 has more parental capacity than parent p^2". We write $p^1 \geq_p p^2$ if and only if $p^1 >_p p^2$ or $p^1 = p^2$. Let c_n, for all $n = 1, ..., k$, denote the n^{th} least needs child; i.e., c_1 is the one with least needs,...,c_k is the one with the major needs. So, we can write $c_1 >_c ... >_c c_k$. Symmetrically, let p_n, for all $n = 1, ..., m$, denote the n^{th} highest parental capacity parent; i.e., p_1 is the one with highest parental capacity, ..., p_m is the one with the lowest parental capacity. Hence, we can write $p_1 >_p ... >_p p_m$. Notice that c^n and c_n mean different things, the former is the n^{th} arbitrary child, while the latter is the n^{th} least needs child, as we just said. The same applies for parents. Having said so, we proceed to state two more axioms.

Consistency axioms: Let $p \in P$ and $c \in C$. $\forall i \in N$,

S1 $\forall c^1, c^2 \in C$ such that $c^2 >_c c^1$, if $c^1 p \succ_i \emptyset$, then $c^2 p \succ_i \emptyset$;

S2 $\forall p^1, p^2 \in P$ such that $p^2 >_p p^1$, if $c p^1 \succ_i \emptyset$, then $c p^2 \succ_i \emptyset$.

In words: consistency axiom S1 says that if for any voter i it is acceptable to match a certain child with a certain parent, it is also acceptable, for that voter, to match that same parent with a child with less needs; consistency axiom S2 says that if for any voter i it is acceptable to match a certain child with a certain parent, it is also acceptable, for that voter, to match that same child with a parent with major parental capacity.

2.2 Voting Procedure

To define an agenda we use Apesteguia, Ballester, and Masatlioglu's (2014) definition in the context of our model: An **agenda** O is an ordered list of all possible matches. We can write $O = (m_1, m_2, ..., m_{|C\times P|})$, where $m_j = c_{m_j} p_{m_j}$. We also write $O[j] = m_j$ to indicate that m_j occupies the j-position on the agenda O. Our voting procedure is defined in the following manner:

Algorithm 1 Voting over Matches (VM)

Input: An agenda $O = (m_1, m_2, ..., m_{|C\times P|})$; an empty matching $\mu_O^0 = \emptyset$.

Initial $t = 1$

Iterative step

If $t >\mid C \times P \mid$, i.e., all the ordered list has been scrutinized, then the output matching is $\mu_O^{|C\times P|} \in 2^{C\times P}$ or simply μ_O.

Else:

If $\mu_O^{t-1} \cup \{m_t\}$ is not a matching, then $\mu_O^t := \mu_O^{t-1}$.

Else:

Ask every voter i to report yes if m_t is an acceptable match and no if it is unacceptable.

If m_t is approved by more than $\frac{n}{2}$ voters, then $\mu_O^t := \mu_O^{t-1} \cup \{m_t\}$.

Else:

$\mu_O^t := \mu_O^{t-1}$.

$t := t + 1$.

Intuitively, this algorithm works as follows: it takes an agenda O, which orders all possible matches in a certain manner, and an empty matching as inputs. Then, match per match, following the ordered list O, checks whether the match in question joins the matching. To see how this occurs, consider the iterative step in which it is determined if m_t, i.e., the match with the t-position

on O, joins μ_O^{t-1} or not. First, check if the parent or the child in m_t participate in μ_O^{t-1}. If this is the case, then $\mu_O^{t-1} \cup \{m_t\}$ is not a matching and m_t does not join μ_O^{t-1}. Else voting is conducted over the approval of m_t. If it is approved, then m_t joins μ_O^{t-1}, otherwise it does not. The process keeps going until we have done this for all possible matches, in other words, until all the ordered list O has been scrutinized. To shed more light on how this algorithm works we write down the example that follows.

Example 1: Consider $n = 3$ voters, $k = 3$ children and $m = 3$ parents. Assume $(\succeq_i)_{i \in N}$ satisfying S1 and S2. Moreover, assume this voter preference profile is such that the voters' acceptable matches are the following:

Voter	
1	$c_1p_1, c_2p_1, c_3p_1, c_1p_2, c_2p_2, c_3p_2, c_1p_3, c_2p_3$
2	$c_3p_1, c_2p_1, c_1p_1, c_3p_2, c_2p_2, c_1p_2$
3	$c_1p_1, c_1p_2, c_1p_3, c_2p_1, c_2p_2, c_2p_3$

Consider the next two agendas:

$$O^1 = (c_2p_1, c_2p_2, c_2p_3, c_1p_1, c_1p_2, arbitrary),$$
$$O^2 = (c_3p_1, c_3p_2, c_3p_3, c_2p_1, c_2p_2, c_2p_3, c_1p_1, c_1p_2, c_1p_3).$$

Suppose we input O^1 into the VM algorithm. The first match over which voting is conducted is c_2p_1. Notice this match is acceptable for the three voters. Hence, it is approved. So, $\mu_{O^1}^1 = \emptyset \cup \{c_2p_1\} = \{c_2p_1\}$. In the next iterative step, i.e., the 2^{nd} iterative step (when t=2), voting is not conducted because c_2 is already participating in $\mu_{O^1}^1$, and thus $\mu_{O^1}^1 \cup \{c_2p_2\}$ is not a matching. Then $\mu_{O^1}^2 = \mu_{O^1}^1$. The same happens for any other match with c_2 or p_1 as one of its components. Observe that in the 5^{th} iterative step voting is conducted over the approval of c_1p_2. Since this match is acceptable for the three voters, it is approved and $\mu_{O^1}^5 = \{c_2p_1\} \cup \{c_1p_2\} = \{c_2p_1, c_1p_2\}$. But then the only match that could join $\mu_{O^1}^5$ is c_3p_3 which is unacceptable for all voters, and thus it is not approved when voting is conducted. Therefore, inputting O^1 into the VM algorithm produces $\mu_{O^1} = \{c_2p_1, c_1p_2\}$.

Now suppose we input O^2 into the VM algorithm, the first pair of approved matches are c_3p_1 and c_2p_2. So the only remaining match over which voting is conducted is c_1p_3. Notice this vote takes place in the 9^{th} iterative step because c_1p_3 occupies the 9-position on the agenda O^2. Observe that the match c_1p_3 is acceptable for voters 1 and 3 but not for voter 2. Hence, a majority votes

in favor of c_1p_3, and thus it is approved. So, $\mu^9_{O^2} = \{c_3p_1, c_2p_2\} \cup \{c_1p_3\} = \{c_3p_1, c_2p_2, c_1p_3\}$. Therefore, inputting the agenda O^2 into the VM algorithm produces $\mu_{O^2} = \{c_3p_1, c_2p_2, c_1p_3\}$.

2.3 Results

Proposition 1. *Let $(\succeq_i)_{i\in N}$ satisfying S1 and S2. The VM Algorithm is agenda-dependent. In particular, the cardinality of the output matching depends on the agenda.*

Proof. Consider Example 1. As we saw, $\mid \mu_{O^1} \mid = 2$ and $\mid \mu_{O^2} \mid = 3$. □

This result raises a question. Is there an agenda such that the VM algorithm always produces a matching with at least the same cardinality as the one it produces taking as input any other agenda? If the answer is yes, is this agenda unique? We see next that under some consistency restrictions on voters' preferences the answers to these questions are yes and no. Before stating these results, let us write down some definitions and a lemma.

Let $(\succeq_i)_{i\in N}$. For a given child $c \in C$, $P(c)$ denotes the set of parents such that if $p \in P(c)$, cp is an approvable match under yes/no simple majority. We can write:

$$P(c) = \{p \in P : \text{ there is } H \subseteq N \text{ such that for all } h \in H, cp \succ_h \emptyset \text{ and } \mid H \mid > \frac{n}{2}\}.$$

Symmetrically, for a given parent $p \in P$, $C(p)$ denotes the set of children such that if $c \in C(p)$, cp is an approvable match under yes/no simple majority. We can write:

$$C(p) = \{c \in C : \text{ there is } H \subseteq N \text{ such that for all } h \in H, cp \succ_h \emptyset \text{ and } \mid H \mid > \frac{n}{2}\}.$$

Lemma 1. *Let $c \in C$ and $p \in P$.*
1. If S1 holds, then $\forall\, c^1, c^2 \in C$ such that $c^2 >_c c^1$, if $p \in P(c^1)$, then $p \in P(c^2)$.
2. If S2 holds, then $\forall\, p^1, p^2 \in P$ such that $p^2 >_p p^1$, if $c \in C(p^1)$, then $c \in C(p^2)$.

Proof. Let $p \in P$ such that there are $c^1, c^2 \in C$ such that $p \in P(c^1)$ and $c^2 >_c c^1$. Then there is $H \subseteq N$ such that for all $h \in H$, $c^1 p \succ_h \emptyset$ and $\mid H \mid > \frac{n}{2}$. But then, S1 implies for all $h \in H$, $c^2 p \succ_h \emptyset$. Hence, $p \in P(c^2)$. This proves part 1. Replacing all the P/p's for the C/c's and using S2 instead of S1, we get part 2. □

Let $(c, *) \in C \times P$ denote the match of child c with an arbitrary parent. Also, let $\mathscr{O}^c$ denote the class of agendas such that if $O \in \mathscr{O}^c$, then

$$O = ((c_k, *)_1, ..., (c_k, *)_m, (c_{k-1}, *)_{m+1}, ..., (c_{k-1}, *)_{2m}, ..., (c_1, *)_{(k-1)m+1}, ..., (c_1, *)_{km}).$$

Moreover, O^c denotes an arbitrary agenda in $\mathscr{O}^c$. Notice a few things about this agenda:

- It has km entries because $\mid C \times P \mid = km$;

- The first m matches in it have the major needs child, c_k, i.e., for all $p \in P$ (recall that there are m parents in P) there is a match of child c_k with p in the first m positions of O^c; the next m matches in O^c have the second major needs child, c_{k-1}, i.e., for all $p \in P$ there is a match of child c_k with p in some position between the $(m+1)$-position and the $2m$-position of O^c;...;the last m matches in O^c have the least needs child, c_1, i.e., for all $p \in P$ there is a match of child c_1 with p in some position between the $[(k-1)m+1]$-position an the km-position of O^c.

An example of an agenda of this class, for $k = m = 3$, is O^2 in Example 1. Another example, also with k=m=3, is $O^3 = (c_3p_2, c_3p_1, c_3p_3, c_2p_3, c_2p_1, c_2p_2, c_1p_1, c_1p_2, c_1p_3)$.

It turns out that, under S1, if the VM algorithm takes as input any agenda of this class, it produces a matching with at least the same cardinality as the one it produces taking as input any other agenda. Furthermore, we just saw there are different agendas of this class. Now we state this result formally.

Proposition 2. *Let $(\succeq_i)_{i\in N}$ satisfying S1. Inputting O^c in the VM algorithm produces μ_{O^c} such that, for any O, $\mid \mu_{O^c} \mid \geq \mid \mu_O \mid$.*

Proof. Consider an arbitrary $(\succeq_i)_{i\in N}$ satisfying S1 and an arbitrary O. Let $\mid \mu_O \mid = x$. Notice $x \leq min\{k, m\}$.
To show: $\mid \mu_{O^c} \mid \geq x$. Or equivalently, there are at least x parents in P participating in μ_{O^c}.
Step 1: $\mid P(c_{x-n+1}) \mid \geq n$ for all $n = 1, ..., x$.
To prove step 1 we proceed by contradiction: For all $n = 1, ..., x$, assuming $\mid P(c_{x-n+1}) \mid < n$ implies $\mid \mu_O \mid < x$.
Consider such an n. Suppose $\mid P(c_{x-n+1}) \mid < n$. This implies $\mid P(c_{x-n+1}) \mid \leq n-1$. But then there are at most $n-1$ children in C participating in μ_O such that the mate of any of these children is a parent in $P(c_{x-n+1})$. We can write this as:

$$\mid \{c \in C : \text{ exists } p \in P(c_{x-n+1}) \text{ such that } cp \in \mu_O\} \mid \leq n-1. \tag{1}$$

Suppose (1) is not true. Then there are two children in C participating in μ_O with the same parent in $P(c_{x-n+1})$ as a mate. This, by definition of matching, is a contradiction. So (1) must be true.
Moreover, for all p $\notin P(c_{x-n+1})$, the contrapositive of part 1 Lemma 1 implies: for all $c <_c c_{x-n+1}$, $p \notin P(c)$. In fact, there are $x-n$ children in C above c_{x+n-1} in the order $>_c$, then:

$$\mid \{c \in C : \text{ exists } p \notin P(c_{x-n+1}) \text{ such that } cp \in \mu_O\} \mid \leq x-n. \tag{2}$$

Therefore, by (1) and (2), $|\{c \in C : \text{exists } p \in P \text{ such that } cp \in \mu_O\}| = |\mu_O| \leq n-1+x-n = x-1 < x$. A contradiction. We are done with step 1.

Before proceeding to step 2, let us provide some definitions.

Let q_1 denote the parent in $P(c_x)$ such that $c_x q_1$ is before $c_x p$ on O^c for any other $p \in P(c_x)$; q_2 denote the parent in $P(c_{x-1})\backslash\{q_1\}$ such that $c_{x-1}q_2$ is before $c_{x-1}p$ on O^c for any other $p \in P(c_{x-1})\backslash\{q_1\}$;...;$q_x$ denote the parent in $P(c_1)\backslash\{q_z : z < x,\ z \in Z_{++}\}$ such that $c_1 q_x$ is before $c_1 p$ on O^c for any other $p \in P(c_1)\backslash\{q_z : z < x,\ z \in Z_{++}\}$.

Step 2: q_n exists for all $n = 1,...,x$.

To prove this consider such an n. By step 1, $|P(c_{x-n+1})| \geq n$. Furthermore, it is clear that $|\{q_z : z < n,\ z \in Z_{++}\}| \leq n-1$. Therefore, $|P(c_{x-n+1})\backslash\{q_z : z < n,\ z \in Z_{++}\}| \geq 1$. But then, by agenda definition, there is a parent, call it q_n, in $P(c_{x-n+1})\backslash\{q_z : z < n,\ z \in Z_{++}\}$ such that $c_{x-n+1}q_n$ is before $c_{x-n+1}p$ on O^c for any other parent $p \in P(c_{x-n+1})\backslash\{q_z : z < n,\ z \in Z_{++}\}$. Hence, we are done with step 2.

Step 3: For all such q_n, there is a child c_{q_n} such that $c_{q_n} \leq_c c_{x-n+1}$ and $c_{q_n}q_n \in \mu_{O^c}$.

We prove this by strong induction.

Base case: For $n = 1$. Consider the t^{th} iterative step in the VM algorithm such that $c_x q_1 = O^c[t]$, i.e., the "moment" in the algorithm when it is determined if $c_x q_1$ joins $\mu_{O^c}^{t-1}$ or not. Fix $p \in P(c_x)$ such that $p \neq q_1$. First notice that by definition of q_1, it is such that $c_x q_1$ is before $c_x p$ on O^c, so $\mu_{O^c}^{t-1} \cup \{c_x q_1\}$ is not a matching only if there is $c \in C$ such that $cq_1 \in \mu_{O^c}^{t-1}$. If there is such a child c, then, by definition of O^c, $c <_c c_x$. If there is no such a child c, voting over the approval of $c_x q_1$ is conducted and since $q_1 \in P(c_x)$, $c_x q_1$ is approved and $c_x q_1 \in \mu_{O^c}^t$. Hence, $c_{q_1}q_1 \in \mu_{O^c}$ with $c_{q_1} \leq_c c_x$.

Induction step: Induction Hypothesis: Step 3's statement is true for all $K = 2,...,n-1$. We have to show it is true for n. Consider the t^{th} iterative step in the VM algorithm such that $c_{x-n+1}q_n = O^c[t]$, i.e., the "moment" in the algorithm when it is determined if $c_{x-n+1}q_n$ joins $\mu_{O^c}^{t-1}$ or not. Fix $p \in P(c_{x-n+1})$ such that $p \neq q_n$. If $p = q_z$ for some $z \in Z_{++}$ such that $z < n$, then $c_{x-n+1}p \notin \mu_{O^c}$ because there is c_{q_z} such that $c_{q_z}p \in \mu_{O^c}$ and $c_{q_z} \leq_c c_{x-z+1} <_c c_{x-n+1}$, by the induction hypothesis. If $p \neq q_z$ for all $z \in Z_{++}$ such that $z < n$, then $c_{x-n+1}p \notin \mu_{O^c}^{t-1}$ because q_n is such that $c_{x-n+1}q_n$ is before $c_{x-n+1}p$ on O^c. Hence, $\mu_{O^c}^{t-1} \cup \{c_{x-n+1}q_n\}$ is not a matching only if there is $c \in C$ such that $cq_n \in \mu_{O^c}^{t-1}$. If there is such a child c, then, by definition of O^c, $c <_c c_{x-n+1}$. If there is no such a child c, voting over the approval of $c_{x-n+1}q_n$ is conducted and since $q_n \in P(c_{x-n+1})$, $c_{x-n+1}q_n$ is approved and $c_{x-n+1}q_n \in \mu_{O^c}^t$. Hence, $c_{q_n}q_n \in \mu_{O^c}$ with $c_{q_n} \leq_c c_{x-n+1}$.

Therefore, for all $n = 1,...,x$, q_n is a participating parent in μ_{O^c}. Hence, $|\mu_{O^c}| \geq |\mu_O|$. □

We find more results appealing to the symmetry of our model. Let $\mathscr{O}^p$ denote the class of

agendas such that if $O \in \mathscr{O}^p$, then

$$O = (c^1 p_m, c^1 p_{m-1}, ..., c^1 p_1, ..., c^k p_m, c^k p_{m-1}, ..., c^k p_1).$$

Recall that c^n denotes the n^{th} arbitrary child. Now let O^p stand for an arbitrary agenda in this class. Notice that this agenda is such that every child in C appears with all parents one after the other, from the one with the lowest parental capacity to the one with the highest parental capacity. For example, let k=2 and m=3 and consider the agendas $O^4 = (c_2 p_3, c_2 p_2, c_2 p_1, c_1 p_3, c_1 p_2, c_1 p_1)$ and $O^5 = (c_1 p_3, c_1 p_2, c_1 p_1, c_2 p_3, c_2 p_2, c_2 p_1)$. Clearly, $O^4, O^5 \in \mathscr{O}^p$.

Proposition 3. *Let $(\succeq_i)_{i \in N}$ satisfying S2. Inputting O^p in the VM algorithm produces μ_{O^p} such that, for any O, $\mid \mu_{O^p} \mid \geq \mid \mu_O \mid$.*

Proof. By symmetry, replace all p/P's for c/C's and viceversa in the proof for proposition 1, and use part 2 Lemma 1 instead of part 1 Lemma 1. □

Notice that for given k, m, if $O \in \mathscr{O}^c$ and $O \in \mathscr{O}^p$, then

$$O = (c_k p_m, c_k p_{m-1}, ..., c_k p_1, c_{k-1} p_m, c_{k-1} p_{m-1}, ..., c_{k-1} p_1, ..., c_1 p_m, c_1 p_{m-1}, ..., c_1 p_1).$$

Denote this agenda by O^*.

Corollary 1. *Let $(\succeq_i)_{i \in N}$ satisfying S1 or S2. Inputting O^* in the VM algorithm produces μ_{O^*} such that, for any O, $\mid \mu_{O^*} \mid \geq \mid \mu_O \mid$.*

Proof. If S1 (S2) holds, this is just a particular case in which proposition 2 (3) applies. □

3 Concluding Remarks

By way of conclusion let us provide the economic intuition of our results, their policy implications and some open questions. The intuition is: If voting is conducted over matches in a sequential manner, whenever a match is approved, the pool of available children and parents for other matches is reduced. Then for some voters' preferences, there are agendas which produce less matches than others. Such agendas leave parents unmatched because they do not have enough capacity to satisfy the needs of the remaining children, which may well have had satisfied the needs of children who have already been matched with parents who could have satisfied the needs of the remaining children. This might happen even if our two consistency axioms hold.

Whenever we assume that if any voter accepts to match a child with a parent, it accepts to match the parent in question with a less needs child (S1), proposition 2 holds. Then agendas ordering children from the one with major needs to the one with least needs, maximize the number

of produced matches versus any agenda. The intuition behind this result is that the first children to get a match are the ones with the major needs, i.e., the ones that are "more difficult" to match and the ones that remain in the pool of available children are "easier" to match because they have less needs. The role played by S1 in this is the following: If a child with relatively a lot of needs can be matched with more than one parent, i.e., their match is approvable, then after matching this child with one of these parents, the unmatched parents are "saved" for them to be part of an approvable match with a child with less need.

We consider that Corollary 1 has policy implications because it gives a particular agenda for which the number of matches is maximized whenever S1 or S2 hold. The SNDIF might want to adopt this agenda given VM's agenda-dependency. However, before presenting a policy proposal it is necessary to explore this mechanism further. In particular, it is important to relax the assumptions stated just before the model section of this paper. This is to allow some voters to have special features like the ones the Chairman and the Technical Secretary have, and to consider strategic behavior on voters' behalf. A next step is to incorporate parents' and children's preferences and discuss whether the matching produced by the VM algorithm is stable or not.

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