THE CARLO ALBERTO NOTEBOOKS

Collegio Carlo Alberto

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Working Paper No. 49
July 2007
www.carloalberto.org

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July 2007[5]

[1]The first author acknowledges research funding from MEC, Grant No. SEJ2006-05710/ECON. Both Triossi and Romero-Medina acknowledge financial support from MEC, Grant No. SEJ2005-06167/ECON.

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Abstract

We analyze the evolution on the design of a policy measure promoted by the Spanish Government: the Ramón y Cajal Program. In the first calls of the Program, an eligibility requirement for a researcher was a preacceptance from at least one Spanish research institution. This requirement was removed in the fourth call. We model the recruiting process as a two-sided matching model to find the reason for the new design. We model the situation as if research centers decided by majority to play either the old or the new mechanism. Our results prove that in a repeated game and assuming that research personnel is scarce, even endogamic centers will prefer the new mechanism after a finite number of calls. We also analyze application data for the first five calls, finding empirical support to our assumptions and theoretical findings.

Keywords: Two-sided Matching Markets, Stable Matching, R&D, Policy Analysis, Differences in Differences.

JEL Classification: C21, C78, D78.

1 Introduction

This paper analyzes the design of a policy measure promoted by the Spanish Government: the Ramón y Cajal Program, named after the 1906 Nobel Prize in Physiology Santiago Ramón y Cajal. The Program was motivated by two pervasive problems: the scarcity of R&D personnel in Spain and the commonly accepted practice of endogamy or inbreeding in the Spanish academia. To mitigate this situation, the Spanish Government thus decided to establish a Program aimed at financing top and promising researchers with a centralized selection procedure under rigourous and objective criteria. Those selected researchers would receive a five-year contract in a Spanish research center, as well as priority in their choices of research in accordance with their relative position in the ranking. Afterwards, the research centers chosen by the corresponding selected candidates would receive a subsidy of eighty percent of the researcher's salary for the five-year period, paid during each of the years in a decreasing scheme.

The objective of the program was double: to encourage Spanish research centers to hire top researchers and to attract young promising researchers to join Spanish research centers (See Sanz Menéndez, 2002 and 2003, for an account of the institutional background). A key feature of the Program in its first two calls was that for a researcher to qualify, she needed a *preacceptance* by a participant research center, that is, a formal commitment by the center that it would hire the researcher if she was appointed by the Program. Behind this requirement, it lay, according to the Spanish legislation, the exclusive right of universities to hire their personnel. The research centers put forward this issue within the discussion of the Ramón y Cajal Program rules, so that they actually enforce a preacceptance stage in the Program design. However, this requirement was relaxed in the third call, so that researchers without preacceptance became elegible and preacceptance became optional, although selected candidates with preacceptance kept priority in the centers that had endorsed them. Finally, preacceptance was completely removed since the fourth call.

We are very much intrigued by this change in the design of the Program. We claim that it is a clear case of reaction from the players to the market circumstances and a conclusive evidence that mechanisms can evolve according with the needs and influence of those who design them. We shall provide support to this point both theoretical and empirically. In addition, we shall analyze the evolution of the mechanism and its performance over time.

With this purpose in mind, we use a two-sided matching model and build a more general game. In this game, research centers have the possibility to play any of the two different versions of the Ramón y Cajal matching mechanism in each call. Therefore, a center can either play a version with the rules of the first two calls, 2001 and 2002, with the preaceptance requirement, or a version of the fourth call, in 2004 and onwards, without the preaceptance requirement (both mechanisms have been extensively analyzed in Romero-Medina and Triossi, 2006). At the beginning of each call, the research centers decide which mechanism to play by majority voting.

We study the incentives of the research centers to impose the candidate preacceptance and remove it afterwards. Our theoretical results prove that in a repeated game under the assumption that research personnel is scarce, even endogamic institutions will prefer the procedure without preacceptance to the original one after a finite number of calls. The rationale behind is that after a finite numbers of calls, the cost to the centers of searching suitable candidates by themselves is high enough that they will prefer a centralized selection procedure in which any researcher is allowed to apply. On the other hand, the pressure from the insiders (those endorsed by the centers) who initially met the conditions to apply has almost disappeared, so that preaceptance does no longer play the role to exclude insider competitors from the market.

Our assumptions and theoretical results are confronted with the data about applications in the first five calls of the Ramón y Cajal Program. We first provide descriptive evidence that supports our assumptions. We then take advantage of the changes in the application rules in 2003 and 2004, by which potential candidates in two different groups, those who are insiders in research centers and those who are not, are affected differently by such changes. We measure such differential effect in order to measure the effect of the policy change, and enquire whether such estimated effect keeps coherency with our theoretical results. We see that the change in the procedure rules, which majorly consists on the removal of the preacceptance requirement, favors the opportunities of outsider candidates, what is consistent with the predictions of our theoretical model. This effect is found both when we measure the effect in the score achieved by each applicant in the evaluation process, and when we consider the probability that each applicant is appointed by the Program.

The rest of the paper is organized as follows Section 2 introduces the basic matching model. Section 3 introduces and analyzes and the mechanisms used in the Ramón y Cajal Program both the old new and the dynamic game that we build upon then along the different calls of the program. Section 4 presents the theoretical implications of the model and Section 5 presents the policy analysis from data on Program applications in the first five calls, between 2001 and 2005. Finally, Section 6 concludes.

2 The model

The problem considered here consists of:

1. a set of departments (or research centers) $D = \{d_1, ..., d_k\}$,
2. a set of researchers $R = \{r_1, ..., r_f\}$,
3. a list of strict departments' preferences over researchers $P_D = (P_{d_1}, ..., P_{d_k})$,
4. a list of strict researchers' preferences over departments $P_R = \left(P_{r_1}, ...P_{r_f} \right)$.

The triple (D, R, P), where $P = (P_D, P_R)$ is called a **Matching Market**. Let $d \in D$. Department d's preference profile, P_d is a strict order defined on 2^R, the set of all subsets of R.[1] Let $R' \subset R$ be a set of researchers. The favorite group of researchers for department d is willing to hire among the ones belonging to R' is called the **choice set from** R' and is denoted by $Ch_d(R', P_d)$, or $Ch_d(R')$, when no ambiguity is possible. Formally, $Ch_d(R', P_d) = \arg\max_{P_d} \{R'' : R'' \subset R'\}$. If $\varnothing P_d R'$ department d prefers not to employ any researcher rather than jointly employing the researchers in R' and R' is called **unacceptable to** d. Otherwise R' is **acceptable to** d.

The maximum numbers of researchers department d is willing to hire is d's **quota** and is denoted by q_d (or q_i if $d = d_i$ for some $i = 1, .., k$). Formally $q_d = \max \{\sharp R' : Ch_d(R', P_d) \neq \varnothing\}$, and the set of every department quotas is denoted as $q = (q_1, ..., q_k)$. For any researcher $r \in R$, her preference profile, P_r is a strict order defined on $D \cup \{r\}$. Any department d such that $sP_r d$ is said to be **unacceptable to** r. It means that r prefers to stay unemployed rather than joining department d. Otherwise d is said to be **acceptable to** r.

[1] As usual, for all $r, r' \in S$ and for all $d \in D$, $rP_d r'$, $rP_f \varnothing$ and $\varnothing P_d d$ denote $\{r\} P_d \{r'\}$, $\{r\} P_d \varnothing$ and $\varnothing P_d \{r\}$, respectively.

An important role is played by application costs, for this reason a cardinal representation of researchers' preferences is introduced. For each $r \in R$ let u_r be a function $u_r : D \cup \{r\} \rightarrow R$ representing P_r, that is, for all $d, d' \in D$,

$$dP_r d' \quad \text{if and only if} \quad u_r(d) > u_r(d')$$

and

$$dP_r d' \quad \text{if and only if} \quad u_r(d) > u_r(r).$$

Let $\delta > 0$ be the cost that each researcher r pays in order to apply to each department[2], in the old mechanism. It represents the participation costs, the cost to participate to the centralized selection, to be paid only once in the new mechanism. Throughout the paper, it is assumed that $u_r(d)$ □ $\delta > 0$, for all d such that $u_r(d) > u_r(r)$. It means that each researcher is willing to apply to any acceptable department. For each $x \in D \cup R$, R_x denotes x's weak preference relation.

A matching is a function that assigns researchers to departments. Formally:

Definition 1 *A **matching** on (D, R) is a function $\mu : D \cup R \rightarrow 2^R \cup D$, such that, for every $(d, r) \in D \times R$*

1. $\mu(d) \in 2^R$,

2. $\mu(r) \in D \cup \{r\}$,

3. $\mu(r) = d \Leftrightarrow r \in \mu(d)$.

A matching is individually rational if no department is willing to reject any researcher who has been assigned to, and each researcher prefers such assignment rather than none. Formally:

Definition 2 *The matching μ is **individually rational** if*

1. $Ch_d(\mu(d)) = \mu(d) \; \forall \; d \in D$

2. $r \in R$ *if* $\mu(r) R_r r \; \forall r \in R$.

[2]There is no loss of generality in assuming that the costs of applying to different departments is the same for all departments and all researchers. Otherwise, one can re-rank departments taking into account application costs.

A matching μ is blocked by a department-researcher pair (d, r) if d and r are not assigned each other but r would prefer to join d rather than her mate under μ and d would hire r if it was given to choose among the researchers in $\mu(d) \cup \{r\}$. Formally:

Definition 3 *The matching μ is* ***blocked by the pair*** $(d, r) \in D \times R$ *if:*

1. $dP_r\mu(r)$,
2. $r \in Ch_d(\mu(d) \cup \{r\}\}$.

Finally:

Definition 4 *The matching μ is* ***stable in market*** (D, R, P) *if it is individually rational and if no pair blocks it. Otherwise μ is* ***unstable****.*

□(D, R, P) denotes the **stable set**, the set of matchings that are stable in market (D, R, P).

The stable set may be empty. The literature has focused on preference restrictions where researchers are not seen as complements. More precisely, a department's preferences are substitutable if it wants to hire a researcher even when other researchers become unavailable.

Along the paper and to guarantee the existence of stable matching, we shall assume that preferences of departments over groups of researchers are responsive to the preferences they have among individual researchers

Definition 5 *Let $d \in D$ and let P_d a strict order on R. $P_d^{\#}$ over sets of researchers is* ***responsive to*** *P_d over individual researchers if, whenever $\mu'(d) = \mu(d) \bigcup \{r\} \setminus \{\sigma\}$ for σin $\mu(d)$ and r not in $\mu(d)$,then d prefers $\mu'(d)$ to $\mu(d)$ (under $P_d^{\#}$) if and only if d prefers r to σ (under P_d).*

Roth and Sotomayor (1990) have shown that, under this restriction, the deferred acceptance algorithm (Gale and Shapley, 1962) produce either the department-optimal or the researcher-optimal stable matching, depending on whether the departments or the researchers make the offer.

In our analysis, the outcome of the mechanism is compared with the one where preferences of research centers meet the ranking of the candidates provided by the governmental agency and based on objective criteria. This ranking will be represented by a strict order T over the set of researchers.

If a department evaluates research group according to T, we say that its preferences are meritocratic. More precisely, a department has **meritocratic preferences** if she would prefer to hire researcher r rather than r', if and only if r is better ranked than r' according to T, irrespective of any other researcher in the set of applicants. In other words, P_d is meritocratic if it is responsive to T, which is

Definition 6 *Let $d \in D$ and let T a strict order on R. $P_d^{\#}$ over sets are **responsive to** T if, for all $R' \subset R$ such that $\sharp R' \leq q_d$ and for all r, $r' \in R$, $R' \cup \{r\} \, P_d^{\#} R' \cup \{r\} \Longleftrightarrow rTr'$.*

The objective of the Government is to give priority to better researchers: The better a researcher is ranked, the higher her priority to choose her affiliation. We say that a Social Choice Rule is responsive to the ranking if no researcher envies a worse ranked one. Let Φ be a class of matching markets and let F be a correspondence from Φ to the set of matchings on (D, R).

Definition 7 *F is responsive to T if $\forall (D, R, P) \in \Phi$ and $\forall \mu \in F(D, R, P)$, rTr' and $\mu(r) \in D \Longrightarrow \mu(r) \, R_r \mu(r')$, $\forall r, r' \in R$.*

The concept of implementation used throughout the paper is implementation in Subgame Perfect Equilibrium (SPE from now on). Let E_x be a set of strategies for player $x \in R \cup D$ and let $E = \prod_{x \in R \cup D} E_x$ be the set of strategy profiles. A matching mechanism is described as the set of strategies available to each agent and by a function that assigns a matching to each profile of strategies.

Definition 8 *A matching mechanism **implements** F **in Subgame Perfect Equilibrium** (SPE) if*

1. *$\forall$ $(D, R, P) \in \Phi$ and $\forall$ $\mu \in D(D, R, P)$ there exists a SPE of the game $G = \{D, R, P, \ \}$ yielding μ as outcome,*

2. *each SPE outcome of G belongs to $F(D, R, P)$.*

Throughout the paper, only equilibria in pure strategies are considered.

Finally we shall, for the purpose of our analysis, divide the researchers in two types: The researchers that are insiders in a research department and those that are not. Therefore at call of the program t a set of researchers, R^t is available $R^t = I^t \cup O^t$. I^t is the set of insiders at time t. $I^t = \bigcup_{d \in D} I_d^t$. $I_{d'}^t \cap I_d^t = \varnothing$ (each researcher is insider of at most one center. $I^t \cap O^t \neq \varnothing$, in general).

3 The Ramón y Cajal Program

The Ramón y Cajal Program was established by the Spanish Government in a general context of lack of R&D personnel in Spain and with Spanish Universities hiring policies into question. This latter issue has generated a lively debate that has spread out on international press and scientific journals. The two main issues are: (i) the lack of enough funding and (ii) the existence of social networks that regardless of the candidate scientific merits, systematically hire one of their members (Navarro and Rivero, 2001). Inbreeding has a long tradition in Spain. Its existence has been linked with poor scientific performance (see, for instance, Eisenberg and Wells, 2000; Soler, 2001). In addition, Spanish academia suffers from hostility towards researchers who had completed their training abroad (Ferrer, 2000).

In order to encourage hiring of R&D personell in research centers while circumventing the aforementioned distorsions, the Spanish Government implemented the Ramón y Cajal Program. The Program would finance five-years contracts in research centers to the selected researchers. The selection procedure was centralized in an evaluation agency, "Agencia Nacional de Evaluación y Prospectiva (ANEP)". This evaluation agency, appointed by the Government, appraises all elegible applicants based in rigorous and objective evaluation criteria (mainly publication records), in which the better the researchers, the higher their priority to choose available positions. For that purpose, 24 evaluation committees of Spanish and international experts, one in each research field, were constituted by the evaluation agency (see Siune, 1999). Overall, 341 experts took part in the evaluation in every call. If a contract was granted to a researcher, she could join the research departments that had preaccepted her. The objective was twofold: (i) to provide incentives to research centers to hire top researchers and (ii) to encourage top researchers to join Spanish research centers.

In order to illustrate our theoretical claims associated to the evolution of the Ramón y Cajal Program, we will provide data evidence about characteristics and outcomes of research applicants in different calls. The data analyzed have been provided by the Dirección General de Investigación of the Ministerio de Educacion y Ciencia. We have data on researcher applications and information provided by the 151 research institutions that participated in the Program in five annual calls between 2001 and 2005. We have dropped from the sample those observations with missing status or score or with missing values in individual characteristics, which represents less than one percent of observations. Most participant institutions have more than one research department among the 24 research areas in with the applicants where divided. A total of 24 committees, one for each research discipline, created by the "Agencia Nacional de Evaluación y Prospectiva (ANEP)" evaluated the applicants.

When the Ramón y Cajal Program was started, there was a large number of Spanish researchers that were already on the system under temporary positions, that hereinafter we will denominate as insiders. Most of them had a low probability to get a stable contract within the Spanish R&D system, mainly because of lack of funding. Regarding this, the empirical evidence about the first call in Table 1 is quite clear. Among those applicants who obtained a contract in 2001, 60 percent were insiders, that is, researcher already in the system.

The original design of the Program, which determined the matching mechanism, was essentially kept in the first three calls, from 2001 to 2003. Since the fourth call, in 2004, there was a key modification which affected the elegibility conditions. Specifically, while the original design required the candidates to ask for a preacceptance by a participant research center, such requirement was completely removed since 2004. Such preacceptance meant that the center endorsed such candidate, with a formal commitment to hire the researcher if she was appointed by the Program.

The thesis of this paper is that insider pressure compelled the original design of the Program. However, when this pressure declined, such design was no longer useful to the objectives of the research centers involved and was reformed. Therefore, research centers accommodate the mechanism to their needs, so that the apparently ill-designed procedure rules are in fact crafted with a purpose in mind. Furthermore, when a rule no longer plays a role, it is eliminated. In particular, the rule in question is the preaceptance of the candidate by research centers, which is explained by the existence of a sizeable stock of insiders in the R&D Spanish system that exerted pressure on the Program. Whenever the stock of insiders dropped and then such pressure weakened, preacceptance was no longer optimal and was therefore removed.

The existence and number of active insiders is crucial in our analysis therefore we shall make an effort to justify why they exist and how they behave period after period. In the initial period the number of insiders and the need to give them opportunities to find an entry point in the Spanish R&D system is among the political objectives of the program. For that they perform a rigorous and objective evaluation based mainly in publication records. In order to produce this evaluations Committees of Spanish and international experts in each field were appointed to review candidatures and clear quality standards where established.

Under these circumstances, what happens with the insiders? The original design, in practice, promoted collusion among research centers and prevented outsiders to enter the evaluation process by no preaccepting them (Romero-Medina and Triossi, 2006). Nevertheless, soon enough the research centers consented that Program eligibility requirements become more demanding. In the first three calls, the requirements at the time of application for a candidate to be eligible were to have a Ph.D. degree and to have spent at least 18 months after obtaining her B.A. in a research center different than the one she is applying to. However, while the preacceptance requirement was removed in the fourth call, the candidate requirements became more stringent. Since then, such requirements were to have a PhD degree, yet obtained in the last ten years (with maternity leave, military service or great illness excluded from time computation), and to have spent at least 24 months after obtaining her PhD in a university or research center different than the one she is applying to.

These tighter requirements challenged the possibilities of insiders to get a contract through the Program.[3] Very specially, the need to spend 24 months in a different research center after obtaining the PhD jeopardizes insider elegibility, and helps to break the implicit contracts that the research centers might have with the insiders. We would then expect the number of insider applicants to be reduced year by year because of several reasons. Some of them get out of the pool of potential applicants either because they were selected and got a contract in the earlier call, or because they fail to satisfy the

[3]At the same time another program called "Juan de la Cierva" vas developed aimed to researchers that are about to present her doctoral dissertation or had done so in the last three years.

elegibility requirements in the next call. Among those insiders who remain in the pool of potential applicants, their chances to be selected in next calls depends on whether their quality ranks them above the quality threshold and the number of positions available.

3.1 The Program design

We now present the corresponding matching mechanisms determined by the two alternative designs of the Program. The first matching mechanism, which we call old mechanism, describes the original design used in the three first Program calls. The second matching mechanism, the new mechanism, is the one in use since the fourth edition. In addition, we shall describe the dynamic game where research centers can decide between both alternative mechanisms in Subsection 3.1.3 and some additional simplifying assumptions in Subsection 3.1.4.

3.1.1 The old mechanism

In a preliminary stage, each research department communicates to the evaluation agency its quota (number of positions available) in each research area. The evaluation agency must acknowledge such quota, and then decides the maximum number of contracts to be financed, denoted by $Q = \sum_{i=1}^{k} q_i$.

The allocation procedure takes place as a five stage game.

1. **Researcher Preacceptance Applications.** Each applicant asks a preliminary acceptance to one or more departments. For each researcher $r \in R$, let $D_1(r)$ be the set of departments r applied to. For each $d \in D$, let $R_1(d)$ be the set of researchers applying to department d.

2. **Department Preacceptance Decisions.** For each preacceptance application received, each department decides to endorse the researcher or not. A department preacceptance obliges it to appoint the endorsed candidate a position if her application is granted and the ranking enables her to choose such department. For each department $d \in D$, let $R_2(d) \subset R_1(d)$ be the set of researchers with its preacceptance. For each researcher $r \in R$, let $D_2(r) \subset D_1(r)$ be the set of departments that has accepted her. Each department d with a positive number of

endorsed candidates then notifies to the the Government the set of researchers $R_2(d)$ with preacceptances. Only the applicants with at least one preacceptance are eligible.

The Evaluation Agency Ranks Preaccepted Researchers. Applicants are ranked by a committee of experts in each area. The ranking criteria are public knowledge. The setup is one of complete information, so we assume that the ranking itself is publicly known. Such ranking is denoted by T, formally a strict order on R.

3. **First Assignment.** The selected researchers with at least one preacceptance are assigned in accordance with the ranking T, until Q positions are filled. Priority is given to the best ranked applicants. The i^{th} ranked researcher is denoted by r^i.The best ranked researcher, r^1 is assigned to the department she chooses among the ones in $D_2(r^1)$. For $i \leq Q$, r^i is assigned to the department she chooses among the ones that have some spare positions in $D_2(r^i)$, if any. The rest remain unmatched. At her turn, each researcher must choose a position among the ones available in the departments that endorsed her. This assignment is denoted by μ^1. If all positions are filled, the process ends. Otherwise, the procedure goes to the fourth stage.

4. **Second Preacceptance Decision.** Each department d with unfilled positions is asked to submit a new list $R_4(d)$, of acceptable researchers among the r^i $(i \leq Q)$ who are unmatched under μ^1. For every such r^i, let $D_4(r^i)$ be the set of departments that preaccepted r^i at this point of the procedure.

5. **Second Assignment.** Unfilled positions are appointed to the researchers r such that, $D_4(r) \neq \varnothing$ by the same procedure of stage 3, and using $R_4\left(r\right)$ instead of $R_2\left(r\right)$. A second matching μ^2 is completed with those selected researchers that remained unassigned in stage 3. The process ends at this point.

The final assignment μ is obtained from μ^1 and μ^2 as follows: for $i \leq Q$, $\mu(r^i) = \mu^1(r^i)$ if $\mu^1(r^i) \in D$, $\mu(r^i) = \mu^2(r^i)$ otherwise. Set $\mu(r) = r$ otherwise. At any point of the process, applicants can leave the game.

Throughout the paper, we consider not only the full assignment procedure, that we call the **full game**, but also the reduced game ending with the first assignment in stage 3, that we call **reduced game.** The full game is analyzed extensively in Romero-Medina and Triossi (2006). In such paper, it was shown that there can be equilibria where the stages four and five plays an active role. However, the set of stable matching can be implemented if the reduced game is played. In fact, the full game is played by a tiny set of agents, where stages 4 and 5 are explained by the existence of informational problems. Given that our aim in this paper is different we shall consider the reduced game when we refer to the game played in the first three calls of the Program.

3.1.2 The new mechanism

Since the fourth Program call, the assignment procedure was completely reshaped. The main innovation was the elimination of preacceptances. Under the new mechanism, any researcher willing to participate is eligible. Only one research proposal is necessary to enter the selection. This mechanism just imposes the application cost to the participants. On the other hand, the matching stage is completely decentralized. In this way the universities preserved their independence in hiring new personnel.

1. **Candidates' application.** Applicants simultaneously send their scientific curriculum vitae and a research proposal to the evaluation agency. Let R_1 be the set of agents who apply for a Ramón y Cajal contract.

   The Evaluation Agency ranks all applicants. The best $Q' = \min\{\sharp R_1, Q\}$ ranked researchers $r^1, ..., r^{Q'}$, *are entitled* to get a contract financed through the Program. We call them idoneous. The remaining applications are definitely disregarded.

2. **Assignment.** In a decentralized way, the departments and the idoneous applicants sign contracts. Each department d_i cannot sign more than q_i contracts with idoneous researchers. A matching μ is agreed.

   We assume the decentralized matching, which is an extension of Sotomayor (2003) to the many to one case, takes place as follows.

2.1 Each department d proposes a subset of selected researchers $R(d)$ among the set of idoneous researchers.

2.1.1 r^1 joins a department d among the ones that have selected her, if any.

2.1.t $(2 \leq t \leq Q')$ r^t chooses a department among the ones that have selected her and have unfilled positions.

3.1.3 The dynamic game

Along the process of the dynamic game the set of departments is fixed along the process D

The old and new mechanisms are the two alternatives offered to the research centers. We introduce a previous state in which research centers decided which mechanism to play an then the chosen mechanism is played.

1. Step 1: Departments majority (and sincerely) vote for choosing between the old and the new mechanism.
2. Step 2: The mechanism chosen is played.

t Step t: Departments vote by majority (and sincerely) to choose between the old and the new mechanism.

t+1 Step $t+1$: The chosen mechanism is played.

3.1.4 Additional assumptions

We shall assume a behavior of the research centers that is both commonly accepted and against the results we want to obtain. We shall assume that research centers are either endogamic or strongly endogamic.The less endogamic theywere, the better for our results, so that any relaxation of this conditions shall work in favor of our results.

Definition 9 *A department is "endogamic" if* $\forall d, d' \in D$, $\forall i, i' \in I_d^t, i'' \in I_{d''}^t$, $\forall o, o' \in O^t \backslash I_d^t$, $\forall t \geq 1$

1. $iP_d^t o$
2. $iP_d^t i' \Longleftrightarrow iT^t i'$
3. $oP_d^t o' \Longleftrightarrow oT^t o'$

Definition 10 *A department is "collusively endogamic" if* $\forall d, d' \in D$, $\forall i, i' \in I_d^t, i'' \in I_{d''}^t$, $\forall o, o' \in O^t \backslash I_d^t$, $\forall t \geq 1$

1. $\varnothing P_d^t i''$
2. $i P_d^t o$
3. $i P_d^t i' \Longleftrightarrow i T^t i'$
4. $o P_d^t o' \Longleftrightarrow o T^t o'$

Notice that endogamy is a two-side phenomenon. It is true that research departments prefer their insiders but it is also true that insider researchers prefer to stay in their own department than to move to another one. To strengthen our results, we shall assume that insiders are faithful to their research centers.

This behavior can be seen looking at data on the first call (the one with the largest stock of insiders). Table 2 shows that most of the applicants seek and receive preaceptances from only one research center. This can be either because centers are collusively endogamic or because researchers only consider acceptable the center where they are incumbent. *Note that "collusively endogamic" centers can impose faithfulness on their candidates.*

Definition 11 *A researcher is faithful if* $i \in I_d^t$ *then* d *is* i*'s favorite department.*

Finally, we shall need a technical property to avoid the influence of strong tastes or preferences.

Definition 12 *Property 1: If* $i \in I_d^t$, $o \in O \backslash I_d^t$ *and* $o T^t i$ *then* o *is acceptable to* d.

Although Property 1 is an additional restriction on department preferences that could be included in the earlier endogamic definitions, it has been presented separately because it is only needed in the new mechanism.

We shall assume that, under the old mechanism, it is more costly to hire an outsider than an insider. This is due to the fact that the preacceptance requirement makes the departments to undertake the screening process of candidates. Such process requires studying each applicant curriculum before deciding whether to endorse her or not. Under the new mechanism, though, screening of candidates is centralized in the evaluation agency, so that all the involved departments receive the same objective information about the selected applicants. Therefore, selection costs are much smaller for the departments. Let c_O and c_N be the cost for a department of hiring an outsider under the new and the old mechanism, respectively, where $c_N < c_O$. Besides, the cost of hiring an insider is zero (or it is simply much lower than the one for an outsider and it is thus normalized to zero).

Even if we do not model explicitly how insiders form their success probabilities, it is natural to assume that after a finite number of periods being rejected, a researcher will stop applying because it will become discouraged. Let $\alpha_d \in [0, 1)$ be the discouragement ratio of insiders in the research center d who wer not granted in the previous call, which it is assumed to be constant over time for simplicity. Let also β_d be the capacity to generate new insiders in research center d. Therefore, the set of insiders in period $t+1$ assuming that no insider in d was granted in period t is

$$\left|I_d^t\right| + \beta_d \left|I_d^t\right| \square \alpha_d \left|I_d^t\right| = \left|I_d^{t+1}\right|,$$

so that the number of insiders that will apply on the next period is

$$\left|I_d^{t+1}\right| = \left|I_d^t\right| (1 + \beta_d \square \alpha_d),$$

and if $\alpha_d > \beta_d$, then

$$\left|I_d^t\right| > \left|I_d^{t+1}\right| \forall d \in D, \forall t \geq 1.$$

Eventually, for some t, $|I_d^t| < q_d^t$, so at some point departments will have to consider outsider candidates. In fact, the change in the application and elegibility rules along the succesive calls of the program made harder to have insider candidates.

The total number of applications, shown in Table 3, experienced a sharp drop in 2004, precisely when the mechanism (which affected, among other things, to the elegibility rule) was reformed. It is interesting to remark that since 2002 a significant proportion of earlier unsuccessful candidates applied in latter calls, as it is shown in the upper panel of Table 4. Since 2002, at least 41 percent of the applicants had applied in a previous call. In the middle panel, we report the number of granted applications by call and by number of previous applications, and the corresponding relative frequencies of succesful applications (as an estimate of the unconditional probability of being awarded with a grant) in the lower panel. From this latter information, we see that the probabilities of receiving a grant are kept at moderately high values even for those with two or more previous applications. This evidence suggests that, among those candidates which are not awarded in a particular call, discouraged individuals (those not applying in the next call) have lower average quality than those who apply again.

3.2 Additional evidence

It appears that the average scores of the candidates in any year differ very much by area, which reflects heterogeneity both in the quality of candidates by area and in the evaluation criteria of each area's committee. In Table 5, we report the average scores, broken down by call and by each of the 24 research areas. In general, the average score appears to be larger in 2004 than in 2001 for most areas, yet given the standard errors (not reported here) the differences over time are not statistically significant in most areas. However, in no case we can attribute such differences to variation in the overall quality of the applicants.

An interesting change in the application requirements took place in the third call, in 2003. With the acquiescence of research centers, applications without preacceptance were allowed, leaving preacceptance as optional. As a consequence, as it is shown in Table 6, about 11 percent of the researchers in 2003 applied without any preacceptance. Looking at the marginal distributions of applicants with and without preacceptance, we can see a larger average score for the first ones, though the difference is not statistically significant. Also, the percentage of granted applications is much larger for those applicants with preacceptance.

A deepest change took place in 2004, by which the preacceptance was completely removed from the application procedure. If we concentrate on those researchers who applied in 2003, we have two different groups, those with preacceptance and those without preacceptance in 2003. Their (unconditional) estimated success probabilities in 2003 (27.5 vs. 16.9 percent) are remarkably different. Among the applicants in 2003 who were rejected, 614 applicants with preacceptance and 64 without preacceptance applied again in 2004. The marginal analysis that provides Table 6 (in which there is no control for the characteristics of the candidates) indicates that the average scores and the success frequencies in 2004 of the candidates who had also applied in 2003 look alike (if anything, they are slightlly larger for those without preacceptance in 2003).

We can take advantage of the past information about this fraction of applicants in 2004 who also have applied in 2003. The change in the application requirements, by which preacceptance was completely removed in 2004, provides a natural experiment.

4 Theoretical implications

Proposition 1 *Assume that departments are endogamic (collusively endogamic). Then, there exists a unique stable matching.*

Proof. By contradiction: Assume it is not the case. Then, there exists a research department d and a researcher r such $d = \mu_R(r)$ and $\mu_R(r) P_r \mu_D(r)$ where $\mu_R(r)$ and $\mu_D(r)$ denote the optimal stable matching for researchers and departments, respectively.

Let r be the best ranked of such researchers according to T such that $\mu_R(r) \neq \mu_D(r)$. Consider the following order of execution of the Deferred Acceptance Algorithm. First, all insiders apply, according to their ranking in T. Then, all researchers in $O \backslash I$ according to their ranking in T. By the time r makes her proposal, the department $d = \mu_R(r)$ is r's favorite department among the ones who have empty positions at this point. Let R_d be the set of researchers who are better ranked than r according to T and belong to the same group as r. In this case, they all are outsiders. It is the case that none of them has already requested d as her best option or has taken the last position d offers. This is because if this where the case, $d \neq \mu_R(r)$.

Now consider the Deferred Acceptance Algorithm where copies of the departments make proposals. Since $d = \mu_R(r) P_r \mu_D(r)$, it must happen that r never receives a proposal from d. If r is not an insider for d, then d fills all her positions with better insiders and/or better ranked outsiders (in the case of collusively endogamic preferences, they cannot be only insiders). But then, these researchers strictly prefer μ_R to μ_D and are better ranked than r, a contradiction with the previous statement.

The same argument applies when r is an insider for d, but now, before proposing to r, d has already filled all its positions with better ranked researchers. ■

Notice that the case of collusively endogamic preferences is stronger than the case of endogamic preferences. Therefore, collusion among research centers in the form of rejecting any insider from other research center will strengthen the uniqueness result.

Corollary 1 *The old mechanism under collusion has a unique SPE outcome which is generally not responsive to T.*

Proof. Let us consider the situation where each research center has an insider and the insider has enough quality to pass the screening process undetaken by the evaluation agency. In such a case, the only stable matching is the mutual agreement match. This match is not responsive to T. ■

Good researchers prefer the new mechanism to the old one so they would always push in favor of the new mechanism. With the new mechanism, the first Q ranked researchers have the chance of obtaining a position.

Corollary 2 *The new mechanism under collusion has a unique SPE outcome. If additionally Property 1 holds and all research centers are acceptable to any researcher, then all the best Q researchers are hired.*

Proof. The uniqueness follows from the main result on the new mechanism and holds also under the more general conditions. The second part of this Corollary holds because all good researchers become acceptable to the research centers and viceversa. Therefore, no preselected researcher will be prevented to sign a contract because of the agents preferences. ■

Lemma 1 *Let rTr' and assume $\mu_N(r') \in D$. Then, $\mu_N(r) R_r \mu_O(r)$. If Property 1 holds and all research centers are acceptable to any researcher, all the best Q researchers are hired. Then $\mu_N(r) \in D$.*

Proof. Let r be the best of such researchers. The first claim is obvious when $\mu_O(r) = r$ or if $\mu_O(r) = d \in D$ and $r \in I_d$. The second claim follows from Property 1 and the fact that all research centers are acceptable to any researcher. ■

If departments have enough insider candidates to fill their positions, they prefer the old mechanism to the new one.

Proposition 2 *If the number of insiders is big enough $|I_d^t| \geq q_d^t$, the departments prefer the old mechanism to the new one. Some departments prefer it strictly.*

Recall that hiring costs are higher for outsider than for insiders. This means that departments without insiders always strictly prefer the new mechanism over the old one.

Proposition 3 *If $|I_d^t| = 0$, then department d strictly prefers the new mechanism. If hiring costs were equal for insiders and outsiders, then d would be indifferent.*

Lemma 2 *If $\alpha_d > \beta_d$, $\forall d \in D$ once the new mechanism is chosen, the new mechanism will be played forever afterwards.*

Proof. This follows from Propositions 2 and 3 and the dynamics that we have assumed for insiders because if $\alpha_d > \beta_d$ then $|I_d^t| > \left|I_d^{t+1}\right|$ $\forall d \in D$, $\forall t \geq 1$. If it is convenient to play the new mechanism for a majority of departments at time t. then the number of departments willing to play the new mechanism will not decrease along time t. ■

As the stock of insiders decreases, the departments are more prompted to switch to the new mechanism in order to minimize the search cost.

Proposition 4 *Assume $c_N < c_O$ and $\alpha_d > \beta_d$. Then, the departments will eventually switch from the old game to the new one, and the new one will be played forever afterwards.*

Proof. Since $\alpha_d > \beta_d \rightarrow |I_d^t| > \left|I_d^{t+1}\right|$ $\forall d \in D$, $\forall t \geq 1$, whenever this makes convenient to play the new mechanism for a majority of departments at time t, the number of departments willing to play the new mechanism will not decrease along time t. In fact, the number of insiders, given that $\alpha_d > \beta_d$, will decrease until $|I_d^t| = 0$ at some t. Then, by Proposition 3 the new game is always chosen thereafter. ■

5 Policy analysis

The change in the application requirements, by which preacceptance is completely removed in 2004, provides a natural experiment by which certain individuals are affected by the policy change. In particular, we can compare the outcomes in 2004 and 2003 for those applicants without preacceptance in 2003. Our approach simply consists on a differences-in-differences (DID) estimator. Formally, let $NoPre_i$ be a binary variable which equals one if individual i had not a preacceptance in 2003 and zero otherwise, and let $Y2004_i$ a binary variable for the period after the policy change (i.e., it equals one for those observations in 2004 and zero for those observations in 2003). Let Y_i be the outcome that we are interested in (e.g., individual score), and u_i an unobserved random error which includes individual characteristics not included in the specification. To analyze the effect of the change in the elegibility rules, we consider

$$Y_i = \beta_0 + \delta_0 Y2004_i + \beta_1 NoPre_i + \delta_1 Y2004_i \times NoPre_i + u_i$$

The critical coefficient is δ_1, which measures the differential effect on the mean outcome of the policy change for those individuals without preacceptance in 2004. It can be easily seen (see Wooldridge, 2002) that δ_1 captures the difference between the time change in the average outcome between 2003 and 2004 for the individuals affected by the policy rule and the corresponding change for the remaining individuals.

The validity of this simple specification requires that the only source of mean variation being the policy change. In order to control for unmeasured differences in individuals that are not attributable to the policy change, we add different controls for the 24 application areas (we include a set of binary variables corresponding to each different area), as well as individual characteristics. The individual characteristics that we have available are the country zone in which the individual earned her PhD, the years passed since she earned the PhD, the country zone of residence at the time of application, a binary variable about whether the individual has delivered more than one application in that call. As country zones, we take Spain as the reference country, and define binary variables for UE-15 countries (excluding spain), Other European countries, Latin American countries, North American countries (US and Canada), Other OECD countries, and Other countries (what basically includes non-OECD Asian and African countries). These two sets of binary variables are interacted with $Y2004_i$ in one of the specifications in order to allow their effects to vary between 2003 and 2004. In addition, we include the variable $endogamy_i$, which equals one for those candidates with a preaceptance in 2003 in the same centre in which they earned the PhD and zero otherwise (those that either belong to collusively endogamic departments or are faithful); a second order polynomial in $years_i$, which measures the time passed (in years) since the candidate earned her PhD; and *Several projects*, a binary variable which indicates if the candidate has proposed more than one project.

We consider two alternative outcome variables for each individual: the score given to the candidate and whether the candidate is awarded with the grant or not. In the case of the empirical model for scores, we regress by OLS the score achieved by each individual on the covariates that we have presented. The results are shown in Table 7. Column (i) and (ii) include the simplest specifications, with and without the set of binary variables for research areas. The set of area dummies are found to be strongly significant, yet in any case the major result, which concerns the estimate of δ_1, is very similar in both columns. From such estimate, we can assert after the change in the application requirements in 2004, the score for applicants without preacceptance in 2003 who applied again in 2004 have, on average, a higher score by about 9 points. The three last columns provide include, in addition to area dummies, the further covariates discussed earlier. In column (iii), the endogamy variable, the second-order polynomial in the time passed after finishing the PhD, and the indicator for several projects were added. All these variables appear as significant, and the effect of the policy change is also positive and significant, yet the estimated effect becomes smaller than in the earlier columns. The time passed since the PhD was finished has a quadratic effect, which is positive but marginally decreasing for those with a relatively recent PhD. In the absence of other covariates capturing candidate quality, this variable captures the fact that, ceteris paribus, the longer the time since the PhD was finished, the larger the scientific production of the candidate. In this same line of reasoning, proposing several projects has a positive effect on the score. Last, the effect of our indicator for endogamic behaviour is positive.

In column (iv), the sets of binary variables for PhD zone and residence zone were added, taking Spain as the reference group, whose dummy variable is omitted. We believe that this information can help to capture candidate quality better. First, the variables for PhD zones capture the average quality of the academic centres within. Second, the variables for residence may capture the specific quality of the candidate, because in most cases they proxy the place were the candidate is working at the time of application (so the larger the quality of the candidate, the larger the quality of the centre that is willing to hire her). We have also provided tests for joint significance of the set of PhD and residence variables, respetively. Regarding the PhD variables, we find plausible positive effects for EU-15, North America and other OECD countries, though they turn to be individually and jointly non significant. More interestingly, the Residence variables show to be strongly significant both individually and jointly. Applicants with residence in North America,other OECD countries, and EU-15 countries achieve higher average scores, whereas residents in Latin America, non-OECD Asian and African countries achieve significantly lower average scores. Concerning the main aspect of interest, the policy change effect is positive and significant, its magnitude being very similar to that in column (iii), so that those without preacceptance in 2003 who applied again in 2004 have on average a positive differential score about 7.8 points.

In the last column, we interact the covariates used in column (iv) with $Y2004_i$ in order to allow differential effects of such variables between 2003 and 2004. The sets of PhD dummies and Residence dummies are significant at levels below ten percent. The same happens with the sets of these variables interacted with $Y2004_i$, reflecting differential effect of these candidate characteristics in the two different calls. We also find a slight differential effect of the polynomial in time passed since the candidate earn the PhD. Also, the effect of the endogamy variable appears much stronger for the 2004 call. The qualitative result about our major feature of interest, the average differential score in 2004 for those without preacceptance in 2003, is significant and positive, about 9 points.

In addition to the effect of the change in application procedure on the score, it is worth to evaluate whether such change actually affects the grants awarded. However, given that now our dependent variable is dychotomic, reflecting concession or rejection of the grant, we will use a probit model in order to estimate the effects of the earlier covariates on the probability of obtaining the grant. Given that the percentage of grants per research area lie about 24%, out interest for the effect on the average score is limited, since granted applications are mostly quite above the average score of the corresponding area. Therefore, we have also analyzed whether the policy change has affected the concession of grants. We follow the same empirical strategy as with the model for scores. In this case, since all candidates with

PhD or residence in non-OECD Asia or Africa did not receive the grant, they were excluded from the sample. The estimation results are shown in Table 8. Regarding our main feature of interest, we find a positive effect for those without preacceptance in 2003 who applied again in 2004. In all the specifications, the estimate of this effect is significant at the 1 percent level. Furthermore, the magnitude of the effect is not sensitive to the addition of further control variables, as PhD and residence dummies and interactions of variables with the year of application. Evaluating at the average values of the variables, for a candidate without preacceptance in 2003 who applied again in the next call, the increase in her probability of being granted in 2004 with respect to 2003 is about ten percentage points. The results provide evidence that the prospects of outsiders are significantly improved when the elegibility requirement of preacceptance is fully removed.

6 Conclusions

The Ramón y Cajal Program was created to improve Spanish scientific researchers' base by promoting the recruitment of top-quality researchers. We analyze the role of the research centers in the redesign of the original version of the mechanism and study the reasons they have to impose it in the first place. An appropriate design should consider agents motivations so as to provide them with the right incentives to perform their goals. We setup a theoretical framework which describes the agent behavior as well as the Program procedures both under the old and the new mechanism. The theoretical assumptions are justified by means of the descriptive evidence based on data about applications to the Program in the first five calls. The removal of the preliminary acceptance requirement made that all applicants were considered by the evaluation committees. The new design means an improvement over the original one. While it is not fully guaranteed that departments are competing for the best researchers (although it is under our theoretical assumptions), it ensures that the overall quality of the selected applicants is improved, and the impossibility to exclude any candidate. Besides, under the new mechanism, research centers do not bear the costs of screening candidates.

The new mechanism is thus more efficient because no qualified researcher can be excluded, and screening costs are endogenized by the system. The benefits of the new design put under question the rationale for the preacceptance requirement in the old mechanism, as well as the motivation of its removal. The answer to this is clear-cut. The original mechanism was partly aimed at favoring the large stock of insiders in the research centers, and it was reformed as soon as the preacceptance was not useful anymore for the majority of research centers.

Among the predictions of the theoretical model, the most relevant is that the new mechanism favors that the best researchers are granted, irrespective on whether they are insiders or otusiders with regard to the research centers involved. We test the validity of this prediction taking advantage of the fact that the succesive changes in 2003 and 2004 in the elegibility rules affect differently insider and outsider candidates. Our empirical results point out that the full removal of the preacceptance requirement favors the opportunities of outsiders, keeping consistency with our theoretical results.

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Table 1
Final Distribution of Ramón y Cajal Contracts in the first call

Insiders	
All	60%
Outsiders	
Non-resident	14%
Resident	26%
All	40%

(Source: DGI, MCYT from Sanz Menéndez et al., 2002)

Table 2
Preacceptances by candidate in the first call

Number of preacceptances	1	2	3	4	5	> 5
Applicants	2229	486	124	45	24	14
(percentage)	76.3%	16.6%	4.2%	1.5%	0.8%	0.4%
Granted	562	150	31	11	12	8
(percentage)	72.6%	19.4%	4.0%	1.4%	1.6%	1.0%

(source: DGI, MCYT from Romero-Medina and Triossi, 2006)

Table 3
Applications by call

		2001	2002	2003	2004	2005
Total		2793	2557	2603	1357	1318
Granted		772	476	685	291	241
%		27.6	18.6	26.3	21.4	18.3
	Drop out	360	111	95	15	1

Table 4
Applications by call and by number of previous applications

Total					
	2001	2002	2003	2004	2005
0	2793	1497	1447	561	696
1		1060	615	404	269
2			541	228	167
3				164	111
4					75

Granted					
	2001	2002	2003	2004	2005
0	772	289	365	117	140
1		187	156	90	55
2			164	57	19
3				27	14
4					13

% of granted applications					
	2001	2002	2003	2004	2005
0	27.6	19.3	25.2	20.9	20.1
1		17.6	25.4	22.3	20.5
2			30.3	25.0	11.4
3				16.5	12.6
4					17.3

Table 5
Average scores by call and by research area

	2001	2002	2003	2004	2005
Physic and Space Sciences	73.0	77.8	76.8	81.6	79.9
Earth Sciences	60.9	74.7	72.5	68.3	72.8
Materials Science and Technology	63.2	70.6	71.2	77.3	71.3
Chemistry	64.1	65.5	75.5	82.0	65.4
Chemical Technology	63.0	73.7	75.8	87.1	87.0
Plant and Animal Biology. Ecology	64.6	69.5	74.0	75.0	78.6
Agriculture	63.7	69.4	68.4	73.5	74.2
Livestock and Fishery	61.1	65.1	73.4	64.3	68.6
Food Science and Technology	59.1	64.6	65.9	74.7	82.5
Molecular and Cell Biology and Genetics	62.2	67.8	69.6	69.3	70.6
Physiology and Pharmacology	63.8	73.3	71.6	72.2	72.1
Medicine	59.9	66.2	68.7	71.6	70.2
Mechanical, Ship and Aeronautical Engineering	59.6	65.0	59.6	81.4	69.1
Electrical and Electronic Eng. and Robotics	65.8	65.1	61.4	63.2	73.0
Civil Engineering And architecture	50.6	64.6	48.2	77.5	72.0
Mathematics	68.4	78.6	56.2	77.3	83.1
Computer Sciences	51.9	59.7	61.5	59.9	60.2
Information and Communication Technologies	60.8	74.4	69.4	67.0	69.3
Economics	69.8	65.3	60.7	80.8	74.3
Law	54.8	66.6	59.5	68.7	74.5
Social Sciences	27.6	56.5	60.1	61.6	65.5
Psychology and Education Sciences	52.9	59.4	45.7	57.5	66.7
Philology and Philosophy	59.4	64.2	75.0	81.4	79.6
History and Art	60.3	79.7	79.6	85.5	87.8

Table 6
Characteristics of applications in 2003 and 2004

Applications in 2003

	Number	Avg. score	Std. dev.	Granted	% Granted
All	2603	70.9	18.9	685	26.3
With preacceptance	2307	71.5	18.7	635	27.5
w/o preacceptance	296	66.3	19.5	50	16.9

Applications in 2004

	Number	Avg. score	Std. dev.	Granted	% Granted
All	1357	75.0	17.4	291	21.4
Did not apply in 2003	679	72.3	18.8	139	20.5
Also applied in 2003	678	77.7	15.3	152	22.4
With preacceptance	614	77.5	15.4	135	22.0
w/o preacceptance	64	79.8	14.0	17	26.6

Table 7
Model of scores

	(i)	(ii)	(iii)	(iv)	(v)
Research area dummies	No	Yes	Yes	Yes	Yes
PhD and Residence zone dummies	No	No	No	Yes	Yes
Constant	71.46	68.17	61.95	59.82	59.33
	(0.39)	(1.74)	(1.83)	(1.93)	(1.98)
Y2004	3.33	3.57	3.18	3.05	5.54
	(0.58)	(0.57)	(0.56)	(0.55)	(3.13)
NoPre	-5.20	-5.23	-4.83	-5.22	-5.58
	(1.19)	(1.18)	(1.19)	(1.18)	(1.19)
NoPre × Y2004	10.24	9.26	7.68	7.76	8.98
	(2.00)	(2.02)	(2.01)	(2.00)	(2.05)
endogamy			1.97	2.14	1.33
			(0.65)	(0.68)	(0.79)
years			1.62	1.85	2.02
			(0.17)	(0.18)	(0.19)
years2			-0.05	-0.06	-0.06
			(0.01)	(0.01)	(0.01)
Several projects			6.73	6.72	6.83
			(0.60)	(0.59)	(0.71)
endogamy × Y2004					2.52
					(1.18)
years × Y2004					-0.35
					(1.07)
years2 × Y2004					-0.02
					(0.09)
Several projects × Y2004					-0.36
					(1.08)
Wald tests of significance					
All variables	55876	73447	81421	83935	84753
(% p-value)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)
Area dummies		373.1	386.4	400.9	403.6
(% p-value)		(0.00)	(0.00)	(0.00)	(0.00)
Polynomial in years			103.52	129.32	126.36
(% p-value)			(0.00)	(0.00)	(0.00)
Poly. in years × Y2004					7.24
					(2.68)

Table 7 (ctd)
Model of scores. PhD and residence zone.

PhD	(i)	(ii)	(iii)	(iv)	(v)
EU-15				0.38	-0.47
				(0.90)	(1.12)
Europe other				-4.79	-4.88
				(2.28)	(2.17)
Latin America				-2.28	-5.98
				(1.72)	(2.23)
North America				1.80	1.34
				(1.71)	(2.02)
OECD other				4.76	4.62
				(3.88)	(4.71)
Other				3.04	-1.46
				(4.99)	(5.86)
Residence					
EU-15				3.30	4.61
				(0.80)	(0.94)
Europe other				-3.23	-2.09
				(4.30)	(5.05)
Latin America				-4.07	-1.25
				(2.29)	(2.81)
North America				6.50	7.92
				(0.99)	(1.21)
OECD other				5.37	6.97
				(2.09)	(2.56)
Other				-15.92	-13.69
				(5.67)	(6.30)
Wald tests of significance					
PhD dummies				9.84	13.20
(% p-value)				(13.15)	(4.00)
Residence dummies				73.56	70.86
(% p-value)				(0.00)	(0.00)

Table 7 (ctd)
Model of scores.
Interactions of PhD and residence zone with Y2004

PhD × Y2004	(i)	(ii)	(iii)	(iv)	(v)
EU-15					2.32
					(1.70)
Europe other					-1.04
					(5.65)
Latin America					9.32
					(3.12)
North America					0.53
					(3.12)
OECD other					0.10
					(8.05)
Other					13.59
					(10.30)
Residence × Y2004					
EU-15					-4.11
					(1.56)
Europe other					-3.23
					(9.09)
Latin America					-7.20
					(4.20)
North America					-3.71
					(1.78)
OECD other					-4.92
					(3.92)
Other					-8.58
					(11.85)
Wald tests of significance					
PhD × Y2004 dummies					11.58
(% p-value)					(7.20)
Residence × Y2004 dummies					13.14
(% p-value)					(4.09)

Table 8
Probability of obtaining the grant

	(i)	(ii)	(iii)	(iv)	(v)
Research area dummies	No	Yes	Yes	Yes	Yes
PhD and Residence zone dummies	No	No	No	Yes	Yes
Constant	-0.60	-0.69	-0.92	-1.02	-1.06
	(0.03)	(0.15)	(0.16)	(0.17)	(0.17)
Y2004	-0.20	-0.20	-0.22	-0.23	0.40
	(0.05)	(0.05)	(0.05)	(0.05)	(0.26)
NoPre	-0.36	-0.33	-0.32	-0.34	-0.36
	(0.09)	(0.09)	(0.10)	(0.10)	(0.10)
NoPre × Y2004	0.53	0.57	0.50	0.49	0.54
	(0.19)	(0.19)	(0.20)	(0.20)	(0.21)
endogamy			0.09	0.08	0.04
			(0.05)	(0.06)	(0.07)
years			0.05	0.07	0.09
			(0.014)	(0.013)	(0.015)
years2			-0.002	-0.002	-0.003
			(0.001)	(0.001)	(0.001)
Several projects			0.38	0.39	0.38
			(0.05)	(0.05)	(0.06)
endogamy × Y2004					0.18
					(0.12)
years × Y2004					-0.20
					(0.09)
years2 × Y2004					0.012
					(0.007)
Several projects × Y2004					0.02
					(0.10)
Wald tests of significance					
All variables	1015.4	1104.4	1127.0	1150.3	1165.9
(% p-value)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)
Area dummies		161.6	173.4	173.3	171.4
(% p-value)		(0.00)	(0.00)	(0.00)	(0.00)
Polynomial in years			22.7	36.2	45.6
(% p-value)			(0.00)	(0.00)	(0.00)
Poly. in years × Y2004					10.4
(% p-value)					(0.56)

Table 8 (ctd)
Probability of obtaining the grant. PhD and residence zone.

PhD	(i)	(ii)	(iii)	(iv)	(v)
EU-15				-0.07	-0.07
				(0.07)	(0.09)
Europe other				-0.41	-0.59
				(0.16)	(0.20)
Latin America				-0.17	-0.36
				(0.14)	(0.18)
North America				-0.07	-0.07
				(0.13)	(0.16)
OECD other				0.41	0.49
				(0.29)	(0.37)
Residence					
EU-15				0.21	0.27
				(0.06)	(0.07)
Europe other				0.09	0.19
				(0.30)	(0.333)
Latin America				0.06	0.18
				(0.16)	(0.19)
North America				0.51	0.55
				(0.08)	(0.10)
OECD other				0.60	0.58
				(0.15)	(0.19)
Wald tests of significance					
PhD dummies				9.7	13.8
(% p-value)				(8.3)	(1.7)
Residence dummies				52.1	41.6
(% p-value)				(0.00)	(0.00)

Table 8 (ctd)
Probability of obtaining the grant.
Interactions of PhD and residence zone with Y2004

PhD × Y2004	(i)	(ii)	(iii)	(iv)	(v)
EU-15					0.02
					(0.15)
Europe other					0.62
					(0.42)
Latin America					0.50
					(0.28)
North America					-0.02
					(0.28)
OECD other					-0.25
					(0.60)
Residence × Y2004					
EU-15					0.27
					(0.07)
Europe other					0.19
					(0.33)
Latin America					0.18
					(0.19)
North America					0.55
					(0.10)
OECD other					0.58
					(0.19)
Wald tests of significance					
PhD × Y2004 dummies					15.0
(% p-value)					(13.3)
Residence × Y2004 dummies					55.7
(% p-value)					(0.00)