Matching Candidates and Jobs in Government Recruitment under Multidimensional Sorting: An Empirical Study of Matching Games Without Individual-level Data*

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Abstract

I study matching mechanism design in government recruitment, focusing on a primary method for recruiting bureaucrats in China: the National Civil Service Exam (NCSE). The NCSE is a centralized matching mechanism where each candidate can apply for *one* position before taking a meritocratic exam, causing strategic application. An econometric challenge arises in studying matching games in the absence of individual-level data. I propose a job-matching model with two-sided heterogeneity and demonstrate its nonparametric identification using position-level data. I apply the framework to estimate an empirical model of the NCSE. In the counterfactual analysis, I introduce a strategy-proof 'first-exam-then-apply' mechanism. Simulations reveal that the NCSE can outperform the alternative mechanism when candidates' characteristics are multidimensional.

Keywords: government recruitment, matching, nonparametric identification, multidimensional sorting, market design

JEL Clacification: C14, C51, D47, D73, J49, H11

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1 Introduction

Recruiting bureaucrats is a necessary task for all governments and has important implications for governance, such as the provision of public goods and services.[1] Although the literature has extensively studied self-selection into the government or public sector (e.g., Besley (2005); Dal Bó and Finan (2018); Besley et al. (2022)), the assignment of candidates to specific jobs remains less explored. Many governments worldwide, including those of Bangladesh, China, and India, adopt a centralized matching market framework in the recruitment process (Gale and Shapley, 1962; Becker, 1973), where the government employs a mechanism to match candidates to jobs based on both screening outcomes (e.g., written exams or interviews) and individual preferences.

Individuals apply for government jobs with different intrinsic motives. Some are committed to serving the public, while others may focus more on obtaining personal benefit. As a result, matching candidates to government jobs presents unique challenges because match quality depends not only on a candidate's ability but also on a very important second dimension: civic-mindedness, i,e,. commitment to serving the public.[2] Civic-mindedness plays a pivotal role in fulfilling the responsibilities of government jobs, particularly for positions with many rent-seeking opportunities and in societies with relatively weak institutions. Nevertheless, it is challenging to measure candidate civic-mindedness through merit-based screening methods, such as exams. Therefore, a natural question emerges: Given a pool of candidates and available positions, can the government match candidates with high ability and high civic-mindedness to suitable jobs when civic-mindedness cannot be observed in the recruitment process? In this paper, I examine how matching mechanisms determine matching patterns in government recruitment and how the resulting outcomes can affect government performance.

I focus on the National Civil Service Examination (NCSE) in China, a principal mechanism by which the Chinese government fills entry-level positions. Under the NCSE, each candidate can apply for only *one* position before a meritocratic exam that ranks candidates and determines

[1] Ashraf et al. (2020), Fenizia (2022), Best, Hjort and Szakonyi (2023), Dahis, Schiavon and Scot (2023), Spenkuch, Teso and Xu (2023), Moreira and Pérez (forthcoming), and Aneja and Xu (2024), along with others, provide empirical evidence that government workers significantly impact government performance.

[2] Please refer to Besley and Ghatak (2018) for a discussion of pro-social preferences and incentives in bureaucracy. Dal Bó, Finan and Rossi (2013) and Ashraf et al. (2020) are examples that empirically study prosocial preferences and political selection.

the assignment. The NCSE is very popular and highly competitive, with over 2.5 million applicants competing for approximately 37,000 positions in recent years. Because of privacy concerns, individual-level data from the NCSE is unavailable, a common restriction in sensitive contexts such as government recruitment. In contrast, aggregate-level data is more accessible. I compile a position-level dataset of the NCSE for 2016 and 2017, which contains position characteristics, the number of applicants, and the cutoff score required to pass the selection for each position. Using this position-level dataset, the objective is to estimate the distributions of preference or types for both candidates and the government to analyze how matching mechanisms influence bureaucratic recruitment.

Nevertheless, since assignments are simultaneously determined by preferences and types on both sides, it remains unclear whether these preferences and types can be separately identified with only position-level data. Additionally, since each candidate can apply for only *one* position in the NCSE, strategic applications arise. Observed choices reflect not only individual preferences but also the strategies that candidates employ in response to the choices of others. These econometric challenges arise in contexts broader than government recruitment whenever detailed individual-level data is absent. Therefore, to overcome the challenges, I start by developing an equilibrium non-transferable utility (NTU) matching model for the general labor market that features two-sided heterogeneity and strategic interactions. Subsequently, I analyze the conditions under which the model can be nonparametrically identified.

I consider large matching markets where, in each market, there is a continuum of candidates and a set of firms, each posting a position. Upon posting, all firms commit to market-specific position characteristics, including wages and hiring quotas for each position. On the other side, candidates differ in qualifications that firms value, such as experience or skills. After the vacancy posting, candidates make application choices. The preferences of candidates and firms are flexible. Motivated by the empirical application, I consider the scenario where each candidate is allowed to apply for one position, and the application decision may involve strategic behavior.[3] In addition to evaluating the characteristics of each position, candidates must anticipate the competitiveness of all positions and respond optimally to the application strategies of others.

[3]In Appendix C, I show that the main results can be extended to the scenario where each candidate can make multiple applications.

After the application stage, each firm conducts a meritocratic selection based on its preferences for candidate qualifications to fill the position. I define an equilibrium for each matching market where a set of equilibrium hiring standards adjusts to fill all positions.[4] Since the market is large, each candidate's application decision affects all others through equilibrium hiring standards, which are taken as given by the candidates. I provide sufficient conditions under which a unique set of equilibrium hiring standards clears each matching market. This approach avoids the threat to nonparametric point identification that arises when there is a multiplicity of equilibrium hiring standards.[5]

Conditional on observing the total number of applicants, the equilibrium hiring standard, and position characteristics for each position, I show that both firm and candidate preferences or types can be nonparametrically identified using instruments that independently shift firm and candidate preferences or types. The nonparametric identification result is established using instruments, following the framework developed by Newey and Powell (2003) and Berry and Haile (2014). The key insight for identification is that, when applying for a position, candidates consider both the probability of being matched and the expected utility conditional on being matched with the firm. In equilibrium, the probability of a candidate being matched with firm A must reflect A's preference, represented by the candidate's measured qualifications relative to firm A's equilibrium hiring standard.[6] Therefore, a candidate's application decision contains information from both sides of the market, as do the aggregated application decisions at the position level.

I apply the above framework to study the NCSE and specify a parametric empirical model where candidates differ in their ability and civic-mindedness. Civic-mindedness is an important second dimension that determines a candidate's willingness to engage in rent-seeking activities. While candidates have preferences for a variety of position attributes, less civic-minded candidates are assumed to derive higher utility from potentially high-rent positions, as indicated by the number of past corruption investigations.[7] The exam is modeled as a noisy signal of the applicant's ability. Government preferences affect the assignment of exam papers with different levels of difficulty

[4]Here, equilibrium hiring standards can be multidimensional. For a related setting where stable matching is characterized by cutoffs in large markets, see Azevedo and Leshno (2016).

[5]Please refer to Molinari (2020) for related discussions.

[6]On the equilibrium path, candidates must correctly know firm preferences and equilibrium hiring standards.

[7]The interpretation that a higher number of past corruption investigations implies greater rent-seeking opportunities is supported by empirical studies (Wang and Dickson, 2022; Sun, Zhu and Ni, 2022; Pan, Shu and Ye, 2023).

to positions. Among all candidates who apply for a position, those with higher exam scores are matched. However, candidate civic-mindedness is assumed to be unmeasurable through the exam process.

A candidate strategically chooses a position that maximizes expected utility, including the probability of being matched and the utility conditional on being matched. Candidate ability and the equilibrium cutoff score determine the probability of being matched with a position. The utility conditional on being matched depends on position characteristics and candidate preferences, particularly civic-mindedness.

Using position characteristics, the number of applicants, and the cutoff score for each position, I estimate the empirical matching model with an algorithm building on Berry, Levinsohn and Pakes (1995) and Conlon and Gortmaker (2020). The key distinction lies in the inclusion of an additional market-clearing constraint in the estimation process. Variations in observed cutoff scores, position characteristics, and the number of applicants within and across application markets jointly provide information for identifying model primitives. I employ two sets of instruments, guided by the nonparametric identification results. First, I use a set of instruments motivated by the institutional background to identify government preferences as reflected in the assignment of exam papers to positions.[8] Second, I utilize functions of position characteristics commonly used in the empirical literature on discrete choice to identify candidate types and preferences.

In the counterfactual analysis, I consider a 'first-exam-then-apply' mechanism that is similar to the matching mechanism used in the Bangladesh and India civil service recruitment. Under the alternative mechanism, candidates take the same meritocratic exam. The candidate ranked rth based on the exam score selects a position in the rth round until all positions are filled. Simulation results indicate that, in contrast to the NCSE, the 'first-exam-then-apply' mechanism is more likely to match high-ability candidates to popular positions but also more likely to match low civic-minded candidates to potentially high-rent positions. These patterns emerge because candidates can select from all remaining positions during their turn to maximize their utility conditional on being matched.

[8] I use the location of a position in a sub-provincial-level (or higher) city as an instrument for the use of the provincial exam paper, as cities at the sub-provincial level (or higher) are more likely to have positions affiliated with departments at or above the provincial level. Another instrument, based on the institutional background, used to identify candidate preferences is the local budgetary fiscal expenditure.

Because empirically evaluating government performance is challenging in this setting, I compare the two mechanisms using a simulation. I propose a stylized government production function in which both ability and civic-mindedness matter. Simulations suggest that when the cost of corruption in government is high, the NCSE is a better option, even though it introduces strategic application, because it is less likely to fill high-rent positions with low civic-minded candidates by limiting the number of positions a candidate can apply. This exercise provides insight into matching mechanism design in the labor market context when candidates have multidimensional characteristics and information frictions exist in screening those characteristics.

Related Literature. This paper contributes to the identification of many-to-one Non-transferable Utility (NTU) matching models. By considering limited preference heterogeneity, Agarwal (2015) and Diamond and Agarwal (2017) demonstrate the identification and estimation of preferences in large matching markets. He, Sinha and Sun (forthcoming) demonstrate the nonparametric identification of many-to-one NTU matching markets with rich preference heterogeneity on both sides. The main distinction between this paper and others in the literature is that, to the best of my knowledge, it is the first to nonparametrically identify many-to-one NTU matching models when individual-level data is unavailable to researchers.[9]

In the paper, I build a two-sided matching framework with strategic interaction and shows its identification building on the important contribution of Berry and Haile (2014). There are a number of challenges to overcome in order to extend their analysis to matching models. First, two-sided preferences jointly determines equilibrium allocations in matching markets. Second, unlike the product market which usually features an elastic supply, the number of available positions is fixed in the matching context I consider. Third, based on the first and second points, the potential multiplicity of equilibrium hiring standards poses a threat to nonparametric point identification. Finally, I incorporate the possibility of multiple applications.

The paper contributes to the understanding of political selection. Although there is extensive literature on this topic (see reviews by Finan, Olken and Pande (2017) and Besley et al. (2022), for example), less is understood about mechanism design in matching candidates to civil service

[9] A growing strand of literature studies the econometrics of decision problems under consideration set formation (Cattaneo et al., 2020; Abaluck and Adams-Prassl, 2021; Barseghyan, Molinari and Thirkettle, 2021; Barseghyan et al., 2021; Agarwal and Somaini, 2022). There is a conceptual difference between the probability that different consideration sets are drawn in a job seeker's decision problem and the perceived chance of being hired in this paper. The probability of being matched with a firm consists of both firm preferences and its equilibrium hiring standard.

jobs. Thakur (2021) is another paper I am aware of that studies civil service recruitment in India from a matching market perspective.[10] My paper differs from Thakur (2021) in several dimensions. First, I develop a matching game model and demonstrate nonparametric identification without individual-level data to overcome the empirical challenge. Second, the 'apply first, then exam' system of the NCSE presents a unique institutional feature.[11] I analyze the equilibrium sorting pattern of the NCSE and compare its empirical matching outcomes with those produced by a strategy-proof mechanism. Third, I emphasize the importance of understanding how multidimensional talent characteristics influence government performance and examining the sorting of these traits under different matching mechanisms. The concept of civic-mindedness considered here echoes discussions of pro-social preferences in bureaucracy (e.g., Francois (2000); Besley and Ghatak (2003, 2018)).

The remainder of the paper is organized as follows. Section 2 presents the job-matching model and provides the main identification result. Section 3 applies the theoretical framework to analyze matching mechanism design in the context of the National Civil Service Exam (NCSE) in China. Section 4 concludes.

2 The Matching Game Model and Its Identification

This section presents a non-transferable utility (NTU) job matching game model with two-sided heterogeneity and its nonparametric identification using aggregated-level data. The model is formulated as a job search problem but is also applicable to other matching markets with similar structures, such as school admissions.

Consider a collection of markets, each indexed by t. Markets are generally defined geographically, temporally, or both. Within each market, there is a continuum of agents (i) of mass 1, i.e., a large market approximation. On the other side of the market, there is a set of firms ($j \in \{0,1,...,J\}$). In every market t, each firm j posts *one* vacancy or position. Each position posted by firm j in market t can hire up to λ_{jt} share of agents. The set of all capacities in market t is denoted as $\lambda_t = \{\lambda_{0t},...,\lambda_{Jt}\}$.

[10] In a different setting, a number of studies investigate the cadet-branch matching at US Army programs (Sönmez, 2013; Sönmez and Switzer, 2013; Greenberg, Pathak and Sönmez, 2021, 2023).

[11] Francois, Trebbi and Xiao (2023) is another paper that studies the internal personnel structures in China. Additionally, a burgeoning literature studies the "civil service fever" in China (Feng et al., 2024; Feng, He and Liu, 2023).

Let $x_t = (x_{1t}, ..x_{Jt})$, where x_{jt} represents the characteristics of the position posted by firm j in market t. These characteristics can include factors such as compensation, office environment, location, and other amenities. I assume that firms commit to these characteristics (λ_t and x_t) when posting positions and that both λ_t and x_t are common knowledge. Each agent can be matched with at most one firm in the market they reside in. Given that the total number of jobs is much smaller than the total number of agents, some agents remain unmatched, but no firms remain unmatched.

The sequence of play in each market proceeds as follows: (1) firms post vacancies in market t; (2) each agent applies for one firm; (3) firms conduct meritocratic selections and set equilibrium hiring standards to determine which agents are matched.

Agent Preferences. Agent i derives utility $f\left(x_{jt}^d, w_i\right)$ when *successfully matched* with firm j in market t. Here, $x_{jt}^d \subseteq x_{jt}$ represents a set of firm characteristics that affects agent i's utility upon being matched with firm j. For example, x_{jt}^d may include firm j's posted wage in market t. The vector w_i captures individual heterogeneous tastes or traits. w_i is are randomly drawn from the distribution F_w, which is common knowledge among firms and agents but remains unknown to researchers. However, w_i is private information to agent i and is unobservable to both firms and researchers.

Firm Preferences. Firms evaluate agents based on a set of qualifications q_i, which can be multidimensional (e.g., education level and experience). Qualifications q_i are independently and identically distributed (i.i.d.) according to a known distribution F_q. While q_i is private information for each agent i, the distribution F_q is common knowledge among firms and agents.

Each firm conducts a meritocratic selection process to hire agents. Agents with higher qualifications have a higher probability of being hired. Due to fixed hiring quotas, firm j selects equilibrium hiring standards $\bar{q}_{jt}$ ($\forall t$), where only agents whose measured qualifications meet or exceed the standard are hired. For instance, if firm j bases its decision solely on exam scores (e.g., SAT or GRE), $\bar{q}_{jt}$ represents the minimum score required for being hired by firm j in market t. The equilibrium hiring standard $\bar{q}_{jt}$ can be multidimensional, with dimensionality less than or equal to that of q_i. Researchers are assumed to observe the equilibrium hiring standards for all firms in market t, denoted as $\bar{q}_t = (\bar{q}_{1t}, \ldots, \bar{q}_{Jt})$ for all t. Intuitively, the probability of being matched with firm j decreases as its equilibrium hiring standard becomes more competitive (i.e., higher).

As a result, firm preferences can be represented by a selection function $g(q_i, \bar{q}_{jt}, x_{jt}^f)$, which

determines agent i's probability of being matched with firm j after the meritocratic selection conducted by firm j following the application process.[12] Firms are allowed to have heterogeneous preferences over agent qualifications, represented by $x^f_{jt} \subseteq x_{jt}$ in the selection function g. For example, a firm operating in different regions might prioritize agents with relevant language skills, making those with stronger language proficiency more likely to be matched.

Example 1 *One example of the selection function g is the setting where firms evaluate agents by using an exam. The exam produces a score that is a weighted sum of an agent's individual qualifications plus a noise (ε_{ijt}). Any agent who has a score higher than the equilibrium cutoff score $\bar{q}_{jt}$ is hired. Therefore, given the equilibrium cutoff score $\bar{q}_{jt}$, agent i with q_i has a probability $g\left(q_i, \bar{q}_{jt}, x^f_{jt}\right) = \Pr\left((q_i)^T x^f_{jt} + e_{ijt} \geq \bar{q}_{jt}\right)$ of being hired by firm j in market t. Here, the firm characteristics $x^f jt$ serve as the weights that represent firm-specific preferences.*

Application. I denote v^*_{ijt} as the indirect expected utility that agent i derives when applying for firm j, which equals agent's perceived probability of being hired by firm j and the agent preferences for firms.

$$v^*_{ijt} = \underbrace{g^*\left(q_i, \bar{q}^*_{jt}, x^f_{jt}\right)}_{\text{perceived chance}} \quad \underbrace{f\left(x^d_{jt}, w_i\right)}_{\text{utility of being matched with } j} + \delta_{jt} + \underbrace{\varepsilon_{ijt}}_{\text{i.i.d. pref. shock}} \tag{2.1}$$

$g^*\left(q_i, \bar{q}^*_{jt}, x^f_{jt}\right)$ denotes agent i's perceived probability of being hired by firm j. $\bar{q}^*_{jt}$ is the perceived equilibrium hiring standard of firm j in market t. $\varepsilon_{ijt} \sim F_\varepsilon$ is an i.i.d. preference shock for each agent i when considering firm j, which is observable only to the agent i. δ_{jt} is a preference shifter at firm-market level that affects agents' application choices. For instance, δ_{jt} can represent a firm-market specific application cost. I assumed that $\delta_{jt} = C(x^a_{jt}) + \xi_{jt}$ with $E[\xi_{jt}|x^a_{jt}] = 0$. Here, $x^a_{jt} \subseteq x_{jt}$ is a vector of firm j's characteristics in market t that only impact agents' indirect utility at the application stage. C is a strictly increasing application cost function that depends on position characteristics.[13] ξ_{jt} is a one-dimensional, firm-specific characteristic observable to all agents but not to the researcher.

[12] The function g is assumed to be probabilistic, capturing various sources of uncertainty in the hiring process. For instance, the screening process may include built-in randomness, which can be interpreted as part of the firm's preferences. Additionally, there may be elements of randomness in the hiring process that are beyond the firm's control.

[13] It is possible to extend the model to have some dimensions of cost to be individual-specific. For example, one can assume that $\delta_{ijt} = C_1(x^{a1}_{jt}, \omega^c_i) + C_2(x^{a2}_{jt}) + \xi_{jt}$, where $\omega^c_i \sim F^c_\omega$ is a distribution of person-specific traits that affect

Motivated by the empirical application, I consider scenarios where each agent i chooses *one* firm j in a market t that offers the highest expected utility, $j = \underset{j \in J}{\text{argmax}}\, v^*_{ijt}$. I extend the identification result to scenarios where agents can apply to multiple positions in Appendix C. As is standard in discrete choice problems, utilities are normalized relative to firm $j = 0$ for each agent, i.e., $v^*_{i0t} = 0$.

Equilibrium. I define a Perfect Bayesian Equilibrium for the matching game: (1) Each agent i applies for *one* firm j that maximizes her utility, conditional on firms' preferences and equilibrium hiring standards; (2) Each firm j hires agents according to its preference subject to the labor demanded λ_{jt}. (3) On the equilibrium path, agents' beliefs regarding firms' hiring policies and the set of equilibrium hiring standards in market t, are correct.

An agent's application decision is strategic in equilibrium, as they do not always apply for the position that yields the highest utility conditional on being matched. An important requirement imposed by the equilibrium definition is that agents must be able to form correct expectations regarding each firm j's preference ($g^* = g$) and its equilibrium hiring standard ($\bar{q}^*_{jt} = \bar{q}_{jt}$) when formulating their expected utility, that is, $v_{ijt} = v^*_{ijt}$.[14] Therefore, equilibrium application decisions contain information regarding both agent and firm preferences.

The model is an example of how non-market systems solve the allocation problem in the absence of prices. The set of equilibrium hiring standards $\bar{q}_t$ adjust to to ensure that no firms have empty slots, playing a role analogous to prices in competitive equilibrium models. In equilibrium, an agent's decision regarding where to apply impacts the decisions of all other agents through the equilibrium hiring standards.

Given the above setup, the share of agents applying for firm j in market t (s_{jt}) can be expressed as

$$s_{jt} = \sigma_j(x_t, \bar{q}_t, \xi_t) = \Pr\left(j = \underset{k \in \{0,\ldots,J\}}{\text{argmax}} \quad v_{ikt} \,\middle|\, x_t, \bar{q}_t, \xi_t \right)$$

where $x_{jt} = (x^f_{jt}, x^d_{jt}, x^a_{jt})$. I define $s_t = (s_{1t}, \ldots, s_{Jt})$. Let $\sigma = (\sigma_1, \ldots, \sigma_J)$. The function $\sigma_j(x_t, \bar{q}_t, \xi_t)$ encompasses all the previously introduced unknown objects.[15] Moving forward, I focus on iden-

the cost of agent i applying for firm j with characteristics $x^{a1}_{jt} \subset x^a_{jt}$. The key here is that x^{a2}_{jt} must be at least two dimensional.

[14] One argument supporting this assumption is that agents can infer equilibrium hiring standards from historical data. Evidence for this is provided in the empirical analysis (Section 3).

[15] Specifically, it includes firm selection function g, agent-side unknowns f and C, as well as individual heterogeneity represented by distributions F_q, F_w and F_ε.

tifying the function σ_j, based on observed equilibrium hiring standards q_t, firm characteristics x_t and share of applicants s_t.

Nonparametric Identification. With normalization, I impose the assumption of connected substitutes, as introduced by Berry, Gandhi and Haile (2013), on the application function $\sigma_t(\delta_t, \bar{q}_t)$.

Assumption 1 ***Connected substitutes****: (1) $\sigma_k(\delta_t, \bar{q}_t)$ is non-increasing in δ_{jt} for all $j > 0$, $k \neq j$, and any $(\delta_t, \bar{q}_t)$; (2) for each $(\delta_t, \bar{q}_t) \in supp(\delta_t, \bar{q}_t)$ and any nonempty $\mathscr{K} \subseteq \{1, ..., J\}$, $\exists k \in \mathscr{K}$ and $l \notin \mathscr{K}$ such that $\sigma_l(\delta_t, \bar{q}_t)$ is strictly decreasing in δ_{kt}.*

Assumption 1 is a standard one in the discrete choice literature. It requires that firms are weak substitutes concerning δ_{jt}, i.e., slightly increasing δ_{jt} must weakly decrease the desirability of other firms. Additionally, it requires enough strict substitution among firms such that there is no strict subset of firms that substitute only among themselves. Berry, Gandhi and Haile (2013) shows that a broad set of demand models satisfies the assumption 1. Given Assumption 1 and normalization, demand can be inverted as follows: $x_{jt}^{a(1)} + \xi_{jt} = \sigma_j^{-1}(s_t, \bar{q}_t), j = 1, ..., J$.

Applying the identification results in Newey and Powell (2003), as followed in Berry and Haile (2014), demonstrates the nonparametric identification of agents' and firms' preferences/types in the matching game contingent on the availability of instruments.

Assumption 2 ***Instruments****: (1) For all $j = 1, ..., J, E\left[\xi_{jt} \mid z_t, x_t^{a(1)}\right] = 0$ a.s., (2) For all functions $B(s_t, \bar{q}_t)$ with finite expectation, if $E\left[B(s_t, \bar{q}_t) \mid z_t, x_t^{a(1)}\right] = 0$ a.s. then $B(s_t, \bar{q}_t) = 0$ a.s..*

Proposition 1 *Suppose $\{s_t, x_t, \bar{q}_t, z_t\}$ are observable and that Assumptions 1 and 2 hold. The function σ_j is identified for all j.*

Proposition 1 demonstrate that the proposed matching model is nonparametrically identified in the absence of individual-level data. The nonparametric identification is contingent on the completeness condition of instruments (Assumption 2). In particular, the instruments must move the endogenous variables (s_t and $\bar{q}_t$ here) sufficiently to ensure that any function of these variables can be differentiated from others based on the exogenous variation provided by the instruments. Satisfying the completeness condition for the proposed model requires that instruments must sufficiently move agents' preferences/types and firm preferences.

The intuition is that agents, when making application choices, must take into account the probability of being matched with a firm, which indicates that their application choices carry information about the selection criteria of all firms. Lastly, I emphasize that the simultaneous observability of both the number of applicants and the equilibrium hiring standards for all firms is crucial for identification because they both offer valuable information about firms and agents preferences.

One threat to identification is: Holding all other model elements fixed, are there more than one set of equilibrium hiring standards that are consistent with the matching game model? If multiple equilibria exist, it is more appropriate to establish set identification. This highlights the importance of understanding the conditions under which there is a unique set of $\bar{q}_t$ that fills all vacancies.

I define π_j as a function of x_t, $\bar{q}_t$ and ξ_t that represents the number of agents who apply for firm j in market t and meet the equilibrium hiring standard $\bar{q}_{jt}$. The inequality $\pi_j(x_t, \bar{q}_t, \xi_t) \leq \lambda_{jt}$ must hold due to the slot constraint. I impose the connected substitutes assumption on the function π.

Assumption 3 *(1) $\pi_k(\bar{q}_t)$ is non-increasing in $-\bar{q}_{jt}$ for all $j > 0$, $k \neq j$, and any $(\bar{q}_t)$; (2) for each $\bar{q}_t \in supp(\bar{q}_t)$ and any nonempty $\mathscr{K} \subseteq \{1, ..., J\}$, $\exists k \in \mathscr{K}$ and $l \notin \mathscr{K}$ such that $\pi_l(\bar{q}_t)$ is strictly decreasing in $-\bar{q}_{kt}$.*

Assumption 3 shares a similar intuition as the Assumption 1. In the case where there are only two firms, $j = 1, 2$. This assumption requires that if firm 1 raises its hiring standard, then firm 2 must correspondingly hire more agents.

Proposition 2 *Given assumption 3 and holding all model components as given except for $\bar{q}_t$, there exists a unique set of equilibrium hiring standards $\{\bar{q}_t\}$ that clears the matching market conditional on applications.*

Proof. With Assumption 3, the function π is injective in $\bar{q}_t$ by the main results of Berry, Gandhi and Haile (2013). ■

Determining whether the matching game model implies a function π satisfying Assumption 3 requires case-by-case scrutiny of specific functional forms. I verify in Section 3 that the proposed empirical model satisfies Assumption 3.

3 Empirical Analysis: the National Civil Service Exam in China

In this section, I apply the theoretical framework and identification result to study government recruitment in China.

3.1 Institutional Background and Data

The National Civil Service Exam (NCSE) is theprimary method through which China's central government hires government officials.[16] Besides positions in departments' Beijing headquarters, the NCSE also fills positions in their branch offices nationwide at the provincial, prefecture, and county levels. A prominent example is the State Administration of Taxation. Although its headquarter is located in Beijing, it also has local branches in almost every county of China, with all positions filled via the NCSE. Online Appendix O.5.1 provides a comprehensive list of all the recruiting departments through NCSE during the study period (2016 and 2017).

Figure 1 presents a typical hiring cycle of the NCSE. In early October, the State Administration of Civil Service (SCS) posts detailed job openings online. Prospective candidates can visit the application system to browse available positions and their corresponding restrictions.[17] Each candidate can apply for only *one* position per exam, meaning that this is not a strategy-proof mechanism.

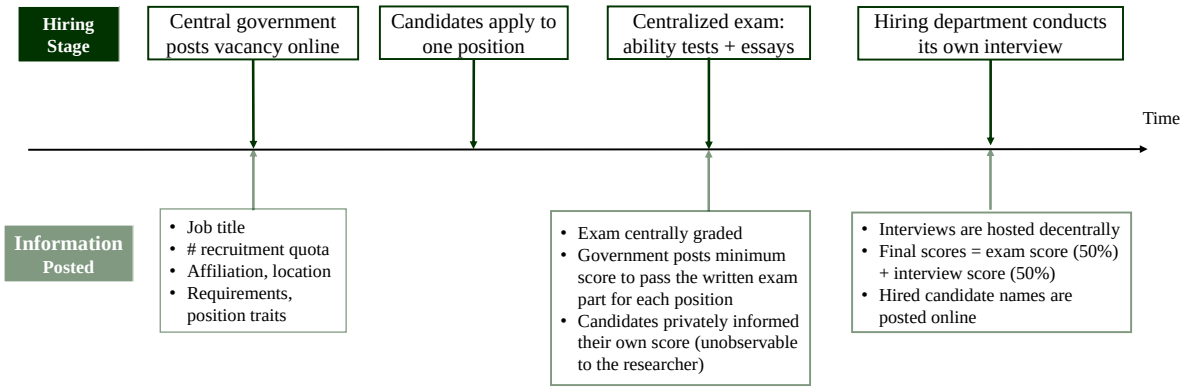


Figure 1: Hiring Process of the NCSE in a Typical Cycle

[16] For a more comprehensive discussion of the civil service fever in China over the past decade, see Feng et al. (2024).

[17] There are some general restrictions on who can participate in the test, e.g., citizenship requirement and minimum age restrictions (usually 18-35). Beyond that, each position has position-specific requirements. For example, many positions require applicants to hold a bachelor's degree. Other restrictions include minimum work experience, political status, and other criteria.

The SCS usually holds its nationwide exam towards the end of November after the application stage. The exam is meritocratic, with standardized exam papers each divided into two segments: ability tests (50%) and an essay (50%).[18] Ability tests for positions affiliated with departments at the sub-provincial level or above (e.g., provincial-level tax administration) includes roughly 10% more challenging questions compared to the exam paper for other positions. I provide the exam guidelines from the NCSE 2016 in Online Appendix O.6, which is an official guide to the examination paper designed by the SCS. It demonstrates that the exam is meritocratic.

For each position, the SCS ranks all applicants based on their scores and establishes a minimum score required for advancing to the interview phase.[19] The minimum qualifying score for passing the written exam phase (i.e., qualifying for the interview) for each position is publicly accessible online. Each candidate also privately receives their own scores.[20] The SCS organizes the grading process after the exam. For each position, SCS ranks all applicants based on their scores and establishes a minimum score required for passing the written exam phase.[21] The minimum qualifying score for passing the written exam phase for each position is publicly accessible online. Each candidate also privately receives their own scores.[22] After the interview conducted by each hiring department, candidates are ranked based on the addition of their written exam score (50%) and the interview performance (50%). The government posts selected candidates online based on the final ranking.

The NCSE in China provides a compelling context for studying matching mechanism design in government recruitment. First, it has an formalized application and recruitment system. Second, it posts many positions with diverse characteristics across locations, providing rich regional variations. Finally. in China, where institutional weaknesses and opportunities for corruption exist, the distinct motivations of government officials significantly impact governance.

[18]Certain positions, such as those in the police force and financial regulation departments, require specialized exams. I exclude positions requiring specialized skills in the main empirical analysis because those positions only attract candidates with relevant background.

[19]There is a national minimum score that applicants must meet to be hired, which is typically very low.

[20]Notably, if certain positions remain unfilled after the exam and interview, the SCS offers unsuccessful candidates a secondary opportunity to apply. I do not focus on this part of the process because of the data constraint. I argue that this is not a significant concern since unfilled positions are considered undesirable.

[21]There is a national minimum score that applicants must meet to be hired, which is typically very low.

[22]unsuccessful candidates a secondary opportunity to apply. I do not focus on this part of the process because of the data constraint. I argue that this is not a significant concern since unfilled positions are considered undesirable. Moreover, those unfilled positions are usually unfilled even after this second application phase.

Dataset. The the NCSE job posting data was collected directly from the SCS, which details job characteristics and basic requirements for each position. The exam results for NCSE 2016 and 2017 were hand-collected from a prominent company that provides exam trainings. For each position, I observe the number of applicants and the minimum score required for passing the written exam phase. The NCSE results I collected are reliable, as the company uses them to assist prospective exam candidates in making application choices. I merged the NCSE results with the job posting data and manually coded the prefecture location for each posted position.[23]

Table 1: Summary Statistics of the NCSE Dataset

Variables	NCSE 2016		NCSE 2017	
	Mean	Std. Dev.	Mean	Std. Dev.
Recruitment quota	1.776	1.480	1.736	1.205
# of applicants	84.015	146.397	87.300	157.770
Cutoff score	113.349	16.212	114.910	21.793
App-to-Recruit Ratio	55.581	97.743	58.146	122.898
Positions	14,146		14,502	

Notes: I only include positions that have a positive number of recruitment quota, # of applicants, cutoff score, App-to-Recruit Ratio (applicants to recruitment quota ratio, or $\frac{\#\text{ applied for } j}{\#\text{ demanded by } j}$), $\frac{\text{interview \#}}{\text{enrollment \#}}$ ratio and location information.

Table 1 presents summary statistics of the NCSE dataset. The statistics reveal that the NCSE attracts a large number of applicants, as the average number of applicants per position exceeds 85. Even accounting for the number of enrollments, there are on average more than 55 applicants competing for each available opening. The large standard deviation also indicates significant variation in applicant numbers across positions, suggesting notable differences in position popularity.

3.2 The Empirical Model

I set up a parametric model to capture key features of the NCSE, building on the framework proposed in Section 2. The nonparametric identification result provides insights into the type of instruments needed for the estimation. To simplify the exposition, I omit the market subscript and detail the model for a specific market.

[23]The county location of many NCSE positions cannot be identified.

A *candidate* i is characterized by ability a_i and civic-mindedness c_i, which are private information. Ability a_i is independently and identically distributed (i.i.d.) according to a cumulative distribution function (CDF) $F_a = \mathrm{N}(\mu_a, 1)$. The mean ability level of candidates in a given market is assumed to be a linear function of the province's GDP per capita, i.e., $\mu_a = \theta_\mu GDP_m + \bar{\theta}_\mu$. This captures differences in candidate pools across matching markets. In Online Appendix O.1.2, I show that provinces with higher GDP per capita have higher average cutoff scores for passing the written exam phase, likely due to differences in educational resources. Civic-mindedness (c_i) is assumed to follow a normal distribution, $F_c = \mathrm{N}(\mu_c, \sigma_c^2)$. The distributions of ability and civic-mindedness are assumed to be independent. Online Appendix O.1.3 presents survey evidence from China supporting the independence of ability and civic-mindedness among individuals interested in government employment. This assumption is further supported by experimental evidence in the literature.(Hanna and Wang, 2017; Barfort et al., 2019)

The centralized exam is modeled as generating a noisy signal of candidate ability, producing a score $\text{score}_i = a_i + \eta_i$ for each candidate i. Here, η_i is i.i.d. and drawn from a normal distribution $\mathrm{N}(\mu_\eta, 1)$. Since the provincial exam paper is designed to be harder than the prefectural exam paper, I account for exam difficulty differences by normalizing the mean noise for the prefectural exam paper and introducing a mean noise term μ_η for the provincial exam paper. Thus, μ_η serves as a shifter for exam difficulty. Given this structure, a candidate with ability a_i has a probability $\Phi(a_i - \bar{q}_j - \mu_\eta \mathbf{1}_{\text{Prov. Exam}})$ of being matched with position j. Higher ability a_i increases the probability of matching with a position j with cutoff score $\bar{q}_j$. Conversely, applying to positions with higher cutoff scores $\bar{q}_j$ reduces the probability of being matched for candidates with ability level a_i.

Φ corresponds to the selection function (g) in Equation (2.1) and reflects the government's preferences. In equilibrium, all candidates accurately anticipate the cutoff scores. Online Appendix O.1.1 provides empirical evidence supporting this assumption, as equilibrium cutoff scores for the same position across different years are similar.

The utility that an agent i derives from being matching with position j is defined as $u(x_j, m_j | c_i) = \theta_x' x_j + c_i m_j$. The vector x_j includes attributes such as the administrative level of the position's department, whether position j is powerful/prestigious, and a measure of wage for position j.[24]

[24]The wage measure is constructed using the average wage for urban non-private units in the prefecture where position j is located. See Appendix O.5.5 for further details.

Positions within the State Administration of Taxation are classified as prestigious and powerful. Conversely, positions involving secretarial and assistant roles, as well as those focused on statistical or computer-related tasks, are excluded from the prestigious and powerful category.[25]

Positions within the State Administration of Taxation are classified as prestigious and powerful. Additionally, positions involving secretarial and assistant roles, as well as those focused on statistical or computer-related tasks, are excluded from the prestigious and powerful category. In Online Appendix O.3.2, I demonstrate that the estimation results remain consistent when an alternative definition of prestigious and powerful positions is used.

I assume that candidates with lower civic-mindedness ($c_i > 0$) derive greater utility from being matched with positions with high potential rent-seeking opportunities, as such positions allow them to potentially extract more rents. Conversely, candidates with higher civic-mindedness derive less utility from positions associated with rent-seeking opportunities. These positions often have a pervasive rent-seeking atmosphere, which may make high civic-mindedness candidates uncomfortable. Additionally, high-rent positions are likely to have many low civic-minded incumbents, with whom high civic-mindedness candidates might prefer not to work.

Following the literature indicating that people in China interpret higher numbers of corruption cases as evidence of greater potential rent-seeking opportunities (e.g., Sun, Zhu and Ni (2022), Wang and Dickson (2022), and Pan, Shu and Ye (2023)), I use the number of past corruption cases to construct a measure of candidate-perceived rent-seeking opportunities. Specifically, I use the cumulative number of city-level corruption cases (m_j) prior to the application deadline. This measure focuses on convicted officials at relatively high administrative levels, as these cases typically attract significant public attention.[26] Thus, m_j serves as a measure of candidate-perceived potential rent-seeking opportunities.

The expected utility that agent i derives when applying for position j is a specific case of Equation 2.1 presented in the previous section. It consists of two components: (1) the probability

[25]The wage measure is constructed using the average wage for urban non-private units in the prefecture where position j is located. See Appendix O.5.5 for further details.

[26]Empirically, m_j is constructed by counting the total number of convicted government officials at the Deputy department level or higher within a prefecture. These cases often involve (vice) mayors or (deputy) departmental heads in provincial government offices.

of being matched with position j and (2) the utility conditional on being matched with position j.

$$U_{ij}^{e}(a_i, c_i, \bar{q}_j) = \underbrace{\overbrace{\Phi(a_i - \bar{q}_j + \mu_\eta \mathbf{1}_{\text{Prov. Exam}})}^{\text{prob of being matched with } j} \overbrace{u(x_j, m_j | c_i)}^{\text{utility from } j} + \delta_j}_{\text{Deterministic part denoted as } U_{ij}(a_i, c_i)} + \varepsilon_{ij}, \tag{3.1}$$

where ε_{ij} follows an Extreme Value Type 1 distribution.[27] δ_j is a position-specific utility term affecting only the application decision, interpreted as an application cost, similar to its role in Equation 2.1. δ_j is defined as $\delta_j = \theta_\delta X_j^\delta + \xi_j$, where X_j^δ represents position characteristics that influence application decisions but do not directly affect the utility derived from obtaining the position.[28] For example, a requirement that all candidates possess two years of work experience does not provide additional utility to a candidate upon being matched with the position. $\theta_\delta X_j^\delta$ represents the cost of meeting specific application requirements. Here, I assume that candidates, regardless of their abilities or civic-mindedness, incur the same cost to satisfy a given qualification requirement. ξ_j captures unobserved position-level characteristics that influence exam takers' position choices during the application stage.

The interview process is excluded from this analysis due to data limitations. This omission is unlikely to be a major concern, as most of the selection occurs during the examination stage. Specifically, local hiring departments typically interview three candidates for every available position. However, on average, more than 18 candidates compete for a single interview slot, as shown in Table 1. The empirical analysis focuses on talent selection prior to the interview stage, with the meritocratic exam serving as a mechanism that constrains subsequent interviews.[29]

The number of candidates hired for position j hires is denoted as λ_j. I assume that the government's labor demand is exogenously determined, as headcount allocations are centrally controlled by the State Commission Office for Public Sector Reform (SCOPSR).[30]

Since no information is available about the population that did not participate in the NCSE, I

[27] Since candidates have not been matched with any job j yet, I assume that $\varepsilon_{i,j}$ here only affects the decision utility. Therefore, the ε_{ij} is multiplied by the probability $\Phi(a_i - \bar{q}_j + \mu_\eta \mathbf{1}_{\text{Prov. Exam}})$.

[28] See Appendix O.5 for detailed descriptions of these characteristics.

[29] An alternative interpretation is that candidates face random selection during the interview process. One might also question whether interviews could effectively screen for civic-mindedness. However, given the structure of interviews in the NCSE, it is unlikely that interviewers have sufficient time or flexibility to assess candidate civic-mindedness. Appendix D.1 provides further details supporting this point.

[30] Many studies on government employment have similarly assumed that the supply of government jobs is exogenously determined; see, for example, Postel-Vinay and Turon (2007), Burdett (2012), and Bradley, Postel-Vinay and Turon (2017).

normalize all positions with labor demand exceeding the number of applicants ($\lambda_j \geq s_j$) to be the "outside" option, meaning that anyone can be matched conditional on applying. The assumption of a uniform outside option for all candidates is less restrictive than it might initially appear. Suppose candidates have heterogeneous outside options in the model. In that case, one might suspect that the application behavior of very high-ability candidates would change, as they have greater incentives to apply sincerely—considering only the utility conditional on being matched. However, exceptionally high-ability candidates are also more likely to be matched with a position under the model. As a result, they already apply sincerely even in a model without heterogeneous outside options.

The probability that an agent i chooses position j is given by $Pr_{ij}(a_i, c_i, \bar{q}_j) = \frac{\exp\left(U_{ij}(a_i, c_i, \bar{q}_j)\right)}{1+\sum_j \exp\left(U_{ij}(a, c_i, \bar{q}_j)\right)}$, which follows from the distributional assumption on ε_{ij}. By integrating over types, the share of candidates who apply for position j can be expressed as:

$$s_j = \int_{\mathbb{R}} \int_{\mathbb{R}} \frac{\exp\left(U_{ij}(a_i, c_i, \bar{q}_j)\right)}{1 + \sum_j \exp\left(U_{ij}(a_i, c_i, \bar{q}_j)\right)} dF_c(c_i) dF_a(a_i) \tag{3.2}$$

Let s_j denote the observed share of applicants for position j in a given application market. Based on application decisions and exam results, the central administration determines cutoff scores $\{\bar{q}_j\}$ to fill all posted positions. Specifically, for any selective position j, the following equality must hold:

$$\lambda_j = \int_{\mathbb{R}} \underbrace{\Phi(a_i - \bar{q}_j + \mu_\eta \mathbf{1}_{\text{Prov. Exam}})}_{\text{Prob candidate with } a_i \text{ passing } \bar{q}_j} \underbrace{\left[\int_{\mathbb{R}} \frac{\exp\left(U_{ij}(a_i, c_i, \bar{q}_j)\right)}{1 + \sum_j \exp\left(U_{ij}(a_i, c_i, \bar{q}_j)\right)} dF_c(c_i) \right]}_{\text{number of applicants for position } j} dF(a_i) \tag{3.3}$$

I establish the uniqueness of the equilibrium cutoff scores by invoking Proposition 2. Detailed calculations are provided in Appendix B.1.

Proposition 3 *Fixing a set of utility parameters and the number of candidates demanded for each position j ($\{\lambda_j\}$), I define the right-hand side (RHS) of Equation (3.3) as $\pi_j(\bar{q}_1, \bar{q}_2, ..., \bar{q}_j)\ \forall j > 0$. I demonstrate that $\frac{\partial \pi_j}{\partial \bar{q}_j} < 0$ for all j and $\frac{\partial \pi_j}{\partial \bar{q}_{j'}} > 0$ for all pairs of j and j'. As a result, there exists a unique set of $\bar{q}_j$ that clears the matching markets according to Proposition 2.*

Equilibrium sorting pattern. The NCSE restricts each candidate to apply for *one* position before the exam, leading to strategic application. Candidates do not always choose a position maximizing the utility conditional on being matched. When making an application decision, each

candidate evaluate the position characteristics and the expected cutoff score of each position.[31] Moreover, the difference in measurability leads to a unique sorting pattern in equilibrium. Low civic-minded candidates applying more frequently to high-rent jobs pushes up the equilibrium cutoff scores for those positions, further discouraging candidates with higher civic-mindedness from applying. As a result, high-rent positions in equilibrium are more likely to match with low civic-minded candidates. In Online Appendix O.2, I provide a simple version of the model to illustrate the idea in more detail.

3.3 Estimation and Empirical Matching Pattern

The sample used for structural estimation is constructed from the 2016 and 2017 NCSE datasets. Each province is defined as an application market t, reflecting exam takers' home preferences.[32] I assume that all candidates choose a position from application market t after evaluating all positions in that market. Positions requiring specialized skills are excluded because such positions attract candidates with specific expertise, making them less likely to apply for other more generic positions.[33] Additionally, positions in *Hainan*, *Xinjiang*, and *Tibet* are omitted due to their unique administrative structures.[34] Please refer to Appendix D.2 for more details about these exclusions.

I aggregate positions within a prefecture by department type, administrative level of the department, and exam type.[35] For each constructed representative position, I calculate the average position characteristics, average cutoff scores, and average number of applicants. For example, if the State Agency of Tax opens five positions in a prefecture for the 2016 NCSE and all positions are evaluated using the prefecture exam, I construct a representative position where the position characteristics are the averages of the characteristics of all five positions.

The reasons for aggregating positions at the prefecture $\times$ department type $\times$ exam type level

[31] Candidates with the highest ability level engage less in strategic application because their probability of being matched with a position is very close to 1 given their high ability.

[32] Positions from the four municipalities—*Beijing*, *Shanghai*, *Tianjin*, and *Chongqing*—are excluded. Although municipalities in China are provincial-level administrative units, they cover significantly smaller areas compared to typical provinces. Consequently, there is little variation in prefecture-level characteristics within these municipalities.

[33] Examples of positions requiring specialized skills include police-related positions in the railway system, translator positions requiring specific language skills, and positions requiring expertise in meteorology, sailing, computer science, or medical knowledge.

[34] Another reason is the limited coverage of these regions in the "China City Statistical Yearbook." For example, while Xinjiang comprises 14 prefectures, the Yearbook provides data for only 2 of them for most statistics.

[35] Due to the large number of departments participating in the NCSE and the fact that not all departments recruit every year, I categorize all departments into nine types based on their functional similarities. For the empirical analysis, I use department types instead of individual departments. For further details, please refer to Online Appendix O.5.

are twofold. First, the average number of positions within an application market is 349 before aggregation. It is unlikely that candidates evaluate all alternatives when applying. Moreover, such a large number of alternatives poses challenges for estimation. Second, because I only observe prefecture-level variations in average wages and corruption investigations, aggregating positions at the prefecture $\times$ department type $\times$ exam type level does not result in significant information loss. After aggregation, I obtain 48 application markets and 1,853 positions. Table 3 presents the summary statistics of the sample constructed for estimation. Online Appendix D.3 provides summary statistics for position requirements (X_j^{δ}).

I classify the parameters of interest into two sets: non-linear parameters (NLP) $\Theta = \{\theta_x, \theta_\mu, \bar{\theta}_\mu, \mu_c, \sigma_c, \mu_\eta\}$ and linear parameters (LP) θ_δ'. I modify the nested fixed-point algorithm originally proposed by Berry, Levinsohn and Pakes (1995) by imposing a slot constraint on the optimization problem, reflecting the fixed number of slots for each position j. I derive a Generalized Method of Moments (GMM) estimator from the population moment condition $E\left[Z_j \xi_j\right] = 0$ and employ a standard two-step procedure for GMM estimation. Additional details are provided in Appendix O.3.1.

The insight from the nonparametric identification result in Theorem 1 is that instruments shifting candidates' preferences/types and government preferences independently are required. In practice, I use three sets of instruments in the estimation.

Government preference is represented by the shifter (μ_η) representing differences in exam difficulty. The first instrument I use is the administrative level of the department of a position. Typically, the provincial exam paper is required when the department of that position has an administrative rank at or above sub-province level. The second instrument used to identify μ_η is whether a position is located in a sub-provincial or higher-level city. Since sub-provincial or higher-level cities are much more likely to have positions affiliated with a department at or above the sub-province level, positions in those cities are more likely to be assigned the provincial exam paper. Both instruments are constructed based on China's basic institutional features, meaning they are unlikely to be related to any specific position-level unobserved heterogeneity while shifting the probability that a position is assigned a harder exam paper.

Second, I use a set of prefecture-level variables to help identify candidate preferences for prefecture characteristics. I use the average prefecture characteristics of other positions in the same application market as instruments. Additionally, I utilize the prefecture budgetary fiscal expenditure,

which affects the material benefits of government jobs. It is mean-independent of position-level unobserved characteristics and current preference-level shocks because the government budgetary expenditure is determined at the beginning of a fiscal year, long before the NCSE application time. The third set of instruments is based on position characteristics, which assists in identifying candidate preferences for position characteristics. Specifically, I use the average position characteristics of other positions in the same application market.

Table 2: Non-linear Parameter Estimates

Non-linear Para	Estimates and Standard Errors		
	$\bar{\theta}_\mu$ (Ability Dist Cons)	θ_μ (Ability Dist Slope)	μ_c (Civic Dist Mean)
Estimate	-4.260	3.497	0.957
Std. Error	(0.060)	(0.019)	0.020)
	σ_C (Civic Dist Var)	μ_η (Exam Shifter)	θ_x (Status / Power)
Estimate	0.954	-7.208	6.381
Std. Error	(0.010)	(0.043)	(0.008)
	θ_x (Level)	θ_x (Wage)	
Estimate	12.294	0.868	
Std. Error	(0.036)	(0.002)	

Notes: Please refer to Table 5 in the Appendix E for LP estimates θ_δ. Online Appendix O.3.1 present more details about the estimation. A Sargen - Hansen test (or Sargan's J test) is performed to check the validity of the instruments. I find that the p-value is larger than the significance level (0.05), meaning that the null hypothesis is not rejected and the instruments are considered valid. In Online Appendix O.3.2, I report estimates using an alternative way of defining prestigious and power positions.

Table 2 presents the estimated NLP (Θ) from the preferred specification. Consistent with the empirical patterns shown in Appendix O.1.2, application markets with a higher average GDP per capita attract candidates of correspondingly higher ability on average ($\theta_\mu > 0$). The province exam paper is found to be generally more challenging than the prefecture exam paper ($\mu_\eta < 0$). Estimates on candidates' preferences ($\theta_x > 0$) suggest that positions characteristics, including status (powerful), administrative levels, and wages, are all desirable. Low civic-minded candidates express stronger preferences for positions with higher past anti-corruption cases than high civic-minded candidates, though candidates on average prefer positions with higher past anti-corruption cases ($\mu_c > 0$). Table 5 in the Appendix E reports the estimated LP (θ_δ). Linear parameters are interpreted as costs associated with requirements for the candidates, suggesting that these requirements may deter candidates from applying for the position. In the later analysis, it is sufficient to use the

$\{\delta_j\}$ obtained in the estimation process to capture position-specific characteristics that shifts the application decision for each position j.

Using the set of estimates, I obtain the model-predicted average ability (A_j) and civic-mindedness (C_j) of all matched candidates for each position j as follows:

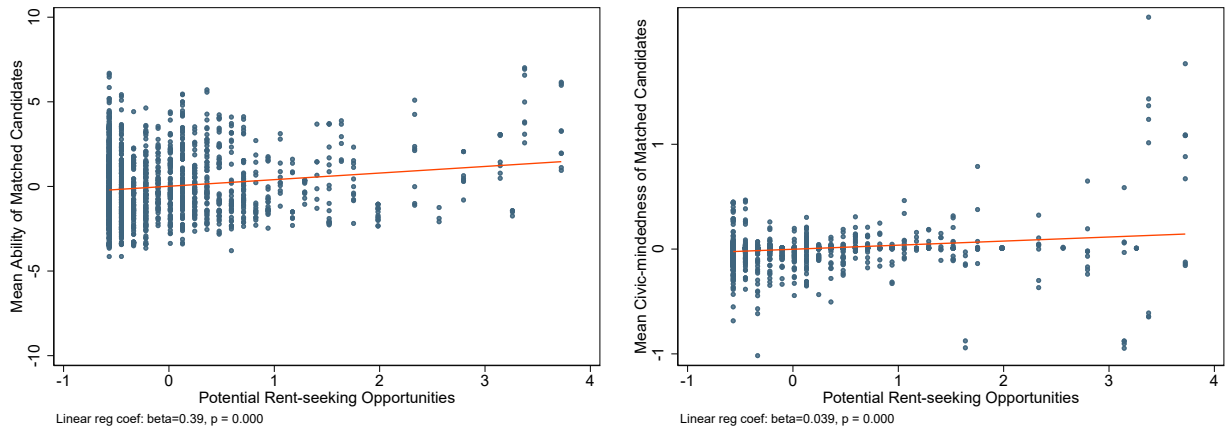
$$A_j = \frac{1}{\lambda_j} \int \int a_i \Phi(a_i - \bar{q}_j + \mu_\eta \mathbf{1}_{\text{Prov. Exam}}) Pr_{ij}(a_i, c_i) dF_c dF_a$$

$$C_j = \frac{1}{\lambda_j} \int \int c_i \Phi(a_i - \bar{q}_j + \mu_\eta \mathbf{1}_{\text{Prov. Exam}}) Pr_{ij}(a_i, c_i) dF_c dF_a.$$

Here, $Pr_{ij}(a_i, c_i)$ denotes the estimated choice probability derived from the empirical model. Within the integrals, $\Phi(a_i - \bar{q}_j + \mu_\eta \mathbf{1}_{\text{Prov. Exam}}) Pr_{ij}(a_i, c_i)$ represents the likelihood that a candidate of type a_i and c_i applies to and is subsequently matched with position j.

3.4 Empirical Sorting Pattern

I use the position-level average civic-mindedness and ability from the estimation to study the empirical matching pattern.



Notes: The y-axis of the left figure represents the estimated average ability of all matched candidates ($\{A_j\}$) residualized using year fixed effects. I drop prefectures with past corruption cases that are in the 99th percentile or higher in the plot to prevent the influence of outliers. The y-axis of the right figure represents the estimated average civic-mindedness of all matched candidates ($\{C_j\}$) residualized by year fixed effects. For each figure, I draw a linear fit prediction.

Figure 2: Multidimensional Sorting: Potential Rent-seeking Opportunities

The left panel of Figure 2 indicates that high rent positions are more likely to be matched with high-ability candidates on average. This empirical pattern emerges because positions with greater rent-seeking opportunities are generally preferred by candidates. Since higher $C_j$corresponds to

lower average civic-mindedness for position j, the right panel reveals that high-rent positions hire candidates with lower civic-mindedness on average, though the magnitude is modest. The empirical matching pattern shown in the right panel is consistent with the equilibrium characteristics discussed at the end of Section 3.2: applying more frequently to high-rent jobs pushes up the equilibrium cutoff scores for those positions, further discouraging candidates with higher civic-mindedness from applying. Nevertheless, the negative correlation between civic-mindedness and rent-seeking opportunities is not large, partly because the NCSE restricts candidates to applying for only one position before the exam. Uncertainty about the exam and potential competition discourages lower civic-minded candidates from applying for their preferred high-rent positions.

Figure 5 provides additional evidence of sorting: high-wage positions tend to match with candidates of higher ability. However, candidates with both lower and higher civic-mindedness exhibit similar likelihoods of being matched with high-wage positions. This result is expected, as candidates with varying levels of civic-mindedness exhibit similar preferences for wages.

3.5 Counterfactual Analysis

I consider a 'first-exam-then-apply' mechanism as an alternative matching mechanism. In this mechanism, candidates first take an exam with the same exam paper and then apply for a position. Priority is assigned to candidates with higher exam scores. This mechanism is a version of the serial dictatorship (SD) that is similar to that used for matching candidates to civil service positions in the Bangladesh Civil Service and the Indian Administrative Service (IAS) (Thakur, 2021).

Mechanism 1 *A 'first-exam-then-apply' mechanism with meritocratic priority ranking allocates positions to candidates through the following five steps: (1) The government announces vacancies. (2) Candidates' preference shocks for all positions are realized. (3) The government organizes an exam for all candidates interested in applying for a position. The exam provides a noisy signal of candidate ability, but candidate civic-mindedness remains unknown to the government. (4) The government ranks all candidates based on their exam scores. (5) Each candidate, in order of their rank, selects a position until all positions are taken.*

The mechanism outlined above eliminates exam uncertainty in the application process and is strategy-proof because: (1) obtaining a higher score increases a candidate's likelihood of being

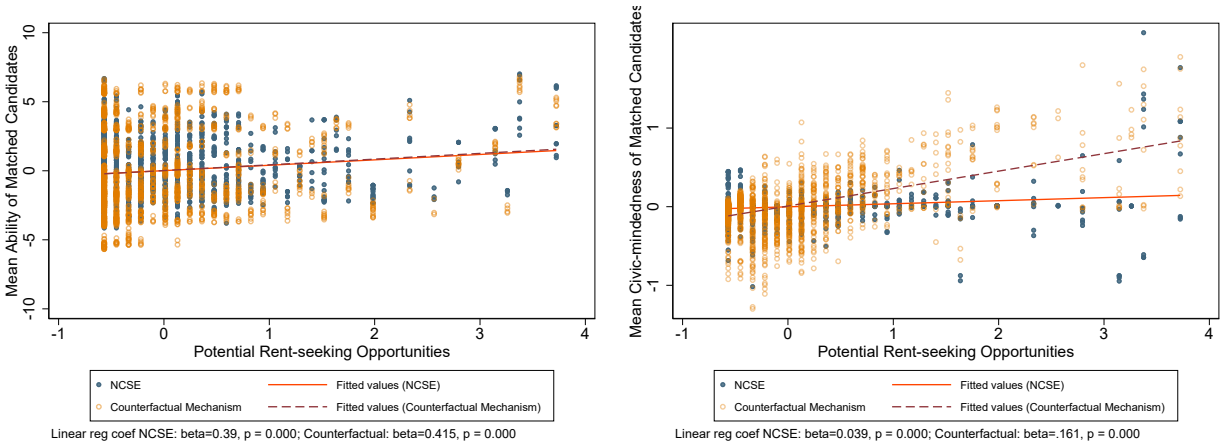
matched with their most preferred position, and (2) no candidate can secure a more preferred position through untruthful reporting during the application stage. An alternative way to design the mechanism is to ask all candidates to submit a full rank-order list for all positions in their application market before the government announces candidate rankings in the exam. This alternative arrangement produces the same matching outcome as Mechanism 1 in the context of this paper when a single exam paper is used.

A candidate's indirect utility for applying to a position under Mechanism 1 differs from what is specified in Equation (3.1). Under Mechanism 1, candidates have already learned their ranking within the application market. Specifically, candidate i's utility for being matched with position j is now given by $U_{ij}^{c}(c_i) = u(x_j, m_j|c_i) + \delta_j + \varepsilon_{ij}$.

I simulate counterfactual matches and denote the simulated average ability and civic-mindedness of all matched candidates through the alternative Mechanism 1 as $\{A_j^s\}$ and $\{C_j^s\}$ respectively. Details about the simulation procedures are provided in Online Appendix O.4.1.

Sorting pattern: alternative mechanism versus the NCSE. Since applications occur after the revelation of candidates' relative exam rankings, high-ability candidates are more likely to be matched with desirable positions under the alternative mechanism than under the NCSE. Therefore, candidates with high ability are more likely to be matched with generally desirable positions (high x_j). In other words, the average ability of candidates for desirable positions should be higher, while the average ability of candidates for less-desirable positions should lower under the alternative mechanism than under the NCSE. This reasoning also applies to civic-mindedness. Candidates with lower civic-mindedness are more likely to be matched with their preferred positions, particularly those with high corruption opportunities. As a result, compared to the NCSE, the counterfactual mechanism facilitates stronger sorting.

Figures 3 illustrate the counterfactual sorting pattern compared to the sorting pattern under the NCSE. The right panel of Figure 3 shows that under the alternative mechanism, the correlation between the average civic-mindedness of matched candidates and potential rent-seeking opportunities is over three times stronger than under the NCSE. In contrast, while the correlation between the average ability of matched candidates and potential rent-seeking opportunities (left panel of Figure 3) is more pronounced than under the NCSE, the increase is smaller (approximately 6%), as not all candidates strongly prefer high-rent positions.



Notes: The y-axis of the left figure represents the average ability of matched candidates residualized by year fixed effects. I drop prefectures with past corruption cases that are in the 99th percentile or higher in the plot to prevent the influence of outliers. The y-axis of the right figure represents the average civic-mindedness of matched candidates for each position residualized by year fixed effects. The dots denote the same matching outcome estimates shown in Figure 2. The circles denote simulated matching outcomes based on the mechanism 1. For each figure and each matching outcome, I draw a linear fit prediction. The fit prediction for the NCSE is a solid line while the fit prediction for the counterfactual mechanism is a dashed line.

Figure 3: Multidimensional Sorting (Counterfactual) : Potential Rent-seeking Opportunities

As expected, Figure 6 shows that high-ability candidates are more likely to be matched with positions with high average wages under the alternative mechanism compared to the NCSE. Furthermore, it shows that the correlation between the average civic-mindedness of matched candidates and the prefecture's average wages under the counterfactual mechanism remains close to zero.[36] This finding aligns with expectations, as candidates prefer high wages regardless of their civic-mindedness.

Consequence on Government Performance. Since government jobs in China are desirable and have a very low quit rate (less than 0.015%) among employees, I focus on the potential implications of these mechanisms for government performance through a simulation exercise.[37] The goal is to highlight the significance of multidimensional sorting—specifically, ability and civic-mindedness sorting, with an emphasis on the unobservability of civic-mindedness.[38]

[36]Under the 'first-exam-then-apply' mechanism, the positive correlation between average wages and average civic-mindedness is more pronounced. This occurs because wages are positively correlated with potential rent-seeking opportunities. As a result, the stronger positive correlation between average wages and average civic-mindedness arises mechanically when the counterfactual mechanism matches a greater number of low civic-minded candidates to high-rent jobs.

[37]See the following news report for the low quit rate for government employees in China: http://union.china.com.cn/kx/txt/2018-01/30/content_40208798.htm

[38]See Thakur (2021) for discussions on designing matching mechanisms that balance the trade-off between candidate preferences and optimizing government performance under ability sorting.

Empirically assessing government performance is notoriously difficult, particularly in evaluating the contribution of newly recruited candidates to departmental performance. Therefore, I assume a stylized government production function for public goods and services (Equation 3.4), which allows for a clear comparison of the costs and benefits of each mechanism.

$$Y = \int_j \left(W_j^a \times A_j^{\vartheta_a} - W_j^c \times \underbrace{\mathbf{1}_{\{C_j \geq 0\}} C_j^{\vartheta_c}}_{\text{low civic-mindedness is costly}} \right) dj \tag{3.4}$$

Here, Y represents total government output, which can be public goods or services. $A_j^{\vartheta_a}$ indicates that positions with candidates of higher average ability contribute to greater government output. $\mathbf{1}_{\{C_j \geq 0\}} C_j^{\vartheta_c}$ represents the cost of employing low civic-minded government workers.[39] Employing candidates with lower civic-mindedness reduces the performance of position j due to their potential involvement in rent-seeking activities. ϑ_a reflects the importance of ability in government production, while ϑ_c represents the cost of corruption or the effectiveness of government agencies in countering rent-seeking activities. A larger parameter ϑ_c implies a higher cost of corruption but lower effectiveness of government agencies in eliminating rent-seeking activities. The *larger* the parameter ϑ_c, the *higher* the cost of corruption but the *lower* the effectiveness of government agencies against rent-seeking activities. I assume that ability contributes equally to all positions ($W_j^a = 1, \forall j$), but assign different weights to civic-mindedness $W_j^c \neq 1$ based on potential rent-seeking opportunities. This reflects that low civic-minded candidates impose greater costs when matched with high-rent positions.

In the empirical exercise, I fix $\vartheta_a = 2$ and vary ϑ_c.[40] Figure 4 presents the result. The solid line depicts government output at various ϑ_c values under the NCSE, while the dashed line illustrates the same under the alternative mechanism. The analysis indicates that the NCSE outperforms the alternative mechanism when the cost of hiring low civic-minded candidates (ϑ_c) exceeds a threshold. Conversely, when the relative importance of civic-mindedness (ϑ_c) falls below this threshold, the alternative mechanism produces more government outputs. Different values of ϑ_a produce different thresholds, but the empirical pattern remains the same. This result emerges

[39] This assumption is based on two primary reasons: (1) introducing an additional parameter complicates the analysis, and (2) most positions are filled with candidates of low civic-mindedness on average (or $C_j > 0$).

[40] When only employee ability matters for government performance, the alternative mechanism yields a better governance outcome if government performance is a convex function of average ability ($\vartheta_a > 1$).

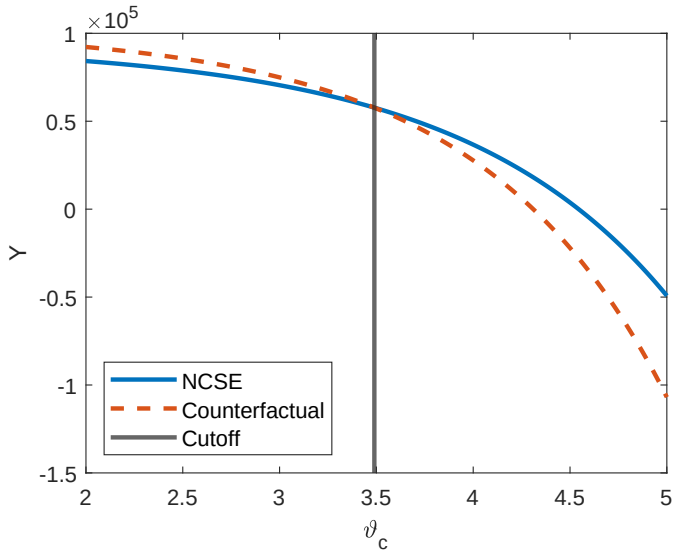


Figure 4: Implications on Government Performance: A Comparison

Notes: The Y-axis represents weight government output Y. The solid line plots the government output given NCSE while the dashed line plots the government output given the alternative mechanism. I fix $\vartheta_a = 2$ in the simulation to focus on how the change of ϑ_c affect Y. The x-axis represents the importance of civic-mindedness in government production ϑ_c. A higher ϑ_c implies a more important impact of candidate civic-mindedness relative to the ability. The vertical line indicates the threshold value where the Ys induced by two mechanisms are equal. Position weights W_j^c is constructed based on the number of potential rent-seeking opportunities (past corruption cases).

because the alternative mechanism is more likely to match lower civic-minded candidates with high-rent jobs than the NCSE. This induces significant costs to government production when civic-mindedness plays a substantial role in government performance (i.e., when ϑ_c is large relative to ϑ_a). In Online Appendix O.4.2, I demonstrate that the pattern shown in Figure 4 remains robust when using weights on ability alone or incorporating both ability and civic-mindedness weights.

Alternatively, this exercise can be interpreted as a revealed preference analysis, providing insights into the underlying objectives of the government given mechanisms like the NCSE and a strategy-proof alternative. Since the Chinese government designed and adopted the current NCSE mechanism for recruitment, the simulation exercise suggests that low civic-minded government officials likely pose significant threats to the Chinese government.

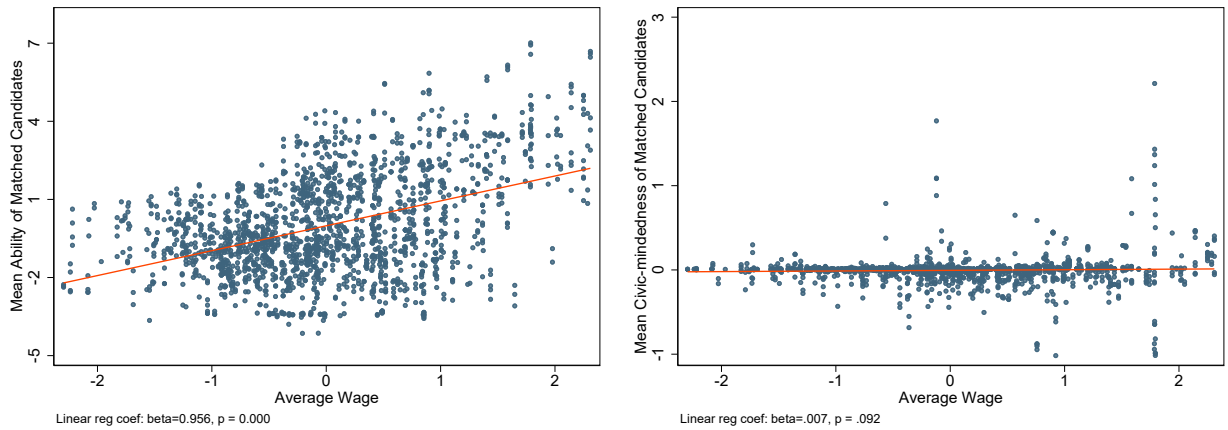
4 Conclusion

This paper develops a new approach to the nonparametric identification of matching models when individual-level data is unavailable. I apply the model and identification results to study matching mechanism design in government recruitment, emphasizing multidimensional sorting and informa-

tion frictions in the matching process. A central takeaway is that matching mechanisms promoting sorting may be less desirable when important yet hard-to-detect worker attributes, such as civic-mindedness, are relevant to on-the-job performance. The findings have broader implications for mechanism design in the hiring process, particularly in situations where attributes like work ethic are pivotal for on-the-job performance but remain undetectable in standard hiring processes.

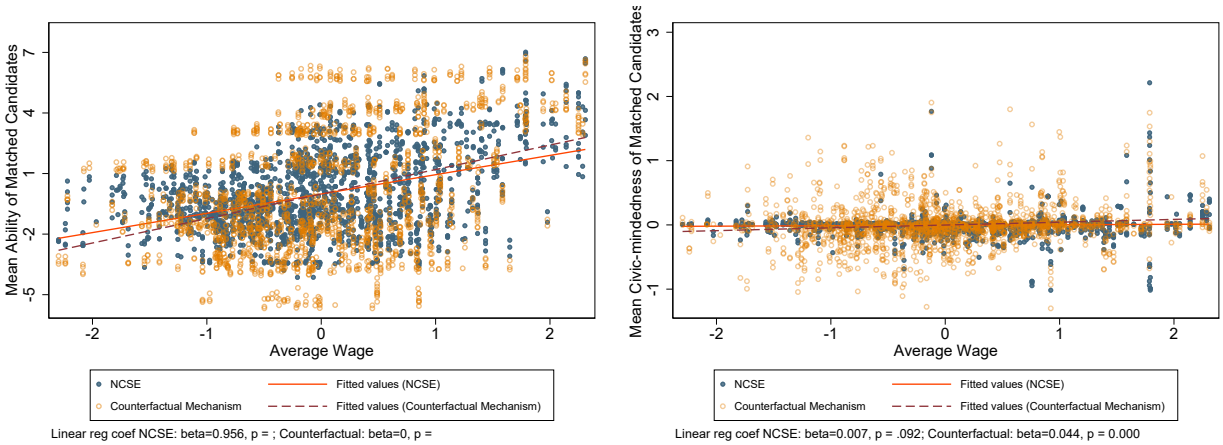
There are several directions in which the design of matching mechanisms in government recruitment, as presented in this paper, could be further developed. First, this paper primarily focuses on analyzing the written exam component of the National Civil Service Examination in China due to data limitations. However, it is important to recognize that advanced screening methods could potentially identify candidates' civic-mindedness. Should better screening tools become available, they may change sorting patterns in government recruitment. Moreover, this paper focuses on a fixed pool of candidates interested in government positions. Exploring the impact of matching mechanisms in government recruitment on the broader labor market — both within the public sector and beyond — represents a promising direction for improving our understanding of government recruitment. I leave these extensions to future research.

A Figures and Tables



Notes: The y-axis of the left figure represents the estimated average ability of all matched candidates ($\{A_j\}$) residualized using year fixed effects. The Y-axis of the right figure represents the estimated average civic-mindedness of all matched candidates ($\{C_j\}$) residualized by year fixed effects. For each figure, I draw a linear fit prediction line. I drop prefectures with average wage that below the 0.1th percentile or higher in the plot to avoid outliers.

Figure 5: Multidimensional Sorting: Average Wages



Notes: The y-axis of the left figure represents the average ability of matched candidates for each position residualized by year fixed effects. The y-axis of the right figure represents the average civic-mindedness of matched candidates for each position residualized using year fixed effects. The dots are matching outcomes in Figure 2. The circles denote simulated matching outcomes based on mechanism 1. For each figure, I draw two linear fit prediction lines. I drop prefectures with average wage that below the 0.1th percentile or higher in the plot to avoid outliers.

Figure 6: Multidimensional Sorting: Average Wages

Table 3: Summary Statistics of the Sample Used for Estimation

	Mean	Std. Dev.
Panel A		
# of application markets (t)	48	—
# of positions per application markets (t)	38.604	—
Share of j using province exam paper	0.080	—
Panel B		
# of candidates demanded	4.318	2.166
# of applicants	91.192	94.941
Cutoff score	120.965	7.857
Panel C		
Prestigious / Powerful	0.310	0.442
Level	1.492	0.609
Non-Private unit wage	57354.89	10743.84
Past corruption cases	4.889	8.623
Observations	1,853	

Notes: Panel A shows summary statistics for the application markets. Panel B summarizes three NCSE results that are used in the estimation. Panel C presents summary statistics for variables that matters for the utility conditional being matched with a positions. For summary statistics of the position requirements (X_δ), please refer to Table 4 in the Appendix D.3.

B Omitted Proofs

B.1 Proof for Proposition 3

Proof. Pick an arbitrary j,

$$\pi_j = \int\int \Phi(a_i - \bar{q}_j + \mu_\eta \mathbf{1}_{\text{Prov. Exam}}) \left[\frac{\exp\left(U_{ij}(a_i, c_i, \bar{q}_j)\right)}{1 + \sum_j \exp\left(U_{ij}(a_i, c_i, \bar{q}_j)\right)} \right] dF_c dF_a$$

Then

$$\frac{\partial \pi_j}{\partial \bar{q}_j} = \int\int -\Phi'(a_i - \bar{q}_j + \mu_\eta \mathbf{1}_{\text{Prov. Exam}}) \left[p \frac{\exp\left(U_{ij}(a_i, c_i, \bar{q}_j)\right)}{1 + \sum_j \exp\left(U_{ij}(a_i, c_i, \bar{q}_j)\right)} \right]$$
$$+ \Phi(a_i - \bar{q}_j + \mu_\eta \mathbf{1}_{\text{Prov. Exam}}) \left[p \frac{\partial \frac{\exp\left(U_{ij}(a_i, c_i, \bar{q}_j)\right)}{1 + \sum_j \exp\left(U_{ij}(a_i, c_i, \bar{q}_j)\right)}}{\partial \bar{q}_j} \right] dF_c dF_c$$

The first term is negative. I only need to show that $\frac{\partial \frac{\exp\left(U_{ij}(a_i, c_i, \bar{q}_j)\right)}{1 + \sum_j \exp\left(U_{ij}(a_i, c_i, \bar{q}_j)\right)}}{\partial \bar{q}_j} < 0.$

$$\frac{\partial \frac{\exp\left(U_{ij}(a_i, c_i, \bar{q}_j)\right)}{1 + \sum_j \exp\left(U_{ij}(a_i, c_i, \bar{q}_j)\right)}}{\partial \bar{q}_j} =$$
$$\frac{-\exp\left(U_{ij}(a_i, c_i, \bar{q}_j)\right) \Phi'(a_i - \bar{q}_j + \mu_\eta \mathbf{1}_{\text{Prov. Exam}}) \left(1 + \sum_j \exp\left(U_{ij}(a_i, c_i, \bar{q}_j)\right)\right) + \exp\left(U_{ij}(a_i, c_i, \bar{q}_j)\right)^2 \Phi'(a_i - \bar{q}_j + \mu_\eta \mathbf{1}_{\text{Prov. Exam}})}{\left(1 + \sum_j \exp\left(U_{ij}(a_i, c_i, \bar{q}_j)\right)\right)^2}$$
$$= \frac{-\exp\left(U_{ij}(a_i, c_i, \bar{q}_j)\right) \Phi'(a_i - \bar{q}_j + \mu_\eta \mathbf{1}_{\text{Prov. Exam}}) \left(1 + \sum_{k \neq j} \exp\left(U_{ik}(a_i, c_i, \bar{q}_k)\right)\right)}{\left(1 + \sum_j \exp\left(U_{ij}(a_i, c_i, \bar{q}_j)\right)\right)^2} < 0$$

Now I've shown that $\frac{\partial \pi_j}{\partial \bar{q}_j} < 0$ for all j. The case for $\frac{\partial \pi_j}{\partial \bar{q}_{j'}} > 0$ is analogous.

$$\frac{\partial \pi_j}{\partial \bar{q}_k} = \int\int \Phi(a_i - \bar{q}_j + \mu_\eta \mathbf{1}_{\text{Prov. Exam}}) \left[\frac{\partial \frac{\exp\left(U_{ij}(a_i, c_i, \bar{q}_j)\right)}{1 + \sum_j \exp\left(U_{ij}(a_i, c_i, \bar{q}_j)\right)}}{\partial \bar{q}_k} \right] dF_c dF_a$$

Notice the term in the bracket is negative.

$$\frac{\partial \frac{\exp\left(U_{ij}(a_i, c_i, \bar{q}_j)\right)}{1 + \sum_j \exp\left(U_{ij}(a_i, c_i, \bar{q}_j)\right)}}{\partial \bar{q}_k} = \frac{-\exp\left(U_{ij}(a_i, c_i, \bar{q}_j)\right) \Phi'(a_i - \bar{q}_k + \mu_\eta \mathbf{1}_{\text{Prov. Exam}}) \exp\left(U_{ik}(a_i, c_i, \bar{q}_k)\right)}{\left(1 + \sum_j \exp\left(U_{ij}(a_i, c_i, \bar{q}_j)\right)\right)^2} < 0$$

■

C Multiple Applications

Here, I discuss how to extend the main identification result to the case where agents can make multiple application choices.

I assume that each agent i is allowed to apply to a total of $\bar{J}_a$ different positions. Moreover, in the application stage, I assume that each agent applies sequentially to firms according to the descending order of the expected utility that he/she derives. Specifically, agent i initially applies to one firm, denoted as j_1, which provides the highest utility. Following this, the agent applies to another firm, denoted as j_2, offering the highest utility among the remaining firms. The agent continues this process sequentially until reaching the limit $\bar{J}_a$.[41] The application process concludes after agents have submitted all their applications.

After the application stage, neither the firms nor the researchers can ascertain the order in which agents applied to each firm. However, I can simulate a rank order list for each agent. Assuming that each agent's choice of j_a is unique with probability 1, the share of agents who apply to firm j can be expressed as:

$$s_{jt} = \sigma_j(\chi_t) = Pr_1(j_1 = j) + Pr_2(j_2 = j) + ... + Pr_{\bar{a}}(\bar{J}_a = j)$$

$s_t = (s_{1t}, ..., s_{Jt})$ is the vector that collects the number of agents who apply for firm j in market t empirically. $\sigma(\chi_t) = (\sigma_1(\chi_t), ..., \sigma_J(\chi_t))$ is a vector that collects the model predicted number of agents who apply for firm j in market t. $Pr_a(j_a = j)$ (in short $Pr_1(j)$) is the share of candidates that choose firm j in their ath application. For example, if $\bar{J}_a = 2$, then I can write the probability $Pr_1(j)$ and $Pr_2(j)$ more precisely:

$$Pr_1(j) = Pr\left(\underset{j \in \mathscr{J}}{\text{argmax}}\ v_{ijt}|\chi_{jt}\right), \quad Pr_2(j) = (1 - Pr_1(j)) \sum_{k \neq j} Pr\left(\underset{j \in \mathscr{J}/k}{\text{argmax}}\ v_{ijt}|\chi_{jt}\right)$$

While $Pr_1(j)$ is the same as the analysis in the main part of the paper, $Pr_2(j)$ is the conditional probability that agent i sends the second application to firm j while sending the first application to a firm $k \neq j$.

[41] Notice here that a job seeker does not have an incentive to apply for a position that does not derives the highest expected utility in his/her ath application conditional on a set of equilibrium hiring standards because of the assumption that each applicant is infinitesimally small.

Similarly, I can formulate the slot constraint function $\pi_j(x_t, \bar{q}_t, \xi_t)$ in this scenario. The feasibility of this approach stems from two key factors. First, each agent's preference order on applied firms can be simulated due to the application structure. Second, the large market approximation implies that there is a deterministic share of agents applying for a position is successfully hired. The uniqueness of the set of equilibrium hiring standards arises similarly from the Assumption 3.

Finally, the identification result follows closely from proposition 1 given the completeness assumption on instruments (Assumption 2). I provide an illustration of a simple random utility model that satisfies the connected substitutes assumption, wherein applicants are allowed to apply to two firms.

Example 2 *In the example, each agent can apply for two firms. The utility that an agent i's expected utility from applying for firm j equals $\delta_{jt} + u(q_i, x_{jt}) + \varepsilon_{ijt}$. Here, q_i is i.i.d. drawn from a known distribution F_q while ε_{ijt} is i.i.d. drawn from EVT1.*

According to the above setup, I can write $Pr_1(j)$ and $Pr_2(j)$ as

$$Pr_1(j) = \frac{\exp(\delta_{jt} + u(q_i, x_{jt}))}{\sum_{j \in \mathscr{J}} \exp(\delta_{jt} + u(q_i, x_{jt}))} \qquad Pr_2(j) = \left(1 - \frac{\exp(\delta_{jt} + u(q_i, x_{jt}))}{\sum_{j \in \mathscr{J}} \delta_{jt} + u(q_i, x_{jt})}\right) \sum_{k \neq j} \frac{\exp(\delta_{jt} + u(q_i, x_{jt}))}{\sum_{j \in \mathscr{J}/k} \exp(\delta_{jt} + u(q_i, x_{jt}))}$$

The total number of applications received by firm j can be written as

$$s_j = \int_{\mathbb{R}} \int_{\mathbb{R}} \overbrace{\frac{\exp\left(U_{ij}(q_i, c_i)\right)}{1 + \sum_j \exp\left(U_{ij}(q_i, c_i)\right)}}^{j \text{ is the 1st choice}} dF_c(c_i) dF_q(q_i) + \int_{\mathbb{R}} \int_{\mathbb{R}} \underbrace{\left(1 - \frac{\exp\left(U_{ij}(q_i, c_i)\right)}{1 + \sum_j \exp\left(U_{ij}(q_i, c_i)\right)}\right)}_{j \text{ is not the 1st choice}} \sum_{k \neq j} \underbrace{\frac{\exp\left(U_{ij}(q_i, c_i)\right)}{1 + \sum_{j \in \mathscr{J}/k} \exp\left(U_{ij}(q_i, c_i)\right)}}_{j \text{ is the 2nd choice}} dF_c(c_i) dF_q(q_i) \quad \text{(C.1)}$$

Differentiating s_{jt} w.r.t. δ_{jt} for all j yields the Jacobian matrix. Three results can be demonstrated: 1, $\frac{\partial s_{jt}}{\partial \delta_{jt}} > 0$; 2, $\frac{\partial s_{jt}}{\partial \delta_{kt}} < 0 \; \forall k \neq j$; 3, the Jacobian matrix satisfies the Diagonal Dominance Condition through conventional arguments thereby implying its non-singularity. Consequently, the connected substitutes assumption is satisfied. This means that the set of $\{\delta_{jt}\}$ can be obtained by inverting the observed number of applications. Following this, one can rely on instruments to identify both firm and candidate preferences and types.

A natural upper limit of the number of applications each agent can submit is $J-1$, or $\bar{J}_a \leq J-1$. This is because if all agents send applications to all firms, then the number of applicants is no longer

informative. Formally, the upper limit $\bar{J}_a$ is restrained by the Assumption 1, because inversion result will become invalid as the number applications each candidate is allowed to submit increases.

D Details of the NCSE Dataset

D.1 Interview process

During the interview process, each candidate will face many interviewers. The entire process has been recorded starting from NCSE 2016. In the interview process, interviewers will ask each candidate 4-5 questions, and the whole process typically lasts less than 30 minutes. Results of the interview will typically be announced 1-7 days after the interview. The questions asked during these interviews are typically not designed by the hiring department itself but are designed by another professional department within the government, although there is some flexibility.

In sum, due to the rigid process and the limited time, interviewers and interviewees do not have a chance to interact closely, making it hard for the interviewer to elicit a candidate's civic-mindedness during the process.

D.2 Sample Construction

The initial sample adjustment involves the exclusion of positions from four municipalities—*Beijing*, *Shanghai*, *Tianjin*, and *Chongqing*. This equates to a reduction of 3,991 positions, or 13.9% of the original 28,648 positions.[42]

For the structural analysis, the assumption is that each agent assesses every position in the applicant market. In order to formulate a more homogeneous group for analysis, positions demanding unique skills are omitted. Agents applying for these positions are presumably disinclined to consider alternative positions due to their specialized skills. The discarded positions include policy-related railway positions, translator roles necessitating specific language skills, and positions requiring expertise in meteorology, sailing, computing, or medicine. In total, 6,225 positions demanding unique skills were dropped, which constituted 22% of the original 28,648 positions.

The third adjustment to the sample involved the exclusion of positions from *Hainan* province, *Xinjiang*, and *Tibet*. This resulted in a reduction of 2,082 positions, or 7.3% of the total positions.

[42]Majority of positions affiliated with the central government headquarters are in Beijing. Positions tied to the central government but located outside Beijing are also omitted due to their negligible presence in the dataset (approximately 0.1%).

After these sample adjustments, a refined sample consisting of 16,763 positions was obtained. Given the presence of 48 application markets in the sample, each application market, on average, contained 349 positions. For each application market t, non-competitive positions—those with a recruitment quota equal to or greater than the number of applicants—are assigned. Five application markets feature exclusively competitive positions. For these markets, a position with the lowest cutoff score for passing the written exam phase is normalized to be the outside option.

D.3 Summary Statistics of Position Requirements

I present summary statistics for position restrictions contained in the X_δ after I aggregate positions at the prefecture $\times$ department types $\times$ exam types.

Table 4: Summary Statistics of the Sample Used for Estimation (X_δ)

Variable Name	Mean	Std. Dev.
Education: degree requirement	0.560	0.546
Minimum Work Experience	0.180	0.285
Political Status	0.075	0.221
Fresh College Graduate	0.354	0.369
English Exam Minimum Score	0.368	0.456
College major: humanity	0.172	0.263
College major: Social Science	0.633	0.368
College major: Science	0.401	0.367
College major: Finance	0.506	0.380
Minimum serving requirement	0.008	0.270
Poor region	0.107	0.251
Placed based policy	0.169	0.315
Observations	1,853	

Except for the degree requirement variable, all other variables can be understood as the share of positions within a prefecture $\times$ department types $\times$ exam types cell that have the specific requirement. For example, the average share of positions within a prefecture $\times$ department types $\times$ exam types cell of having a minimum work experience requirement is 18.3%. Fresh college grad is a

position requirement indicating that only the fresh college graduate of the year can apply. English Exam minimum score is a position requirement that only agents who pass the College English Test (CET-4 or CET-6) with a certain minimum score. Poor region is a position characteristic indicating that the position locating in a poor area. Placed based policy is a position characteristic indicating that the position enjoys a place based policy.

The degree requirement is coded differently. Before the data aggregation at the prefecture $\times$ department types $\times$ exam types level, it equals one if the position has no minimal degree requirement. It equals 2 if it requires at least a bachelor's degree. It equals 3 if it requires at least a master's degree. Therefore, the degree requirement after the data aggregation is a composite measure of the degree requirement within a prefecture $\times$ department types $\times$ exam types cell. A higher degree requirement measure implies a higher average degree requirement for positions within a representative position at the prefecture $\times$ department types $\times$ exam types level.

E Linear Parameter Estimates (θ_δ)

In this subsection, I present linear parameter estimates obtained in the structural estimation. I regress the inverted set of $\{\delta_j\}$ on a set of position requirements X_δ to obtain the set of linear parameters θ_δ

Table 5: Linear Parameter Estimates θ_δ

Linear Para.	Estimates (Standard Errors)			
	Education	Work exp	Political status	Grad Only
Estimate	-0.190	-0.477	-0.524	-0.452
Std. Error	(0.537)	(0.232)	(0.161)	(0.351)
	English Min	Humanity	Social science	Science
Estimate	-0.290	0.656	0.385	0.416
Std. Error	(0.402)	(0.216)	(0.503)	(0.373)
	Finance	Min 5 year	Poor	Place policy
Estimate	-0.231	0.074	-0.121	-0.556
Std. Error	(0.435)	(0.193)	(0.187)	(0.246)
	Constant			
Estimate	1.510			
Std. Error	(0.686)			

I find that requirements such as a higher degree, longer work experience, attaining political status, being a fresh graduate of that year, passing an English exam, having a major in finance and willingness to work in relatively undeveloped areas or areas with special treatments are associated with a higher cost for candidates. Contrarily, positions requiring a humanities, social science, or science major do not seem to discourage candidates from applying, indicating that a significant number of candidates possess one of these majors. The set of parameter estimates are intuitive since all position requirements other than the college major requirements appear to be costly to candidates. One exception is the commitment to the position for more than five years, which is in-precisely estimated.

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Supplementary Appendix: For Online Publication

O.1 NCSE: Additional Empirical Patterns

O.1.1 Hiring Standard: Cross-year Comparison

I demonstrate that the equilibrium cutoff scores for the same position, despite having openings in different years, exhibit a considerable degree of similarity. This observation substantiates the assumption in the matching game model that candidates have rational expectations regarding the equilibrium cutoff score of each position, as they can infer the cutoff score for a specific position by leveraging information from past exams.

Supplemental position comparison data is collected from the same company that offers exam training to NCSE takers. In order to assist exam takers in making informed application decisions, the company's website provides historical cutoff scores required for passing the written exam phase for the same position from past exams (if available) for direct comparison. Applicants can conduct a search for positions they are interested in and subsequently access the cutoff scores from the preceding three years of exams. I web scraped the data from the company's website and have accordingly compiled a set of identical positions. Altogether, there are 1657 positions that had openings for the 2017 and 2015 NCSE, as well as 2854 positions that had openings for the 2017 and 2015 NCSE. To account for the differences in exam papers, I have standardized the scores for each year.

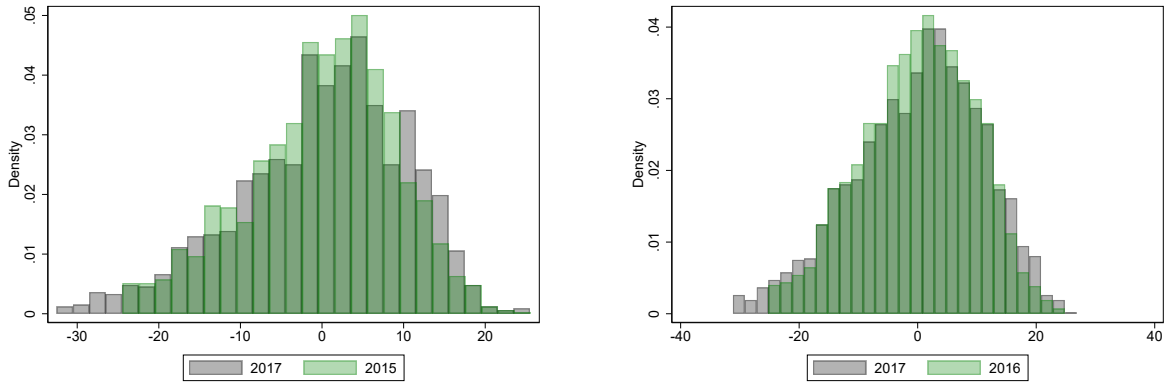


Figure O.1.1: Equilibrium Cutoff Score ($\bar{q}_t$) of a Same Positions in Different Years

Notes: In the left (right) panel, I plot the histogram of equilibrium cutoff score ($\bar{q}_t$) of a same positions in 2017 and 2015 (2016). I drop positions that require special skills. T-tests suggest that scores are not statistically significantly different for any of the two comparison groups.

In Figure O.1.1, the left (right) graph depicts the distributions of equilibrium cutoff scores for positions that had openings in both 2017 and 2016 (2015). The distributions of scores exhibit close resemblance to each other. T-tests suggest that the mean equilibrium scores across any two pairs of exams do not display a statistically significant difference.

O.1.2 Empirical Evidence of Sorting: Province-level Evidence

I present empirical evidence of sorting at the provincial level. I show that provinces with a higher GDP per capita tend to have higher average equilibrium cutoff scores. In line with the primary structural estimation, I exclude positions that are in four municipalities and those that require special skills. Furthermore, positions from *Hainan*, *Xinjiang*, and *Tibet* are also excluded.

In the left panel of Figure O.1.2, I plot the average equilibrium hiring standards for each province against its corresponding provincial GDP per capita. The figure shows a clear upward trend, indicating that provinces with higher GDP per capita generally have higher equilibrium hiring standards on average. These findings corroborate the empirical specification that provinces with a higher GDP per capita have a candidate pool with a higher average ability.

One explanation is that provinces with higher GDP per capita attract more applicants than other provinces. Therefore, cutoff scores in those provinces are naturally higher than that in other provinces. In the right panel of Figure O.1.2, I show that the correlation between provincial average applicants to recruitment quota ratio (App-to-recruit ratio) and provincial GDP per capita is much less pronounced than the correlation between average cutoff scores and the provincial GDP per capita. This evidence further supports that provinces with a higher GDP per capita have a candidate pool with a higher average ability.

Several other plausible explanations exist as to why provinces with higher GDP per capita possess a candidate pool with superior average ability levels. First, provinces with higher GDP per capita tend to host more prestigious universities, which draw talents from across the country. Secondly, regions with a higher GDP per capita are likely to offer better amenities, attracting candidates from other provinces to apply.

O.1.3 Correlation Between Ability and Civic-mindedness

In the empirical model, candidate ability (a_i) and civic-mindedness (c_i) are assumed to be independently distributed. I present survey evidence supporting this assumption. The survey sample

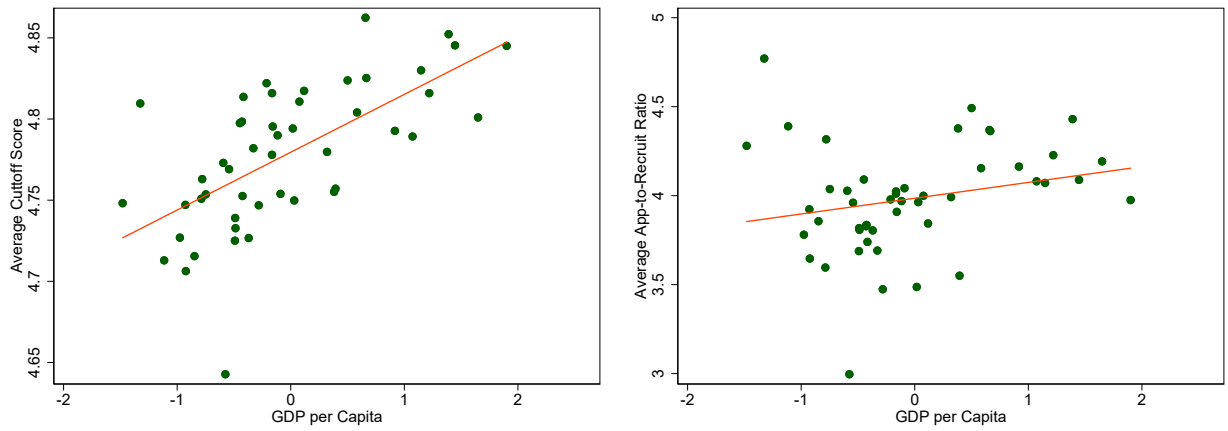


Figure O.1.2: Empirical Sorting: Province GDP per Capita

Notes: In the left panel, the Y-axis represents the logged province average cutoff score (equilibrium cutoff score $\bar{q}_t$) in 2016 and 2017 NCSE. In the right panel, The Y-axis represents the logged province average App-to-recruit Ratio in 2016 and 2017 NCSE. X-axis represents the province GDP per capita. I exclude positions that are in municipalities and require special skills. I drop positions from *Hainan*, *Xinjiang* and *Tibet*.

comes from Feng, He and Liu (2023), which surveys college students from Liaoning and Guangdong provinces in China.

Table O.1.1: Correlation Between Ability and Civic-mindedness: Survey Evidence

	(1)	(2)	(3)	(4)
	Advocate Social Issues Online (2) and Offline (2)		Donation	Blood Donation
Elite University	0.0127	0.00451	0.0287	-0.0433
	(0.0352)	(0.0356)	(0.0363)	(0.0354)
Interest in Gov Jobs	Yes	Yes	Yes	Yes
Age	Yes	Yes	Yes	Yes
Gender	Yes	Yes	Yes	Yes
Obs	1,003	1,003	1,003	1,003

Notes: Elite university is a variable that takes value 1 if the survey respondent self reported as a student from an elite university (a member of project 211 or project 985) in China. I restrict the sample to those who report high interests in government jobs.
*** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$

I use behavioral indicators to represent a respondent's civic-mindedness. These activities include blood donation, disaster- or poverty-relief donations, online advocacy, discussion, or message forwarding for social issues, and face-to-face participation in social causes. The primary dependent variable proxying each respondent's ability is their self-reported status as a student in an elite Chinese university, i.e., those universities as part of Project '211' or Project '985'.

I focus on respondents that report high preferences on government jobs. Table O.1.1 presents

the estimated correlation between self-reported civic-mindedness and ability, controlling for respondent demographics like age and gender. I find no significant correlation between measured civic-mindedness and ability levels. This survey-based empirical evidence supports the assumption in the empirical model that candidate ability (a_i) and civic-mindedness (c_i) are independently distributed

O.2 Matching Game: Equilibrium Properties

In the matching game model proposed in section 2, the application decisions of agents affect each other through the set of equilibrium hiring standards. Within an environment where agents exhibit heterogeneous preferences for jobs, a position is likely to be filled disproportionately by the sub-population that prefers it distinctly. The logic underlying this is that when a sub-population favors a job and applies to it more frequently than to other positions, the equilibrium hiring standard of this position is driven upward by this sub-population. Yet, the high equilibrium hiring standard deters applications from other agents who hold no special preference for the job. In essence, the intensity of agents' preferences for specific jobs or job characteristics significantly shapes the matching outcome. I further illustrate the intuition using the example 3.

Example 3 *Assume the there are only two positions, denoted $j = 1,2$, both offering the same number of slots, i.e., $\lambda_1 = \lambda_2 = \lambda$. There is a continuum of agents, each possessing the same ability level a. Agents only differ in one preference parameter c. A proportion $p = \frac{1}{2}$ of the agents have a preference c_H, while the remaining proportion of agents has a preference c_L.*

The indirect utility of an agent of type c when matched with a job $j = 1,2$ is represented as $\bar{u} = f_1(c_L) > f_1(c_H) = f_2(c_L) = f_2(c_H) = \underline{u}$, where $f_j(c_i)$ is the utility level when agents with c_i is matched with position j. In this example, I set $\delta_j = 0$, whereas ε_{ij} is independently and identically distributed from an EVT1 distribution.

Each job conducts an interview that serves as a noisy signal of agent ability a. Specifically, $y_i = a + \eta_i$, where η_i is drawn from a normal distribution $N(0, \sigma_\eta^2)$.

In this scenario, agents with a preference type c_L favor job 1 over job 2, while agents with a preference type c_H exhibit no preference between the two jobs.

From this setup, I define the equilibrium hiring standard of job j as $\bar{q}_j$. An agent has a probability $\Phi\left(\frac{a-\bar{q}j}{\sigma_\eta}\right)$ of being matched with job j. I can immediately define the probability of a type c_i agent i choosing job j ($Pr_j(c_i)$) given the passing scores $\bar{q}_1$ and $\bar{q}_2$, as follows:

$$Pr_1(c_L) = \frac{\exp\left(\Phi(\frac{a-\bar{q}_1}{\sigma_\eta})\bar{u}\right)}{\exp\left(\Phi(\frac{a-\bar{q}_1}{\sigma_\eta})\bar{u}\right)+\exp\left(\Phi(\frac{a-\bar{q}_2}{\sigma_\eta})\underline{u}\right)}, \quad Pr_2(c_L) = \frac{\exp\left(\Phi(\frac{a-\bar{q}_2}{\sigma_\eta})\underline{u}\right)}{\exp\left(\Phi(\frac{a-\bar{q}_1}{\sigma_\eta})\bar{u}\right)+\exp\left(\Phi(\frac{a-\bar{q}_2}{\sigma_\eta})\underline{u}\right)}$$

and

$$Pr_1(c_H) = \frac{\exp\left(\Phi(\frac{a-\bar{q}_1}{\sigma_\eta})\underline{u}\right)}{\exp\left(\Phi(\frac{a-\bar{q}_1}{\sigma_\eta})\underline{u}\right)+\exp\left(\Phi(\frac{a-\bar{q}_2}{\sigma_\eta})\underline{u}\right)}, \quad Pr_2(c_H) = \frac{\exp\left(\Phi(\frac{a-\bar{q}_2}{\sigma_\eta})\underline{u}\right)}{\exp\left(\Phi(\frac{a-\bar{q}_1}{\sigma_\eta})\underline{u}\right)+\exp\left(\Phi(\frac{a-\bar{q}_2}{\sigma_\eta})\underline{u}\right)}$$

Similarly, I can further specify the market clearing condition as follows:

$$\lambda = \Phi(\frac{a-\bar{q}_1}{\sigma_\eta})\left[\frac{1}{2}\frac{\exp\left(\Phi(\frac{a-\bar{q}_1}{\sigma_\eta})\bar{u}\right)}{\exp\left(\Phi(\frac{a-\bar{q}_1}{\sigma_\eta})\bar{u}\right)+\exp\left(\Phi(\frac{a-\bar{q}_2}{\sigma_\eta})\underline{u}\right)}+\frac{1}{2}\frac{\exp\left(\Phi(\frac{a-\bar{q}_1}{\sigma_\eta})\underline{u}\right)}{\exp\left(\Phi(\frac{a-\bar{q}_1}{\sigma_\eta})\underline{u}\right)+\exp\left(\Phi(\frac{a-\bar{q}_2}{\sigma_\eta})\underline{u}\right)}\right]$$

and

$$\lambda = \Phi(\frac{a-\bar{q}_2}{\sigma_\eta})\left[\frac{1}{2}\frac{\exp\left(\Phi(\frac{a-\bar{q}_2}{\sigma_\eta})\underline{u}\right)}{\exp\left(\Phi(\frac{a-\bar{q}_1}{\sigma_\eta})\bar{u}\right)+\exp\left(\Phi(\frac{a-\bar{q}_2}{\sigma_\eta})\underline{u}\right)}+\frac{1}{2}\frac{\exp\left(\Phi(\frac{a-\bar{q}_2}{\sigma_\eta})\underline{u}\right)}{\exp\left(\Phi(\frac{a-\bar{q}_1}{\sigma_\eta})\underline{u}\right)+\exp\left(\Phi(\frac{a-\bar{q}_2}{\sigma_\eta})\underline{u}\right)}\right]$$

Additionally, I can analytically derive the share of type C_L (or type C_H) candidates that are matched using

$$\frac{1}{2}\Phi(\frac{a-\bar{q}_1}{\sigma_\eta})\frac{\exp\left(\Phi(\frac{a-\bar{q}_1}{\sigma_\eta})\bar{u}\right)}{\exp\left(\Phi(\frac{a-\bar{q}_1}{\sigma_\eta})\bar{u}\right)+\exp\left(\Phi(\frac{a-\bar{q}_2}{\sigma_\eta})\underline{u}\right)}+\frac{1}{2}\Phi(\frac{a-\bar{q}_2}{\sigma_\eta})\frac{\exp\left(\Phi(\frac{a-\bar{q}_2}{\sigma_\eta})\underline{u}\right)}{\exp\left(\Phi(\frac{a-\bar{q}_1}{\sigma_\eta})\bar{u}\right)+\exp\left(\Phi(\frac{a-\bar{q}_2}{\sigma_\eta})\underline{u}\right)}$$

Upon analytically deriving the agent's choice problem and the market-clearing conditions for jobs, I obtain the following equilibrium characterization.

Lemma 1 *The equilibrium has the following properties:*

1. $\bar{q}_1 > \bar{q}_2$;
2. $Pr_1(c_L) > Pr_1(c_H)$;
3. *Among all matched agents, there are more type C_H agents than type C_L agents.*

Please refer to Appendix O.2.1 for proofs.

Lemma 1 shows that agents favoring position 1 (type c_L) apply to position 1 more frequently than agents of the alternate type. Moreover, position 1 has a higher hiring standard than position 2 in equilibrium.

This simple example underscores how preference intensity affect the equilibrium matching outcome. An agent's preference for specific job characteristics informs their application decisions, which, in turn, impact the equilibrium hiring standard. Ultimately, these equilibrium hiring standards reverberate back into agents' application decisions.

O.2.1 Proof for Lemma 1

Proof. I evaluate the claims one by one.

1. Suppose $\bar{q}_1 < \bar{q}_2$, then $Pr_1(c_H) > Pr_2(c_H)$, $Pr_1(c_L) > Pr_2(c_L)$ and $\Phi(\frac{a-\bar{q}_1}{\sigma_\eta}) > \Phi(\frac{a-\bar{q}_2}{\sigma_\eta})$. Combining all 3 conditions above I get

$$\lambda = \Phi(\frac{a-\bar{q}_1}{\sigma_\eta}) \left[\frac{1}{2} \frac{\exp\left(\Phi(\frac{a-\bar{q}_1}{\sigma_\eta})\bar{u}\right)}{\exp\left(\Phi(\frac{a-\bar{q}_1}{\sigma_\eta})\bar{u}\right) + \exp\left(\Phi(\frac{a-\bar{q}_2}{\sigma_\eta})\underline{u}\right)} + \frac{1}{2} \frac{\exp\left(\Phi(\frac{a-\bar{q}_1}{\sigma_\eta})\underline{u}\right)}{\exp\left(\Phi(\frac{a-\bar{q}_1}{\sigma_\eta})\underline{u}\right) + \exp\left(\Phi(\frac{a-\bar{q}_2}{\sigma_\eta})\underline{u}\right)} \right]$$
$$> \Phi(\frac{a-\bar{q}_2}{\sigma_\eta}) \left[\frac{1}{2} \frac{\exp\left(\Phi(\frac{a-\bar{q}_2}{\sigma_\eta})\bar{u}\right)}{\exp\left(\Phi(\frac{a-\bar{q}_1}{\sigma_\eta})\bar{u}\right) + \exp\left(\Phi(\frac{a-\bar{q}_2}{\sigma_\eta})\underline{u}\right)} + \frac{1}{2} \frac{\exp\left(\Phi(\frac{a-\bar{q}_2}{\sigma_\eta})\underline{u}\right)}{\exp\left(\Phi(\frac{a-\bar{q}_1}{\sigma_\eta})\underline{u}\right) + \exp\left(\Phi(\frac{a-\bar{q}_2}{\sigma_\eta})\underline{u}\right)} \right] = \lambda$$

   Suppose $\bar{q}_1 = \bar{q}_2$, then $Pr_1(c_H) = Pr_2(c_H) = \frac{1}{2}$ while $Pr_1(c_L) > Pr_2(c_L)$ still holds. This is a contradiction for the market clearing condition.

2. Given the knowledge that $\bar{q}_1 > \bar{q}_2$, I examine the claim $Pr_1(c_L) > Pr_1(c_H)$. The sign of $Pr_1(c_L) - Pr_1(c_H)$ hinges on

$$\exp\left(\Phi(\frac{a-\bar{q}_1}{\sigma_\eta})\bar{u}\right)\exp\left(\Phi(\frac{a-\bar{q}_1}{\sigma_\eta})\underline{u}\right) + \exp\left(\Phi(\frac{a-\bar{q}_1}{\sigma_\eta})\bar{u}\right)\exp\left(\Phi(\frac{a-\bar{q}_2}{\sigma_\eta})\underline{u}\right)$$
$$- \exp\left(\Phi(\frac{a-\bar{q}_1}{\sigma_\eta})\underline{u}\right)\exp\left(\Phi(\frac{a-\bar{q}_1}{\sigma_\eta})\bar{u}\right) - \exp\left(\Phi(\frac{a-\bar{q}_1}{\sigma_\eta})\underline{u}\right)\exp\left(\Phi(\frac{a-\bar{q}_2}{\sigma_\eta})\underline{u}\right)$$

which hinges on the sign of

$$\exp\left(\Phi(\frac{a-\bar{q}_1}{\sigma_\eta})\bar{u}\right)\exp\left(\Phi(\frac{a-\bar{q}_2}{\sigma_\eta})\underline{u}\right)-\exp\left(\Phi(\frac{a-\bar{q}_1}{\sigma_\eta})\underline{u}\right)\exp\left(\Phi(\frac{a-\bar{q}_2}{\sigma_\eta})\underline{u}\right)$$
$$=\exp\left(\Phi(\frac{a-\bar{q}_2}{\sigma_\eta})\underline{u}\right)\left[\exp\left(\Phi(\frac{a-\bar{q}_1}{\sigma_\eta})\bar{u}\right)-\exp\left(\Phi(\frac{a-\bar{q}_1}{\sigma_\eta})\underline{u}\right)\right]>0$$

3. The share of matched candidates from both types can be analytically expressed as

$$\frac{1}{2}\Phi(\frac{a-\bar{q}_1}{\sigma_\eta}Pr_1(c_L)+\Phi(\frac{a-\bar{q}_2}{\sigma_\eta})Pr_2(c_L)$$

and

$$\frac{1}{2}\Phi(\frac{a-\bar{q}_1}{\sigma_\eta})Pr_1(c_H)+\Phi(\frac{a-\bar{q}_2}{\sigma_\eta})Pr_2(c_H)$$

The difference of the above two equations is

$$\frac{1}{2}\Phi(\frac{a-\bar{q}_1}{\sigma_\eta})\left[Pr_1(c_L)-Pr_1(c_H)\right]+\frac{1}{2}\Phi(\frac{a-\bar{q}_2}{\sigma_\eta})\left[Pr_2(c_L)-Pr_2(c_H)\right]$$

Rearranging terms and apply $Pr_2((c_L)=1-Pr_1((c_L)$ and $Pr_2((c_H)=1-Pr_1((c_H)$, I find

$$\frac{1}{2}\left[\Phi(\frac{a-\bar{q}_1}{\sigma_\eta})-\Phi(\frac{a-\bar{q}_2}{\sigma_\eta})\right]\left[Pr_1(c_L)-Pr_1(c_H)\right]<0$$

Because $Pr_1(c_L)>Pr_1(c_H)$ and $\Phi(\frac{a-\bar{q}_1}{\sigma_\eta})<\Phi(\frac{a-\bar{q}_2}{\sigma_\eta})$, the number of matched type c_L agents are less than the number of matched type c_H agents.

Now I've evaluated all claims.

■

O.3 Estimation: Details and Additional Results

O.3.1 Additional Details of the Estimation

Below I outline the algorithm that I use in the estimation.

1. An initial set of non-linear parameters ($\hat{\Theta}$) is guessed in the outer loop.

2. The application equation (3.2) is inverted for each application market (t) to get $\hat{\delta}_j$, which is a function of Θ.

3. According to $\hat{\delta}_j = \theta_\delta X_\delta + \xi_j$ the parameter$\hat{\theta}_\delta$is estimated, and the residual $\hat{\xi}_j(\hat{\Theta})$is obtained.

4. Instruments (Z_j) are interacted with the residual $\hat{\xi}_j\left(\hat{\Theta}\right)$ to form moments, denoted as $\Omega(\hat{\Theta}) = \frac{1}{J}\Sigma_j\left[Z_j \times \hat{\xi}_j(\hat{\Theta})\right]$.

5. In the outer loop, the GMM objective function is minimized,

$$\Theta^* = \text{argmin}_\Theta \left[\Omega(\hat{\Theta})\right] W \left[\Omega(\hat{\Theta})\right]'$$

subject to the slot constraint:

$$\frac{1}{J}\sum_j \left[\int_{\mathbb{R}} \Phi(a_i - \bar{q}_j + \mu_\eta \mathbf{1}_{\text{Prov. Exam}}) \left[\int_{\mathbb{R}} \frac{\exp\left(U_{ij}(a_i, c_i, \bar{q}_j)\right)}{1 + \sum_j \exp\left(U_{ij}(a_i, c_i, \bar{q}_j)\right)} dF_c(c_i)\right] dF(a_i) - \lambda_j\right] = 0$$

6. In the first step, the weighting matrix W is set as $Z'Z$. In the second step, I re-estimate the model using the optimal weighting matrix.

7. Given the set of estimates Θ^*, I estimate $\hat{\delta}_j^*$ for each position j and obtain estimates $\hat{\theta}_\delta^*$ by estimating linear regression $\hat{\delta}_j^* = \theta_\delta X_\delta + \xi_j$.

A key step of the estimation algorithm is inverting the number of applicants to obtain the δ_j for each position j using a contraction mapping. As recommended by Conlon and Gortmaker (2020), I use the SQUAREM algorithm of Varadhan and Roland (2008) to solve the contraction mapping. I use sparse grids generated by the method proposed in Heiss and Winschel (2008) to ensure that the numerical integration is accurate.[43] Further, I use 10 randomly drawn starting values to help confirm that the estimation procedure identifies a global minimum of the objective function.

O.3.2 Parameter Estimates: Alternative Definition

In this subsection, I present parameter estimates with alternative specifications. Specifically, I classify positions from the following departments as prestigious and powerful positions: State Administration of Taxation, China Maritime Safety Administration, National Energy Administration, National Materials and Equipment Reserve, Administration of Customs, and Ministry of Natural Resources. Furthermore, I exclude positions tasked with publicity, data analysis, secretarial

[43] I download the code from the website http://www.sparse-grids.de/ to get sparse grids.

and assistant roles, statistical, and computer-related tasks from the list of prestigious and powerful positions.

Table O.3.1: Non-linear Parameter Estimates: Other Results

Non-linear Para	Estimates and Standard Errors		
	$\bar{\theta}_\mu$ (Ability Dist Cons)	θ_μ (Ability Dist Slope)	μ_c (Civic Dist Mean)
Estimate	-4.228	3.531	-0.996
Std. Error	(0.012)	(0.004)	(0.008)
	σ_C (Civic Dist Var)	μ_η (Exam Shifter)	θ_x (Power)
Estimate	1.021	-4.593	8.295
Std. Error	(0.001)	(0.009)	(0.007)
	θ_x (Level)	θ_x (Wage)	
Estimate	11.775	1.350	
Std. Error	(0.015)	(0.002)	

Notes: Please refer to Table O.3.2 for linear parameter estimates θ_δ.

In Table O.3.1 and O.3.2, I show non-linear and linear estimates using the alternative definition of powerful and prestigious positions. Estimates reported in Table O.3.1 (for non-linear parameters Θ) and O.3.2(for linear parameters θ_δ) closely resemble those reported in Table 2 (for non-linear parameters Θ) and Table 5 (for linear parameters θ_δ) based on the preferred way of defining prestigious and powerful positions.

O.4 Details of Counterfactual Analysis

O.4.1 Simulation Procedures

In the counterfactual analysis, I simulate 10,000 candidates each with an ability and a civic-mindedness in each application market. For each candidate, I simulate an exam score by adding a noise term to their intrinsic ability-level. Consistent with the empirical model, the exam noise is drawn from a standard Normal distribution. In the counterfactual analysis, I assume that there is only one exam paper that is used for all candidates. Because candidates differ in a single dimension (i.e., ability) from the government's perspective, it is sufficient to have only one exam for all candidates in the counterfactual analysis. A candidate's indirect utility for applying for a position is now different from what's specified in Equation (3.1) because, when the counterfactual mechanism 1 is implemented, candidates have already learned their ranking among all candidates

Table O.3.2: Linear Parameter Estimates θ_δ: Other Results

Linear Para.	Estimates (Standard Errors)			
	Education	Work exp	Political status	Grad Only
Estimate	0.009	-0.728	-0.449	-0.711
Std. Error	(0.693)	(0.298)	(0.207)	(0.452)
	English Min	Humanity	Social science	Science
Estimate	-0.455	0.632	0.241	0.489
Std. Error	(0.518)	(0.278)	(0.649)	(0.482)
	Finance	Min 5 year	Poor	Place policy
Estimate	-0.020	0.017	-0.155	-0.693
Std. Error	(0.561)	(0.249)	(0.241)	(0.317)
	Constant			
Estimate	1.562			
Std. Error	(0.885)			

in the application market. Specifically, candidate i's utility of being matched with position j is now $U^c_{ij}(a_i, c_i) = u(x_j, m_j|c_i) + \delta_j + \varepsilon_{ij}$

Here, $u(x_j, m_j|c_i)$ and δ_j are part of the estimation results. Notice that δ_j is included here because it is assumed to affect candidate application. I simulate preference shock ε_{ij} for each candidate-position pair. All candidates are ranked based on their exam score in descending order. Candidates who rank rth can choose a position in the rth place that delivers the highest $U^c_{ij}(a_i, c_i)$ among all positions that still have at least one vacancy. The admission process stops when all positions are filled. Collecting the matched candidates in each position, I calculate the average ability level and civic-mindedness level for each position j. I repeat the simulation 100 times to obtain the average matching pattern in the counterfactual analysis. I denote the simulated average ability and civic-mindedness of all matched candidates through the counterfactual mechanism 1 as $\{A^s_j\}$ and $\{C^s_j\}$ respectively.

O.4.2 Consequence on Gov Performance: Position Weighting

Here, I present more simulation results following the discussions at the end of Section 3.5. Specifically, I show simulation results when employing different weighting functions.

In the left panel of Figure O.4.1, I use the prefecture average non-private sector wage to construct the weighting function W_j in the aggregation. That is to say, positions having a higher

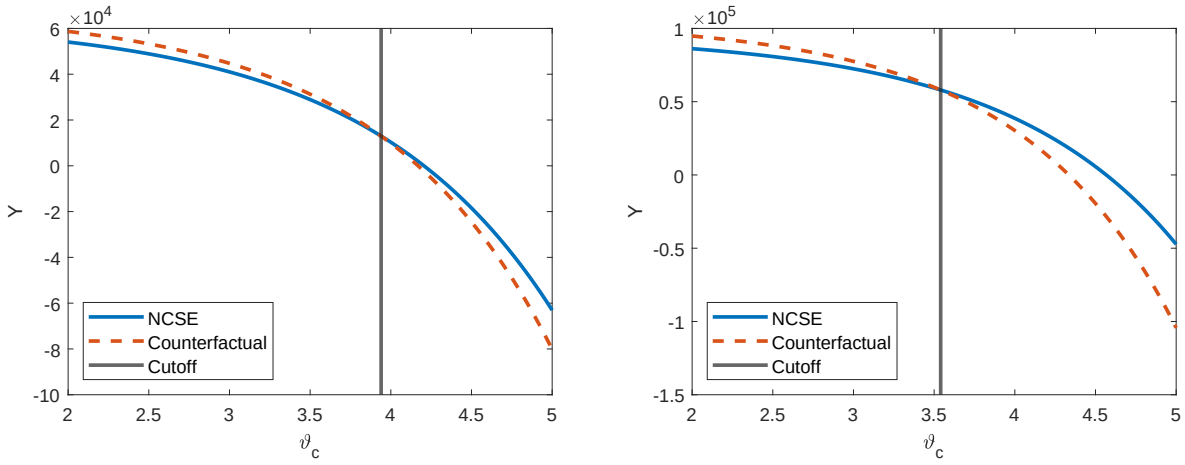


Figure O.4.1: Government Performance: Alternative Weighting

Notes: The Y-axis represents weighted the government output Y. The solid line plots the government output given NCSE while the dashed line plots the government output given the alternative mechanism. I fix $\vartheta_a = 2$ in the simulation to focus on how the change of ϑ_c affect Y. The x-axis represents the importance of civic-mindedness in government production ϑ_c. A higher ϑ_c implies a more important impact of candidate civic-mindedness relative to the ability. In the left panel, positions with higher wages are assigned a larger weight (W_j^a) in the simulation. In the right panel, positions with higher wages and higher potential rent-seeking opportunities are assigned larger weights (W_j^a and W_j^c) in the simulation.

average non-private sector wage is more important for the government performance when staffed with candidates possessing higher ability. The simulation exercise indicates that the cutoff value of ϑ_c when the NCSE outperforms the alternative mechanism is different than that is shown in Figure 4. Similarly, I use both weights on ability and civic-mindedness when plotting the right panel of Figure O.4.1. The simulation exercise indicates that the cutoff value of ϑ_c when the NCSE outperforms the alternative mechanism is smaller than that is shown in the left Figure.

O.5 Additional Details of the NCSE Data Cleaning

NCSE is managed by the central government, which fills positions for three types of government organizations: central party organs, central state administrations (along with their local branches), and public administrations governed by civil servant law (along with their local branches). NCSE positions have many categorical characteristics. For example, more than 20 different departments are hiring during 2016 and 2017. Moreover, because each position may require different combinations of majors in school, the set of majors is also large. Therefore, I make some categorization changes to reduce the dimension of some of position characteristics by combining.

O.5.1 Department

Numerous government organizations engage in recruitment via the NCSE. However, not every department conducts hiring annually. To prevent certain departments from exhibiting insufficient observations, I categorize these into nine distinct types, reflective of functional similarities. These categories encompass audit, tax, transportation, resource, custom, prison, postal, finance, and statistics departments. The specific categorizations are explained in Table O.5.1

Department Types	**List of Departments**	**% of the Total Positions**
Audit	State Auditing Administration	0.49%
Tax	State Administration of Taxation	64.24%
Transportation	Ministry of Transport, Civil Aviation Administration of China, China State Railway Group Co., Ltd., Pearl River Administration of Navigational Affairs, Yangtze River Administration of Navigational Affairs, China Maritime Safety Administration	6.59%
Resource	Ministry of Water Resources, National Bureau of Surveying and Mapping (now in Ministry of Natural Resources), China Earthquake Administration, China Meteorological Administration, State Oceanic Administration, National Energy Administration, State Administration of Work Safety, Administration of National Materials and Equipment Reserve, Ministry of Natural Resources	9.66%
Custom	Entry-Exit Inspection and Quarantine Bureau (now in Administration of Customs), Administration of Customs	7.21%
Prison	Qincheng Prison, Yancheng Prison	0.04%
Postal	State Post Bureau	0.61%
Finance	China Banking Regulatory Commission, China Insurance Regulatory Commission, Securities Regulatory Commission	6.04%
Statistics	National Bureau of Statistics of China	5.12%

Table O.5.1: Departments by Type

O.5.2 Education

The NCSE enforces two distinct requirements on educational background: the degree requirement and the major requirement.

Almost every position necessitates a minimum degree requirement. For instance, applicants are expected to possess at least a bachelor's degree. I exclude positions necessitating a PhD degree due to the limited number.

Contrary to the degree requirement, the major requirement varies significantly across positions. Certain positions require a very specific college major; for instance, some positions within the China National Meteorological Administration mandate a major in meteorology. I exclude positions that necessitate specialized skills, specifically positions related to railway policy, translators requiring particular language proficiency, and positions demanding expertise in meteorology, sailing, computer science, or medicine. The remaining majors are grouped into four broad categories: humanities, social sciences, STEM, and finance, with each category comprising several distinct majors.

O.5.3 Political Status

There are three types of political status requirements in NCSE 2016 and 2017. The majority of positions do not impose any requirement concerning political status. The second type necessitates applicants to be CCP members. The third type requires applicants to either be CCP members or members of the Chinese Communist Youth League. I combine the second and third types to circumvent the small sample issue.

O.5.4 Work experience

Work experience in this context refers to the minimum number of years of Grassroots Work experience (*ji ceng gong zuo jing li*). A majority of positions do not impose any work experience prerequisite. A minority of positions require applicants to possess a minimum of two years of work experience. A few positions necessitate at least one, two, or five years of work experience. To optimize data utilization, I generate a dummy variable representing the minimum work experience requirement. The dummy variable equals 1 (0) if the position possesses (does not possess) a minimum work experience requirement.

O.5.5 Information Regarding Compensation

The NCSE database lacks wage information for each posted position. Legal compensation for government officials within China's government lacks transparency. The legal compensation of China's government workers consists of four parts: base salary, stipends, subsidies and bonuses. The base salary, consisting of headship pay and rank pay, is transparent following the announcement by the State Council since 2006 https://www.gov.cn/zhengce/content/2019-03/19/

content_5375052.htm. The basic salary is the same for everyone given the same position and level. However, departments in different places have their own stipends, subsidies and bonuses plan, making the overall compensation non-transparent.

There is no reliable source offering a comprehensive description, let alone potential illegal returns (grey income and other rent-seeking opportunities) associated with government positions. Deng et al. (2023) provide estimates regarding the unofficial incomes of officials in China. Feng, He and Liu (2023) examines the consequence of this non-transparency on the self-selection into the government recruitment using an information experiment.

I argue that the absence of compensation data does not significantly impact the analysis of this paper for three primary reasons. First, government workers' legal compensation is determined by governmental regulations, implying that it cannot adjust flexibly to the forces of demand and supply as witnessed in competitive labor markets. As a result, there's no need for concerns about wages being set endogenously in response to changes in labor supply. Second, given the absence of compensation details in job postings, candidates do not have access to position-specific wage information during the application process. Lastly, the patterns in position choice inherently reflect job seekers' holistic preferences for each available position.

I use a measure called average urban non-private units. Urban non-private units refer to all non-private legal entities in urban areas. These specifically include state-owned economies, urban collective economies, joint-venture economies, stock economies, economies invested by foreign, Hong Kong, Macao, and Taiwan investors, other economic entities, and their affiliated institutions. The employees of urban non-private units do not include those employed in township enterprises, private enterprises, individual urban workers, retired or resigned personnel, as well as others who are not counted within the scope of the workforce as per relevant regulations.

O.6 NCSE 2016: Official Guide of the Written Exam

I translate the official guide of the 2016 NCSE for the written exam. I only include the Public Subject Written Examination because it is relevant for the analysis.

The content for the Administrative Professional Test (ability test) is uniform across all position types. However, the complexity of the examination questions in the ability test is greater at the provincial level or above, compared to the prefecture level or below. Specifically, the 2016 exami-

nation paper for the provincial level or above contains 135 questions, while that for the prefecture level or below consists of 130 questions. The province or above exam has 15 harder questions compared to the prefecture exam.

The question for the policy essay varies between the provincial exam and the prefecture exam, with the former's question being more challenging. Nonetheless, the primary set of skills each examination paper aims to assess remains largely analogous. The only distinction lies in that the provincial examination paper additionally evaluates analytical and problem posing skills, whereas the prefectural examination paper gauges implementation skills instead.

In the subsequent sections, I provide the fully translated examination syllabus from the NCSE 2016 for reference.

O.6.1 Content of the Public Subject Written Examination

The public subject written examination for civil servants recruitment in 2016 by central authorities and their directly affiliated institutions comprises two parts: the Administrative Professional Ability Test and the Policy Essay. Both parts adopt a closed-book examination format.

The Administrative Professional Ability Test is an objective test with a time limit of 120 minutes and a full score of 100. The Policy Essay is a subjective test with a time limit of 180 minutes and a full score of 100.

O.6.2 Answering Requirements

Administrative Professional Ability Test. Applicants must bring examination stationery, including pens or signing pens with black ink, 2B pencils, and erasers. Applicants must fill in the admission ticket number at the designated place with a 2B pencil and answer on the answer card. Answers made elsewhere are invalid.

Policy Essay. Applicants must bring examination stationery, including pens or signing pens with black ink, 2B pencils, and erasers. Applicants must fill in the admission ticket number at the designated place with a 2B pencil, and answer on the answer card at the designated place with a pen or signing pen. Answers made elsewhere or made in pencil are invalid.

O.6.3 Introduction to the Administrative Professional Ability Test

Test Content. The Administrative Professional Ability Test mainly tests basic qualities and abilities closely related to civil service, suitable for objective written examination, including verbal

comprehension and expression, quantitative reasoning, judgment reasoning, data analysis, and common sense judgment.

Verbal comprehension and expression mainly test applicants' ability to think and communicate in language, quickly and accurately understand and grasp the connotation of text materials, and find main information and important details based on materials. Common types of questions include reading comprehension, logical fill-in-the-blank, and sentence expression.

Quantitative reasoning mainly tests applicants' understanding of the quantitative relationship between things and their ability to solve quantitative problems, which mainly involves the analysis, reasoning, judgment, and operation of data relationships. Common types of questions include numerical reasoning and mathematical operations.

Judgment reasoning mainly tests applicants' ability to analyze and reason about various relationships, involving understanding, comparison, combination, deduction, and induction of figures, language concepts, object relationships, and text materials. Common types of questions include graphical reasoning, definition judgment, analogy reasoning, and logical judgment.

Data analysis mainly tests applicants' ability to comprehensively understand and analyze various forms of texts, charts, and other materials. This part usually consists of statistical charts, numbers, and text materials.

Common sense judgment mainly tests applicants' basic knowledge and ability to use this knowledge for analysis and judgment, focusing on the understanding of national conditions and social conditions, basic qualities of comprehensive management, and involves politics, economics, law, history, culture, geography, environment, nature, science and technology, etc.

Introduction to Question Types. The Administrative Professional Ability Test involves various types of questions, which will be combined according to the purpose of the examination, the situation of the applicants, in terms of types, quantity, and difficulty. The following are introductions to some commonly used question types: Verbal comprehension and expression, Quantitative reasoning, Judgment reasoning, Data analysis and Common sense judgment. I omit example questions here.

O.6.4 Introduction to Policy Essay

Policy Essay is an examination subject testing the basic abilities required for office work. The Policy Essay exam paper consists of precautions, given materials, and answering requirements. Policy Essay examination is set up with two types of exam papers according to different requirements for provincial level and above (including sub-provincial level) management positions, prefecture (place) and below management positions, and administrative law enforcement positions.

Provincial level and above (including sub-provincial level) management positions' Policy Essay examination mainly tests applicants' reading comprehension ability, comprehensive analysis ability, problem posing and solving ability, and textual expression ability.

Reading comprehension ability - requires a comprehensive grasp of the content of the given materials, accurately understanding the meaning of the given materials, accurately refining the viewpoints contained in the facts, and revealing the essential problems reflected.

Comprehensive analysis ability - requires analysis and induction of the entire or part of the content, viewpoints, or problems of the given materials, multi-angle thinking about the content of the materials, and making reasonable inferences or evaluations.

Problem posing and solving ability - requires using one's own practical experience or life experience, on the basis of understanding and analyzing the given materials, to identify and define problems, make assessments or trade-offs, and propose solutions or measures.

Textual expression ability - requires proficient use of the designated language, using explanation, statement, argumentation, etc., to accurately, appropriately, concisely, and fluently express thoughts and viewpoints.

prefecture (place) and below management positions and administrative law enforcement positions' Policy Essay examination mainly tests applicants' reading comprehension ability, implementation ability, problem-solving ability, and textual expression ability.

Reading comprehension ability - requires understanding the main content of the given materials, grasping the relationship between different parts of the given materials, and making appropriate explanations for the viewpoints and facts involved in the given materials.

Implementation ability - requires accurately understanding work goals and organizational intentions, adhering to the principle of lawful administration, and timely and effectively completing

tasks according to objective actual conditions.

Problem-solving ability - requires using one's own knowledge and experience to make correct analysis and judgment on specific problems, and propose practical measures or methods.

Textual expression ability - requires proficient use of the designated language, and accurate and reasonable explanation, statement, or interpretation of events and viewpoints.