The Road to Ascension: Exams, Lineages and Civil Servants of the Joseon Dynasty

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Abstract

In this paper, we investigate how civil service exams historically screened talent for bureaucrats and family lineages influenced their final appointments. We explore the Joseon Dynasty (1392 to 1897 CE) as an exemplary case that implemented the humanities examination (*mun-gwa*) in order to select candidates for high-ranking positions in the court. The kingdom's comprehensive records on family ties and court official appointments over multiple centuries allow us to construct family network data with detailed information on individual exam scores and political careers. We find that the exam performance and family connections worked in tandem to select high-ranking officials. We find that top exam-scorers were more likely to become high-ranking officials, and that having illustrious family lineages, i.e. ancestors passing the exam or holding high-ranking official positions, also played a significant role in determining candidates' political careers. Furthermore, we find that family lineages became especially important for official appointments during periods of political instability. (WORD COUNT: 9588)

Keywords: networks, civil service examination, political elites, meritocracy, Joseon Dynasty, political stability

1 Introduction

How do governments screen and select high-performing civil servants? Among the various policies implemented for this purpose, the civil service examination system remains as an exemplary institutional innovation that aimed to recruit civil servants based on their merit. First found in Chinese dynasties, other Asian countries including Korea and Vietnam later implemented the system (Liu 2007). Furthermore, the British and other European states as well as the United States government adopted similar practices in selecting their own (Teng 1943). Despite the importance and prevalence of these exams, relatively few studies have analyzed the merit-based system and its implications, especially in historical context.[1] In particular, it has been difficult to match individual exam performance with subsequent political careers, and to study the impact of ancestral influence reaching back more than three generations, mainly due to lack of available data.

In this paper, we show that the civil service exam enabled the selectorate to choose a pool of qualified candidates based on merit. These candidates who passed the exam were then further assessed by the court in the high-ranking civil servant appointment process. For our analysis, we introduce and utilize historical records from the Joseon Dynasty of Korea (1392-1897 CE). Among the dynasties that adopted civil service exams, Joseon stands out as an invaluable case study offering comprehensive records of exam passers, their eventual career paths as well as family lineages. The kingdom during this period was a centralized bureaucratic state that gave opportunities for those who succeeded in its merit-based examination, called *gwa-geo*, that was maintained over five centuries. The examination system was the most significant means of recruiting officials for major central and provincial government posts, and those who passed *gwa-geo* formed the ruling class (Wagner 1974). Among the

[1] One such study is by Jiang and Kung (2020), who discuss the civil service examination system in late imperial China and find that candidates with exam-passing fathers, grandfathers and great-grandfathers were more likely to pass the exam themselves, as they inherited the "cultural capital" that provided the relevant knowledge for passing the exam. While Jiang and Kung (2020) mainly look at whether ancestors influenced the descendant's likelihood of passing the exam, we are primarily interested in their influence on the descendant's actual political career after the exam.

different types of exams under *gwa-geo*, *mun-gwa* (the humanities examination on the principles of government administration, ethics and family) was the most selective and accordingly elevated successful candidates to the highest elite status in society.[2]

Spanning over five centuries, the Joseon Dynasty's exam records comprise the world's longest continual data of such kind under a single dynasty. Our paper is the first study examining the eventual political ascension of exam passers and the importance of family networks.[3] Specifically, we use an individually linked database of exam passers and their ancestors found from the exam roster (*Mun-gwa-bang-mok*) for around 9,000 individuals from 1393 to 1776 CE, essentially covering the 380 years of the Joseon Dynasty (roughly three quarters of the total period from 1393 to 1894).[4]

For our empirical exercise, we exploit the official appointment record of each candidate with his family background, allowing us to construct a family network containing information on his ancestors' exam scores and history of holding office. From the construction of family networks, we then calculate a "lineage score" for each individual. The score takes into account whether the ancestors, including maternal and spouse's predecessors as well as those from more than three generations ago, also passed the exam and reached high offices. It captures relevant family background information that the selectorate would have obtained in order to evaluate the candidate's expected family endowment.[5]

[2]The merit-based examination comprised four categories: (1) *mun-gwa* (humanities examination); (2) *mu-gwa* (military examination); (3) *jap-gwa* (technical examination); and (4) *saeng-won-si* and *jin-sa-si* (classics and literary licentiate examination). In this study, we focus on those who succeeded in *mun-gwa* because they represented the ruling class of Joseon as major state officials. Successful candidates of *saeng-won-si* and *jin-sa-si* became qualified to enroll at the National Confucian Academy (*Sung-kyun-kwan*), which trained students for *mun-gwa*. They could alternatively be appointed as ninth-ranked junior officials, which were the lowest positions among the court officials. Those who passed military or technical examinations were regarded as lower-class officials. Protected officials (*Eum-seo*) were low-ranked positions specifically reserved for the merit subjects who did not have to take the exam in order to obtain this elite status. Henceforth throughout the paper we focus on *mun-gwa* only and refer to it simply as "the exam." Among the exam passers (i.e., *mun-gwa* passers), around 40 percent eventually became high-ranking officials (*dang-sang-gwan*) in our dataset (see Table 2), which is similar to 44 percent found in Won (2007).

[3]As a complement to our study, James Lee and Cameron Campbell have worked on compiling the China Government Employee Database during the Qing period: (https://www.shss.ust.hk/lee-campbell-group/china-government-employee-database-qing-cged-q/).

[4]In the following data section, we discuss in detail our choice of period coverage and the number of exam passers included in our data.

[5]In their seminal model, Becker and Tomes (1979) describe family endowment as ""endowments" trans-

Next, we estimate the association between the exam performance, the lineage score and the probability of reaching a high-ranking official position. We find that younger exam passers in the top score tier group were more likely to become high-ranking officials; those who passed the exam at a younger age likely had longer careers in the court with more opportunities for promotions, and the top-scorers obtained the advantage of initial appointment of higher-ranked positions. We also find that those with higher lineage scores, i.e. stronger family endowment, were also more likely to rise to the top of the bureaucracy. This result is robust across alternative regression models and when controlling for the age and the score in the final exam. The findings suggest that the selectorate considered both the exam performance as well as family lineages to assess the candidate's overall qualification. In discussing our results, we additionally show that the lineage effect on exam passers' careers became even more pronounced during periods of political instability. The ancestral influence appears to have been particularly valuable in these times, when the probability of exam passers being appointed to an official position was generally low.

We organize the paper as follows. In Section 2, we introduce the relevant literature and discuss the significance of our study. In Section 3, we provide a historical background of the examination system and official rank positions in the court during the Joseon Dynasty. In Section 4, we explain data sources and the sample used for our study. In Section 5, we discuss why and how we use the lineage score to measure the ancestral influence on the descendants' eventual career trajectories, and introduce key variables. Section 6 presents our baseline results. We discuss our results in relation to political instability in Section 7. Section 8 concludes.

ferred from parents to children, including a family's caste, religion, race, "culture," genes, and reputation for honesty and reliability." (pg. 1155). In this paper, we consider the plausible case that the selectorate would estimate the candidate's expected family endowment based on the records of ancestors' court appointments and exam performance.

2 Relevant Literature

Our work relates to several strands in the literature. First, the study contributes to seminal works on the institutional selection of bureaucrats and political elites. Dal Bó et al. (2017) for example show that democracy can produce competent and socially representative politicians, while Cruz et al. (2017) document that family connections still matter for electoral outcomes in a democracy, as they facilitate relationships of political exchange. Other works in the literature further find that official appointment is heavily determined by power hierarchies and loyalty concerns. Leaders in authoritarian regimes tend to hire mediocre and loyal, non-threatening candidates for positions in the bureaucracy (Zakharov 2016; Egorov and Sonin 2011; Reuter and Robertson 2012), while the British colonial administration promoted governors based on patronage appointments.(Xu 2018)

Like elections and other processes implemented to select civil servants in the modern period, Joseon's historical civil service exam was an institutional innovation aimed at better governance. The meritocratic practice was implemented in order to select a pool of qualified candidates based on merit, and present them to the selectorate for evaluation and final appointment. The combination of both merit and family connections considered during the appointment process echoes contemporary counterparts, while providing a unique historical context based on the rich archival data.[6]

Our paper furthermore relates to existing research on the inter-generational persistence in political power (Dal Bó et al., 2009), wealth (Clark and Cummins, 2015), education (Clark and Cummins, 2014), as well as exam success (Wagner, 1974; Huang, 2016; Jiang and Kung, 2020) due to predecessors' social class standings. Our work builds on these papers and extends the study on how the family lineage effect can persist and stem from even distant ancestors going back more than three generations ago. This approach is in line with a set

[6] Jia et al. (2015) discusses the case of bureaucrat selection in China where provincial leaders' performances as well as their connections with top politicians determine their promotions; Aman-Rana (2020) finds that merit-based evaluation of officers can be harnessed in nepotistic discretionary-promotions of bureaucrats in Pakistan.

of empirical studies highlighting the importance of studying intergenerational transmission reaching back multiple generations (Mare, 2011; Lindahl et al., 2015; Adermon et al., 2018; Long and Ferrie, 2018; Huang, 2016; Braun and Stuhler, 2018; Olivetti et al., 2018; Solon 2018), as they find a much higher level of persistence in ancestral influence than what could be captured from immediate predecessors only. A natural question that arises from these studies is how one can quantify and measure the effect of more distant family members. Our lineage score attempts to capture this information from family network data, and we use the measure to explore the extent of ancestral influence on the political carrier trajectories of descendants in the Joseon Dynasty.

Finally, our work complements the burgeoning literature applying network analysis to topics in economic history (Esteves and Mesevage 2019). Previous studies bring network concepts into historical contexts to explore trade relations (Edwards and Ogilvie 2012; Goldberg 2012; Greif 2006; Van Doosselaere 2009), international currency (Flandreau and Jobst 2009; Eichengreen et al. 2019), interlocks between firms (Scott and Hughes 1980; Fohlin 2007; Vasta and Baccini 1997), and many more.[7] Given the nature of predecessor-descendant relations, our study fits well into the network analysis framework. It contributes to empirical studies exploring family lineages from this methodological approach. We combine exam rankings, family connections and official appointment, and employ network analysis to explain the various effects of ancestral influence on descendants' political careers under the examination system.

[7]For a recent survey of applied research on social networks in economic history, please see Esteves and Mesevage (2019).

3 Historical Background

3.1 Humanities Examination

The examination system was the first hurdle to clear to become a high-ranking official in the Joseon era. Passing the exam appears to have been extremely difficult; the process was so competitive that it took ten to fifteen years on average to pass the exam and the average passing age was about 34.[8] Those who entered government service by passing the exam thus expected to serve in important posts of key ministries (Lee 1994).

The exam (*mun-gwa*) was broadly categorized into regular exams and irregular exams. The triennial exam (*sik-nyeon-si*) was regularly implemented, and the irregular exams included the augmented exam (*jeung-gwang-si*), the special exam (*byul-si*), the memorial exam of royal visitation to the Confucian hall (*al-sung-si*), and so on. Although the augmented exam was one of the irregular exams, we regard it as a regular exam since it was similar in structure and process to the triennial exam.[9]

Table 1 summarizes the structure and selection process of a regular exam. Panel A shows the regular structure of the examination. It was implemented in the order of the first-round (*cho-si*), the second-round (*bog-si*), the final-round (*jeon-si*), and then confirmation by the king. These exams were meant to mainly test the candidate's ability in writing compositions and knowledge of Confucian texts (Lee 2003). A total of 240 successful candidates, including 50 from the National Confucian Academy (*Sung-kyun-kwan*), 40 from the capital Hanyang (currently Seoul), and 150 from local provinces were chosen for the first-round examination, and they were assembled in the capital for the second-round examination (Lee 2008). Only

[8]This indicates that studying for the exam might have been prohibitively costly since the average lifespan estimate was only fifty during the Joseon Dynasty (Paik 2014).

[9]Both triennial examination (*sik-nyeon-si*) and augmented examination (*jeung-gwang-si*) consisted of the same three separate examinations and selected top 33 candidates out of total 240 candidates from the second-round examination as shown in Table 1. Since the regular exams and irregular exams still likely had different characteristics regarding the process and purpose of the test, we control for the different types of exams in our empirical analysis.

33 successful candidates were selected for the final-round examination. In the final round, the candidates wrote essays on a subject chosen by the king, and their administrative and political competence were evaluated accordingly. The exams were held under the policy of anonymous and sealed submissions to minimize any grading bias (Lee 2004), and both the examiners and the king determined the rankings of these final candidates (Won 2019).[10]

Panel B presents that the initial placement of an exam passer was determined depending on his status at the time of taking the exam (if any) and his score in the final-round examination. If the individual did not have any previous position in the court, his initial placement primarily depended on his performance in the final-round examination. Those who placed in the first-tier (*gap-gwa*), became sixth or seventh-rank officials immediately. Those in the second-tier (*eul-gwa*) and third-tier (*byung-gwa*) were assigned temporary positions at the eighth or ninth rank until actual positions became available (Won 2007). Those who already had official positions at the time of taking the exam were promoted up by one to four ranks according to their exam scores. There was thus a sizeable gap in the career paths of civil servants according to their grades in the final-round examination and pre-existing court status.

3.2 Official Position Assignment and Promotion

The civil service office in the Joseon Dynasty comprised nine main ranks as presented in Table 2. Each rank was divided into the senior level (*jeong*) and the junior level (*jong*), and the posts above the sixth rank junior official were further subdivided into the upper level (*sang-gye*) and the lower level (*ha-gye*) for a total of 30 ranks. The high-ranking officials above or equal to the third-rank senior upper official title were collectively called the palace-ascendable officials (*dang-sang-gwan*).[11] The remainders, called the palace-downward officials (*dang-ha-gwan*), comprised mid-ranking officials (*cham-sang-gwan*) who were higher

[10] Throughout our paper, we focus only on the successful candidates who passed the preliminary exams and advanced to the final-round examination. We refer to them as the "exam passers" or "successful candidates" and use the term "final-round examination candidates" interchangeably for the same group.

[11] Henceforth we refer to this group simply as the "high-ranking officials."

Table 1 The Process of Mun-gwa Examination and Initial Placement in the Joseon Dynasty

Panel A. The Process of Examination

First-round examination (*cho-si*)	240 candidates were selected from each province (150), capital city (Hanyang) (40), and National Confucian Academy (50).
↓	
Second-round examination (*bog-si*)	33 successful candidates were selected.
↓	
Final-round examination (*jeon-si*)	The 33 candidates were ranked as first tier (3), second tier (7), and third tier (23).
↓	
Confirmation by King	
↓	

Panel B. Initial Placement by Score in the Final-round Examination

Grade in the final-round examination	Official rank (position) assignment	
	if the exam passer did not have an official position at passing the exam	if he already had an official position
First tier		
First rank (*jang-won*)	Junior sixth rank position	Promotion of 4 ranks
Second and third rank	Senior seventh rank position	Promotion of 3 ranks
Second tier	Junior eighth rank	Promotion of 2 ranks
Third tier	Senior ninth rank	Promotion of 1 rank

Notes: In the process, the regional quotas in the first-round examination were proportional to the population in each province. The local quotas did not apply to the second-round examination or the final-round examination. The table of initial placement is re-tabulated from Lee (1994). Exam candidates scoring in the second- and the third-tier groups without previous official positions were not guaranteed posts and instead only received official ranks (not real official positions). They had to wait as temporary officials until positions became vacant. If mid-ranking officials passed the exam, they were guaranteed to have promoted positions even if they did not place in the first-tier group in the final-round examination (Won 2007).

than or equal to the sixth-rank junior officials, and low-ranking officials (*cham-ha-gwan*) who were lower than the sixth-rank junior officials. The high-ranking official appointment was determined through the following evaluation process:

1. the Minister of Personnel (*Yi-jo-pan-seo*) usually recommended up to three successful exam passers for each high-ranking position;

2. the king nominated one out of the recommended candidates;

3. the Ministry of Personnel requested the Office of the Censor (*Sa-gan-won*) and the Office of the Inspector (*Sa-heon-bu*) to check whether there was any problem in the final candidate's qualification, especially in regard to his family background.

The appointment of each high-ranking official was thus driven by the selectorate (the king and other officials who had the authority of recommendation and verification). The high-ranking officials were the ministers authorized to participate in discussions or parties with the king at palace halls (Yi 2015). They were given important rights to vote on the administration, to recommend other officials, and to direct the military (Cha 2002). According to Table 2, about 40% of the sample used in our baseline analysis reached these positions. The mid-ranking officials were in charge of the central administration as well as local government duties, with promotion possibilities to the high-ranking official positions (Cha 2012). However, promotions from the low-ranking to the mid-ranking, and from the mid-ranking to the high-ranking were difficult to achieve because the bureaucracy further entailed rigorous screening processes Lee (1994).

Table 2 Civil Service Rank System in the Joseon Dynasty and Sample Distribution

Rank and Sub-rank			Distribution by rank in the sample used for baseline analysis: Number	Percent	Cumulative percent	Classification of positions
1st	Senior	Upper Lower	285	4.13	4.13	High-ranking officials
1st	Junior	Upper Lower	69	1.00	5.13	
2nd	Senior	Upper Lower	618	8.95	14.08	
2nd	Junior	Upper Lower	975	14.12	28.20	
3rd	Senior	Upper	867	12.56	40.75	
		Lower	856	12.40	53.15	Mid-ranking officials
3rd	Junior	Upper Lower	442	6.40	59.55	
4th	Senior	Upper Lower	326	4.72	64.27	
4th	Junior	Upper Lower	256	3.71	67.98	
5th	Senior	Upper Lower	536	7.76	75.74	
5th	Junior	Upper Lower	189	2.74	78.48	
6th	Senior	Upper Lower	628	9.09	87.57	
6th	Junior	Upper Lower	453	6.56	94.13	
7th	Senior		74	1.07	95.21	Low-ranking officials
7th	Junior		9	0.13	95.34	
8th	Senior		19	0.28	95.61	
8th	Junior		3	0.04	95.66	
9th	Senior		191	2.77	98.42	
9th	Junior		109	1.58	100.00	
Observations			6905	100.00		

Notes: This table presents the civil service rank system in the Joseon Dynasty and the sample distribution by rank. High-ranking officials (*dang-sang-gwan*) were defined as the ministers of upper senior third or higher ranks, collectively known as 'palace-ascendable officials.' They were given important rights to vote on the administration, to recommend other officials, and to direct the military of the relevant officials Cha (2002). Officials from the lower junior sixth rank to the lower senior third rank were called 'mid-ranking officials (*cham-sang-gwan*)' and they were in the charge of central administration and local government.

4 Data and Sample

For our analysis, we utilize the Joseon Dynasty's court exam roster records (*Mun-gwa-bang-mok*) that contains the entire list of all exam passers qualified for the final-round examinations held throughout the dynasty.[12] The digitized version from the Academy of Korean Studies contains various information on each final exam candidate and his family. These include the candidate's name, his post or title at the time of the examination, the year of birth and the score ranking in the final-round examination. The roster also provides information on the candidate's family clan, his place of residence, career highlights, and the names of the father, the foster father (if any), the paternal grandfather, the paternal great-grandfather, the maternal grandfather, and the father-in-law.[13]

The family information comes from each individual who successfully advanced to the final-round examination; upon taking the exam, the candidate had to fill out an application form with names of his father (and foster-father, if any), paternal grandfather and great-grandfather, as well as his maternal grandfather and father-in-law. The records from the roster thus make it possible to trace each individual's family lineage back to at least his great-grandfather. It is possible to also link the individual to his more distant ancestors, as long as one or more of his ancestors on the application form passed the exam themselves and provided information on their own ancestors. Using the information on ancestors found from the roster, Lee (2018) has constructed each exam passer's family network. From Lee (2018) we are able to identify 47,768 nodes (14,720 exam passers and their 33,048 family members) and a network consisting of 49,229 ties connecting these nodes.[14]

[12] There are 15,151 successful candidates on the exam roster. Among them, 431 successful candidates passed the exam more than once, so in total there are 14,720 unique individuals who passed the exam.

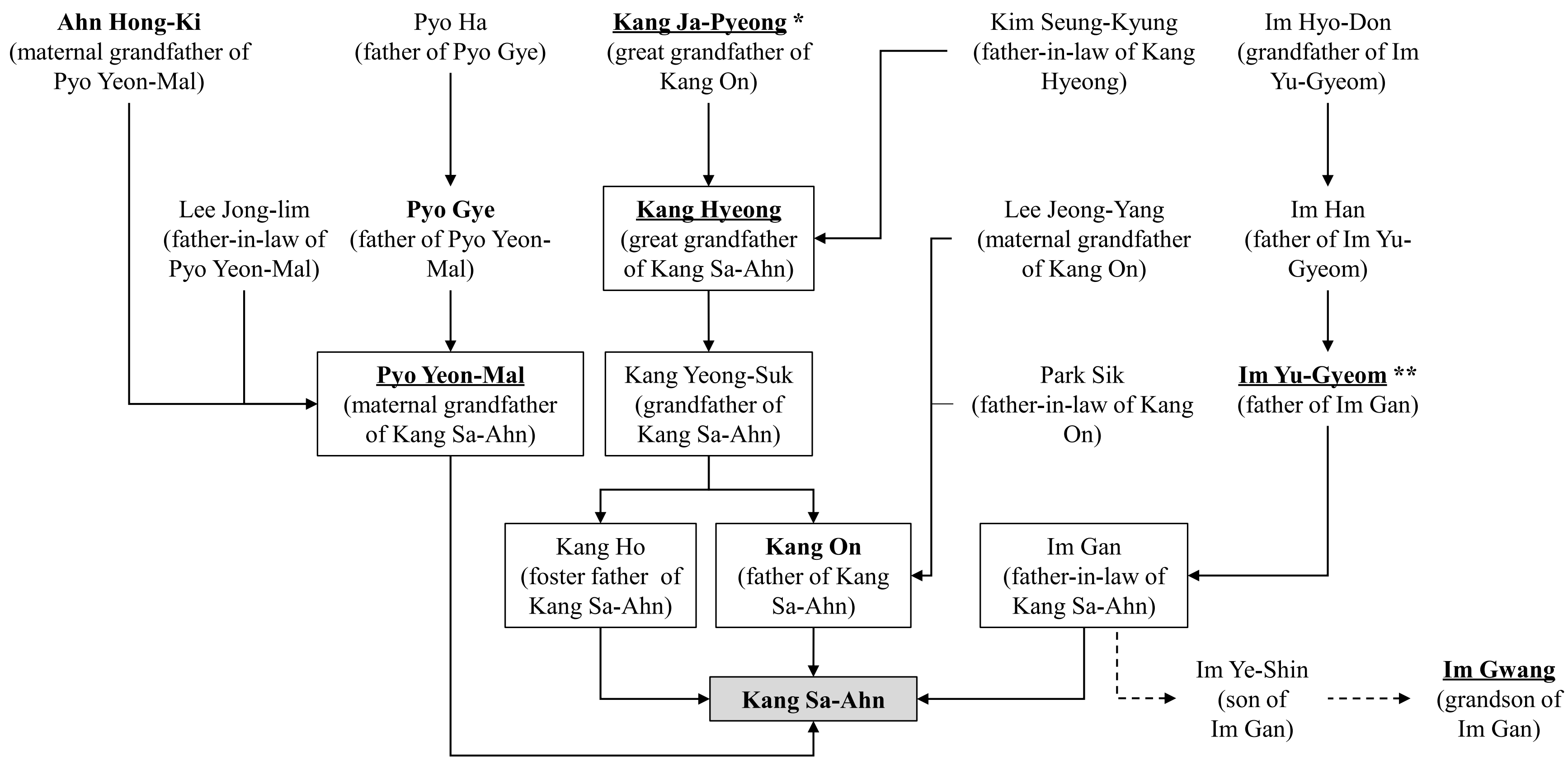
[13] The database construction initially started with the "Civil Examination Rosters Project (*Mun-gwa* Project)" by Edward W. Wagner and Jun-ho Song (Song 2010), and their efforts to digitize the rosters took about forty years. The Academy of Korean Studies has since expanded the data and made them available to the public after taking over the project (Wagner 1974; Lee 2018). The examination records database is available at the Academy of Korean Studies (AKS)' Historical Figures Comprehensive Information System (http://people.aks.ac.kr/index.aks).

[14] In the Appendix we further describe our data selection in more detail.

Figure 1 below illustrates the case of Kang Sa-Ahn, who appears on the exam roster as having taken the final-round examination in 1542.[15] The names in boxes are of Kang's predecessors that Kang wrote down on his application, the names in bold indicate those who passed the exam themselves, and the names underlined are those who also became high-ranking officials (*dang-sang-gwan*).

[15]Kang Sa-Ahn passed the exam at the age of 19 and had an exam score in the third-tier. He was initially placed in the ninth rank senior position and eventually reached the third rank lower senior position. There are many other men who are linked to Kang Sa-Ahn indirectly; given the space constraint, we only illustrate the linkages directly coming from Kang's closest ancestors. In Appendix A, we also give examples of other notable exam passers and their families in the dynasty.

Figure 1: An Example of Family Network



Notes: This family network shows the nodes and ties related to Kang Sa-Ahn. We illustrate the ties that are directly or indirectly linked to Kang Sa-Ahn in our dataset. Due to space constraint, we limit the number of figures to the extent that they still help us to understand the basic network structure. The names in bold represent the men who passed the exam (*mun-gwa*) and names underlined are those who finally reached the high-ranking positions. We can deduce that Im Gan, who was the father-in-law of Kang Sa-Ahn, has a tie with Im Yu-Gyeom even though Im Gan was not a successful candidate. Im Gwang passed the exam in 1624 and was a grandson of Im Gan. That is, from the exam roster we know that Im Gwang was a son of Im Ye-Shin, a grandson of Im Gan, a great grandson of Im Yu-Gyeom, and so on. In this specific example, the number of nodes is 26 and the number of ties is 27. The relationships between individuals are noted in parenthesis.

Figure 1 also shows how we can connect family members in the network, including those not in boxes. For example, Kang Sa-Ahn is tied to Kang Ja-Pyeong (marked with *) because Kang Sa-Ahn's great grandfather (Kang Hyeong) also passed the exam, meaning that Kang Hyeong also put down family information on the exam roster, and he was the son of Kang Ja-Pyeong. Kang Sa-Ahn is also connected to Im Yu-Gyeom (marked with **) through the Im family network.

5 Lineage Score and Variables

5.1 Lineage Score for Measuring Ancestral Influence

Given the multitudes of complex family relations that can be considered from our rich data set, we introduce our lineage score as a scalar measure capturing ancestral influence from different family relations across multiple generations. In Appendix D.2, we also show an alternative set of findings with indicators for whether having exam-passing predecessors of varying family ties (father, grandfather, great grandfather, father-in-law, and maternal grandfather) affects the descendant's high-ranking position attainment. The results show that controlling for the father's exam status only does not capture the full extent of ancestral influence from other family members, who themselves have statistically significant influence on the descendant. Similarly, confining our analysis to only predecessors up to three generations past would mean that we may still fail to account for the influence of other family members from four generations ago or more. A network-based measure in this regard allows us to consider all the family ties as well as information contained in each tie. In other words, we follow the recent literature that explicitly recognizes the need for multigenerational analysis in understanding long-run intergenerational persistence (Mare 2011; Lindahl et al. 2015; Adermon et al. 2018; Long and Ferrie 2018; Jiang and Kung 2020; Huang 2016; Solon 2018). A formal derivation of the aggregated network measure based on the historical appointment process is available in Appendix E. In constructing the measure, we assume that the selectorate considers candidates with illustrious lineages, i.e. high expected family endowments, favorably. We also assume that the selectorate cannot directly observe the candidate's true endowment, and that it instead relies on family records of exam-passing ancestors with high-ranking positions in order to assess the candidate's expected level of family endowment.

In the following, we provide a brief explanation of how we calculate the lineage score. For each exam passer in our data, we first count the number of his ancestors who passed the exam as well as those who were high-ranking officials (*dang-sang-gwan*).[16] That is, we utilize two types of lineage scores in the analysis below: one based on the ancestors' exam performance, and another based on their positions in the court. In calculating these scores, we also apply a weight to each predecessor linked to the descendant in our data. The first weight, which is called a decay factor in the network literature, discounts the influence of distant ancestors. We use 0.5 as the decay factor in the baseline analysis, which implies a compounding 50% decrease in influence for every generational gap (e.g., the weight of the grandfather in the lineage score calculation would be $0.5^2 = 0.25$). We also test whether the baseline result is robust under alternative decay factor values.[17]

The second weight varies depending on the lineage type. There are four types of close ties as recorded in the exam roster: the father, the foster father (if any), the maternal grandfather, and the father-in-law.[18] We put equal weights in the baseline analysis, but assign lower weights on non-paternal ties as alternative specification in the robustness checks

[16]In an early version of this paper, we used a degree-based centrality measure following the method of Katz (1953) and found similar results and implications with those of the current version. We discuss how our lineage score is related to the Katz centrality in Appendix E.

[17]Since our paper is the first study using a network concept in genealogy research, there is yet no rule of thumb for setting the decay factor in this context. Moreover, there appears to be no standard decay factor in other contexts, and its value varies across different studies: 0.5 in Katz (1953); 0.33 in Jackson (2010); 0.11 to 0.31 in Cruz et al. (2017); and 0.4 in Bonacich and Lloyd (2001). We also test cases with values of 0.1 and 1 in Table C2. The summary statistics of lineage scores under $\delta = 0.5$ and $\delta = 1$ are reported in Table D3.

[18]One of our contributions is that in addition to paternal lineage, we include maternal and spousal lineages in our calculation as well. Becker (1981) extends the endowment transmission model to incorporate influence from other relatives besides the parents. Similarly, we maximize the use of our data and consider all the lineage types to control for potential factors omitted in the previous empirical literature.

section.[19] This flexibility in assigning weights based on types of family ties is an important advantage when calculating the lineage score to capture family connections. We are not only able to identify the ties that individuals have, but also weigh each predecessor based on the ties that these connections themselves have. Furthermore, we are able to include multiple indirect connections beyond the immediate family members.[20]

In Table 3, we present lineage score calculations for Kang Sa-Ahn from Figure 1. In Panel A, we consider exam-passing ancestors and in Panel B we only consider ancestors who achieved high-ranking positions. We set the decay factor δ as 1 in Column 1, meaning that there is no discount for distant ancestors. In this case, the lineage score is simply the number of ancestors who passed the exam or who reached high-ranking positions. For example, in Panel A, Kang Sa-Ahn's lineage score (with $\delta = 1$) is 7, since he has seven ancestors who passed the exam themselves.[21] In Column 2, we change the decay factor from 1 to 0.5. The lineage score in Panel A is 1.9375 ($= 0.5 \times 2 + 0.5^2 \times 3 + 0.5^3 \times 1 + 0.5^4 \times 1$) since he has two exam-passing ancestors from one generation ago (Kang On and Pyo Yeon-Mal), three from two generations ago (Ahn Hong-Ki, Pyo Gye, and Im Yu-Gyeom), one from three generations ago (Kang Hyeong), and one from four generations ago (Kang Ja-Pyeong). In Column 3, we adjust the weight of the maternal grandfather ties from 1 to 0.5, which means that all the ancestors from the maternal lineage are discounted relative to the paternal lineage by 0.5. Finally, in Column 4, we replace the weight of the father-in-law tie from 1 to 0.5.

A higher lineage score means that the descendant has more exam-passing ancestors or ancestors in high-ranking positions. Since passing the exam was a prerequisite for obtaining

[19] We assign the weight of the foster father ties as zero; there is no clear direction on what the appropriate weight should be, especially relative to one given to paternal ties with the biological father. The foster father-son ties account for only 2.47 percent of the total ties (1,214 out of total 49,229 ties) in our data set and have little impact on the baseline results when we assign greater values to the weight.

[20] One caveat in calculating the lineage score as above is that exam passers born in a later time period systematically have higher scores than those born earlier, since later-born individuals naturally have more records of ancestors on the exam roster. As a way to address this bias, we restrict the number of generations of predecessors used to calculate the lineage score to five. As a robustness check, we also test whether our result is affected by this cutoff, by changing the cutoff number from 3 to 10 (these results are available upon request) and find that our results stay consistent.

[21] The number corresponds to the group of individuals presented as bold text in Figure 1, except Gwang Im who is not an ancestor of Kang Sa-Ahn.

Table 3 An Example of Lineage Scores Calculation: Kang Sa-Ahn

	(1)	(2)	(3)	(4)
Panel A. Based on ancestors' exam pass				
Kang Sa-Ahn's lineage score	7	1.9375	1.375	1.25
Panel B. Based on ancestors' high-ranking position				
Kang Sa-Ahn's lineage score	4	0.9375	0.6875	0.5625
Network weights				
Distance (decay factor)	1	0.5	0.5	0.5
Lineage types				
Father	1	1	1	1
Maternal grandfather	1	1	0.5	0.5
Father-in-law	1	1	1	0.5
Foster father	0	0	0	0

Notes: This table shows the lineage scores of Kang Sa-Ahn based on Figure 1. Panel A is based on exam-passing ancestors and Panel B only consider influences of ancestors who achieved high-ranking positions. In Columns 1, the decay factor δ is set as 1, meaning that there is no discount imposed on distant ancestors. In Column 2, we change the decay factor to 0.5 and use this method as our baseline in later regressions. Column 3 adjust the weight of the maternal grandfather from 1 to 1/2. Finally, in Column 4, we replace the weight of the father-in-law from 1 to 1/2.

any high-ranking position, the two types of scores that we calculate in our study are highly correlated. The scores capture the relevant and available information that the selectorate would have obtained in order to estimate the candidate's expected family endowment.

Table D3 in Appendix D.1 provides the summary statistics of lineage scores with $\delta = 1$ as well as $\delta = 0.5$. The mean lineage score with $\delta = 1$ indicates that on average the exam passers in our sample have around 3.89 ancestors who passed the exam. The score ranges from 0 to 67 with the standard deviation around 6.3. When the decay factor is 0.5, the score ranges from 0 to 6.375, with the mean of 0.667 and the standard deviation of 0.877. Table D3 Columns 5 and 6 also show the mean lineage scores for those who eventually became high-ranking officials and those who did not. The scores are generally two times higher for those who became high-ranking officials than the rest.

5.2 Variables

Our dependent variable is an indicator equal to one if the exam passer in our data ever became a high-ranking official, i.e., above or equal to the third rank senior official title (*dang-sang-gwan*). Our main independent variable is the lineage score based on the family networks. We also consider the exam passer's grade tier (first, second, and third) and age at the time of the final-round examination as additional explanatory variables. For the selectorate, the exam grade tier would reflect the candidate's knowledge pertaining to statecraft beyond just Confucian studies. The final exam tested on both administrative and political expertise, and was meant to screen those for senior appointments in the government (Kim 2015). The topic of the exam was open and allowed for highly subjective answers from candidates, who often had to give their opinions on issues that the king himself confronted.[22] Second, the age upon passing the exam would reflect the final exam candidate's ability in writing compositions and memorizing codified knowledge of the Confucian classics (Lee 2003). The assumption here is that the more competent candidate would be more likely to pass the exam at a younger age (Marsh 1961; Huang 2016; Jiang and Kung 2020). Younger successful candidates, in turn, would have more opportunities over time to go up in the ranks than their counterparts.[23]

Furthermore, we consider other confounding factors that might affect the candidate's career, including his family clan, the type of exam that he passed, the place of residence at the time of exam, and his pre-exam status. During the Joseon Dynasty, each family belonged

[22] In order to compare the final rankings of candidates in the Chinese civil service examination, Huang (2016) and Jiang and Kung (2020) standardize the ranks as follows:

$$\frac{\text{total number of passers in a given exam} - \text{actual ranking}}{\text{total number of passers in a given exam}}$$

with the value ranging in $[0, 1)$. In our study, we standardize the final grade in terms of the three tiers (as described in Table 1) instead of individual (continuous) rankings. In the case of Joseon, court appointment was affected by final grade tiers rather than individual ranking within each tier.

[23] Controlling for only one of these two competence measures can be misleading. For example, even though two candidates may both score in the first-tier (top three in the regular exam), one passing the exam at a younger age would have been considered to be more competent than the other. Similarly, if two candidates passed the exam at the same age, then the one whose grade is higher would likely have a higher chance of success in the court.

to a clan. Wagner (1974) points out that 21 leading clans produced over 40 percent of the exam passers while 560 extremely minor clans produced only 10 percent of the select group. This may indicate that those who came from major family clans might have been favored to pass the examination and hold high-ranking positions in the court. We identify 682 family clans in our data and include their dummies in our sample. As described in Section 3.1, *mun-gwa* was broadly categorized into regular exams and irregular exams. Notably, the characteristics between the regular (the triennial exam and the augmented exam) and the irregular (special exam, the memorial exam, and so on) exams were substantially different. The triennial exam (*sik-nyeon-si*) was regularly scheduled every three years to select 33 people.[24] On the other hand, other irregular exams were carried out on ad-hoc bases when there was a national event, and the number of selected exam candidates was not fixed. Some argue that these irregular exams were difficult for local students who did not reside nearby the capital city, because they were conducted after only a short notice period and had different exam structures, and so on (Won 2019).

In addition to the family clan and exam types, the place of residence might be systematically related to the candidate's political career. During the Joseon period, educational environment varied across regions. For example, people living in the capital city (*Han-yang*; currently Seoul) or *An-dong* (region of North *Gyeong-sang* Province) had better opportunities to be exposed to the Confucian education culture than those in Ham-gyong province, which was located in the northeast periphery of the peninsula. We match each candidate's residence to a district (*Gun-Hyun*) and include 261 district dummies. Finally, we control for the exam passer's pre-exam status with a set of indicators for the following: student, classics licentiate, literary licentiate, and court officer. As explained in Section 3.2 and Table 1, the initial placement after passing the exam was systematically determined in part by the candidate's status before the exam. Descriptive statistics of all the variables discussed here

[24] Although the augmented exam (*jeung-gwang-si*) was an irregular exam, we group exam passers from this exam with the ones who took the regular exam because it had the same three-stage structure and selected the same number of passers as the triennial exam.

are reported in Table D3 in Appendix D.1.

6 Family Network and Political Power

6.1 Baseline Estimation

We first start with a simple graphical illustration of the lineage effect on court official appointment. Figure 2 presents two binned scatter plots; the left panel uses the lineage score based on whether the exam passer had exam-passing ancestors, and the right panel uses the lineage score based on whether his ancestors were high-ranking officials. For each plot, we create cutoffs across the log-transformed linear score distribution of exam passers to create equal-sized bins. In each bin, we classify every exam passer as belonging to the first, the second or the third tier based on his exam score, and calculate the proportion of each score tier group that obtain high-ranking positions in the court. We then plot the proportion of exam passers in each score tier against the mean lineage score in each bin.

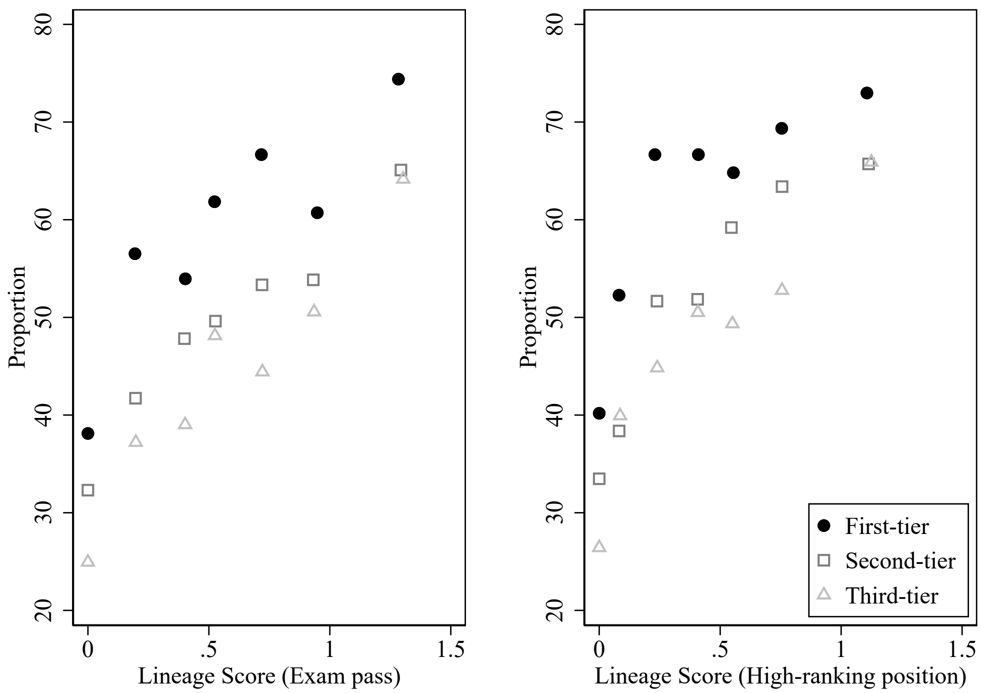
Both panels in the figure show that the final exam candidates who scored in the first-tier (the top three out of thirty-three candidates in the case of the regular exam) were generally more likely to become high-ranking officials for any given level of lineage score, compared to other tier groups. That is, we find that exam performance was indeed an important predictor of high-ranking official appointments. At the same time, the figure also shows that candidates with high lineage scores were also more likely to become high-ranking officials, even when they placed in lower score tier groups. In fact, we see that candidates in the second and third score tiers of the highest lineage score group were more likely to become high-ranking officials than those in the first score tier of the lowest lineage score group.

Next, we estimate the following linear probability model:[25]

$$y_i = \alpha + \beta L_i + \gamma T1_i + \tau T2_i + \theta A_i + \mathbf{Z}_i'\mathbf{H} + \varepsilon_i \tag{1}$$

[25] We also present results from logit and probit estimations in Table C2.

Figure 2: Proportion of Candidates Obtaining High-Ranking Positions



Notes: This figure is a binned scatter plot indicating the proportion of candidates becoming high-ranking officials. To construct this binned scatter plot, we first divide the lineage scores into equal sized-groups and plot the means of the y-axis variable within each tier group in the final examination against the mean value of log-transformed lineage scores in each bin.

where y_i is a dummy variable indicating whether individual i became a high-ranking official; L_i denotes i's log-transformed lineage score based on exam-passing ancestors or ancestors with high-ranking positions in the court;[26] $T1_i$ is the first-tier group dummy based on the final exam score and $T2_i$ is the second-tier group dummy;[27] A_i is the age upon passing the final-round exam; $\mathbf{Z}_i$ is a vector of additional confounders including the exam passer's family clan, pre-exam status, exam type, and place of residence.

Table 4 summarizes the baseline estimation results across different model specifications. We report the key coefficients $(\hat{\beta}, \hat{\gamma}, \hat{\tau}, \hat{\theta})$ and their robust standard errors (Column 4 presents clustered standard errors at the family clan level). Panel A uses the lineage score based on exam-passing ancestors, and Panel B uses the lineage score based on ancestors with high-ranking positions. In Column 1 we only control for the lineage score, and additively include the exam grade tier dummies in Column 2 and the candidate's age in Column 3, respectively.[28] In Column 4, the full set of controls includes the pre-exam status, exam type, family clan, and place-of-residence fixed effects. The estimation results are statistically significant at the one-percent level and suggest that the likelihood of becoming a high-ranking official is higher for those (i) with higher lineage scores, (ii) who are in the first- and second-tier groups at the final-round exam compared to the third-tier group, and (iii) who passed the exam at a younger age.

For substantive interpretation, we first consider the coefficient estimate of the first-tier dummy $(\hat{\gamma})$. Panel A Column 4 in Table 4 suggests that a first-tier exam passer had a higher probability of becoming a high-ranking official compared to a third-tier exam passer by 10.7 percentage points. To get a sense of the magnitude of effects from lineage scores,

[26]Appendix Figure E2 shows that the lineage scores are right-skewed, with a clump at zero. To reduce the skewness, we add a value of one and apply log transformation to the scores. An alternative to this approach may be the Inverse Hyperbolic Sine transformation (IHS) (Johnson 1949; MacKinnon and Magee 1990; Pence 2006; Burbidge et al. 1988; Bellemare and Wichman 2020). However, there is a concern that this practice could cause a bias when the original value is small (the literature requires a value of at least 10 in order to avoid the bias, while our lineage scores are distributed from zero to around 5 or 6). We find that applying IHS transformation instead still yields similar results.

[27]Here, the third-tier group in the final-round exam is the omitted reference group.

[28]The β coefficient estimates in Column 2 correspond to the slopes in Figure 2.

Table 4 Effects of Family Networks on High-level Official Positions: Baseline Estimation

Dependent variable: Dummy = 1 if the candidate became a high-ranking official

	Total sample				By final-round exam grades		
					First-tier	Second-tier	Third-tier
	(1)	(2)	(3)	(4)	(5)	(6)	(7)
Panel A. Using lineage score based on ancestors' exam pass							
Lineage score	0.119***	0.116***	0.108***	0.050***	0.013	0.062*	0.053***
	(0.006)	(0.006)	(0.006)	(0.007)	(0.045)	(0.032)	(0.009)
First-tier dummy		0.147***	0.140***	0.107***			
		(0.018)	(0.017)	(0.019)			
Second-tier dummy		0.061***	0.060***	0.030*			
		(0.014)	(0.014)	(0.016)			
Passing age			-0.008***	-0.006***	-0.008	-0.005**	-0.007***
			(0.001)	(0.001)	(0.008)	(0.002)	(0.001)
Panel B. Using lineage score based on ancestors' high-ranking position							
Lineage score	0.121***	0.119***	0.112***	0.054***	0.016	0.064**	0.056***
	(0.006)	(0.006)	(0.006)	(0.007)	(0.041)	(0.029)	(0.009)
First-tier dummy		0.150***	0.143***	0.108***			
		(0.018)	(0.018)	(0.020)			
Second-tier dummy		0.063***	0.063***	0.030*			
		(0.014)	(0.014)	(0.016)			
Passing age			-0.008***	-0.006***	-0.008	-0.005**	-0.007***
			(0.001)	(0.001)	(0.007)	(0.002)	(0.001)
Full controls	No	No	No	Yes	Yes	Yes	Yes
Sample mean of dependent variable	0.41				0.54	0.45	0.38
Observations	6,905				703	1,414	4,788

Notes: We conducted the regressions in Equation (1) across different model specifications. The dependent variable is a dummy variable for whether the individual's highest official position obtained throughout his career was higher than or equal to the third rank upper senior position, i.e. belonging to the group of high-level rank officials (*dang-sang-gwan*). Lineage scores are log transformed after adding one. Panel A uses the lineage score based on exam-passing ancestors and Panel B on ancestors with high-ranking position. In Column 1, we only control for the lineage scores. We additively include final-round exam score tiers in Column 2 and passing age in Column 3, respectively. In Column 4, the specification includes the pre-exam status, exam type, family clan, and place-of-residence fixed effects. Family clan fixed effects include the dummies of 682 family clans. Exam type fixed effects include the regular exams (*sik-nyeon-si* and *jeung-gwang-si*) and the irregular exams (*byul-si*, *alsung-si*, and so on). Residence fixed effects include 261 district-level (*Gun-Hyun*) region dummies. Each cell reports the estimated coefficient and standard error. From Columns 5 to 7, we divided sample into final-round exam grades. Robust standard errors are used in Columns 1-3 and clustered standard errors at family clans are used in Columns 4 to 7. A single asterisk denotes statistical significance at the 90% level of confidence, double 95%, and triple 99%.

consider two types of exam passers: those in between the 90th percentile and the top of the distribution of lineage scores (top 10 percent group), and others in between the bottom and the 70th percentile of the distribution (bottom 70 percent group). This useful grouping follows the cut-off criteria in the final-round exam score tiers, in which the first-tier comprises the top three candidates out of 33 ($3/33 \approx 0.09$), the second-tier comprises the next seven candidates below the top tier ($7/33 \approx 0.21$), and the third-tier comprises the remaining 23 candidates ($23/33 \approx 0.7$).[29] The results shown in Column 4, Panel A in Table 4 also suggest that if an exam passer in the bottom tier of lineage score (bottom 70 percent) moves to the top tier (top 10 percent), we have a 4.8 percentage-point increase in the likelihood of the individual becoming a high-ranking official on average.[30] According to this interpretation, the lineage score has a sizable effect given that the likelihood of being high-ranking officials over the sample mean is already high at 40.8 percent; a 4.8 percentage-point increase means an additional increase by 11.8 percent from the mean.[31]

7 Family Network and Political Stability

Under what circumstances did ancestral influence matter more for successful political careers in the court? Given that our outcome variable is the candidate's likelihood of becoming a high-ranking official, the overall political climate during the appointment would

[29]The distribution of final-round exam tier groups in our baseline sample is as follows: 0.102 for the first-tier, 0.205 for the second-tier, and 0.693 for the third-tier (please refer to Table D3 in Appendix D.1). By definition, the estimated coefficient of the first-tier dummy corresponds to the percent points increase when moving up from the bottom tier group to the top tier group.

[30]The magnitude from lineage score effect can be calculated as the following:

$$\hat{\beta} \times (\bar{T} - \bar{B}) \times 100$$

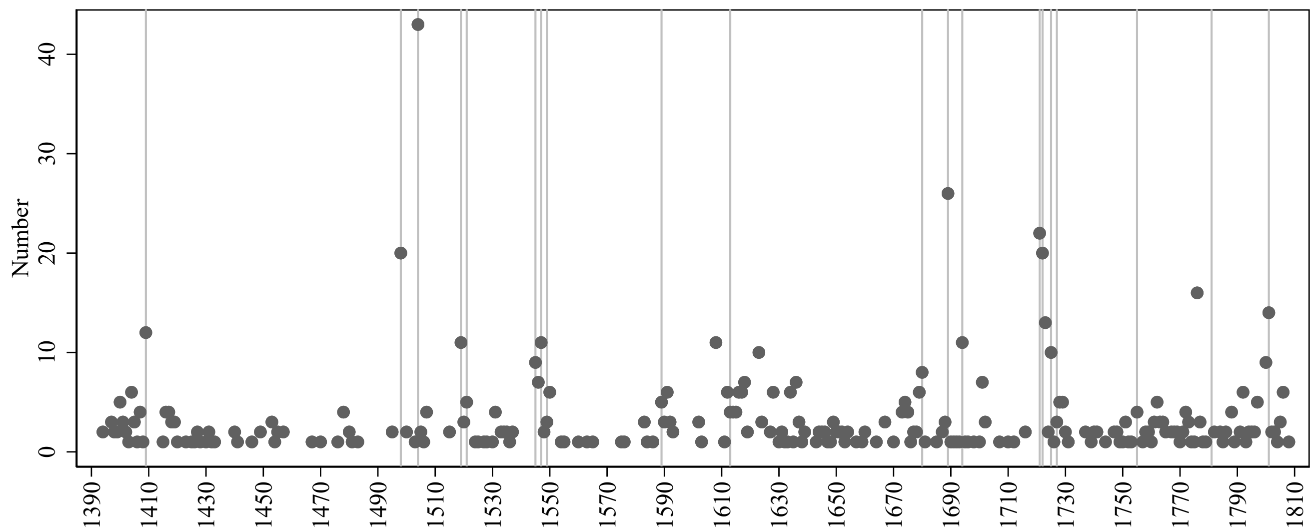
where $\hat{\beta}$ is an estimated coefficient of lineage score (reported in Table 4), $\bar{T}$ is the average of log-transformed lineage score of the top 10 percent (1.095) and $\bar{B}$ is the average of log-transformed lineage score of the bottom 70 percent (0.136). For example, the calculation result mentioned in the text is obtained from $0.05 \times (1.095 - 0.136) \times 100 = 4.8$. Similarly, when we move up from the bottom 70 percent to the top 10 percent of the sample in the distribution of the exam-passing age, we obtain a 10.4 ($= -0.006 \times [21.17 - 38.46] \times 100$) percentage-point increase in the likelihood of being a high-ranking official on average.

[31]In the Appendix we provide a series of robustness checks for the baseline results. We test whether the results hold across the spectrum of different court positions, under alternative regression models, as well as decay factors, varying weights for different family relations, and pre-exam status.

have been especially important for the exam passer's success. During times of turmoil, family connections and background might prove especially useful for the candidate's survival and success in the court relative to other periods. In the following, we document the changing significance of our lineage scores throughout various points of instability, which we measure with the number of government officials in exile.

In the absence of more fine-grained measures, we introduce the number of exiles in the court as a proxy for the overall political instability in each period. During the Joseon Dynasty, exile was a severe punishment that forced the condemned to live in the peripheries far from the capital. Bureaucratic exiles mostly occurred during political upheavals and power struggles. For the following exercise, we have hand-collected individual exile information from two sources. First, the Encyclopedia of Korean Culture (*Han-guk-mik-jok-mun-hwa-dae-baek-gwa*) lists figures of importance in Korean history with their names, birth and death years, family clans, and biographies. We have created a list of about 900 historical figures with exile locations and years by searching for biographies with keywords related to exile. Furthermore, we found 250 additional cases of exiled outcasts from the Annals of the Joseon Dynasty (*Joseon-wang-jo-sil-lok*). Since some exile cases were due to relocations to other areas as continuation or extenuation of their punishment, the number of (unique) exile cases is lower than that of exiled figures. In sum, the total number of exiles during the Joseon Dynasty is 838 in our data. Figure 3 shows the yearly number of exiles (black dots) and major political upheavals such as political purges and treason cases (vertical lines). We find that the number of exiles sharply increased during politically unstable periods.

Figure 3: Annual Number of Exiles and Periods of Political Instability in the Joseon Dynasty



Notes: Each dot depicts the number of exiles by year. Vertical lines are political events including Literati Purges and Treason Cases. Major political upheavals include the followings: The First Literati Purge of 1498 (*Muo-Sahwa*); The Second Literati Purge of 1504 (*Kapcha-Sahwa*); The Third Literati Purge of 1519 (*Kimyo-Sahwa*); Fourth literati purge of 1545 (*Eulsa-Sahwa*); False Treason Case of 1521 (*Shinsa-Muok*); Treason Case of 1589 (*Gichuk-Oksa*); Treason Case of 1613 (*Gyechuk-Oksa*); Treason Cases of 1721 and 1722 (*Shinyim-Oksa*); Treason Case of 1755 (*Eulhae-Oksa*); Turn of 1680 (*Gyeonshin-Hwanguk*); Turn of 1689 (*Gisa-Hwanguk*); Turn of 1694 (*Gaapsul-Hwanguk*); Turn of 1721 (*Shinchuk-Hwanguk*); Turn of 1725 (*Eulsa-Hwanguk*); Turn of 1727 (*Jeongmi-Hwanguk*); Persecution of 1781 (*Sinhae-Bakhae*); Persecution of 1801 (*Shinyu-Bakhae*); Persecution of 1839 (*Gihae-Bakhae*).

We take the means of annual exile numbers over the five years or ten years since each individual passed the exam (i.e., the 5- or 10-year moving average that is specific to the individual and his year of passing the exam). Because political exiles are volatile, the moving average provides a better proxy for the average political environment. Our measure for political instability is thus the average number of exiles that the exam candidate would have witnessed over the five or ten years since the exam.[32] The sample mean of this variable is around 2 (i.e., there were 2 exile cases on average in the central government during five or ten years since one's exam success) and reported in Table D3 of Appendix D.1.

We add additional terms to Equation (1) to check whether ancestral influence was stronger under politically unstable periods:

$$
\begin{aligned}
y_i = \alpha + \beta_1 L_i + \gamma_1 T1_i + \tau_1 T2_i + \theta_1 A_i + \mathbf{Z}_i'\mathbf{H} \\
+ \beta_2 L_i E_i + \gamma_2 T1_i E_i + \tau_2 T2_i E_i + \theta_2 A_i E_i + \mu E_i + \varepsilon_i
\end{aligned} \tag{2}
$$

where E_i is the average number of exiles around i's exam year, standardized to zero mean and standard deviation of one. All other variables are the same as in Equation (1). The estimated coefficient β_2 measures how much greater the lineage effect was on obtaining a high-ranking position when the average number of exiles was one standard deviation higher than the average. We can interpret the coefficients for the interaction terms with the exam performance and the age upon passing exam in the same way.

In Table 5, we report the estimated results with key variables. The estimation in Panel A uses the lineage score based on whether the ancestors passed the exam. In Column 1, we include the average number of exiles over five years since the candidates' exam passing year. The results show a positive, statistically significant interaction effect between our political instability measure (i.e., Avg. Exile) and lineage score. In other words, when times are

[32]Considering that the average exam-passing age was 34.74 (Table D3 in Appendix D.1) and the average lifespan during the Joseon Dynasty was around 50, the time spans of five- or ten-years would have covered a significant period of one's political career post-exam.

Table 5 Heterogeneous Effects Across Political Instability

Dependent variable: Dummy = 1 if the candidate became a high-ranking official

	Period for calculating the average number of exiles (Time 0: Year of passing the exam)			
	From 0 to 4	From 0 to 9	From -5 to -1	From -10 to -1
Key control variables	(1)	(2)	(3)	(4)
Panel A: Using lineage score based on ancestors' exam pass				
Lineage score	0.1111***	0.1113***	0.1113***	0.1105***
	(0.0167)	(0.0166)	(0.0172)	(0.0172)
Lineage score × Avg. Exile	0.0435***	0.0304**	0.0079	0.0223
	(0.0124)	(0.0138)	(0.0144)	(0.0160)
First-tier dummy	0.1090***	0.1093***	0.1113***	0.1124***
	(0.0184)	(0.0186)	(0.0192)	(0.0192)
First-tier dummy × Avg. Exile	-0.0195	-0.0217	-0.0002	-0.0110
	(0.0185)	(0.0200)	(0.0175)	(0.0170)
Second-tier dummy	0.0309**	0.0324**	0.0316**	0.0320**
	(0.0152)	(0.0153)	(0.0155)	(0.0155)
Second-tier dummy × Avg. Exile	0.0062	-0.0059	-0.0144	-0.0126
	(0.0165)	(0.0153)	(0.0148)	(0.0135)
Passing age	-0.0079***	-0.0080***	-0.0080***	-0.0079***
	(0.0008)	(0.0008)	(0.0007)	(0.0007)
Passing age × Avg. Exile	0.0027***	0.0026***	0.0019***	0.0020***
	(0.0007)	(0.0007)	(0.0007)	(0.0006)
Avg. Exile	-0.0948***	-0.0834***	-0.0851***	-0.0978***
	(0.0256)	(0.0271)	(0.0258)	(0.0246)
Panel B: Using lineage score based on ancestors' high-ranking position				
Lineage score	0.1461***	0.1473***	0.1491***	0.1479***
	(0.0175)	(0.0173)	(0.0177)	(0.0175)
Lineage score × Avg. Exile	0.0525***	0.0326**	0.0025	0.0165
	(0.0152)	(0.0156)	(0.0177)	(0.0214)
First-tier dummy	0.1103***	0.1105***	0.1120***	0.1132***
	(0.0186)	(0.0188)	(0.0194)	(0.0193)
First-tier dummy × Avg. Exile	-0.0168	-0.0198	0.0025	-0.0092
	(0.0188)	(0.0201)	(0.0174)	(0.0171)
Second-tier dummy	0.0313**	0.0326**	0.0319**	0.0324**
	(0.0152)	(0.0153)	(0.0155)	(0.0154)
Second-tier dummy × Avg. Exile	0.0055	-0.0066	-0.0139	-0.0119
	(0.0164)	(0.0151)	(0.0150)	(0.0136)
Passing age	-0.0080***	-0.0081***	-0.0081***	-0.0080***
	(0.0008)	(0.0007)	(0.0007)	(0.0007)
Passing age × Avg. Exile	0.0026***	0.0026***	0.0018***	0.0019***
	(0.0007)	(0.0007)	(0.0007)	(0.0006)
Avg. Exile	-0.0893***	-0.0798***	-0.0835***	-0.0927***
	(0.0245)	(0.0264)	(0.0255)	(0.0247)
Observations	6,905	6,905	6,905	6,905

Notes: This table summarizes the regression results of Equation (2). Columns 1 and 2 set the significant career periods as 5 years and 10 years since passing the exam (post-exam periods), respectively. Columns 3 and 4 do the same for pre-exam periods. Each cell reports the estimated coefficient and standard error clustered at family clans in parenthesis. A single asterisk denotes statistical significance at the 90% level of confidence, double 95%, and triple 99%.

politically unstable, the exam passers with many more exam passing ancestors were more likely to become a high-ranking official. On the other hand, the interaction terms with the final-round exam score tiers are not statistically significant, while the sign of the interaction term with the exam-passing age is positive and statistically significant. These results suggest that regardless of political instability, exam performance did have a consistently positive effect on promotion, while younger candidates did not have an additional advantage of being promoted during the political turmoil. In Column 2, we define political instability measure by the average number of exiles over ten years since the candidates' exam passing year, but the results are qualitatively similar to those of Column 1.

Finally, we conduct additional tests by looking at the average number of exiles before the candidate passed the exam. Since the candidate's career as a government official would have started after passing the exam, the political situation after passing the exam should have more influence on his career path than before. The key assumption here is that for a court official, the overall political environment during his career should matter more rather than before. The results in Columns 3 and 4 support this argument, in that the political instability proxy interacted with lineage scores is not statistically significant anymore. Panel B shows the results from using the lineage score based on whether his ancestors reached high-ranking positions. We find that the results again remain substantively similar to those in Panel A.

8 Conclusion

Various exams for selecting state officials and elites continue to be employed today as a core recruiting system for national development. Our study presents the civil service exam of the Joseon Dynasty as an early institutional innovation that effectively screened a pool of qualified candidates for positions in the court. While similar civil service exam systems were historically adopted in other countries and across different time periods, the surviving records from the Joseon Dynasty stand out for their comprehensive information on the candidates' families and official positions obtained, as well as coverage over centuries of rule under a single dynasty.

In our analysis, we find that both the exam performance and family lineages of candidates influenced the high-ranking official appointment process. The exam system screened qualified candidates and gave early advantages for those with top scores by placing them in higher starting court appointments. Family lineages also influenced their eventual career paths in the court, which we interpret as the selectorate favoring candidates with higher expected family endowment in its assessment. Finally, we find that the lineage effect remained strong and became more pronounced in times of political instability when there were less exam passers.

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Online Appendix: The Road to Ascension: Exams, Lineages and Civil Servants of the Joseon Dynasty

Contents

A Case Studies of Notable Exam Passers

Here we provide a brief bibliography of Lee Gun Chang, a well-known scholar and politician in the late Joseon period who successfully passed the exam at exceptionally young age. According to the Biographies of Notable Persons from the Academy of Korea Studies (http://people.aks.ac.kr/index.aks), Lee passed the exam at the age of fifteen and is recorded as the second youngest candidate among the 15,151 who passed the final exam throughout the dynasty. In the exam, Lee ranked the 13th in his batch of 33 final exam takers in 1866 AD. Lee became a secret royal inspector *(amhaeng-eosa)* for Gyeonggi province, a high-ranking official in the third senior upper position (the lowest position comprising *dang-sang-gwan*, the high-ranking official group) in 1880 AD. Lee's family lineage suggests a privileged upbringing. Lee's paternal grandfather Lee Si Won was a minister of personnel *(yijo-panseo)*, a high ranking official in the second senior upper position, while his father Lee Sang Hak was also a high ranking official in the second junior position *(yijo-champan)*. The Biographies detail Lee's childhood years as Lee being educated by his grandfather early on, to the extent that Lee successfully began to compose writing at the age of five. The Biographies also note the grandfather's continuing influence throughout Lee's career. Given his illustrious career in the court, the selectorate appears to have recognized both Lee's exam performance as well as his family background in appointing him to the high ranking position.

Another example from the Encyclopedia of Korean Culture (http:encykorea.aks.ac.kr/) is the Kim family clan of Kwangsan that produced 256 exam passers. Some of the most notable are the descendants of Kim Ik Gyum from the clan, who was posthumously commemorated with the title of the chief state counselor (*yeong-uijeong*) of the first senior upper position for his resistance efforts (and later his death) against the Qing Invasion in 1636 AD. Kim Ik Gyum's father is Kim Jang Saeng, who became a high-ranking official (second junior position) in the Ministry of Justice (*hyeongjo-champan*) in 1627 AD. Kim Man Ki is the son, Kim Jin Gyu the grandson and Kim Yang Taek the great-grandson of Kim Ik

Gyum. Each of these descendants passed the final civil service exam in his twenties and became a chief scholar (*daejehak*), a high-ranking official in the second upper lower position. The Kim family subsequently became renowned as having a remarkable lineage of producing chief scholars over three generations, in addition to the already illustrious achievement of the ancestors.

B Data Selection

The court systematically organized exam passers' career highlights and updated them after each king's reign until the period of King Yeongjo (1724-1776 AD). After 1776 AD, this practice was no longer in place **??**.[1] Table B1 shows the number of successful candidates before and after 1776 AD. In Panel B of Column 2, we find that nearly 80 percent of the exam passers on record between 1393 and 1776 AD (i.e., 8,072 out of 10,216) have information on their court positions, but only 5.6 percent of the exam passers between 1777 and 1894 AD have comparable records. In order to avoid any potential bias from this change in the recording practice, we only keep the exam passers between 1393 and 1776 AD as our main sample.

Next, we complement the exam roster data with the Joseon Dynasty's court official appointment record (*Cheong-sun-go*).[2] Specifically, if we find that there is a discrepancy

[1]According to **?**, the exam roster had been organized in a consistent format from the early-period to the King Yeongjo's reign, but this was no longer the case from the first year of King Jeongjo (1777) to the 12th year of King Cheoljong (1861), from the 13th year of King Cheoljong (1862) to the 24th year of King Gojong (1887), and from the 25th year of King Gojong (1888) to the 31th year of King Gojong (1894).

[2]The Academy of Korean Studies provides a digitized version of the appointment record. The record contains information about the official's name, birth year, death year, type of official position (civil, military, protected, or miscellaneous), name of the position, appointment year, and so on. On this record there are 12,153 individuals taking on 48,561 appointments (i.e., on average, each individual took on around 4 positions during his career). There are 10,690 civil officials, 2,581 military officials, 550 protected officials, and 530 miscellaneous officials. Of the 196 positions (133 civil officers, 50 military officers, 9 miscellaneous, and 1 protected) and of the 133 civil officer positions, we can identify the official ranks from the junior ninth rank to the first senior upper for 120 positions, altogether comprising 30 ranks as described in Section **??**. Using the Universal Content Identifier (UCI) system created by the Academy of Korean Studies to code each individual mentioned in historical documents throughout the Joseon Dynasty, we exactly match individuals on the exam roster and the appointment record, at the same time also checking **?**'s network data for any duplicate entries and identical names.

Table B1 Sample Description

	1393-1894 (1)	1393-1776 (2)	1777-1894 (3)
Number of exams	804	620	184
Panel A. Exam roster total samples			
Number of exam passers	14,720	10,216	4,504
Panel B. Samples of Panel A with office information			
Number of exam passers	8,326	8,072	254
Percent of total	56.6	79.0	5.6
Panel C. Samples of Panel B complemented by appointment record			
Number of exam passers	10,932	8,988	1,944
Percent of total	74.3	88.0	43.2
Panel D. Samples of Panel C with birth year information			
Number of exam passers	8,838	6,905	1,933
Percent of total	60.0	67.6	42.9

Notes: The exam roster refers to *Mun-gwa-bang-mok* and the appointment record refers to *Cheong-sun-go*. In Panel C, we complement the office information in the exam roster with the appointment record. Specifically, for an exam passer, if we find that there is a discrepancy between the two documents in terms of the exam passer's highest-ranked official position, we update them accordingly. With the additional data, the total number of exam passers with information on official appointment in our sample increases to 8,988, which is about 88 percent of all the exam passers recorded between 1393 and 1776 AD (see Panel C, Column 2 in Table B1). This constitutes the main sample in our baseline analysis. Panel D shows that when seeking information on the candidate's age upon taking the exam, the sample size decreases; in this case it decreases to 6,905, about 68% of the exam passers between 1393 and 1776 AD (see Panel D, Column 2).

between the two documents in terms of the exam passer's highest-ranked official position, we update them accordingly. With the additional data, the total number of exam passers with information on official appointment in our sample increases to 8,988, which is about 88 percent of all the exam passers recorded between 1393 and 1776 AD (see Panel C, Column 2 in Table B1). This constitutes the main sample in our baseline analysis. Panel D shows that when seeking information of the candidate's age upon taking the exam, the sample size decreases further; in this case it decreases to 6,905, about 68% of the exam passers between 1393 and 1776 AD (see Panel D, Column 2).

C Robustness Checks

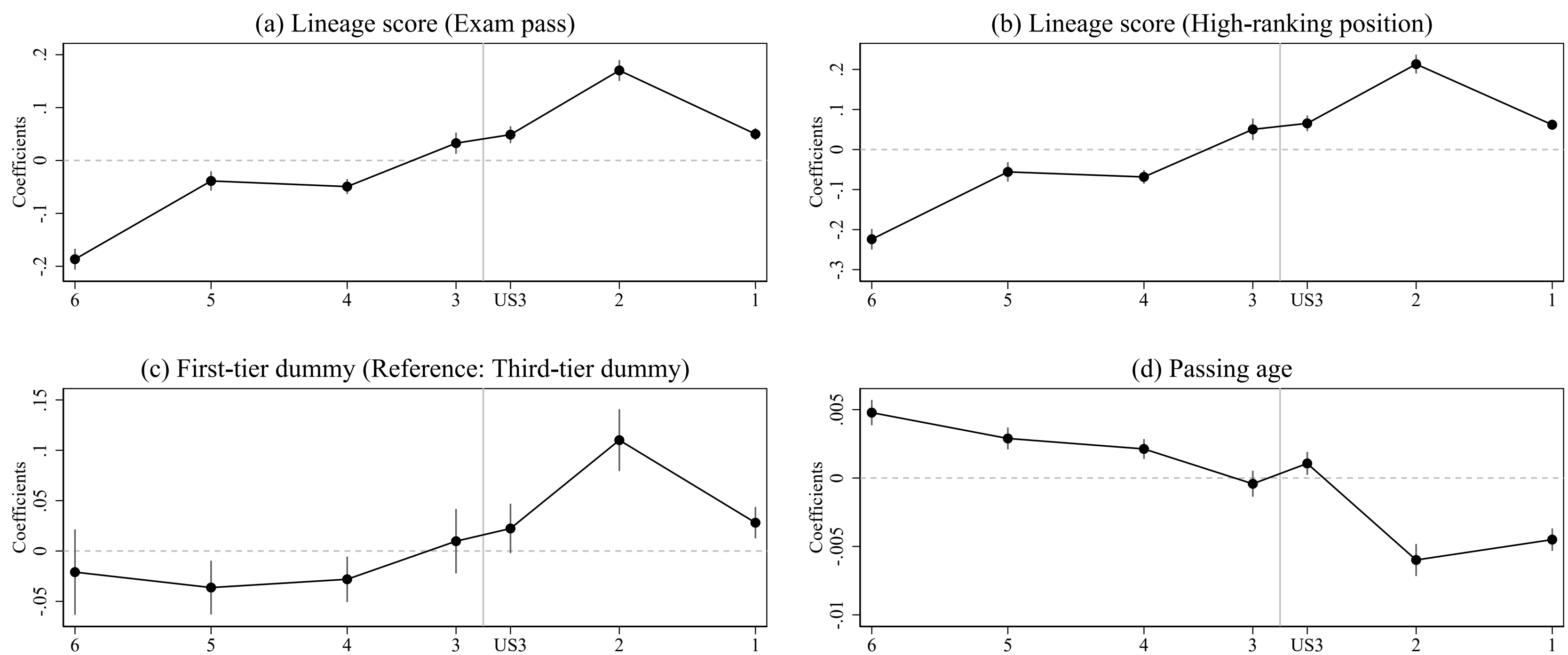
We find that among the exam passers, family lineage mattered for obtaining high-ranking official positions; but how beneficial were these connections across the spectrum of different positions? While we have primarily focused on the likelihood of candidates joining the high-ranking group, in Figure C1 we can also conduct the analysis with outcome variables indicating different levels of official positions—for example, the sixth rank positions (denoted as 6 in the x-axis) or the first rank positions (denoted as 1 in x-axis).[3] We employ the Generalized Ordered Logit model and plot estimated coefficients for the key variables of interest and their 95 percent confidence intervals: the lineage score from exam passing ancestors in Panel (a), the lineage score from high-ranking ancestors in Panel (b), an indicator for the first-tier group in Panel (c), and the age upon passing the exam in Panel (d).

Panels (a) and (b) show that the lineage effects are negative for positions below the third rank; as the lineage score increases, the likelihood of ending in a lower than third rank position decreases. The coefficient estimate for the lineage score however turns positive when the outcome variable is the group of people obtaining positions in the third rank or higher. Similar to these, Panel (c) shows that the effect of being in the first-tier group in the final

[3]The third rank denoted as 3 in the x-axis in Figure C1 includes the positions from the third rank junior to the third rank senior lower level (i.e., those who are classified as mid-ranking officials among the third rank; see Table **??**).

exam was positive and mattered more when obtaining higher ranked positions than lower ranked ones. Finally, Panel (d) shows that younger exam-passers were indeed more likely to obtain higher-ranking (especially the second and the first rank) positions.

Figure C1: Effects on Highest Rank Attained: Generalized Ordered Logit



Notes: This figure shows the likelihood of attaining each rank as a highest-rank position in exam passers' career path. We use the Generalized Ordered Logit model (**?**). Each rank abbreviated on the horizontal axis is explained in Table **??** and text. We report the estimated coefficients and their 95-percent confidence intervals for the lineage score from exam passing ancestors in Panel (a), the lineage score from high-ranking ancestors in Panel (b), an indicator for the first-tier group in Panel (c), and the age upon passing the exam in Panel (d).

Next, we test whether the baseline estimation (Column 4 of Table ??) remains robust under alternative regression models, decay factors, varying weights for different family relations, and pre-exam status. In Table C2, we first present logit and probit regression results in Columns 1 and 2 as alternatives to our linear probability regression. The reported marginal effects are similar to those under the linear probability model. Second, we vary the decay factor in the lineage scores. This factor reflects the discount on each generational gap and is compounded for each gap removed from the predecessor. A small discount value (close to zero) means little weight assigned to predecessors outside of immediate predecessors, while a large value (close to one) means greater influence from individuals in the peripheries (e.g., ancestors from many generations ago) in the score calculation. We try various discount rates, replacing the value ($\delta = 0.5$) in the baseline estimation with $\delta = 0.1$ in Column 3 and $\delta = 1$ in Column 4, and check whether a particular rate causes any bias in the baseline estimation. We find that these alternative values yield substantively similar results.

Table C2 Estimation with Alternative Specifications

Dependent variable: Dummy = 1 if the candidate became a high-ranking official

	Alternative model		Alternative decay factor		Alternative weight for lineage types		Pre-exam status	
	Logit	Probit	$\delta = 0.1$	$\delta = 1$	1/2 for maternal grandfather	1/2 for father-in-law	Official holder	Others
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Panel A: Using lineage score based on ancestors' exam pass								
Lineage score	0.104***	0.106***	0.469***	0.048***	0.128***	0.152***	0.111***	0.108***
	(0.015)	(0.015)	(0.087)	(0.008)	(0.020)	(0.025)	(0.025)	(0.026)
First-tier dummy	0.111***	0.111***	0.112***	0.111***	0.111***	0.112***	0.178***	0.058**
	(0.019)	(0.019)	(0.019)	(0.019)	(0.019)	(0.019)	(0.031)	(0.029)
Second-tier dummy	0.033**	0.033**	0.034**	0.033**	0.033**	0.033**	0.068***	0.014
	(0.016)	(0.016)	(0.016)	(0.016)	(0.016)	(0.016)	(0.022)	(0.023)
Passing age	-0.009***	-0.009***	-0.008***	-0.008***	-0.008***	-0.008***	-0.006***	-0.009***
	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)
Panel B: Using lineage score based on ancestors' high-ranking position								
Lineage score	0.132***	0.134***	0.663***	0.058***	0.171***	0.208***	0.154***	0.129***
	(0.018)	(0.018)	(0.088)	(0.008)	(0.021)	(0.025)	(0.027)	(0.034)
First-tier dummy	0.112***	0.112***	0.112***	0.112***	0.112***	0.112***	0.178***	0.059**
	(0.019)	(0.019)	(0.019)	(0.019)	(0.019)	(0.019)	(0.031)	(0.029)
Second-tier dummy	0.033**	0.033**	0.035**	0.033**	0.034**	0.034**	0.068***	0.014
	(0.015)	(0.015)	(0.016)	(0.015)	(0.016)	(0.016)	(0.022)	(0.024)
Passing age	-0.009***	-0.009***	-0.008***	-0.008***	-0.008***	-0.008***	-0.006***	-0.010***
	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)
Observations	6,064	6,064	6,905	6,905	6,905	6,905	2,860	4,045

Notes: We conducted the baseline regressions using alternative specifications. In Columns 1 and 2, we estimate using the logit and probit model instead of the linear probability model. To make them comparable using the probability scale, we report the average marginal effects across values of each variable. Columns 3 and 4 show the results of different decay factors in the lineage score. In Columns 5 and 6, we use different edge weights according to the kind of ties. In Column 5, we change the edge weight of the maternal grandfather tie from 1 to 1/2 in measuring the lineage score. We additively replace the weight of the father-in-law tie from 1 to 1/2 in Column 6. Columns 7 and 8 show the sub-group analysis depending on the pre-exam status (official holder or not). Each cell reports the estimated coefficient and standard error clustered at family clans in parenthesis. A single asterisk denotes statistical significance at the 90% level of confidence, double 95%, and triple 99%.

In Columns 5 and 6, we check how weight changes on ties depending on the side of the family can affect our results. In our data, there are four types of immediate ties found in the exam roster: the father, the foster father (if any), the maternal grandfather, and the father-in-law. In Column 5 we first give lower weights to non-paternal ties by changing the relational weight of the maternal grandfather from 1 to 1/2 in constructing the lineage score. Second, we additively replace the weight of the father-in-law from 1 to 1/2 in Column 6. The results remain similar to those of the baseline estimation and are again statistically significant at the one-percent level.

Finally, in Columns 7 and 8 we present results based on two separate sub-samples. The first dataset comprises only exam passers already holding office at the time of taking the exam, and the second comprises all the other exam passers in our sample. As explained in Sections **??** and **??**, each successful candidate's status at the time of taking the exam was crucial for his initial appointment after passing the exam. For those who had an official appointment prior, the exam was a valuable opportunity to get a promotion, and influence from their ancestors may have mattered differently from other exam passers. The estimated coefficients in Columns 7 and 8 show that the final-round exam scores mattered more for exam passers with prior official appointments compared to those without. However, the effects from lineage score and passing age from these sub-samples still remain similar to those from our baseline results. This implies that for those without a prior office position, family background and passing age were relatively more important in magnitude than the final-round exam score per se. On the other hand, for those who already held positions in the court, the exam score played a more direct role in determining their promotion.

D Tables

D.1 Summary Statistics

Table D3 provides summary statistics for the variables used in the analyses. We also compare the statistics of those who reached high-ranking positions (denoted as 'High' in Column 5) and those who did not (denoted as 'Low' in Column 6).

D.2 Analysis Using Dummy Variables

In Table D4, we estimate the ancestral influence using the dummies of ancestors' passing the exams or reaching high-ranking positions. We control for the status of five ancestors: father, grandfather, great grandfather, father-in-law, and maternal grandfather. Columns 1 and 2 control for father's status only. Columns 3 and 4 add the status of grandfather and great grandfather. Columns 5 and 6 also add the status of father-in-law and maternal grandfather. Columns 7 and 8 add the exam passer's final grade tiers (first and second; third is a reference group) and age at the time of the final-round examination. Finally, in Columns 9 and 10, we additionally include lineage scores based on ancestors from 4 to 6 generations ago to check whether ancestors further than three generations still matter for descendants' high-ranking position attainments.

Table D3 Summary Statistics

	Total				High	Low	High − Low	
	Mean	SD	Min	Max	Mean		Difference	P-value
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Proportion of high-ranking officials	0.408	0.491	0.000	1.000	1.000	0.000	1.000	.
Exam pass dummies								
Father	0.398	0.490	0.000	1.000	0.498	0.330	0.168***	0.000
Grandfather	0.293	0.455	0.000	1.000	0.376	0.233	0.143***	0.000
Great-grandfather	0.252	0.434	0.000	1.000	0.322	0.205	0.117***	0.000
Father-in-law	0.233	0.423	0.000	1.000	0.311	0.180	0.132***	0.000
Maternal grandfather	0.249	0.433	0.000	1.000	0.320	0.200	0.120***	0.000
High-ranking position dummies								
Father	0.152	0.359	0.000	1.000	0.230	0.099	0.131***	0.000
Grandfather	0.117	0.321	0.000	1.000	0.164	0.083	0.081***	0.000
Great-grandfather	0.097	0.297	0.000	1.000	0.142	0.071	0.071***	0.000
Father-in-law	0.102	0.302	0.000	1.000	0.151	0.070	0.081***	0.000
Maternal grandfather	0.101	0.301	0.000	1.000	0.139	0.075	0.064***	0.000
Lineage score								
Exam pass (δ=0.5)	0.667	0.877	0.000	6.375	0.919	0.494	0.425***	0.000
Exam pass (δ=1)	3.891	6.316	0.000	67.000	5.572	2.734	2.839***	0.000
High-ranking position (δ=0.5)	0.396	0.649	0.000	5.594	0.586	0.266	0.320***	0.000
High-ranking position (δ=1)	2.307	4.290	0.000	48.000	3.435	1.532	1.903***	0.000
Exam performance								
First-tier dummy	0.102	0.302	0.000	1.000	0.135	0.079	0.056***	0.000
Second-tier dummy	0.205	0.404	0.000	1.000	0.226	0.190	0.035***	0.000
Third-tier dummy	0.693	0.461	0.000	1.000	0.639	0.731	-0.091***	0.000
Passing age	34.737	9.146	12.000	76.000	32.843	36.039	-3.196***	0.000
Pre-exam status								
Confucian student	0.205	0.404	0.000	1.000	0.122	0.262	-0.140***	0.000
Classics Licentiate	0.189	0.391	0.000	1.000	0.170	0.202	-0.032***	0.001
Literary Licentiate	0.192	0.394	0.000	1.000	0.204	0.185	0.019**	0.048
Previous official holder	0.414	0.493	0.000	1.000	0.505	0.352	0.153***	0.000
Irregular exam	0.436	0.496	0.000	1.000	0.539	0.365	0.173***	0.000
Lived in Seoul before exam	0.448	0.497	0.000	1.000	0.591	0.349	0.241***	0.000
Average number of exiles								
5 years since passing exam	2.064	1.983	0.000	11.400	1.898	2.154	-0.256***	0.000
10 years before passing exam	2.020	1.516	0.000	8.100	1.931	2.069	-0.138***	0.000
Observations	6,905	6,905	6,905	6905	2,814	4,091	6,905	

Notes: This table reports descriptive statistics on variables related to empirical analysis. We use the sample used for the baseline estimation (i.e., Panel D of Column 2 in Table B1). In the table, the headings of 'high' and 'low' denote those who reached the high-ranking positions (i.e., *dang-sang-gwan*) and the low-ranking positions, respectively. We conduct t-test to see whether the statistics of those who reached high-ranking positions are different with those who did not, and provide its p-values.

Table D4 Effects of Family Background on High-ranking Official Positions

Dependent variable: Dummy = 1 if the candidate became a high-ranking official

Key control variables	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
Exam pass dummies										
Father	0.170***		0.129***		0.109***		0.091***		0.081***	
	(0.012)		(0.013)		(0.013)		(0.013)		(0.013)	
Grandfather			0.099***		0.075***		0.071***		0.055***	
			(0.014)		(0.015)		(0.014)		(0.015)	
Great grandfather			0.087***		0.069***		0.070***		0.038**	
			(0.015)		(0.015)		(0.015)		(0.015)	
Father-in-law					0.114***		0.103***		0.080***	
					(0.015)		(0.015)		(0.015)	
Maternal grandfather					0.090***		0.083***		0.056***	
					(0.014)		(0.014)		(0.015)	
High-ranking positions dummies										
Father		0.246***		0.211***		0.183***		0.162***		0.148***
		(0.016)		(0.017)		(0.017)		(0.017)		(0.017)
Grandfather				0.112***		0.085***		0.082***		0.091***
				(0.019)		(0.020)		(0.019)		(0.021)
Great grandfather				0.137***		0.126***		0.130***		0.066***
				(0.020)		(0.020)		(0.020)		(0.020)
Father-in-law						0.133***		0.120***		0.087***
						(0.020)		(0.020)		(0.021)
Maternal grandfather						0.091***		0.083***		0.046**
						(0.020)		(0.020)		(0.021)
Competency measures										
First-tier dummy							0.134***	0.144***	0.136***	0.144***
							(0.019)	(0.019)	(0.019)	(0.019)
Second-tier dummy							0.058***	0.065***	0.056***	0.063***
							(0.014)	(0.014)	(0.014)	(0.014)
Passing age							-0.070***	-0.073***	-0.071***	-0.074***
							(0.006)	(0.006)	(0.006)	(0.006)
Lineage score based on ancestors from 4 to 6 generations ago										
Exam pass									0.319***	
									(0.047)	
High-ranking positions										0.435***
										(0.066)
Observations	6,905	6,905	6,905	6,905	6,905	6,905	6,905	6,905	6,905	6,905

Notes: Columns 1-6 control for the status of five ancestors only. Columns 7 and 8 add the exam passer's final grade tiers (first and second; third is a reference group) and age at the time of the final-round examination. In Columns 9 and 10 we additionally include lineage scores based on ancestors from 4 to 6 generations ago. A single asterisk denotes statistical significance at the 90% level of confidence, double 95%, and triple 99%.

E Lineage Score

Our key assumption in deriving the lineage score is that the selectorate considers candidates with illustrious lineages, i.e. high expected family endowments, favorably. We further assume that the selectorate cannot directly observe the candidate's true endowment, and that it instead relies on the family background records on exam-passing ancestors with high-ranking positions as useful indicators.

Specifically, all things equal, the selectorate likely chooses a candidate based on family endowment, which follows an AR(1) process:[4]

$$e_{it} = \lambda e_{i,t-1} + w_{it} \tag{E1}$$

where e_{it} denotes the family endowment the candidate receives and λ is a constant that measures the degree of inheritability of endowment.

Since the selectorate cannot directly observe e_{it}, we assume that it observes the outcome of the past generation $y_{i,t-1}$ with noise, i.e.,

$$y_{i,t-1} = e_{i,t-1} + v_{i,t-1} \tag{E2}$$

where w_{it} and $v_{i,t-1}$ are mutually independent and follow the i.i.d. Gaussian random process with means of zero and variances $\mathbb{E}[w_{it}^2] = Q$, $\mathbb{E}[v_{i,t-1}^2] = R$, and $\mathbb{E}[v_{is}w_{it}] = 0$ for all t and s. The initial condition is that e_{i0} is Gaussian with mean zero and variance Σ_0. While the candidate's outcome y_{it} can be interpreted in several ways (e.g., income, education, etc), in our context, y_{it} is an indicator for whether i eventually obtains a high-ranking official position.

Again, the selectorate is assumed to observe $y_{i,t-1}, ..., y_{i0}$ but not $e_{it}, ..., e_{i0}$ at time t. Un-

[4]The AR(1) process assumption on family endowment follows the set up in seminal intergenerational models on social mobility (**???**).

der Equations (E1) and (E2), one can obtain the endowment estimate based on $y_{i,t-1}, ..., y_{i0}$. In other words, the candidate's family endowment is estimated by the selectorate as follows:

$$\mathbb{E}\left[e_{it}|y_i^{t-1}\right] = K\sum_{j=1}^{t}(\lambda - K)^j y_{i,t-j} \tag{E3}$$

where $y_i^{t-1} = [y_{i,t-1}, ..., y_{i0}]$; $K = \frac{\lambda\Sigma}{\Sigma+R} \in (0,1)$; $\Sigma_t \to \Sigma$ and $K_t \to K$ are fixed points of the Kalman filtering equations $K_t = \frac{\lambda\Sigma_t}{\Sigma_t+R}$ and $\Sigma_{t+1} = \lambda^2\Sigma_t + Q - \frac{\lambda^2\Sigma_t^2}{\Sigma_t+R}$. A mathematical derivation of the Kalman filter equations is provided in Appendix F. Equation (E3) suggests that even distant ancestors' outcome matter when the selectorate evaluates the candidate's qualification based on family endowment.

Next, we explain how to compute the lineage score. Let A be the $n \times n$ adjacency matrix with element $a_{ij} \in (0,1]$ if i give an one-step relation to j, varying the value depending on the type of relations, and zero otherwise.[5] We need to note that powers of A represent the relations going from i through intermediaries to j. Thus, $A^2 = {a_{ij}}^{(2)}$, where ${a_{ij}}^{(2)} = \sum_k a_{ik}a_{kj} \in (0,1]$ if and only if i gives an one-step relation to k and k also gives an one-step relation to j, i.e., there is a chain of length two from i to j. Higher powers have similar interpretations. In other words, the adjacency matrix A and powers of A (A^2, $A^3, ...$) represent all the direct and indirect relations in the networks. Then the Katz centrality measure (K) can be obtained as follows **?**:[6]

$$K = \left[\delta A' + \delta^2\left(A'\right)^2 + \delta^3\left(A'\right)^3 + \cdots + \delta^k\left(A'\right)^k + \cdots\right]\mathbf{1} = \left[\left(I - \delta A'\right)^{-1} - I\right]\mathbf{1}$$

[5] Our whole network dataset makes an adjacency matrix A with size of $47,768 \times 47,768$ since the number of individuals (nodes) constructing the network is 47,768 with 14,720 exam passers and their 33,048 family members who were not exam passers. In our context, we have four types of relations: father, foster father (if any), maternal grandfather, and father-in-law. In the baseline analysis, we set the relational weights as

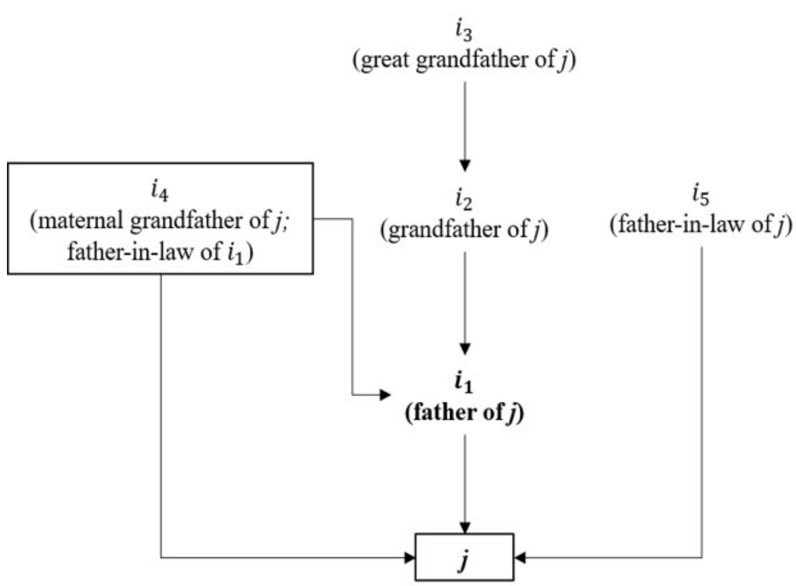
$$a_{ij} = \begin{cases} 1, & \text{if } i \text{ is father, maternal grandfather, or father in law of } j \\ 0, & \text{if } i \text{ is foster father of } j \text{ or they } (i,j) \text{ have no relation} \end{cases}$$

[6] Katz (1953) interprets δ as the force of a probability of effectiveness of a single link: "A k-step chain has probability δ^k of being effective." (**?**, p.41).

where δ is the decay factor (or time discount factor) giving lower effectiveness for more distant ancestors, $\mathbf{1}$ is a column vector with unit elements, and I is the $n \times n$ identity matrix. Intuitively, the Katz centrality measures all the existing direct and indirect links made by the adjacency matrix A.

However, we need to make an adjustment for powers of matrix A to avoid a double counting issue. For example, let's consider a hypothetical case suggested in Figure E1. As explained in Section **??**, an exam passer j filled out an application form for enrolling in the exam with names of his father (i_1), paternal grandfather (i_2) and great-grandfather (i_3), as well as his maternal grandfather (i_4) and father-in-law (i_5). In this example, for simplicity, let's assume that relational weights are all equal to one and that in addition to j, only i_1 has passed the exam. Then, even though j has an one-step relation from i_4 (i.e., $a_{i_4 j} = 1$), he has a two-step relation from i_4 through i_1 since i_1 is also an exam passer and thus possesses family relation with i_4, namely father-in-law, in the exam roster (i.e., $a_{i_4 i_1} = 1$). Therefore, we have both $a_{i_4 j} = 1$ and ${a_{i_4 j}}^{(2)} = 1$, which causes a problem that the relation from i_4 to j is counted twice.

Figure E1: A Hypothetical Family Tree



Notes: In this figure we provide a hypothetical example of family tree. Here the names in bold represent the men who passed the exam (*mun-gwa*).

To address this issue, we define a collection of matrices $\{B_k\}_{k=2}^{\infty}$ with element ${b_{ij}}^{(k)} \in (0,1]$ if i is a k-step ancestor of j and ${a_{ij}}^{(s)} = 0$ for any $s < k$, and zero otherwise. That is, if i is an ancestor of j in a shorter distance (i.e., ${a_{ij}}^{(s)} \in (0,1]$ for any $s < k$), we replace the value of ${b_{ij}}^{(k)}$ to zero, even though they have a relationship in a k-step distance. This means that in the example of Figure E1, we ignore the tie from i_4 to j through i_1 (a two-step relation) by setting ${b_{i_4 j}}^{(2)} = 0$.

Now we make another manipulation for the network since we are not interested in all the links, but "Who really gives and receives political influences?" Therefore, to look at the effects from only exam passing ancestors (or high-ranking position ancestors), we need to make another matrix of relationship between exam passing ancestors (or high-ranking officeholding ancestors) and descendants. Let us denote this as the matrix Y_k^e, which is constructed as

$$Y_k^e = D^e B_k$$

where D^e is a diagonal matrix with diagonal element $d_{ii}^e = 1$ if individual i is an exam passer and zero otherwise. The column sums of Y_k^e give the number of k-step links from exam passing ancestors to descendants. Then we can get our family background index, e.g., lineage score vector made by exam passing ancestors (L^e), as follows:[7]

$$\begin{aligned} L^e &= \delta Y_1^{e\prime}\mathbf{1} + \delta^2 Y_2^{e\prime}\mathbf{1} + \delta^3 Y_3^{e\prime}\mathbf{1} + \cdots + \delta^k Y_k^{e\prime}\mathbf{1} + \cdots \\ &= \left(\delta B_1' + \delta^2 B_2' + \delta^3 B_3' + \cdots + \delta^k B_k' + \cdots\right)(D^e)'\mathbf{1} \end{aligned}$$

Therefore, we note that our lineage score is a variant of the Katz centrality. As a special case, if we set the discount factor as $\delta = 1$ (i.e., in the case that there is no discount for distant ancestors), our lineage score simply becomes the total number of exam passing ancestors.

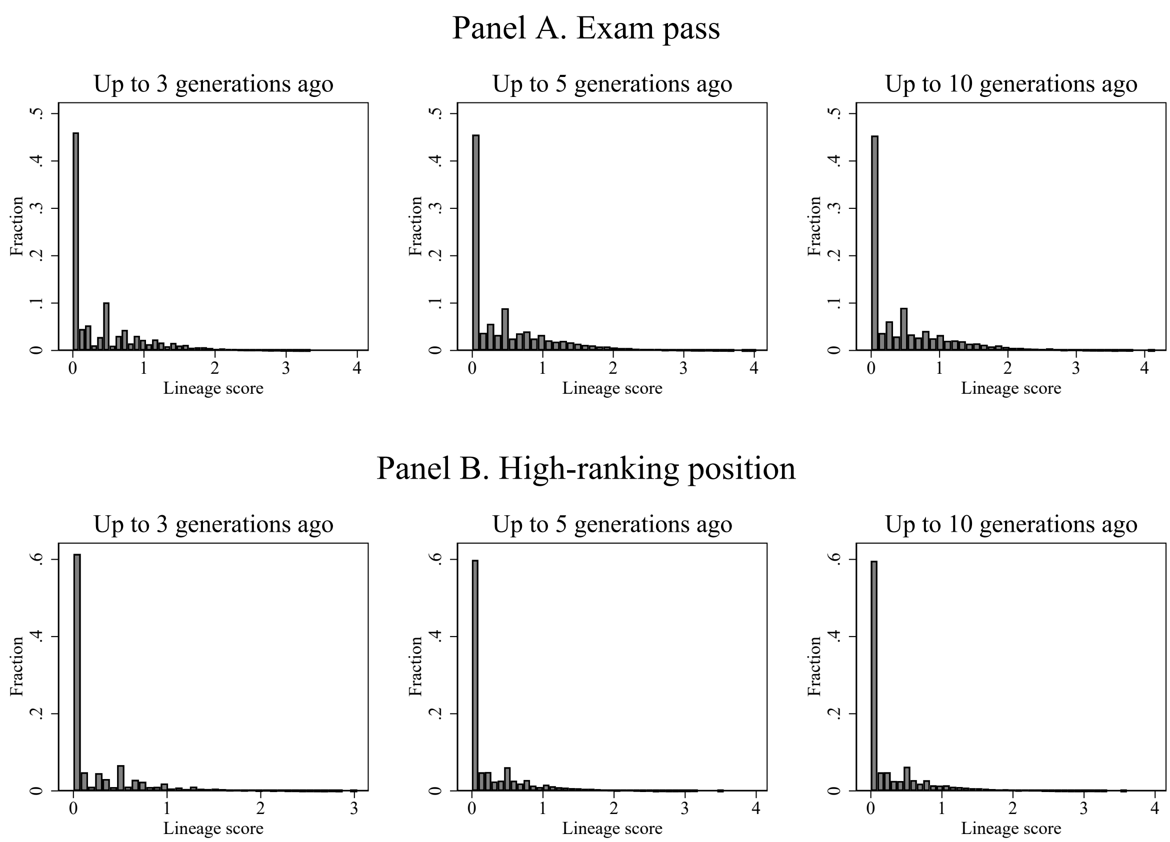
[7] Similarly, we calculate the lineage score vector made by high-ranking position ancestors (L^h) as

$$L^h = \left(\delta B_1' + \delta^2 B_2' + \delta^3 B_3' + \cdots + \delta^k B_k' + \cdots\right)(D^h)'\mathbf{1}$$

where D^h is a diagonal matrix with diagonal element $d_{ii}^h = 1$ if individual i is a high-ranking officeholder and zero otherwise.

Figure E2 shows the distribution of calculated linear scores. We use the family network of five generations above for the baseline estimation. In the figure, we compare the distribution of linear scores when we change the generation limit from five to three and ten generations above. The distribution looks very similar across generation limit. On the other hand, the distribution is right-skewed. So we control for log-transformed lineage scores in the regression analyses.

Figure E2: Distribution of Lineage Scores depending on Generation Limits



Notes: This figure shows the sample distributions of lineage scores. In Panel A, we calculate lineage score based on ancestors' exam pass. On the other hand, in Panel B, we do the same work based on ancestors' high-ranking position holding. In each panel, we set the generation limit differently: 3, 5, or 10. .

F Selectorates' Estimation Problem

In this section, we derive the Equation (E3); the derivation procedure follows the discussion in **?**. Consider the following system:[8]

$$e_{t+1} = \lambda e_t + w_{t+1} \tag{F1}$$

$$y_t = e_t + v_t \tag{F2}$$

where e_t is the family endowment and λ denotes the degree of inheritability of endowment; y_t is the outcome of generation t which is observable as a signal on the endowment amount; w_{t+1} is an iid sequence of normal random variables with mean zero and variance Q; and v_t is another iid sequence of normal random variables with mean zero and variance R. We assume that w_{t+1} and v_s are orthogonal (i.e., $\mathbb{E}w_{t+1}v_s = 0$) for all t and s. We assume that

$$e_0 \sim \mathcal{N}(0, \Sigma_0) \tag{F3}$$

This specification implies that

$$y_0 \sim \mathcal{N}(0, \Sigma_0 + R)$$

The selectorate is assumed to observe $y_t, ..., y_0$ but not $e_t, ..., e_0$ at time t. It knows the structure (F1)-(F2), and estimates endowment e_{t+1} given $y_t, ..., y_0$.

The new information at t relative to what can be inferred from the past can be expressed as $y_t - \hat{e}_t$, where $\hat{e}_t = \mathbb{E}[e_t | y_{t-1}, ..., y_0]$. The selectorate estimates the endowment based on $y_t - \hat{e}_t$:

$$e_0 - \hat{e}_0 = L_0(y_0 - \hat{e}_0) + \eta \tag{F4}$$

[8] We abstract subscript i for each family unless there is risk of confusion.

where η is the least squares residual. The least squares orthogonality condition is

$$\mathbb{E}(e_0 - \hat{e}_0)(y_0 - \hat{e}_0) = L_0 \mathbb{E}(y_0 - \hat{e}_0)^2$$

Solving for L_0 yields the formula

$$L_0 = \frac{\Sigma_0}{\Sigma_0 + R}$$

Equation (F1) implies that

$$e_1 = \lambda \hat{e}_0 + \lambda(e_0 - \hat{e}_0) + w_1 \tag{F5}$$

Applying (F4) gives

$$\begin{aligned} \hat{e}_1 &= \lambda \hat{e}_0 + \lambda L_0 (y_0 - \hat{e}_0) \\ &= \lambda \hat{e}_0 + K_0 (y_0 - \hat{e}_0) \end{aligned} \tag{F6}$$

where $K_0 = \lambda \Sigma_0 / (\Sigma_0 + R)$. Subtracting (F6) from (F5) to get

$$e_1 - \hat{e}_1 = \lambda(e_0 - \hat{e}_0) + w_1 - K_0(y_0 - \hat{e}_0) \tag{F7}$$

Using (F7), we can compute the following recursion:

$$\begin{aligned} \Sigma_1 &= \mathbb{E}(e_1 - \hat{e}_1)^2 \\ &= (\lambda - K_0)^2 \Sigma_0 + (Q + K_0^2 R) \end{aligned}$$

Thus, we have $e_1 | y_0 \sim \mathcal{N}(\hat{e}_1, \Sigma_1)$.

Iterating the above process gives the following set of results:

$$a_t = y_t - \hat{e}_t \tag{F8}$$

$$K_t = \frac{\lambda \Sigma_t}{\Sigma_t + R} \tag{F9}$$

$$\hat{e}_{t+1} = \lambda \hat{e}_t + K_t a_t \tag{F10}$$

$$\Sigma_{t+1} = Q + K_t^2 R + (\lambda - K_t)^2 \Sigma_t \tag{F11}$$

The system of (F8)–(F11) is the celebrated Kalman filter.

In a steady state, in which Σ_t goes to the fixed point Σ, K_t also approaches K and the expected endowment given the information becomes

$$\hat{e}_{t+1} = \mathbb{E}[e_{t+1}|y_t, ..., y_0] = (\lambda - K)\hat{e}_t + K y_t \tag{F12}$$

where $K = \lambda\Sigma/(\Sigma + R) \in (0, 1)$. Iterating backward on (F12) gives

$$\hat{e}_{t+1} = K \Sigma_{j=0}^{t} (\lambda - K)^j y_{t-j} + (\lambda - K)^{t+1} \hat{e}_0$$

Since we assume that $\hat{e}_0 = 0$ in (F3), we have

$$\mathbb{E}[e_{t+1}|y_t, ..., y_0] = K \Sigma_{j=0}^{t} (\lambda - K)^j y_{t-j}$$

which is the equation proposed in (E3).